USEC-01

APPLICATION FOR UNITED STATES NUCLEAR REGULATORY COMMISSION CERTIFICATION

Paducah Gaseous Diffusion Plant

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INTRODUCTION

The United States Enrichment Corporation (USEC or Corporation) hereby submits its initial Application to the Nuclear Regulatory Commission (NRC) for a certificate of compliance for the Paducah Gaseous Diffusion Plant (PGDP) in accordance with section 1701© of the Atomic Energy Act of 1954 (AEA), as amended by the Energy Policy Act of 1992, and 10 CFR Part 76.

USEC entered into a Lease Agreement with DOE over portions of PGDP and assumed responsibility for operations. Pursuant to 10 CFR 76.31, USEC is required to submit an initial application for a certificate of compliance to the NRC governing its operations at PGDP. In accordance with 10 CFR 76.35, this Application includes:

- technical safety requirements (10 CFR 76.35(e));
- a safety analysis report (10 CFR 76.35(a));
- a quality assurance program (10 CFR 76.35(d));
- an emergency plan (10 CFR 76.35(f));
- an environmental compliance status report (10 CFR 76.35(g));
- a fundamental nuclear material control plan (10 CFR 76.35(h));
- a transportation protection plan (10 CFR 76.35(I));
- a physical protection plan (10 CFR 76.35(j));
- a security plan for classified matter (10 CFR 76.35 (k));
- a radioactive waste management program description (10 CFR 76.35(m));
- a depleted uranium management program description (10 CFR 76.35(m));
- a description of USEC's funding program for waste and depleted uranium disposition (10 CFR 76.35(n)); and
- information from which the Commission can prepare an environmental assessment related to DOE's “Plan for Achieving Compliance” (10 CFR 76.35(c)).

The following information is provided in accordance with 10 CFR 76.33(a)(2):

Applicant Name, Address and Other Corporate Information

United States Enrichment Corporation
Two Democracy Center
6903 Rockledge Drive
Bethesda, Maryland 20817

USEC is a wholly owned subsidiary of USEC, Inc., and maintains its headquarters at the above address. USEC is neither owned, controlled nor dominated, by any alien, foreign corporation or foreign government. All shares of USEC are held by USEC, Inc., which is in turn owned by private investors. USEC is responsible for the operation, maintenance, modification, design, fabrication, and testing of the GDPs.

The mailing address for PGDP is:

United States Enrichment Corporation
Paducah Gaseous Diffusion Plant
P.O. Box 1410
Paducah, Kentucky 42002-1410

Information on Corporate Directors and Officers

The directors and principal officers (those officers identified in Safety Analysis Report Section 6.1) of the Corporation are all citizens of the United States. The business address for all such persons is Two Democracy Center, 6903 Rockledge Drive, Bethesda, Maryland 20817.

Principal Officers

Mr. John K. Welch
President and Chief Executive Officer

Mr. Robert Van Namen
Senior Vice President, Uranium Enrichment

Mr. W. Lance Wright
Senior Vice President, Human Resources and Administration

Vacant
Vice President, Operations

Format and Content of the USEC Certification Application

The Application contains a Safety Analysis Report (SAR), Technical Safety Requirements (TSRs), and programs, plans and other documents as described above. In accordance with 10 CFR 76.35(b), the Application also includes a plan prepared and approved by DOE for achieving compliance with respect to any areas of noncompliance with the NRC's regulations identified by USEC as of the date of this Application. The Compliance Plan provides an expanded description of the areas of noncompliance, a justification for continued operation, a description of the plan of action to achieve compliance, and the schedule for completion of those actions, as applicable.

The Application is written in the present tense. The physical description of installed structures, systems and components (SSCs) in the Application is current as of June 1, 1995; except as described in Section 3.16, “Items Addressed by Compliance Plan.” The programs, plans, procedures and other aspects of the facility's operations other than the SSCs are described as they will be when all Compliance Plan items are completed. Each section of the Application contains a subsection entitled “Items Addressed by Compliance Plan.” This subsection describes those aspects of the program, plan or section topic that are not in full compliance with the Application. This subsection also contains a brief description of what is currently in place. Any section which does not have any related Compliance Plan states “None identified.”

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1.0 DEFINITIONS

Assay C [illegible] ^{235}[illegible] % (i.e., 2.75% [illegible])

Completion Time - [illegible]

[illegible] 25% [illegible] 3.0 [illegible] 25% [illegible].

Independent Assessment C [illegible].

Nuclear materials (NMs) C [illegible] ^{233}[illegible].

Safeguards C [illegible].

Tails C [illegible] $_6$ [illegible].

Inspect C [illegible].

UF$_6$ Cylinder (or cylinder) C [illegible] $_6$ [illegible] (2 1/2- [illegible]) [illegible] $_6$ [illegible].

2.0 LIST OF ACRONYMS

[illegible].

ACL - [illegible]
ADP - [illegible]
ALARA - [illegible]
ASME - [illegible]
ANSI - [illegible]
AQ - [illegible]
ARA - [illegible]
CCF - [illegible]
CAAS - [illegible]

CCZ - [illegible]
CFR - [illegible]
CM - [illegible]
CM - [illegible]
CUP - [illegible]
DOE - [illegible]
EAL - [illegible]
ECSR - [illegible]
EOC - [illegible]
EPA - [illegible]
EPIP - [illegible]
ERO - [illegible]
FNMCP - [illegible]
GERT - [illegible]
GET - [illegible]
HP - [illegible]
HRA - [illegible]
HS&E - [illegible]
JCO - [illegible]
LAW - [illegible]
LEU - [illegible]
MBA - [illegible]
NBS - [illegible]
NCS - [illegible]
NDA - [illegible]
NIST - [illegible]
NM - [illegible]
NMC&A - [illegible]
NMSS - [illegible]
NRC - [illegible]
NS&Q - [illegible]
OSHA - [illegible]
PGDP - [illegible]
PM - [illegible]
PORC - [illegible]
PORTS - [illegible]
PRB - [illegible]
PSS - [illegible]
PW - [illegible]
QAP - [illegible]
RA - [illegible]
RMA - [illegible]
RP - [illegible]
RWMP - [illegible]
RWP - [illegible]
S&S - [illegible]
SAE - [illegible]

SAR - [illegible]
SM - [illegible]
SNM - [illegible]
SOP - [illegible]
SPP - [illegible]

SSC - [illegible]
SWU - [illegible]
TSR - [illegible]
UE - [illegible]
UF_6 - [illegible]
USEC - [illegible]

3.0 FREQUENCIES

[illegible] ([illegible])	[illegible]	[illegible]
[illegible]	5 [illegible]	5 [illegible] ([illegible])
[illegible]	2 [illegible]	2 [illegible] 6 [illegible]
[illegible]	365 [illegible]	456 [illegible]
[illegible]	184 [illegible]	245 [illegible]
[illegible]	92 [illegible]	123 [illegible]
[illegible]	31 [illegible]	39 [illegible]
[illegible] [illegible] [illegible]	24 [illegible] 12 [illegible] 6 [illegible]	30 [illegible] 15 [illegible] 8 [illegible]

NOTE: [illegible] 25% [illegible] 33% [illegible].

1. INTRODUCTION AND GENERAL DESCRIPTION OF THE FACILITY

1.1 INTRODUCTION

The Code of Federal Regulations, Title 10, Part 76.35(a) requires that USEC submit, as part of its application for a certificate of compliance, a Safety Analysis Report (SAR) containing the information specified within that section. This SAR contains the information required by Section 76.35(a).

1.2 SITE LOCATION AND DESCRIPTION

The Paducah Gaseous Diffusion Plant (PGDP) is located at 37°6′49″ N. latitude and 88°47′39″ W. longitude measured at the center of the plant, on a 3423-acre tract in McCracken County, Kentucky. The site is generally in a rural area and was previously part of the Kentucky Ordnance Works. Approximately 2079 acres of the site are leased to the Kentucky Department of Fish and Wildlife Resources. The largest cities within a 50-mile radius are Paducah, Kentucky, located approximately 12 air miles to the east and Cape Girardeau, Missouri, located approximately 40 air miles to the west. Portions of 28 counties are located within a 50-mile radius of the plant, 11 of which are in Kentucky, 4 in Missouri, 10 in Illinois, and 3 in Tennessee.

PGDP occupies approximately 650 acres within the Controlled Access Area. Highway U.S. 60 is the closest major highway and intersects the plant access road 3 miles south of the plant. Interstate Highway 24 is to the east of the plant and intersects U.S. 60 near the present city limits of Paducah.

The north, east, and west boundaries of the plant are defined by the Kentucky Wildlife Management Game Reserve. Adjoining the reserve on the north is the Tennessee Valley Authority's Shawnee Steam Plant which is located on the Ohio River.

1.3 FACILITIES LEASED BY USEC

Exhibit A to the Lease [Lease Agreement between the United States Department of Energy (DOE) and the United States Enrichment Corporation, dated as of July 1, 1993 (as amended), hereafter referred to as The Lease] identifies the facilities leased by USEC for PGDP (See also Chapter 2).

1.4 PURPOSE OF OPERATION AND OPERATING PARAMETERS

PGDP enriches uranium using the gaseous diffusion process. A description of this process is found in Chapter 3.

PGDP is designed to operate at a capacity of 11.3 million separative work units (SWU) annually at its rated power level of 3040 MW. PGDP may produce uranium enriched up to 5.5 percent ^{235}U by weight.

1.5 POSSESSION LIMITS

The possession limits for NRC regulated source material, byproduct material, and SNM are shown in Table 1-3.

1.6 AUTHORIZED USES

The authorized uses for each class of NRC regulated material are shown in Table 1-4 (See 10 CFR 76.35(a)(2)). The authorized operations are described in Chapter 3.

1.7 ITEMS ADDRESSED BY COMPLIANCE PLAN

Section deleted

1.8 EXEMPTIONS

The following exemptions to NRC regulations have been identified in this Application:

Section	Exemption
5.3.1.7	Caution signs for Radioactive Material Areas (RMAs), Airborne Radioactivity Areas (ARAs), Radiation Areas (RAs), and High Radiation Areas (HRAs) are maintained as required by 10 CFR 20.1901, 20.1902, 20.1903, 20.1904, and 20.1905 with the following exceptions: 1. Containers located in Radiological Areas within the USEC leased area are exempt from container labeling requirements of 10 CFR 20.1904, as it is deemed impractical to label each and every container. In such areas, one sign stating that every container may contain radioactive material will be posted. By procedure, when containers are to be removed from contaminated or potentially contaminated areas, a survey is performed to ensure that contamination is not spread around plant site.

2. Feed, product, and depleted uranium cylinders, which are routinely transported inside the site boundary between facility locations and/or storage areas at the facility, are readily identifiable due to their size and unique construction, and are not routinely labeled as radioactive material. UF_6 cylinders are constantly attended by qualified Radiological Workers during movement.

Section	Exemption
6.9, Table 6.9-1	10 CFR 76.120(d)(2) requires that written reports of certain events be submitted to the NRC within 30 days. USEC has been exempted from this requirement provided such reports are submitted within 60 days. (Reference: Pierson, Robert C. [NRC] letter to Brown, J. Morris [USEC], "Paducah Gaseous Diffusion Plant - Exemption from Requirement for Submitting Written Event Reports in 30 Days," November 15, 2002.)

The following Special Authorizations have been identified in this Application:

1. Surface Contamination Release Levels for Unrestricted Use:

   Items may be released for unrestricted use if the surface contamination is less than the levels listed in SAR Table 5.3-6.

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Table 1-1 deleted

Table 1-2 deleted.

Table 1 - 3. Possession limits for NRC regulated materials and substances.

Type of Material	Atomic Number	Physical Form	Chemical Form	Possession Limit	Description
A. Source Material[c]	92	Solid, liquid, and gas	UF_6, UF_4, UO_2F_2, oxides and metal	655,000 MTU[a]	Uranium (including natural, depleted and recycled), daughter products, process contaminants, and wastes
					Laboratory chemicals
					Samples for analysis [d, e]
					Instrument calibration material
					Instrument check sources
B. Source Material	90	Solid and liquid	Soluble and insoluble chemicals and metals	10 Ci	Laboratory chemicals, instrument calibration sources, plated metallic sources, instrument check sources, and samples for analysis [d, e]
C. Special Nuclear Material[b, c]	92 (except ^{233}U)	Solid, liquid, and gas	UF_6, UF_4, UO_2F_2, oxides and metal	10,000 MTU	Uranium enriched in isotope 235 up to 5.5 percent by weight, uranium daughter products, process contaminants, and wastes, to include: (1) laboratory chemicals, (2) instrument calibration material, (3) instrument check sources, (4) samples for analysis [d,e], (5) material contained in equipment received from other facilities, and/or (6) material held up in equipment as a consequence of previous operations.
	92 (except isotope 233)	Solid, liquid, and gas	UF_6, UF_4, UO_2F_2, oxides and metal	100 kg ^{235}U	Uranium enriched in isotope 235 to greater than 5.5 percent by weight, but less than 10 percent by weight as: 1) Laboratory calibration standards, 2) Samples for analysis [d, e] 3) Laboratory chemicals, 4) Process contaminates or wastes, 5) Material contained in equipment received from other facilities, or 6) Material held up in equipment as a consequence of previous operations.

Table 1 - 3. Possession limits for NRC regulated materials and substances.

Type of Material	Atomic Number	Physical Form	Chemical Form	Possession Limit	Description
	92 (except isotope 233)	Solid and liquid	UF_6, UF_4, UO_2F_2, oxides and metal	<10,000 grams ^{235}U	Uranium enriched in isotope 235 to greater or equal to 10 percent but less than 20 percent by weight as: 1) Laboratory calibration standards, 2) Samples for analysis [d, e] 3) Laboratory chemicals, 4) Process contaminates or wastes, 5) Material contained in equipment received from other facilities, or 6) Material held up in equipment as a consequence of previous operations
	92	Solid and liquid	UF_6, UF_4, UO_2F_2, oxides and metal	grams ^{235}U + 2(grams ^{233}U + grams Pu) < 1000 grams	Uranium enriched in isotope 235 equal or greater than 20 percent by weight as: 1) Laboratory calibration standards, 2) Samples for analysis [d, e] 3) Laboratory chemicals, 4) Process contaminates or wastes, 5) Material contained in equipment received from other facilities, or 6) Material held up in equipment as a consequence of previous operations
	92	Any	Any	10 grams ^{233}U	Laboratory and instrument calibration sources.
	94	Any	Any	2 grams	Laboratory chemicals, laboratory calibration sources, instrument calibration sources, instrument check sources Samples for analysis [d,e], process contaminants and wastes, material held in equipment from previous operations.
D. Byproduct Material	1,3-84, 88	Solid, liquid, and gas	Oxides, metals, and solutions	2 Ci with no single source to exceed 100 mCi	Nondestructive assay of process materials Instrument calibration sources Analysis of DOE collected samples [d, e] Instrument check sources

Table 1 - 3. Possession limits for NRC regulated materials and substances.

Type of Material	Atomic Number	Physical Form	Chemical Form	Possession Limit	Description
	$^{99}_{43}Tc$	Any	Any	100 µCi in addition to that quantity remaining as a consequence of the historical feed of recycled uranium	Process contaminants and wastes, material held in equipment from previous operations Samples for analysis [d, e] Instrument calibration material Instrument check sources
	93, 95-100	Any	Any	100 µCi in addition to that quantity remaining as a consequence of the historical feed of recycled uranium	Process contaminants and wastes, material held in facilities and equipment from previous operations Samples for analysis [d, e] Instrument calibration material Instrument check sources
E. Neutron Sources	241 Am-Be[d]	Solid	Metal Oxides	500 mCi	Instrument calibration source Soil density and moisture meter
	^{252}Cf	Solid	Metal Oxides	100 mCi	UF_6 assay and flow instrumentation

a. Metric tons uranium
b. See 10 CFR 76 definitions, Plutonium, Uranium 233, Uranium enriched in isotope 233 or in the isotope 235 and any other material that the Commission, pursuant to the provisions of Section 51 of the Act, determines to be nuclear material, but does not include source material or any material artificially enriched in the foregoing but does not include source material.
c. Uranium to be fed to the cascade will meet the requirements of ASTM Standard C996, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5% ^{235}U," or ASTM Standard C787, "Standard Specification for Uranium Hexafluoride for Enrichment," for reprocessed UF_6. All other uranium that does not meet the requirements of ASTM C996 or C787 for reprocessed UF_6 may be accepted by USEC for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds of UF_6) associated with sampling, subsampling, and analyses required to establish receiver's values.
d. Includes analysis of DOE collected samples of groundwater, surface water, soils, biota, scrap, etc. in support of the site remediation effort. All samples are directly related to previous uranium enrichment operations and are needed to support the eventual decontamination and decommissioning of the site.
e. Excludes environmental low-level blind control samples from offsite companies for performance evaluation of laboratory operations.

Table 1-4. Authorized uses of NRC-regulated materials.

Material Type	Authorized Use
A. Source Material, Element 92[b]	1. Heating cylinders and feeding contents into the diffusion process.
	2. Enrichment of uranium up to 5.5 percent enrichment by weight ^{235}U.
	3. Receipt, storage, inspection, and acceptance sampling of cylinders containing natural or recycled uranium, and uranium depleted in ^{235}U generated from domestic gaseous diffusion plant operations.
	4. Filling, assay, storage, and shipment of cylinders with natural uranium and uranium depleted in ^{235}U.
	5. Cleaning and inspection of cylinders used for the storage and transport of process feed, product, and tails containing source or special nuclear material
	6. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products
	7. Process, characterize, package, ship, or store low-level radioactive and mixed wastes
	8. Radiation protection, process control and environmental sample collection, analysis, instrument calibration and operation checks
	9. Maintenance, repair, and replacement of process equipment
	10. Process Control Laboratory analysis and testing
	11. Cold feeding[a]
	12. Transfer between cylinders
	13. Receipt, storage, inspection, and acceptance sampling of two cylinders containing depleted uranium hexafluoride (UF_6) from the former Starmet CMI site.
	14. Receipt, storage, inspection, acceptance sampling and enrichment of one cylinder containing depleted uranium derived from four off-specification cylinders transferred from DOE to USEC.
B. Source Material, Element 90	1. Calibration and use of portable health physics and fixed laboratory equipment
	2. Process Control Laboratory analysis and testing
	3. Process, characterize, package, ship, or store low level radioactive and mixed wastes

Table 1-4. Authorized uses of NRC-regulated materials. (Continued)

	Material Type		Authorized Use
C.	Special Nuclear Material[b]	1.	Heating cylinders and feeding contents into the diffusion process.
		2.	Filling, assay, storage, and shipment of cylinders containing uranium enriched up to 5.5 percent by weight ^{235}U
		3.	Nondestructive testing and analyses of product and process streams
		4.	Receipt, storage, inspection, and acceptance sampling of cylinders containing uranium enriched up to 5.5 percent by weight ^{235}U
		5.	Cleaning and inspection of cylinders used for the storage and transport of process feed, product, and tails containing source or special nuclear material
		6.	Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products
		7.	Process, characterize, package, ship or store low level radioactive and mixed wastes
		8.	Radiation protection, process control and environmental sample collection, analysis, instrument calibration and operation checks
		9.	Maintenance, repair, and replacement of process equipment
		10.	Process Control Laboratory analysis and testing
		11.	Cold feeding cylinders[a]
		12.	Transfer between cylinders
		13.	That remaining in equipment and facilities from previous operations.
		14.	Enrichment up to 5.5% ^{235}U by weight.
		15.	Swipe samples for assays in excess of 5.5 wt% enrichment.

Table 1-4. Authorized uses of NRC-regulated materials. (Continued)

	Material Type	Authorized Use
D.	By-Product Material, Elements 1, 3-84, 88	1. Radiation protection, process control, and environmental sample collection, analysis, instrument calibration, and operation checks
		2. Process Control Laboratory analysis and testing
		3. Nondestructive testing of product and product streams
	93, 95 to 100	1. Calibration and use of portable health physics and fixed laboratory equipment
		2. Process Control Laboratory analysis and testing
		3. Nondestructive testing of product and product streams
		4. Storage of process wastes containing uranium, transuranics, process contaminants and decay products
		5. That remaining in equipment and facilities from previous operations
		6. Process, characterize, package, ship, or store low-level radioactive and mixed waste
		7. Americium - used in smoke detectors
	$^{99}_{43}Tc$	1. That remaining in equipment and facilities as a result of previous operations
		2. Storage of process wastes as a result of feeding recycled uranium
		3. Process Control Laboratory analysis and testing
E.	Neutron Sources, 241 Am-Be, Cf-252	1. Calibration of neutron measuring instrumentation
		2. Internal sources in density meters
		3. UF_6 assay and flow instrumentation

a. Cold feeding or controlled feeding shall be in accordance with an approved TSR and operating procedure.
b. Uranium to be fed to the cascade will meet the requirements of ASTM Standard C996, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5% ^{235}U," or ASTM Standard C787, "Standard Specification for Uranium Hexafluoride for Enrichment," for reprocessed UF_6. All other uranium that does not meet the requirements of ASTM C996 or C787 for reprocessed UF_6 may be accepted by USEC for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds of UF_6) associated with sampling, subsampling, and analyses required to establish receiver's values.

Appendix A

Applicable Codes, Standards, and Regulatory Guidance

This Appendix lists the various industry codes, standards, and regulatory guidance documents which have been referenced in certification correspondence. The extent to which PGDP satisfies each code, standard, and guidance document is identified below, subject to the completion of applicable actions required by the Compliance Plan.

1.0 American National Standards Institute (ANSI)

1.1 ANSI N14.1, Uranium Hexaflouride - Packaging for Transport, 2001 Edition including Addendum 1 and Addendum 3 for all cylinders.

PGDP satisfies the requirements of this standard, except for Section 7 and those portions superseded by Federal Regulations, with the following clarifications:

Cylinders and valves already owned and operated by PGDP that were not purchased to meet this edition of the standard - Satisfy only Sections 4, 5, 6.2.2 - 6.3.5, 7, and 8 of the standard. Cylinders purchased prior to adopting the 2001 version of the standard were manufactured to meet the version of the ANSI standard or specification committed to at the time of the placement of the purchase order.

Tinning of cylinder valve and plug threads: ANSI N14.1 - 1990 and 1995 requires the use of ASTM B32 50A, a 50/50 tin/lead solder alloy described in the 1976 and previous editions of the ASTM standard. ANSI N14.1-2001 requires the use of ASTM B32 with a minimum tin content of 45% such as alloy SN50. Cylinder valve and plug threads that were purchased to meet the 1990 or the 1995 version of the standard were tinned using a method that is conservative with respect to the 2001 version of the standard (minimum tin content of 46% versus 45%) rather than meeting the 1990 or 1995 version of the standard.

Cylinder Valve Protectors (CVPs): For 48X, 48Y and 48G cylinders, the 1990 standard requires these devices to be fabricated from ASTM A285 Grade C or A516 steel. The 2001 standard requires these devices to be fabricated from weldable carbon steel with a minimum tensile strenght of 45,000 lbs/in^2 and a maximum carbon content of 0.26%, such as ASTM A-36 steel. Likewise, the set screws are to be manufactured to specific requirements for each CVP. (Addendum 1 to ANSI N14.1-2001 also allows an alternate cylinder valve protector design.) Cylinders in use at PGDP may meet the CVP design allowed by ANSI N14.1-2001. Alternately, the CVPs for any cylinder in use at PGDP may be steel, similar in design to those specified in ANSI N14.1-1990 and 2001, and meet the intent of this standard. Set screws that are employed in these CVPs are also steel and are manufactured in accordance with the ANSI N14.1-1990 or 2001 design, a derivative of this design, or a grade 5 bolt.

None of the Model 48HX cylinders in use by USEC were manufactured to the ANSI N14.1-2001 standard and this model of cylinder is no longer in production. However, the 2001 version of this standard mistakenly lists the minimum volume for this cylinder as 139 ft^3 and the maximum fill limit as 26,840 pounds. Previous versions of the standard (including the 1990 revision) list the minimum volume for this cylinder type as 140 ft^3 and the maximum fill weight as 27,030 pounds. Model 48HX cylinders at PGDP will comply with the volume requirements and fill limits that are listed in the 1990 version of ANSI N14.1 and are also flowed down into the TSRs.

See SAR Sections 3.7.1, 3.7.3, 3.7.5, 3.15, and 4.3.2.

1.2 ANSI/ANS 2.8, Determining Design Basis Flooding at Power Reactor Sites, 1981 Edition

PGDP used a deterministic, probable maximum flood (PMF) analysis as outlined in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59 and in American National Standards Institute/American Nuclear Society Standard ANSI/ANS-2.8-1981 to assess the potential consequences of a major regional flood at PGDP. Further flooding analysis using probabilistic methods are not required since regional flooding is not a hazard at PGDP because the nominal, top-of-grade elevation at PGDP is above the PMF plus wind wave activity at flood stage.

For references to this standard, see SAR Section 2.4.3.

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1.3 ANSI/ANS 3.1, Selection, Qualification, and Training of Personnel for Nuclear Power Plants, 1987 Edition

PGDP satisfies only the following section of this standard:

Section 4.3.3 - The qualifications of the Radiation Protection Manager identified in SAR Section 6.1 satisfy the requirements of this section of the standard.

1.4 ANSI/ANS 3.2, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants, 1994 Edition

The extent to which PGDP satisfies the requirements of this standard is outlined in SAR Section 6.11.1 and Appendix B to SAR Section 6.11.

1.5 ANSI/ANS 8.1, Nuclear Criticality Safety in Operations With Fissionable Materials Outside Reactors, 1983 Edition

PGDP satisfies the requirements of this standard.

For references to this standard, see SAR Sections 4.3.2.6, 5.2.2.1, 5.2.2.3, 5.2.3.2, 5.2.4.1, and Table 6.9-1.

1.6 ANSI/ANS 8.3, Criticality Accident Alarm System, 1997 Edition

The recommendations of this standard were used as guidance only for the design of the CAAS. PGDP satisfies the requirements of this standard with the following exceptions:

Section 4.4.1 - The CAAS alarm is not audible in all permit-required confined spaces, cell housings associated with cells that are running, and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate.

Section 4.4.2 - An alarm signal with a complex sound wave or modulation is not provided.

Section 5.5 - Not all CAAS alarms are capable of producing the desired signal within one-half second of activation by the minimum accident of concern. All CAAS alarms are capable of producing the alarm signal within two seconds of activation by the minimum accident of concern.

Section 7.2.2 - Instead of acquainting all employees with the alarm signal by actual demonstration at their work location, a recording of the alarm signal will be used to familiarize employees.

For references to this standard, see SAR Sections 3.12.6, 3.15.7.1, and 4.3.2.6.

1.7 ANSI/ANS 8.7 (N16.5), Guide for Nuclear Criticality Safety in the Storage of Fissile Material, 1975 Edition

PGDP satisfies the requirements of this standard with the following exceptions/clarifications:

Section 4.2.6 - Fire protection systems are installed throughout the process buildings where flammable liquids are used in operating equipment. Individual cell housings do not contain fire protection systems.

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Section 5.1 - PGDP does not implement the unit mass limits described in this section. Mass limits are defined in Nuclear Criticality Safety Approvals (NCSAs) and Nuclear Criticality Safety Evaluations (NCSEs).

For references to this standard, see SAR Section 5.2.2.1.

1.8 ANSI/ANS 8.19, Administrative Practices for Nuclear Criticality Safety, 1984 Edition

PGDP satisfies the requirements of this standard.

For references to this standard, see SAR Section 5.2.2.1.

1.9 ANSI/ANS 8.20, American National Standard for Nuclear Criticality Safety Training, 1991 Edition

PGDP satisfies the requirements of this standard.

For references to this standard, see SAR Sections 6.6.5.2 and 6.6.6.1.

1.10 ANSI A17.1, Safety Codes for Elevators, 1971 Edition including Supplements (a) through (g)

PGDP satisfies only the following section of this standard as clarified below:

Rule 1000.4a and Section 1001 - The building C-360 hydraulic lifts (elevator and levelator) are designed and tested to the requirements of this section of the standard for direct-plunger type elevators.

For references to this standard, see SAR Sections 3.7.3.1.1 and 3.7.3.1.2 and TSR Section 2.1.5.6.

1.11 ANSI B30.2, Overhead and Gantry Cranes, 1990 Edition (including Addenda A, 1991)

PGDP satisfies the requirements of the following sections of this standard for liquid UF_6 handling cranes, Feed Facility cranes, and process building cranes (two in building C-310, and one each in buildings, C-315, C-333 and C-337) that are normally parked over cascade equipment:

Section 2-2.1.1 - all
Section 2-2.1.2 - all
Section 2-2.1.3 - all except for paragraphs (6), (8), and (9)
Section 2-2.2.2 - only paragraphs (a), (b)(1), and (b)(4)
Section 2-2.3.1 - all
Section 2-2.4.1 - all

1.12 ANSI B30.9, Slings, 1990 Edition (including Addenda A, 1991)

PGDP satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders:

Section 9-1.6 - all
Section 9-2.8.1 - all
Section 9-2.8.2 - all

1.13 ANSI B30.10, Hooks, 1987 Edition (up through Addenda C, 1992)

PGDP satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders:

Section 10-1.2.1.1 - all
Section 10-1.2.1.2 - all
Section 10-1.2.1.3 - all

1.14 ANSI B30.20, Below the Hook Lifting Devices, 1993 Edition

PGDP satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders:

Section 20-1.3 - all
Section 20-1.4.1 - only paragraphs (a) and (b)

1.15 ANSI NB-23, National Board Inspection Code, 1995 Edition

PGDP satisfies the requirements of this code as described below:

UF_6 accumulators and condensers are inspected at 5 year intervals in accordance with the 1995 edition of the National Board Inspection Code (NBIC).

For references to this standard, see SAR Sections 3.4.1.5 and 3.5.1.5.

1.16 ANSI N323, Radiation Protection Instrumentation Test and Calibration, 1978 Edition

PGDP satisfies the requirements of this standard except as described in SAR Section 5.3.5.

1.17 ANSI N510, Testing of Nuclear Air Treatment Systems, 1989 Edition

PGDP satisfies the requirements of this standard for the periodic testing of HEPA systems that are relied upon for personnel protection or to meet environmental emissions limits with the following exceptions:

Section 11- The test gas specified will be an alternative but equivalent Halide gas,

Section 15 - Laboratory testing of the adsorbent will test for HF loading instead of radioiodine since HF is the gas of concern at PGDP.

For references to this standard, see SAR Sections 5.3.2.10 and 5.3.7.5.

2.0 American Society of Mechanical Engineers (ASME)

2.1 ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities, 1989 Edition

PGDP satisfies the requirements of this standard, including Basic and Supplementary Requirements, with exceptions and clarifications identified in the Quality Assurance Program Description. See also SAR Sections 6.6.13, 6.8.1, and 6.8.2 and Section 7.5 of the Emergency Plan.

2.2 ASME Boiler and Pressure Vessel Code, 1995 Edition

PGDP satisfies the following sections of this code as clarified below:

Section VIII - PGDP satisfies the requirements of Section VIII for the edition in effect at the time of fabrication of the following pressure components and systems: freezer/sublimer, condenser/reboiler, accumulator, autoclave, cell coolant condenser, nitrogen system (relief devices only), air system and dryer, cell coolant pressure relief, CAAS air accumulators, and UF_6 cylinders except that UF_6 cylinders do not have pressure relief devices.

Section IX - PGDP satisfies the requirements of Section IX for the components identified above for Section VIII.

For references to this code, see SAR Sections 3.2.3, 3.2.5.5, 3.3.4.4.1, 3.6.3, 3.6.7.5, and 3.7.1.

3.0 National Fire Protection Association (NFPA)

3.1 NFPA 10, Portable Fire Extinguishers, 1990 Edition

As described in SAR Section 5.4.3, the requirements of this standard were used as guidance only in determining the size, selection, and distribution of portable fire extinguishers. PGDP will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the Authority Having Jurisdiction (AHJ).

For references to this standard, see SAR Sections 5.4.1 and 5.4.3.

3.2 NFPA 13, Sprinkler Systems, 1989 Edition

As described in SAR Section 5.4.1.1, the process buildings meet the definition of Ordinary Hazard Occupancies (Group 2) as stated in this standard and the fire protection system exceeds the required sprinkler discharge density for this type of occupancy. PGDP will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Sections 3.3.5.12, 3.15, 5.4.1, and 5.4.1.1.

3.3 NFPA 15, Water Spray Systems, 1990 Edition

PGDP will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Section 5.4.1.

3.4 NFPA 24, Private Fire Service Mains, 1992 Edition

PGDP will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard, see SAR Section 5.4.1.

3.5 NFPA 25, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems, 1995 Edition

The 90-second response time criteria for the receipt of a sprinkler system flow alarm is consistent with the requirements of this standard. For references to this standard, see SAR Section 5.4.2.

3.6 NFPA 30, Flammable Liquids, 1990 Edition

As described in SAR Section 5.4.1.1, the requirements of this standard are used as guidance only for procedures used to handle flammable liquids. PGDP will satisfy the requirements of this standard for modifications to the plant except as documented and justified by the AHJ.

For references to this standard and year, see SAR Sections 5.4.1 and 5.4.1.1.

3.7 NFPA 72, National Fire Alarm Code, 1996 Edition

The 90-second response time criteria for the receipt of a sprinkler system flow alarm is consistent with the requirements of this standard. For references to this standard, see SAR Section 5.4.2.

3.8 NFPA 101, Life Safety Code, 1991 Edition

PGDP uses the requirements of this standard as guidance only for the review of emergency egress paths.

For references to this standard, see SAR Section 5.4.1.2.

3.9 NFPA 232 (and 232 AM), Standard for the Protection of Records, 1986 Edition

As described in SAR Section 6.10.1.8, there are several acceptable methods for the storage of permanent records. If the NFPA 232 (or 232 AM) method of storage in 2-hour-rated containers is used, any exceptions to this standard will be documented and justified by the AHJ.

4.0 NRC Regulatory Guidance

4.1 Regulatory Guide 1.59, Design Basis Floods for Nuclear Power Plants

PGDP used a deterministic, probable maximum flood (PMF) analysis as outlined in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59 and in American National Standards Institute/American Nuclear Society Standard ANSI/ANS-2.8-1981 to assess the potential consequences of a major regional flood at PGDP. The maps and the procedure outlined in Section B.3.2.2 of NRC Regulatory Guide 1.59 were used to estimate the PMF discharge. Further flooding analysis using probabilistic methods are not required since regional flooding is not a hazard at PGDP because the nominal, top-of-grade elevation at PGDP is above the PMF plus wind wave activity at flood stage.

For references to this regulatory guide, see SAR Sections 2.4.3 and 2.4.3.2.

4.2 Regulatory Guide 8.13, Instructions Concerning Prenatal Radiation Exposure, Revision 2

PGDP satisfies the requirements of this regulatory guide.

For references to this regulatory guide, see SAR Section 5.3.2.2.

4.3 Bulletin 91-01, Reporting Loss of Criticality Safety Controls

PGDP satisfies the requirements of this NRC Bulletin as identified in SAR Table 6.9-1.

4.4 Regulatory Guide 3.67, Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities

PGDP uses examples provided in the Regulatory Guide to develop Emergency Action Levels. For references to this regulatory guide, see the Summary and Section 3.0 of the Emergency Plan.

4.5 Regulatory Guide 5.59 "Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance."

PGDP uses examples from the Regulatory Guide to develop physical security plans for the transportation of special nuclear material of low strategic significance and physical security plans for the protection of special nuclear material of low strategic significance.

For reference to this regulatory guide, see Section 1, Introduction of the Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance and Section 1, Introduction of the Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance.

5.0 Other Codes, Standards, and Guidance Documents

5.1 USEC-651, Uranium Hexaflouride: A Manual of Good Handling Practices, Revision 7, January 1995

USEC-651 supersedes ORO-651, Revision 6. PGDP satisfies the following sections of USEC-651 as clarified below:

Section 3.3 - all

Section 5.2 - all except for paragraph 5.2.2. Not all PGDP cylinders have internal volumes measured by the manufacturer.

Section 5.3 - all

Section 5.4 - all except for paragraph 5.4.4. Some cylinder valves in use at PGDP have less than 13 threads.

Section 10.0 - all except as follows:

First paragraph - Not all PGDP shipping cylinders meet the requirements of the most recent version of ANSI N14.1 (1990 Edition). These cylinders were manufactured prior to the date of ANSI N14.1-90. (See item 1.1, ANSI N 14.1)

Fourth paragraph - Older PGDP cylinders may not have a measured volume that has been certified by the manufacturer. (See item 1.1, ANSI N14.1)

Section 13.1 - all

For references to this standard, see SAR Section 3.15.

5.2 NCRP 112, Calibration of Survey Instruments Used in Radiation Protection for the Assessment of Ionizing Radiation Fields and Radioactive Surface Contamination, 1991

NCRP 112 is an example of a nationally recognized guidance document that may be used to establish calibration requirements for radiological protection instruments. See SAR Section 5.3.5.

5.3 Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, undated

The methodology outlined in this report is one method used to calculate internal dose. See SAR Section 5.3.2.3.

5.4 SNT-TC-1A, Qualification and Requalification of Nondestructive Examination Personnel, 1980 Edition

PGDP satisfies the requirements of this standard with clarifications identified in Section 2.2.4 of the Quality Assurance Program Description.

5.5 EPA 400-R-92-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents

PGDP satisfies the requirements of only Section 2.5 of this document.

For references to this standard, see Sections 3 and 5.5.1.2 of the Emergency Plan.

5.6 ICRP-30, Limits for Intakes of Radionuclides by Workers, 1978

PGDP uses the biokinetic model of this standard for internal dose calculations.

For references to this standard, see SAR Section 5.3.2.3.

5.7 ASTM C787, Specification for Uranium Hexaflouride for Enrichment, 1990 Edition

PGDP satisfies the requirements of this standard as described in SAR Tables 1-3 (footnote c) and 1-4 (footnote b) with the following clarification:

Production from the cascade is considered "material-in-process" and, on occasion, may be refed to the cascade; as such, it is not covered by the feed restrictions described in this standard.

5.8 ASTM C996, Standard Specification for Uranium Enriched to less than 5% ^{235}U, 1990 Edition

PGDP satisfies the requirements of this standard as described in SAR Tables 1-3 SAR Tables 1-3 (footnote c) and 1-4 (footnote b) with the following clarification:

> Production from the cascade is considered "material-in-process" and, on occasion, may be refed to the cascade; as such, it is not covered by the feed restrictions described in this standard.

5.9 U.S. Department of Transportation, North American Emergency Response Guidebook

PGDP uses the initial isolation and protective action distances in this guidebook for determining emergency action levels. For the reference to this guidebook, see Section 3.0 of the Emergency Plan.

5.10 U.S. National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards

PGDP uses the exposure limits in this guide for determining emergency action levels. For the reference to this guide, see Section 3.0 of the Emergency Plan.

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2. SITE CHARACTERISTICS

This chapter provides information on the location and site characteristics of the Paducah Gaseous Diffusion Plant (PGDP) facility as specified in 10 Code of Federal Regulations (CFR) 76.35(a)(8). The purpose is to provide a description of site characteristics needed to support the assumptions used in determining the impacts of normal operation, emergency planning, and the hazard and accident analysis contained in Chapter 4 regarding (1) the contribution of external and natural phenomena to initiation of events, and (2) the site related assumptions used in evaluating accident consequences. This chapter includes descriptions of:

1. The location of the site and facility and its proximity to public and other facilities (Section 2.1.1).
2. Local population location and density (Section 2.1.3).
3. Sources of external manmade event contributors such as nearby airports, railroads, and utilities (Section 2.2).
4. The historical basis for site characteristics in meteorology, hydrology, geology, and seismology (Sections 2.3 through 2.6).

2.1 GEOGRAPHY AND DEMOGRAPHY OF THE SITE

This section describes the PGDP site location and description, surrounding populations, and use of nearby land and waters.

2.1.1 Site Location

PGDP is located in western Kentucky, in McCracken County as shown in Figure 2.1-1. The site is located about 3.6 miles south of the Ohio River, 19.9 miles east of the confluence of the Ohio and Mississippi Rivers, and 20 miles west of the Tennessee and Cumberland Rivers. The Missouri state boundary is 20 miles to the west, and Tennessee's state border is about 40 miles to the south. The city limits of Paducah, Kentucky, are 10 miles east of PGDP, and the city of Metropolis, Illinois, is situated approximately 5 miles north and east of the plant.

Paducah, with a 2000 population of 26,307, is the largest city in the immediate region. Two unincorporated communities, Grahamville and Heath, are located approximately 2 miles east of the plant. Parts of 28 counties in 4 states fall within a 50-mile radius of the plant (11 in Kentucky, 10 in Illinois, 4 in Missouri, and 3 in Tennessee). Figure 2.1-2 shows nearby communities, major highways, railways, and bodies of water.

PGDP's latitude is 37°6′49″ N. and its longitude is 88°47′39″ W. (measured at a central point in the plant). PGDP is situated in Universal Traverse Mercator Zone 16, N 4,108,777 m, and E340,595 m. The plant occupies a 3,423-acre site owned by the Department of Energy (DOE). It is surrounded by the West Kentucky Wildlife Management Area and by predominantly rural and agricultural land. In recent years, industrial, commercial, and residential development in the general vicinity of the site has increased.

2.1.2 Site Description

PGDP is located on a 3,423-acre site, of which approximately 650 acres are within the Controlled Access Area. Of the remaining area, 2,080 are managed by the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area.

In all, the portion of PGDP leased by the United States Enrichment Corporation (USEC) contains more than 115 buildings and structures, with a total floor space of about 8 million ft^2. The fenced area of the site is dominated by four large process buildings, which constitute about 75 percent of the plant's total floor space. There also are cooling towers, electrical switchyards, and several support operations structures, including sewage and liquid effluent treatment plants, decontamination and recovery operations, coal and ash-handling facilities, boiler blowdown, water treatment, steam plant, maintenance operations, laboratories, fluorine facilities, and air plants. The site consists of facilities and areas leased to USEC, buildings leased by USEC that contain deleased areas, and facilities retained by DOE (i.e., non-leased). Activities conducted within facilities leased to USEC, excluding non-leased facilities and access and egress thereto, are conducted in accordance with this Application, with the exception of laboratory activities and associated support services licensed as radioactive material operations by the Commonwealth of Kentucky (see Section 2.2.5). Also, activities conducted by USEC and its agents in areas within the perimeter fence, excluding non-leased areas and access and egress thereto, will also be conducted in accordance with this Application, with the exception of laboratory activities and associated support services licensed as radioactive material operations by the Commonwealth of Kentucky (see Section 2.2.5). DOE will self-regulate DOE activities conducted in non-leased areas and leased areas in accordance with applicable DOE requirements. Buildings and structures leased to USEC and those retained by DOE are shown in Exhibit A of the lease agreement, as amended. The PGDP Facility Lease Status map (C5EC90000A046) depicts the USEC-leased versus DOE-retained buildings, structures and outside areas. There are areas where contamination exists within the USEC-leased areas to legacy DOE activities. Health Physics maintains radiological surveys of currently identified areas.

All existing and future DOE monitoring wells, piezometers, extraction wells, and borings (temporary or permanent) used for the purpose of collecting water level measurements and/or samples for physical and/or chemical analyses are the property of DOE and shall be considered nonleased facilities. DOE/DOE contractor and their subcontractors shall be allowed ingress to and egress from each well, piezometer, or boring location as necessary. Activities conducted in these locations, including ingress and egress, will be managed in accordance with applicable DOE requirements. At the request of USEC, DOE will perform sampling as a reimbursable service.

All existing SWMUs/AOCs are the property of DOE. DOE/DOE contractor and their subcontractors shall be allowed ingress and egress from each SWMU/AOC as necessary, including those that are operating.

2.1.2.1 Topography

The PGDP region is characterized by low relief. Elevations vary from 290 ft above mean sea level (MSL) at the Ohio River to 380 ft above MSL at the plant site, approximately 3.6 miles away. The fenced area is above recorded flood levels.

2.1.2.2 Vegetative Cover

Land within the PGDP security fence is virtually cleared of vegetation; it is a fully developed industrial area. Asphalt or crushed stone covers the area immediately surrounding process buildings, and grass covers the areas surrounding administration, laboratory, fire, and guard buildings.

Mature hardwood forests are located in the 2,080 acres of DOE land outside the fenced area. This 2,080-acre area is used by the Commonwealth of Kentucky for wildlife conservation, and it is managed by the Kentucky Department of Fish and Wildlife under a letter of agreement with the Atomic Energy Commission (AEC) that dates back to the 1950s.

2.1.2.3 On-Site Transportation and Transmission Systems

A total of 23 miles of paved roadway (concrete or asphalt) are located within the fenced area of PGDP. Additionally, patrol roads and paved access roads branch to the perimeter of the plant site.

The PGDP rail system, consisting of slightly more than 17 miles of track, is the primary means of transporting materials such as cylinders and coal. The rail spur enters the site west of Building C-720 and branches out within the fenced area.

PGDP utility systems include communications, electricity, water supply, high-pressure fire water, wastewater treatment, miscellaneous energy, and industrial gases. A Bell system, power dispatching network, and an emergency system constitute the plant's telephone system. PGDP's electrical power is supplied at 161-kV; switchyards are connected with the Tennessee Valley Authority (TVA), Kentucky Utilities Company (KU), and Electric Energy, Inc. (EEI).

PGDP's water supply system includes a DOE-owned pumping station at the Shawnee Steam Plant, two 36-in. raw water lines, the Building C-611 treatment plant, and separate distribution networks for process and sanitary water. Storm water is collected by the storm drainage network, industrial wastewater is pumped to the C-616 treatment plant, and sewage is pumped to C-615.

2.1.2.4 Site Boundary

The north, east, and west boundaries of PGDP are defined by the West Kentucky Wildlife Management Game Reserve. Also adjoining the northern boundary is the Shawnee Steam Plant owned and operated by TVA. Figure 2.1-5 shows the site boundary and the plant boundary.

PGDP site security is maintained as described in the Gaseous Diffusion Plant Security Program. Special work areas in C-720 are exclusion areas within the plant fence. Additionally, the area around the Building C-611 water treatment plant is a controlled area to which access is regulated administratively.

2.1.2.5 Boundaries for Establishing Effluent Release Limits

The controlled area is as defined in 10 CFR Part 20 and is the area outside the restricted area but inside the site (reservation) boundary, access to which can be limited by USEC for the purposes of plant protection, security, emergency preparedness and radiation protection. Adequate measures to limit access to the controlled area, such as utilizing existing gates, can be implemented as directed in site procedures. Figure 2.1-6 shows distances from potential effluent release points to the boundary of the controlled area.

2.1.3 Population

2.1.3.1 On-Site Population

Current United States Enrichment Corporation (USEC) employment on-site at PGDP totals approximately 1,400. Employees work different shift cycles. There are 12-hr shifts

from 7 a.m./p.m. to 7 p.m./a.m., to ensure the plant's continuous operation. Table 2.1-2 provides a breakdown of the approximate number of full-time USEC, DOE, contractor, and other personnel associated with the PGDP as of March 2003.

2.1.3.2 Area Residential Population

McCracken County's population was 65,514 in 2000. Current population density in McCracken County was 261 persons/mi^2 in 2000. The combined 2000 population of the 6 county area surrounding PGDP was 156,108.

The 2000 population within 5 miles of the PGDP centerpoint is approximately 6,628. The geographic distribution of this population is depicted in a radial-sector map in Figure 2.1-7. The map is divided into 22.5-degree sectors, with each segment centered on one of the 16 compass points. The sectors are divided in concentric circles at radii of 1, 2, 3, 4, and 5 miles from the plant. These population data are presented in Table 2.1-3.

Current and projected population density within a 5-mile radius of PGDP are presented in Table 2.1-4. To estimate future population through the year 2030, the Kentucky State Data Center (KSDC) projections of county population growth rate were used.

2.1.3.3 Significant Transient and Special Populations

The following sections identify institutional, transient, and seasonal populations in the PGDP area.

Schools

The McCracken County school district operates three schools within 5 miles of PGDP, as shown in Figure 2.1-8. These schools are Heath Elementary, Middle, and High Schools. The combined 2002-2003 enrollment of these three schools was 1,538. Including teachers and staff, the total school population within 5 miles of PGDP was 1,704.

Just beyond the 5-mile radius are several schools that are within Massac Unit School District No. 1 in Illinois. Clark Elementary, Central Elementary, and Metropolis Middle and Junior High Schools, and Massac County High School are located within 6 miles of PGDP. The combined enrollment of these five schools for 2002-2003 was 1404. Including teachers and staff, the total population of these five schools was 1575.

One day care center operates within 5 miles of PGDP. It has a licensed capacity of 22. Four other day care facilities are located within 6 miles of the plant. These facilities have a combined capacity of 155. In addition, Metropolis Junior High School houses a before-and-after school program with an enrollment of 45 children in the mornings and afternoons.

Hospitals and Nursing Homes

No hospitals are located within 5 miles of PGDP. The closest hospital is Massac Memorial Hospital in Metropolis. It is licensed for 57 beds, but on average, 23 beds are filled. Hospitals in Paducah are Lourdes and Western Baptist, with 389 and 348 licensed beds, respectively. Average occupancy is 61 percent at Lourdes and 60 percent at Western Baptist.

No nursing homes are located within 5 miles of PGDP; however, three nursing homes with a combined licensed capacity of 331 beds are located in Metropolis, several nursing homes are in Paducah, and one is in La Center, in Ballard County, Kentucky. Two homes for persons with developmental disabilities, whose licensed capacity is 38 beds, are located in Metropolis. Apartments for the elderly, consisting of 18 units, are located in Kevil. All of these facilities are within 5 miles of PGDP. No prisons are located within a 5-mile radius of the plant.

Recreation Areas and Recreational Events

There are few on-site recreational activities at PGDP. Although "family days" on which family members can tour facilities have been held, they are not offered on any regular schedule. There is, however, recreational use made of the portion of the West Kentucky Wildlife Management Area, including bow hunting of deer and dog training. The number of users is uncertain because there is no permit system, but it is estimated at less than 5 persons during the week and less than 10 on the weekends.

Emergency planning information is provided for persons who use the West Kentucky Wildlife Management Area through pamphlets at the check-in area.

Other recreation facilities, as shown in Figure 2.1-9, within 5 miles of PGDP at which potentially significant transient populations may be located include the Harrah's Casino (formerly "Players Casino," also referred to as the Southern Illinois, or Metropolis, Riverboat Casino). The casino's capacity is 1,800 people, including 400 employees. The casino currently accomodates approximately 4,200 people daily, and its annual use is over 1.5 million persons.

2.1.4 Uses of Nearby Land and Waters

As shown in Figure 2.1-10, approximately 75 percent of the area within a 5-mile radius of PGDP is used for agricultural purposes or open fields, 15 percent is wooded (especially adjacent to the Ohio River), and about 10 percent is urban and developed. A considerable portion of the area adjacent to PGDP is occupied by the West Kentucky Wildlife Management Area.

Two creeks that traverse PGDP, Little and Big Bayou Creeks, flow to the Ohio River to the north of the plant. The drainage basin of the creeks consists mainly of PGDP, woodland, and farmland.

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Table 2.1-2. PGDP associated personnel as of March 2003.

	Within Security Fence	Within Controlled Area	In Paducah Area
USEC	1,430[a]		12
USEC Construction Subc.	25		
USEC Services Contract	65		
Nuclear Regulatory Commission (NRC)	2		
C-Plant Employees Federal Credit Union	5		
Department of Energy (DOE)		14	
DOE Prime Contractors	40	30	90
DOE Prime Subcontractors	195	50	160
	1,762	94	172

a. Includes 320 shift personnel.

Table 2.1-3. Population estimates for the year 2000 within a 5-mile radius of PGDP, cumulative data.

	Distance (miles)				
	0-1	0-2	0-3	0-4	0-5
N	0	4	9	15	18
NNE	0	3	7	12	18
NE	0	7	29	53	152
ENE	0	17	63	117	599
E	0	61	167	288	382
ESE	0	176	324	506	901
SE	0	95	233	426	941
SSE	0	53	242	348	581
S	0	7	182	450	595
SSW	0	3	114	355	466
SW	0	1	141	329	495
WSW	0	0	96	374	920
W	0	0	58	145	207
WNW	0	5	17	89	171
NW	0	5	16	61	154
NNW	0	5	16	24	38
TOTAL	0	422	1,714	3,585	6,631

Center latitude = 37°6′49″ N.
Center longitude = 88°47′39″ W.

Table 2.1-4. Current and projected population density within 5 miles of PGDP.

Year	Population Density (person/mile^2)
2000	84.4
2010	90.5
2020	96.4
2030	100.9

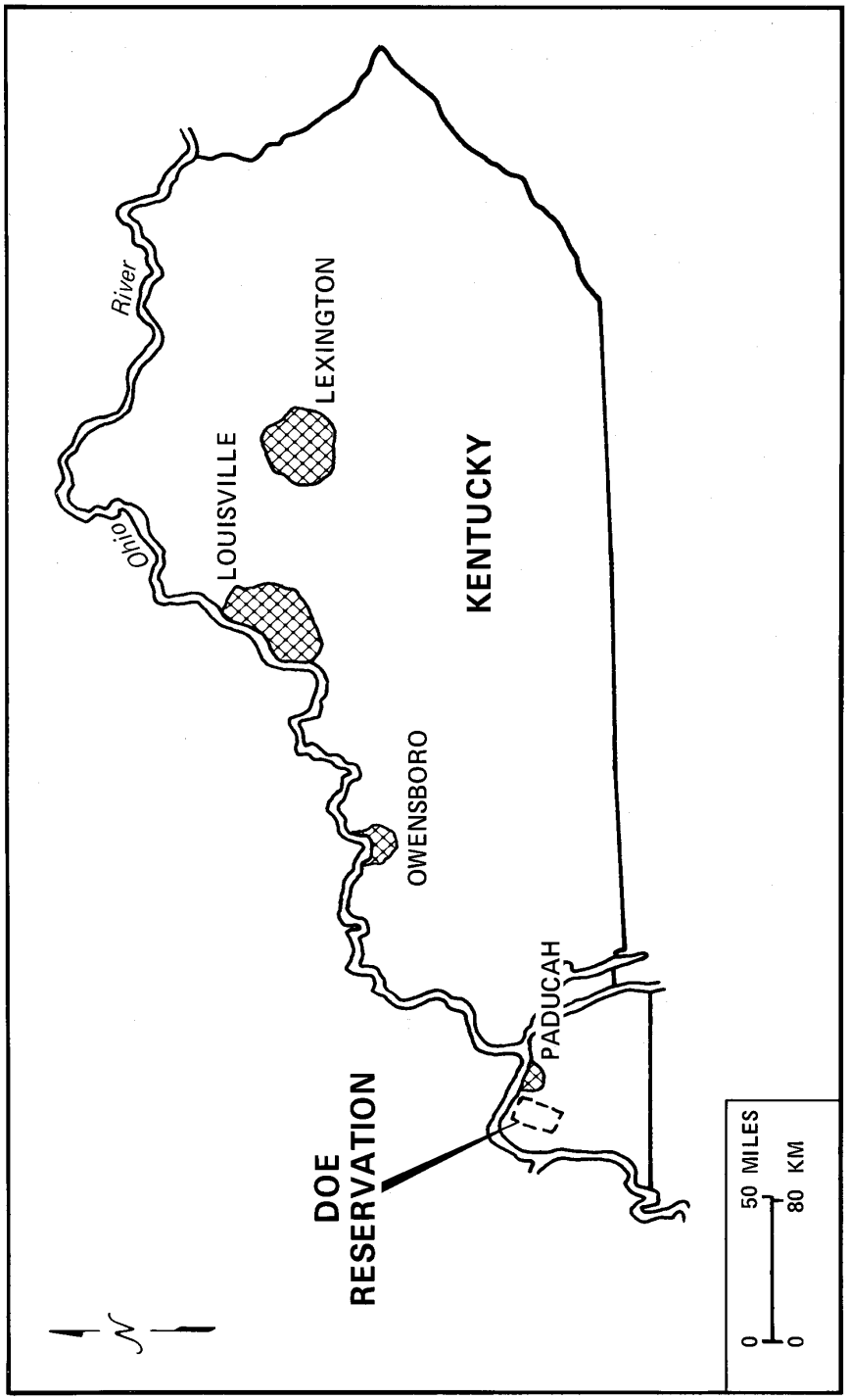

Figure 2.1-1. The location of PGDP

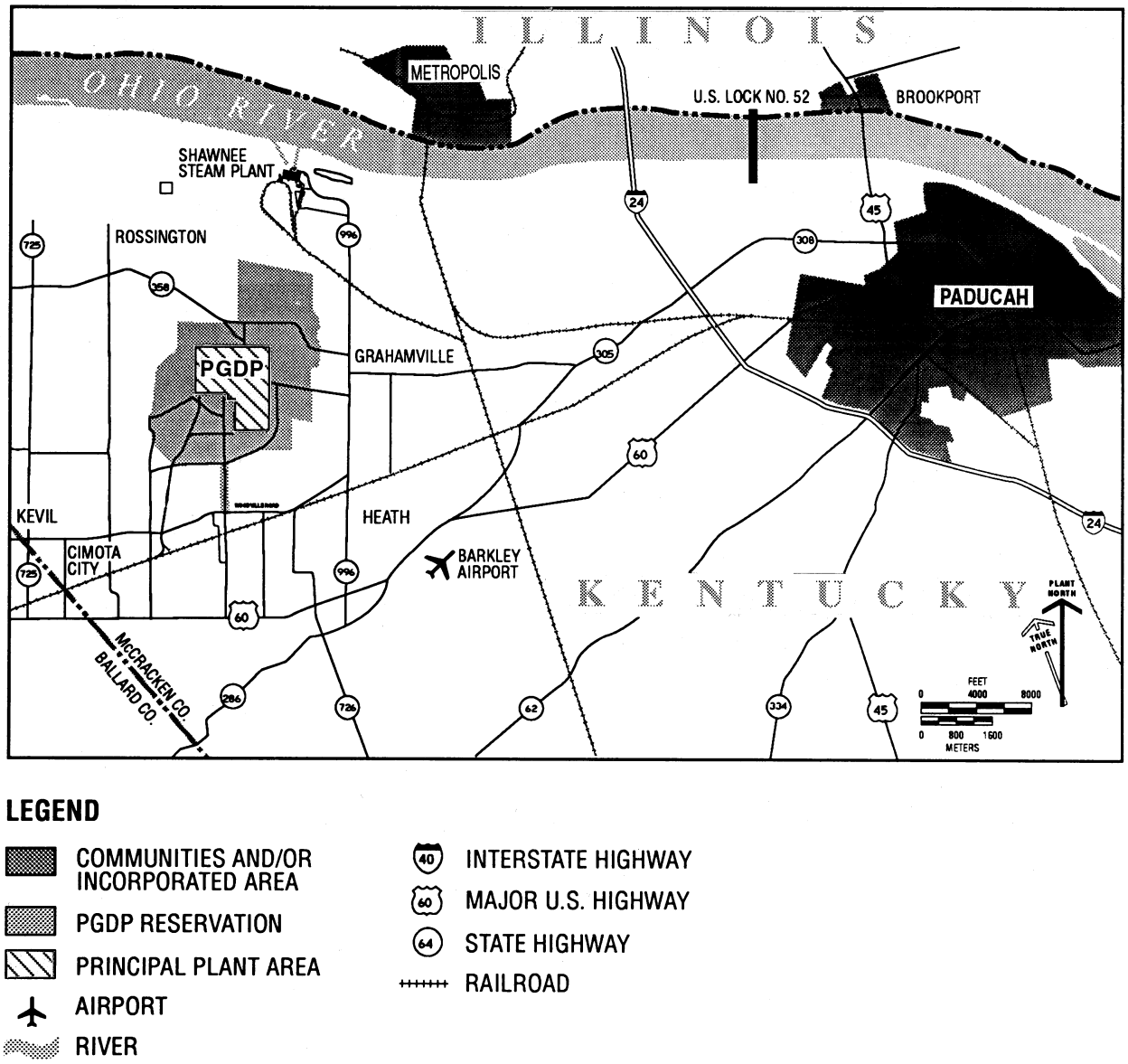

Figure 2.1-2. PGDP and the surrounding region, showing the DOE property boundary, nearby communities, roads, and bodies of water.

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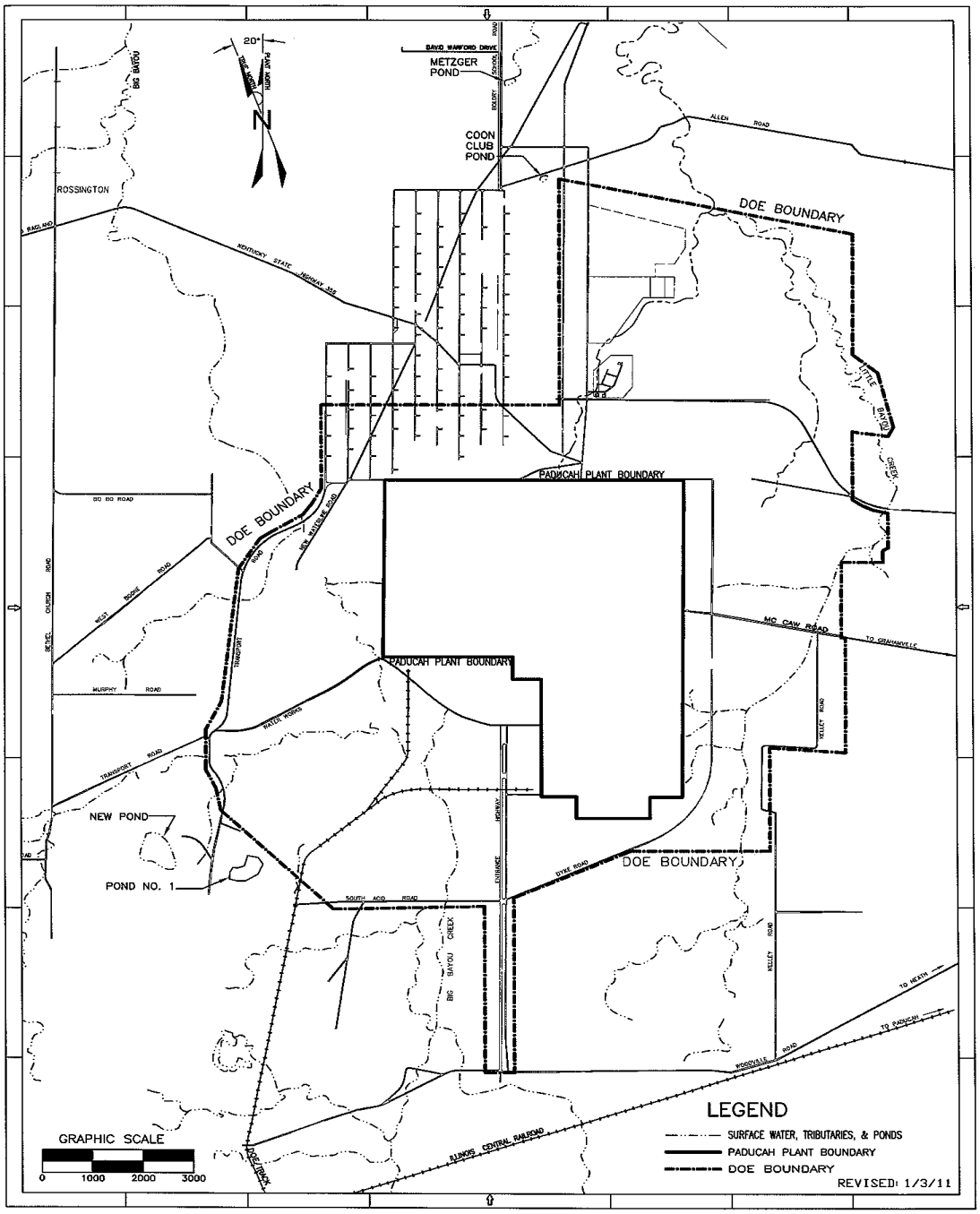

Figure 2.1-5. PGDP site boundary and plant boundary.

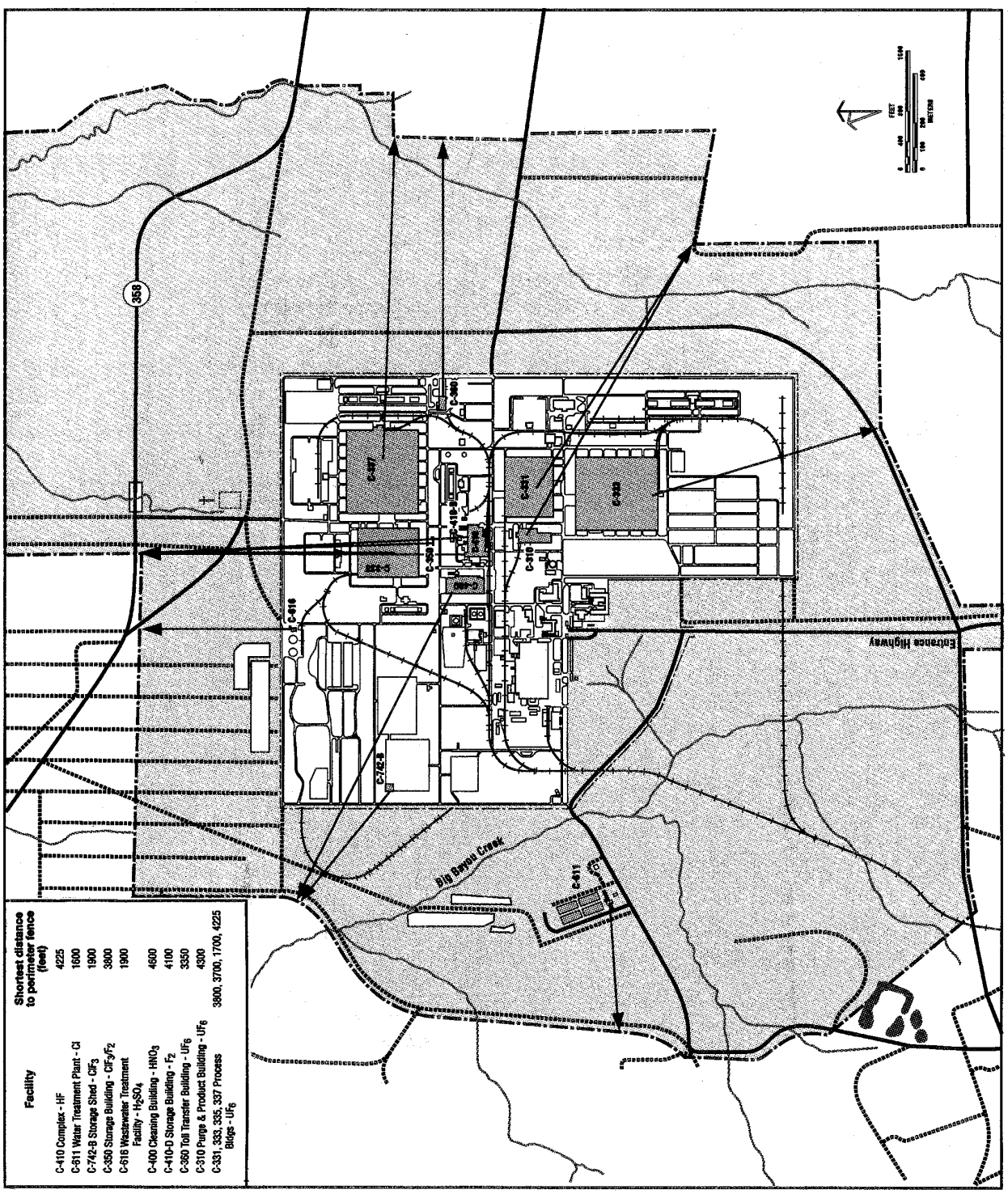

Figure 2.1-6. Shortest distances to the PGDP boundary from effluent release points.

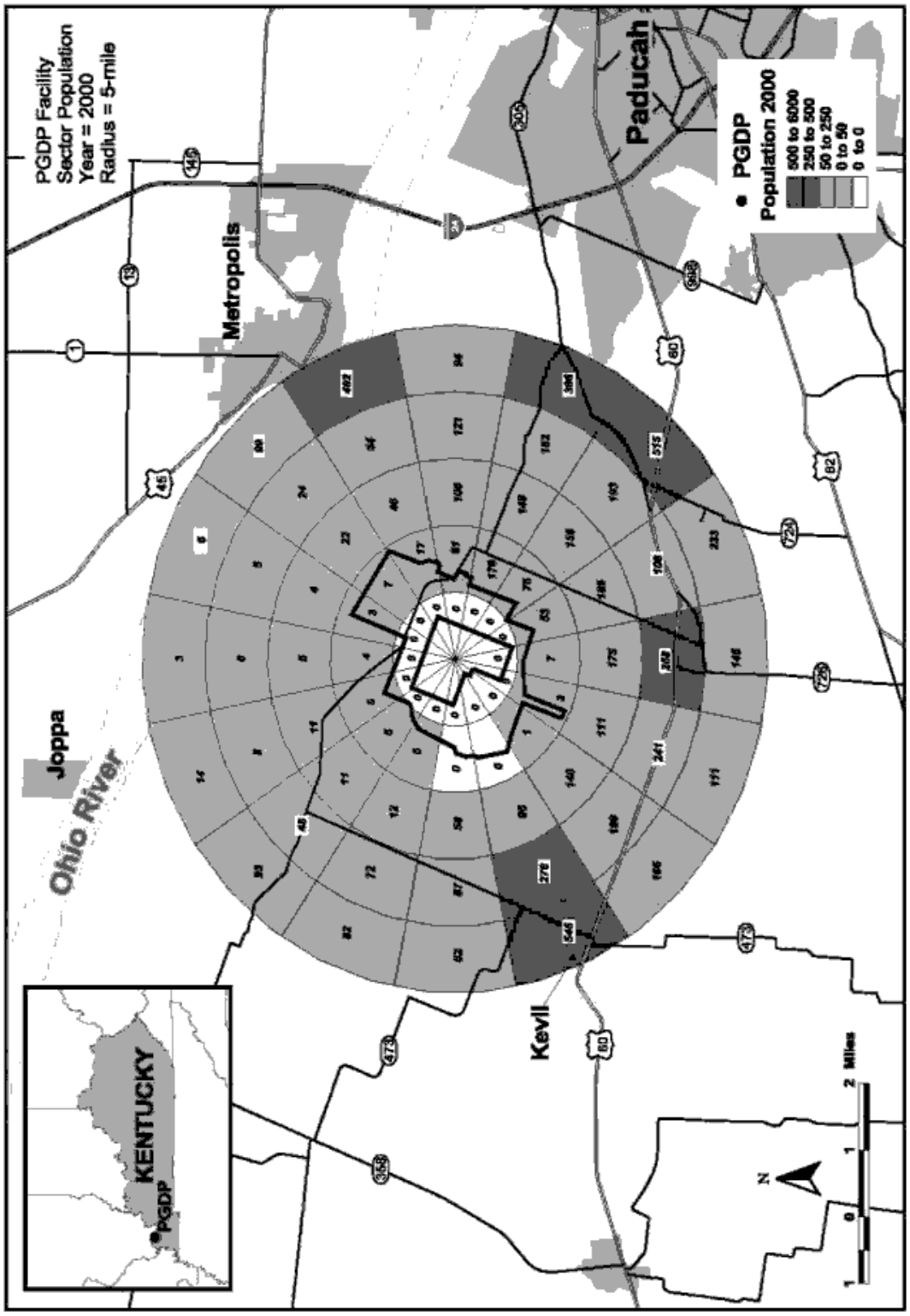

Figure 2.1-7. The 2000 population, by sectors, within 1, 2, 3, 4 and 5 miles of PGDP

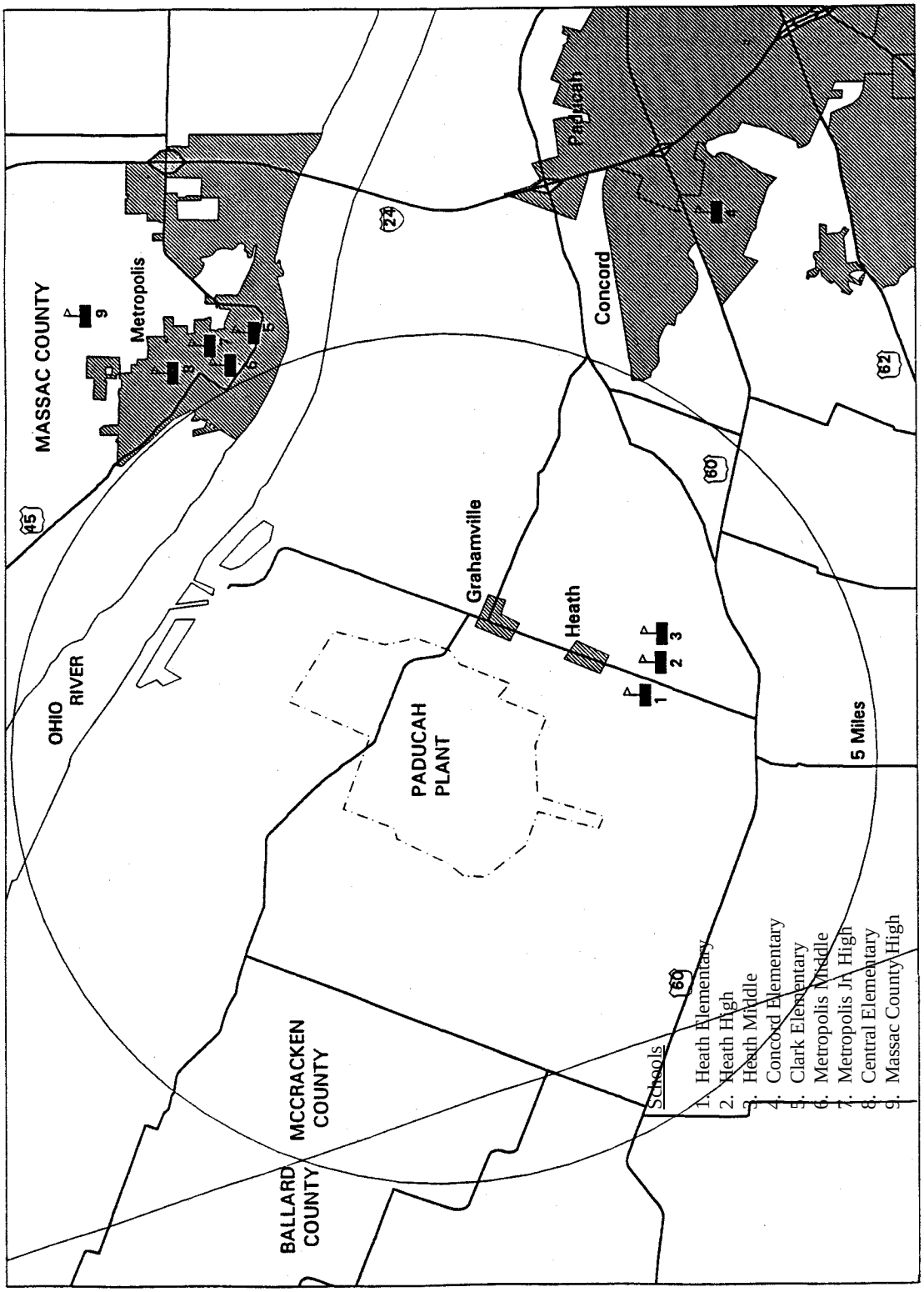

Figure 2.1-8. Schools in the vicinity of PGDP.

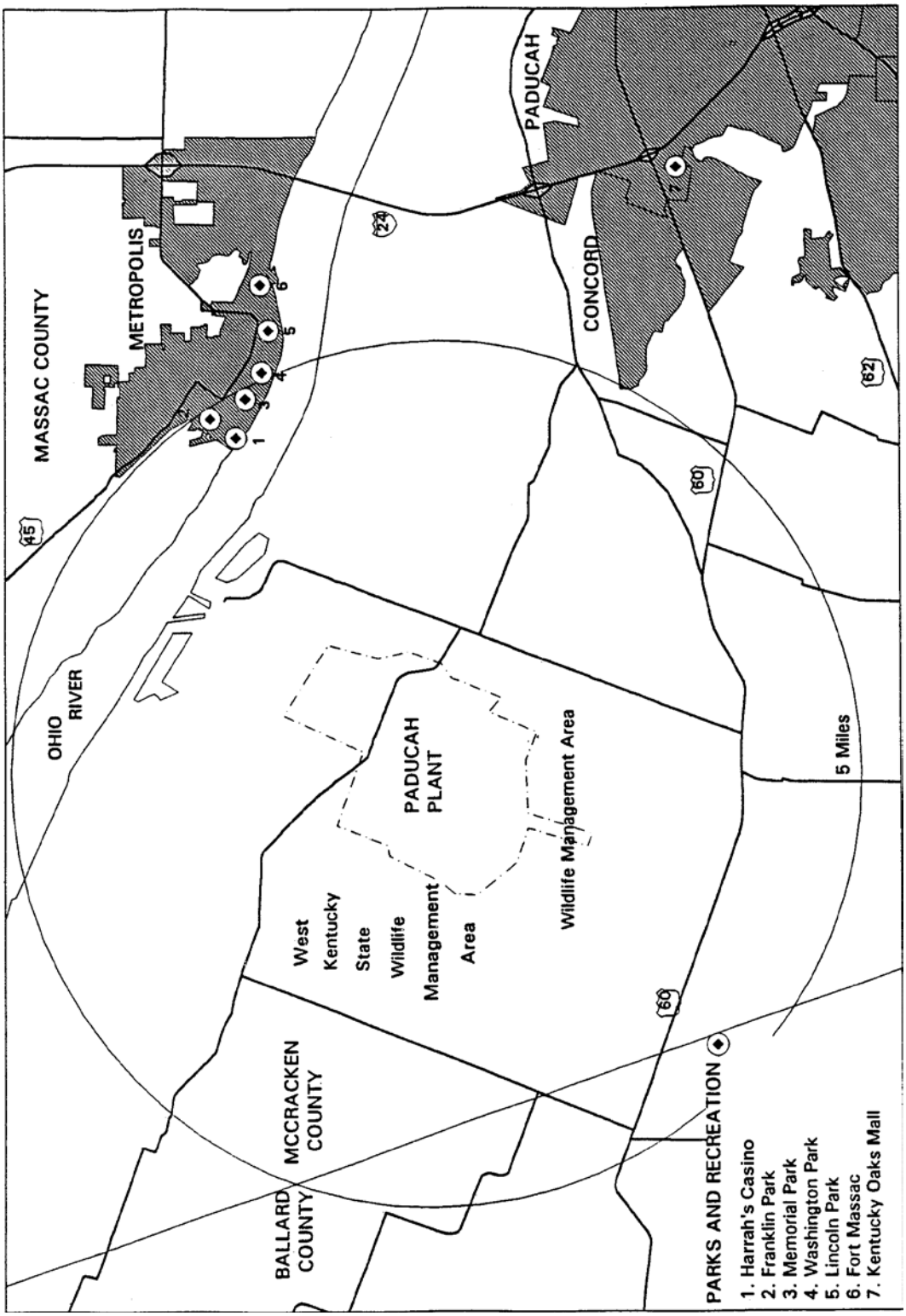

Figure 2.1-9. Public recreation and facilities in the vacinity of PGDP

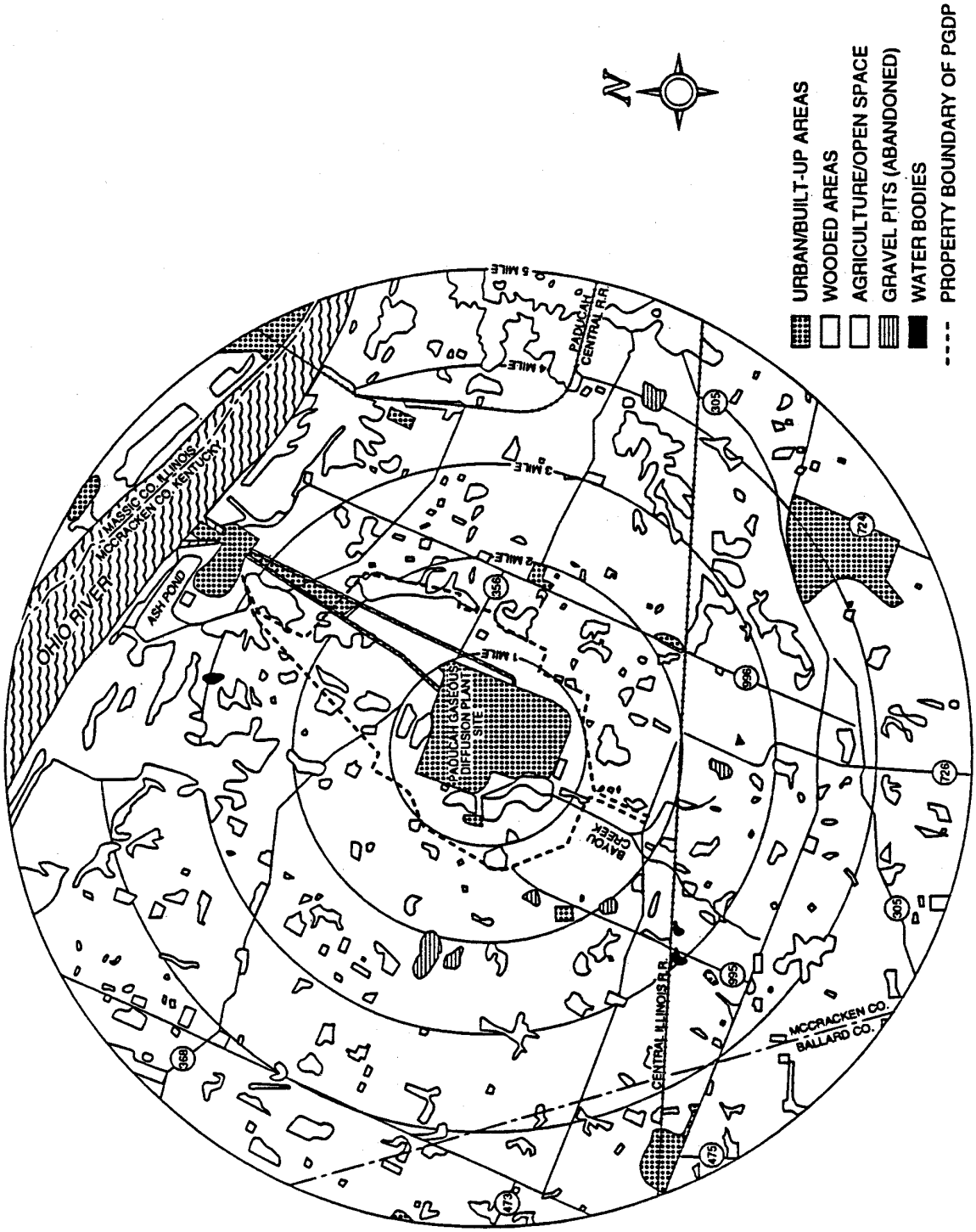

Figure 2.1-10. General land use within 5 miles of PGDP

2.2 NEARBY INDUSTRIAL AND TRANSPORTATION FACILITIES

2.2.1 Industrial Facilities

A number of industries are located within 7 air miles of PGDP. TVA's Shawnee Power Plant, approximately 3 miles north of the plant, employs about 265 people plus on-site contractors. Barkley Regional Airport to the east of PGDP employs about 150 individuals and the Tyler Water Plant to the east of Paducah employs about 200 individuals. Kentucky Oaks Mall is located approximately 7 miles from the plant and the Information Age Park is located approximately 5 miles from the plant.

Across the Ohio River, in Illinois, are several industrial and manufacturing facilities. These facilities, and the approximate number of employees at each facility, include the following:

1. Honeywell, Incorporated, 310 employees.
2. American Electric Power, Cook Coal Terminal, 65 employees.
3. Electric Energy Incorporated, 255 employees.
4. La Farge Corporation, 140 employees (formerly Missouri Portland Cement).
5. Laidlaw Corporation, 110 employees.
6. Metropolis Ready-Mix, 15 employees.
7. TECO Barge Line, 75 local employees.
8. Nation Wide Glove Company, 30 employees.
9. Harrah’s Casino, 950 employees.

Honeywell is licensed by the NRC to manufacture uranium hexafluoride (UF_6) feed, sulfur hexafluoride, iodine pentafluoride, antimony pentafluoride, and liquid fluorine. Some of the UF_6 is shipped to PGDP for use as feed. A release of UF_6 at Honeywell would not affect the operation of PGDP because of its distance and prevailing wind direction. There are no military facilities within 5 miles of PGDP, and the industrial facilities listed above do not have any hazards that could adversely affect PGDP.

2.2.2 Transportation Systems and Routes

A network of highways, rail lines, a regional airport, and water transportation serve the area adjacent to PGDP. The transportation network includes an interstate highway, two rail lines, and several U.S. highways.

U.S. highways that serve Paducah and the surrounding area are U.S. 45 (north-south), U.S. 62 (east-west); U.S. 68 (parallels the southern boundary of Kentucky before joining U.S. 62 in eastern Paducah); and U.S. 60, which follows Kentucky's northern border and is the principal highway access to PGDP. U.S. 60 is intersected by Kentucky Highway 1154 (running north-south), which provides the main access to the plant site at a point approximately 16 highway miles west of Paducah and 3 miles south of PGDP. U.S. 60 (at this intersection with Kentucky Highway 1154) is the closest major highway to PGDP.

I-24 passes through Paducah approximately 12 highway miles east of PGDP. It intersects U.S. 60 near the current city limits of Paducah. I-24 also intersects with I-40 and I-65 in Nashville, Tennessee, and with I-57 in southern Illinois.

Two principal rail lines serve the area. The Burlington Northern Railroad (BN) provides a north-south route between Paducah and Centralia, Illinois. A spur of the Paducah and Louisville Railroad (P&L) that serves PGDP branches off at the Paducah and Illinois (P&I) line about 20 miles west of Paducah. P&I is primarily a connector line for P&L and Illinois Central Gulf Railroad (ICRR), which serves cities between Memphis, Tennessee, and Chicago, Illinois, crossing an area about midway between PGDP and Paducah. This is also the closest approach of commercial rail traffic to PGDP, with the exception of those lines dedicated for PGDP and Shawnee Steam Plant use. Another branch of the ICRR line branches to St. Louis, Missouri, from Fulton, Kentucky, south of Paducah.

Barkley Regional Airport is the largest commercial and general aviation terminal in the region. It is located approximately 10 miles west of Paducah and 4 miles from PGDP. Another airfield that does not provide commercial service is located in eastern McCracken County, Williamson County Airport, approximately 55 miles north of Paducah in southern Illinois, also offers commercial air service.

Water transportation is available on the Ohio, Tennessee, and Cumberland Rivers located within 15 miles of PGDP. In addition, the Mississippi River flows approximately 30 miles to the west. The Port of Paducah, located near the confluence of the Ohio and Tennessee rivers, is a chief distribution terminal for petroleum products, scrap metal, cement, and massive volumes of coal. Barge access from Paducah is readily available to St. Louis, New Orleans, and Pittsburgh. No barge facilities are available or needed for PGDP.

2.2.3 Military Activities

No military facilities exist within 5 miles of PGDP.

2.2.4 DOE Activities

DOE activities on-site and adjacent to the site that do not adversely affect NRC-regulated operations at PGDP include groundwater contamination abatement and control, waste storage activities associated with environmental contamination remediation, waste disposal pilot projects, and limited decontamination and decommissioning (D&D) activities to comply with Resource Conservation and Recovery Act (RCRA) requirements, and management of UF_6 cylinders possessed by DOE.

The DOE regulates the operation of depleted uranium hexafluoride (DUF_6) conversion facility that is located on the DOE reservation south of the PGDP site. Based on the DOE-approved documented safety analysis (Reference 192), operation of the DUF_6 conversion facility will not involve mitigated accident scenarios that would adversely affect NRC-regulated operations at PGDP.

2.2.5 Cabinet for Health Services Commonwealth of Kentucky – Radioactive Material License

PGDP is allowed under a Radioactive Materials License from the Commonwealth of Kentucky (Cabinet for Health Services Commonwealth of Kentucky – Radioactive Material License) to receive radioactive contaminants in samples from sources in addition to what PGDP is currently authorized by the NRC-issued Certificate. PGDP is authorized under the NRC Certificate to conduct analysis of DOE samples related to uranium enrichment activities, including site remediation, from PGDP, PORTS and Oak Ridge. The Commonwealth of Kentucky License covers laboratory sample analyses and characterization activities conducted under contract agreements with DOE and other off-site customers for materials that are not related to uranium enrichment activities. Direct support activities such as shipping, receiving, and waste management are also covered under this radioactive materials license from the Commonwealth of Kentucky.

The activities conducted under the Commonwealth of Kentucky license are not significantly different than activities currently conducted under the SAR. These activities are performed in accordance with the same SAR, Technical Safety Requirements (TSRs), Nuclear Criticality Safety Requirements, Fire Protection Program, Radiation Protection Program and Chemical Safety Program utilized for NRC regulated activities. Samples processed under the Commonwealth of Kentucky license are uniquely identified and handled separately from receipt through disposal. The Application possession limits (Table 1-3) are governing for all operations onsite including those associated with the Commonwealth of Kentucky Radioactive Materials License.

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2.3 METEOROLOGY

This section provides a meterological description of PGDP and its surrounding area. The purpose is to provide meterological information necessary to understand the regional weather phenomena of concern for the PGDP operation and to understand the dispersion analyses performed. Meterological conditions that influence the design and operation of the facility are identified in Section 2.3.3.

2.3.1 Regional Climatology

PGDP is located in the western portion of the Ohio River drainage basin and in the extreme western area of Kentucky. In both elevation and relief, the area is lower than the other regions of Kentucky and is largely an upland plain, which is mostly undulating to gently rolling. The climate of the region may be broadly classified as temperate continental. Because of the geographic location with reference to the center of the continent, the midwinter cold waves from the Canadian Northwest are usually considerably modified by the time they reach Kentucky. In summer when the high pressure off the Florida coast is displaced westward from its normal position, extended periods of hot, humid weather occur. The spring and fall months are usually pleasant. Figure 2.3-2 graphically portrays monthly mean temperatures for the period from 1951 to 1980 at Paducah, Kentucky. (The data points labeled as daily maximum and minimum are averages over the period from 1951 to 1980. July is the hottest month with an average monthly temperature of 79°F, and January is the coldest month with an average temperature of 34°F.

The area lies in the path of rain-producing low-pressure systems moving northeastward from the western part of the Gulf of Mexico in the winder and spring months. Thunderstorms resulting from warm and moisture-laden air originating from the Gulf of Mexico are common during the spring and summer months and frequently deposit heavy amounts of rain. The area also receives precipitation from low-pressure systems that move across the continental United States from west to east. As a result, the precipitation is well distributed throughout the year (see Figure 2.3-3) with an average of 45.8 inches. The greatest daily rainfall during the period 1951-1980 was 8 in. on March 4, 1964. Snowfall occurrence varies from year to year, but is common from December through March. The average annual snowfall for the area is about 10 in. From 1951 to 1980, the maximum monthly snowfall was 22.6 in. which occurred in January 1978.

Occasionally, heavy amounts of rain associated with thunderstorms or low-pressure systems fall in a short period of time. The U. S. Weather Bureau has published values of the total precipitation for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. The results for the geographic locale including PGDP are summarized in Table 2.4-2. A local drainage analysis for extreme storms at PGDP has been performed.

The prevailing wind in the Paducah area comes from a south-to-southwest direction and averages between 7 to 9 mph during a normal year. Significant departures from this average can be expected during various seasons of the year. The wind direction during the winter months at Paducah is from northwest with an average wind speed greater than the annual average. Southwesterly winds with averages less than the annual average wind speed dominate from mid-spring through mid-fall months. On the average, from 1953 to 1989, eight tornadoes were reported a year in Kentucky; but the total

varies from year to year. Tornadoes occur in almost every section of the state and in every terrain — flat area, hilltop, or valley bottom. A greater number of tornadoes occurs in the western and northern sections of the state, and most of them approach from the southwest through the west.

2.3.2 On-Site Meteorological Measurements Program

A 200-ft tower (C-802), located in an open area south of the C-100 administration building at PGDP, contains instrumentation at heights of 33 and 197 ft. This tower was installed in 1987 to replace the older ones, which were in the proximity of large buildings and produced some deficient data. Initial testing and evaluation of the new tower and ancillary systems was conducted in 1988 by the National Oceanic and Atmospheric Administration. At the C-802 tower, meteorological parameters such as wind speed and direction, temperature, barometric pressure, relative humidity, and rainfall have been monitored to provide data on atmospheric stability and dispersion modeling, NESHAP dose modeling, as well as other data for chemical release plume modeling.

The C-802 tower is no longer relied upon to acquire input data for dispersion modeling, NESHAP dose modeling and chemical release plume modeling. A historical meteorological data set (1988-1992) collected from the tower is used for input to the computer code to demonstrate compliance with EPA's 40 CFR 61 dose to the public standard as described in SAR Section 5.1.3.1. The dispersion analysis for the accident evaluation in SAR 4.3 also utilized this historical meteorological data set. Real-time data from the C-300 meteorological station located east of the C-300 Central Control Facility at PGDP is used to provide the primary source for wind speed, wind direction, and temperature input data for chemical release plume modeling supporting emergency management.

In addition to the on-site meteorological measurements program, meteorological measurements data can be obtained from the National Weather Service.

2.3.3 Local Meterology

Hourly temperatures at 33- and 197-ft levels above ground at PGDP for 1992 have been analyzed. Of the 8,784 possible data points, 8,238 are available at each level. The seasonal temperature variation and the daily temperature fluctuations are consistent with the long-term averages for Paducah. The two sets of temperature readings are highly correlated because the two measuring points are separated only by a 164-ft difference in height. Temperature at the 197-ft level is generally lower than that at the 33-ft level.

Hourly relative humidity data for 1991 and 1992 have been analyzed. The numbers of available data points are 7,941 out of 8,760 for 1991 and 8,164 out of 8,784 for 1992. The average relative humidity was 63.7 percent for 1991 and 59.7 percent for 1992.

Hourly wind speed and wind direction data for 1992 obtained from PGDP have been analyzed. Out of 8,874 possible hourly data sets, 8,023 are available for wind speed and 7,931 for wind direction. The average wind speeds are 6.6 and 9.9 mph at 33- and 197-ft levels. The wind-speed and direction for the different elevations are very similar. A corresponding comparison between the wind speed at PGDP and that at Barkley Regional Airport shows a smaller degree of correlation, presumably because of the 4 mile separation of the two locations. Wind roses at 33 and 197 at PGDP constructed from the 1992 data are compared in Figure 2.3-1a. Average wind roses constructed from 1988 to 1992 data are also shown in Figure 2.3-1b and 2.3-1c.

Joint frequency distribution of atmospheric stability, wind direction, and wind speed at 33 ft above ground at PGDP from 1988 to 1992 has been calculated. Sigma theta data (standard deviations of the wind direction) were used when available, and $\Delta T/\Delta Z$ data were used otherwise. In both cases correction was made according to wind speed and hour of the day, so that there would be no F stabilities during the day and no A stabilities during nighttime. The calculated frequency distributions at 33- and 197-ft levels are shown in Tables 2.3-3a and 2.3-3b.

Table 2.3-1 deleted

Table 2.3-2 deleted.

Table 2.3-3a. Joint frequency distribution of atmospheric stability, wind direction, and wind speed at 33 ft above ground at PGDP from 1988 to 1992 (%)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
A	N	0.041	0.669	0	0	0	0	0	0	0.710
	NNE	0.043	0.295	0	0	0	0	0	0	0.338
	NE	0.025	0.221	0	0	0	0	0	0	0.247
	ENE	0.010	0.369	0	0	0	0	0	0	0.379
	E	0.025	0.407	0	0	0	0	0	0	0.432
	ESE	0.031	0.203	0	0	0	0	0	0	0.234
	SE	0.056	0.239	0	0	0	0	0	0	0.295
	SSE	0.069	0.280	0	0	0	0	0	0	0.348
	S	0.122	0.443	0	0	0	0	0	0	0.565
	SSW	0.125	0.478	0	0	0	0	0	0	0.603
	SW	0.132	0.427	0	0	0	0	0	0	0.560
	WSW	0.155	0.361	0	0	0	0	0	0	0.516
	W	0.125	0.354	0	0	0	0	0	0	0.478
	WNW	0.183	0.392	0	0	0	0	0	0	0.575
	NW	0.181	0.735	0	0	0	0	0	0	0.916
	NNW	0.142	0.725	0	0	0	0	0	0	0.867
	Total	1.465	6.598	0	0	0	0	0	0	8.063
B	N	0.008	0.318	0.323	0	0	0	0	0	0.649
	NNE	0.003	0.168	0.191	0	0	0	0	0	0.361
	NE	0.010	0.114	0.071	0	0	0	0	0	0.196
	ENE	0.005	0.265	0.104	0	0	0	0	0	0.374
	E	0.013	0.285	0.071	0	0	0	0	0	0.369
	ESE	0.008	0.132	0.033	0	0	0	0	0	0.173
	SE	0.015	0.127	0.074	0	0	0	0	0	0.216
	SSE	0.033	0.160	0.079	0	0	0	0	0	0.272
	S	0.033	0.231	0.170	0	0	0	0	0	0.435
	SSW	0.041	0.325	0.277	0	0	0	0	0	0.272
	SW	0.053	0.425	0.285	0	0	0	0	0	0.763
	WSW	0.018	0.181	0.066	0	0	0	0	0	0.458
	W	0.018	0.181	0.066	0	0	0	0	0	0.265
	WNW	0.059	0.203	0.117	0	0	0	0	0	0.379
	NW	0.036	0.353	0.242	0	0	0	0	0	0.621
	NNW	0.023	0.287	0.298	0	0	0	0	0	0.608
	Total	0.404	3.842	2.536	0	0	0	0	0	6.783

Table 2.3-3a (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
C	N	0.018	0.153	0.684	0.107	0	0	0	0	0.962
	NNE	0.013	0.158	0.354	0.046	0	0	0	0	0.570
	NE	0.008	0.130	0.196	0.015	0	0	0	0	0.348
	ENE	0	0.270	0.198	0.005	0	0	0	0	0.473
	E	0.010	0.272	0.135	0	0	0	0	0	0.417
	ESE	0.008	0.137	0.120	0	0	0	0	0	0.265
	SE	0.005	0.176	0.114	0.005	0	0	0	0	0.300
	SSE	0.035	0.193	0.287	0.023	0	0	0	0	0.539
	S	0.028	0.280	0.549	0.074	0	0	0	0	0.931
	SSW	0.051	0.389	1.173	0.137	0	0	0	0	1.750
	SW	0.020	0.491	0.845	0.076	0	0	0	0	1.432
	WSW	0.033	0.298	0.333	0.010	0	0	0	0	0.674
	W	0.028	0.206	0.242	0.033	0	0	0	0	0.509
	WNW	0.043	0.186	0.325	0.008	0	0	0	0	0.562
	NW	0.025	0.215	0.394	0.033	0	0	0	0	0.669
	NNW	0.048	0.183	0.539	0.048	0	0	0	0	0.819
	Total	0.374	3.738	6.489	0.620	0	0	0	0	11.220
D	N	0.066	0.730	1.473	0.679	0.025	0	0.010	0.020	3.004
	NNE	0.043	0.865	1.379	0.544	0.015	0	0	0	2.846
	NE	0.025	0.565	0.781	0.092	0	0.003	0	0	1.465
	ENE	0.031	1.043	1.137	0.055	0.003	0	0	0	2.279
	E	0.041	0.806	0.226	0.003	0.003	0	0	0.003	1.081
	ESE	0.048	0.562	0.359	0.013	0	0	0	0	0.982
	SE	0.112	0.956	0.616	0.066	0.013	0	0	0	1.763
	SSE	0.453	1.226	0.875	0.376	0.033	0	0	0	2.963
	S	0.481	1.424	1.750	1.012	0.148	0	0	0	4.815
	SSW	0.445	1.597	2.447	1.686	0.140	0	0	0	6.316
	SW	0.422	1.165	1.063	0.394	0.048	0	0	0	3.093
	WSW	0.465	0.743	0.448	0.127	0.005	0	0	0	1.788
	W	0.382	0.486	0.285	0.055	0	0	0	0	1.218
	WNW	0.468	0.654	0.366	0.064	0	0	0	0	1.552
	NW	0.527	0.845	0.595	0.168	0.005	0.003	0	0	2.142
	NNW	0.374	0.287	0.885	1.104	0.364	0.008	0.003	0	2.740
	Total	4.383	14.552	14.904	5.720	0.446	0.009	0.013	0.023	40.047

Table 2.3-3a (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
E	N	0.061	0.753	0.328	0	0	0	0	0	1.142
	NNE	0.025	0.402	0.422	0	0	0	0	0	0.850
	NE	0.010	0.150	0.112	0	0	0	0	0	0.272
	ENE	0.008	0.346	0.310	0	0	0	0	0	0.664
	E	0.020	0.191	0.013	0	0	0	0	0	0.224
	ESE	0.018	0.298	0.059	0	0	0	0	0	0.374
	SE	0.066	0.707	0.252	0	0	0	0	0	1.035
	SSE	0.333	1.178	0.417	0	0	0	0	0	1.928
	S	0.552	1.585	0.532	0	0	0	0	0	2.668
	SSW	0.555	1.496	0.631	0	0	0	0	0	2.681
	SW	0.558	0.649	0.076	0	0	0	0	0	1.313
	WSW	0.473	0.394	0.059	0	0	0	0	0	0.926
	W	0.336	0.315	0.010	0	0	0	0	0	0.661
	WNW	0.455	0.244	0.028	0	0	0	0	0	0.727
	NW	0.539	0.458	0.081	0	0	0	0	0	1.079
	NNW	0.356	0.697	0.163	0	0	0	0	0	1.216
	Total	4.395	9.863	3.503	0	0	0	0	0	17.760
F	N	0.059	0.348	0	0	0	0	0	0	0.407
	NNE	0.005	0.094	0	0	0	0	0	0	0.099
	NE	0.010	0.025	0	0	0	0	0	0	0.036
	ENE	0.013	0.056	0	0	0	0	0	0	0.069
	E	0.015	0.061	0	0	0	0	0	0	0.076
	ESE	0.028	0.053	0	0	0	0	0	0	0.081
	SE	0.046	0.333	0	0	0	0	0	0	0.379
	SSE	0.371	0.962	0	0	0	0	0	0	1.333
	S	0.633	1.150	0	0	0	0	0	0	1.783
	SSW	0.371	0.962	0	0	0	0	0	0	1.625
	SW	0.577	0.440	0	0	0	0	0	0	1.017
	WSW	0.463	0.176	0	0	0	0	0	0	0.638
	W	0.432	0.132	0	0	0	0	0	0	0.565
	WNW	0.537	0.170	0	0	0	0	0	0	0.707
	NW	0.638	0.196	0	0	0	0	0	0	0.834
	NNW	0.453	0.460	0	0	0	0	0	0	0.913
	Total	4.916	5.645	0	0	0	0	0	0	10.562

Table 2.3-3a (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
G	N	0.036	0.035	0	0	0	0	0.003	0.018	0.092
	NNE	0.018	0.008	0	0	0	0	0	0	0.025
	NE	0.003	0.013	0	0	0	0	0	0	0.015
	ENE	0.003	0.010	0	0	0	0	0	0	0.013
	E	0.028	0.023	0	0	0	0	0	0	0.051
	ESE	0.005	0.010	0	0	0	0	0	0	0.015
	SE	0.043	0.117	0.003	0	0	0	0	0	0.163
	SSE	0.387	0.488	0.003	0	0	0	0	0	0.878
	S	0.593	0.443	0	0	0	0	0	0	1.035
	SSW	0.529	0.555	0	0	0	0	0	0	1.084
	SW	0.369	0.163	0	0	0	0	0	0	0.532
	WSW	0.242	0.046	0	0	0	0	0	0	0.287
	W	0.282	0.036	0	0	0	0	0	0	0.318
	WNW	0.338	0.008	0	0	0	0	0	0	0.346
	NW	0.420	0.010	0	0	0	0	0	0	0.430
	NNW	0.224	0.056	0	0	0	0	0	0	0.280
	Total	3.520	2.022	0.006	0	0	0	0.003	0.018	5.564

Table 2.3-3b. Joint frequency distribution of atmospheric stability, wind direction, and wind speed at 197 ft above ground at PGDP from 1988 to 1992 (%)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
A	N	0.066	0.399	0	0	0	0	0	0	0.465
	NNE	0.091	0.273	0	0	0	0	0	0	0.364
	NE	0.084	0.249	0	0	0	0	0	0	0.332
	ENE	0.062	0.330	0	0	0	0	0	0	0.391
	E	0.106	0.419	0	0	0	0	0	0	0.524
	ESE	0.076	0.251	0	0	0	0	0	0	0.327
	SE	0.066	0.194	0	0	0	0	0	0	0.261
	SSE	0.079	0.276	0	0	0	0	0	0	0.355
	S	0.113	0.239	0	0	0	0	0	0	0.352
	SSW	0.145	0.345	0	0	0	0	0	0	0.490
	SW	0.111	0.293	0	0	0	0	0	0	0.404
	WSW	0.084	0.303	0	0	0	0	0	0	0.387
	W	0.128	0.261	0	0	0	0	0	0	0.389
	WNW	0.128	0.330	0	0	0	0	0	0	.4585
	NW	0.165	0.505	0	0	0	0	0	0	0.670
	NNW	0.145	0.443	0	0	0	0	0	0	0.588
	Total	1.649	5.110	0	0	0	0	0	0	6.757
B	N	0.005	0.246	0.212	0	0	0	0	0	0.463
	NNE	0.017	0.214	0.185	0	0	0	0	0	0.416
	NE	0.015	0.175	0.111	0	0	0	0	0	0.300
	ENE	0.017	0.231	0.160	0	0	0	0	0	0.409
	E	0.034	0.310	0.145	0	0	0	0	0	0.490
	ESE	0.042	0.145	0.084	0	0	0	0	0	0.271
	SE	0.015	0.153	0.094	0	0	0	0	0	0.261
	SSE	0.020	0.165	0.094	0	0	0	0	0	0.278
	S	0.017	0.190	0.130	0	0	0	0	0	0.337
	SSW	0.037	0.254	0.180	0	0	0	0	0	0.470
	SW	0.037	0.276	0.244	0	0	0	0	0	0.556
	WSW	0.015	0.177	0.177	0	0	0	0	0	0.369
	W	0.020	0.182	0.076	0	0	0	0	0	0.278
	WNW	0.022	0.155	0.130	0	0	0	0	0	0.308
	NW	0.019	0.197	0.148	0	0	0	0	0	0.362
	NNW	0.020	0.197	0.231	0	0	0	0	0	0.448
	Total	0.350	3.267	2.401	0	0	0	0	0	6.016

Table 2.3-3b (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
C	N	0.015	0.148	0.623	0.108	0	0	0	0	0.894
	NNE	0.047	0.177	0.490	0.054	0	0	0	0	0.768
	NE	0.017	0.143	0.315	0.049	0	0	0	0	0.524
	ENE	0.022	0.227	0.342	0.044	0	0	0	0	0.635
	E	0.017	0298	0.295	0.025	0	0	0	0	0.640
	ESE	0.017	0.150	0.197	0.047	0	0	0	0	0.411
	SE	0.017	0.148	0.214	0.039	0	0	0	0	0.419
	SSE	0.034	0.155	0.271	0.049	0	0	0	0	0.510
	S	0.032	0.199	0.463	0.066	0	0	0	0	0.761
	SSW	0.044	0.249	0.822	0.209	0	0	0	0	1.325
	SW	0.030	0.283	0.872	0.153	0	0	0	0	1.337
	WSW	0.020	0.197	0.483	0.054	0	0	0	0	0.753
	W	0.010	0.155	0.227	0.047	0	0	0	0	0.438
	WNW	0.027	0.086	0.313	0.042	0	0	0	0	0.468
	NW	0.017	0.108	0.389	0.076	0	0	0	0	0.591
	NNW	0.015	0.113	0.475	0.111	0	0	0	0	0.714
	Total	0.374	3.738	6.791	1.173	0	0	0	0	11.188
D	N	0.081	0.820	1.743	1.773	0.276	0.012	0.007	0.034	4.747
	NNE	0.162	0.795	1.590	1.315	0.187	0.002	0	0	4.052
	NE	0.108	0.731	1.199	0.677	0.062	0	0	0	2.777
	ENE	0.106	0.744	1.233	0.576	0.069	0	0	0	2.728
	E	0.130	1.128	1.017	0.372	0.034	0	0	0	2.681
	ESE	0.101	0.926	0.443	0.037	0.002	0	0	0	2.194
	SE	0.071	0.480	1.125	0.660	0.064	0.005	0	0	2.405
	SSE	0.079	0.542	1.381	1.069	0.148	0.022	0	0	3.240
	S	0.069	0.551	1.962	2.066	0.406	0.079	0	0	5.133
	SSW	0.074	0.620	2.937	3.206	0.724	0.096	0	0	7.657
	SW	0.032	0.551	1.512	1.620	0.219	0.057	0.002	0	3.993
	WSW	0.059	0.384	0.881	0.709	0.081	0.017	0.002	0	2.135
	W	0.059	0.278	0.556	0.554	0.054	0.005	0	0	1.507
	WNW	0.057	0.389	0.510	0.453	0.091	0.002	0	0	1.502
	NW	0.064	0.423	0.793	0.721	0.182	0.042	0.002	0	2.228
	NNW	0.062	0.318	0.990	1.209	0.212	0.047	0.002	0	2.839
	Total	1.314	9.4382	20.355	17.423	2.846	0.388	0.015	0.034	51.818

Table 2.3-3b (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
E	N	0.052	0.483	1.098	0	0	0	0	0	1.632
	NNE	0.052	0.583	0.859	0	0	0	0	0	1.494
	NE	0.069	0.458	0.451	0	0	0	0	0	0.977
	ENE	0.042	0.318	0.293	0	0	0	0	0	0.652
	E	0.086	0.423	0.308	0	0	0	0	0	0.817
	ESE	0.066	0.401	0.490	0	0	0	0	0	0.958
	SE	0.027	0.409	0.859	0	0	0	0	0	1.295
	SSE	0.030	0.421	1.120	0	0	0	0	0	1.571
	S	0.044	0.475	1.487	0	0	0	0	0	2.007
	SSW	0.037	0.458	1.839	0	0	0	0	0	2.334
	SW	0.059	0.340	1.059	0	0	0	0	0	1.458
	WSW	0.047	0.263	0.524	0	0	0	0	0	0.835
	W	0.034	0.239	0.382	0	0	0	0	0	0.655
	WNW	0.059	0.256	0.340	0	0	0	0	0	0.655
	NW	0.059	0.278	0.502	0	0	0	0	0	0.840
	NNW	0.062	0.335	0.547	0	0	0	0	0	0.943
	Total	0.825	6.140	12.158	0	0	0	0	0	19.123
F	N	0.066	0.241	0	0	0	0	0	0	0.308
	NNE	0.066	0.234	0	0	0	0	0	0	0.300
	NE	0.052	0.172	0	0	0	0	0	0	0.224
	ENE	0.079	0.081	0	0	0	0	0	0	0.160
	E	0.084	0.155	0	0	0	0	0	0	0.239
	ESE	0.091	0.111	0	0	0	0	0	0	0.202
	SE	0.054	0.138	0	0	0	0	0	0	0.192
	SSE	0.049	0.160	0	0	0	0	0	0	0.209
	S	0.047	0.177	0	0	0	0	0	0	0.224
	SSW	0.049	0.172	0	0	0	0	0	0	0.222
	SW	0.047	0.086	0	0	0	0	0	0	0.133
	WSW	0.062	0.101	0	0	0	0	0	0	0.162
	W	0.079	0.138	0	0	0	0	0	0	0.217
	WNW	0.079	0.153	0	0	0	0	0	0	0.231
	NW	0.086	0.202	0	0	0	0	0	0	0.288
	NNW	0.096	0.177	0	0	0	0	0	0	0.273
	Total	1.086	2.498	0	0	0	0	0	0	3.5842

Table 2.3-3b (Continued)

Stability Class	Wind Direction	Wind Speed Class (mph)								
		1-3.5	3.5-7.5	7.5-12.5	12.5-18.5	18.5-24.5	24.5-31.5	31.5-38	>38	Total
G	N	0.010	0.202	0	0	0	0	0	0	0.212
	NNE	0.027	0.145	0	0	0	0	0	0	0.172
	NE	0.025	0.076	0	0	0	0	0	0	0.101
	ENE	0.027	0.108	0	0	0	0	0	0	0.135
	E	0.015	0.121	0	0	0	0	0	0	0.135
	ESE	0.015	0.069	0	0	0	0	0	0	0.084
	SE	0.017	0.057	0	0	0	0	0	0	0.074
	SSE	0.005	0.059	0	0	0	0	0	0	0.064
	S	0.007	0.091	0	0	0	0	0	0	0.098
	SSW	0.017	0.062	0	0	0	0	0	0	0.079
	SW	0.002	0.042	0	0	0	0	0	0	0.044
	WSW	0.007	0.044	0	0	0	0	0	0	0.052
	W	0.025	0.039	0	0	0	0	0	0	0.064
	WNW	0.017	0.057	0	0	0	0	0	0	0.074
	NW	0.007	0.052	0	0	0	0	0	0	0.059
	NNW	0.007	0.057	0	0	0	0	0	0	0.064
	Total	0.230	1.281	0	0	0	0	0	0	1.511

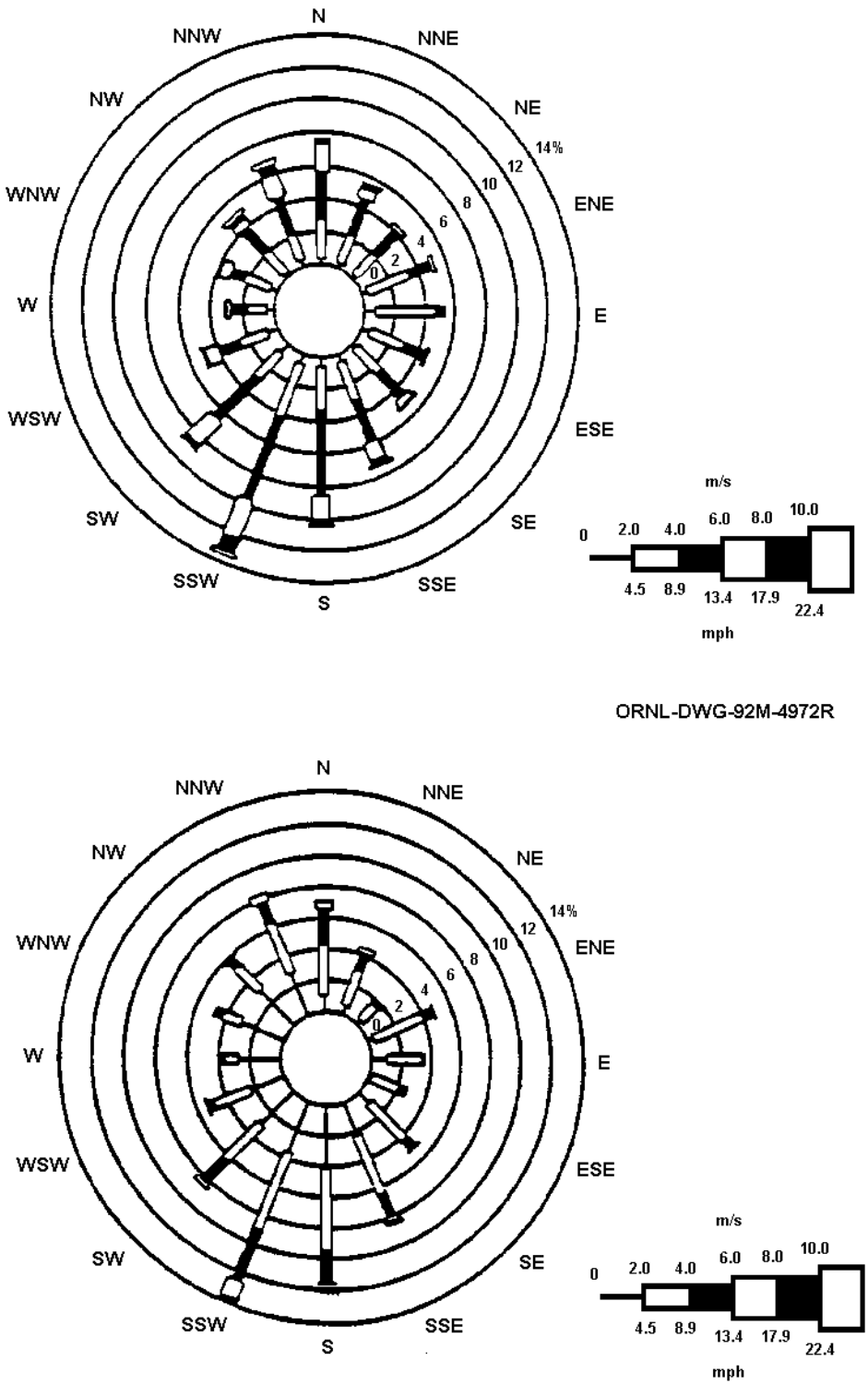

Figure 2.3-1a. Comparison of wind roses at 33 ft and 197 ft levels at PGDP for 1992.

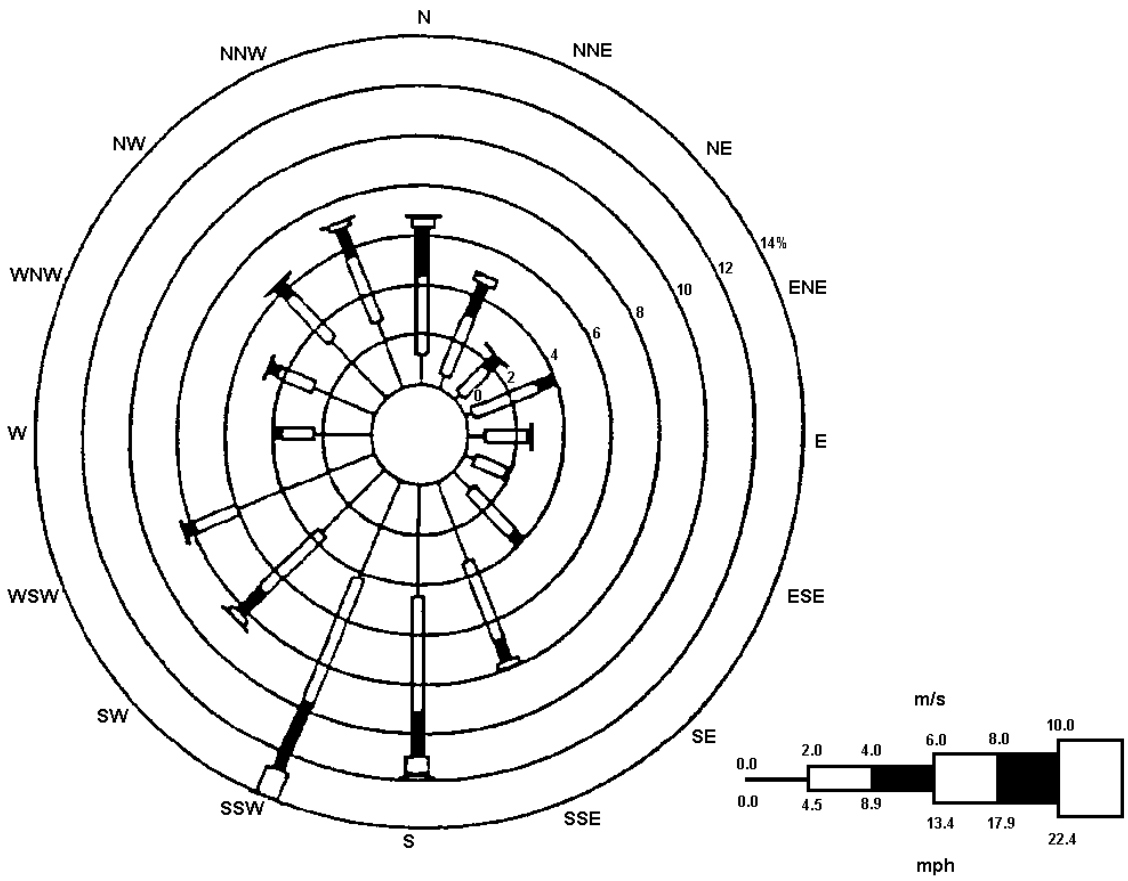

Figure 2.3-1b. Average wind rose at 33 ft level at PGDP for 1988-1992.

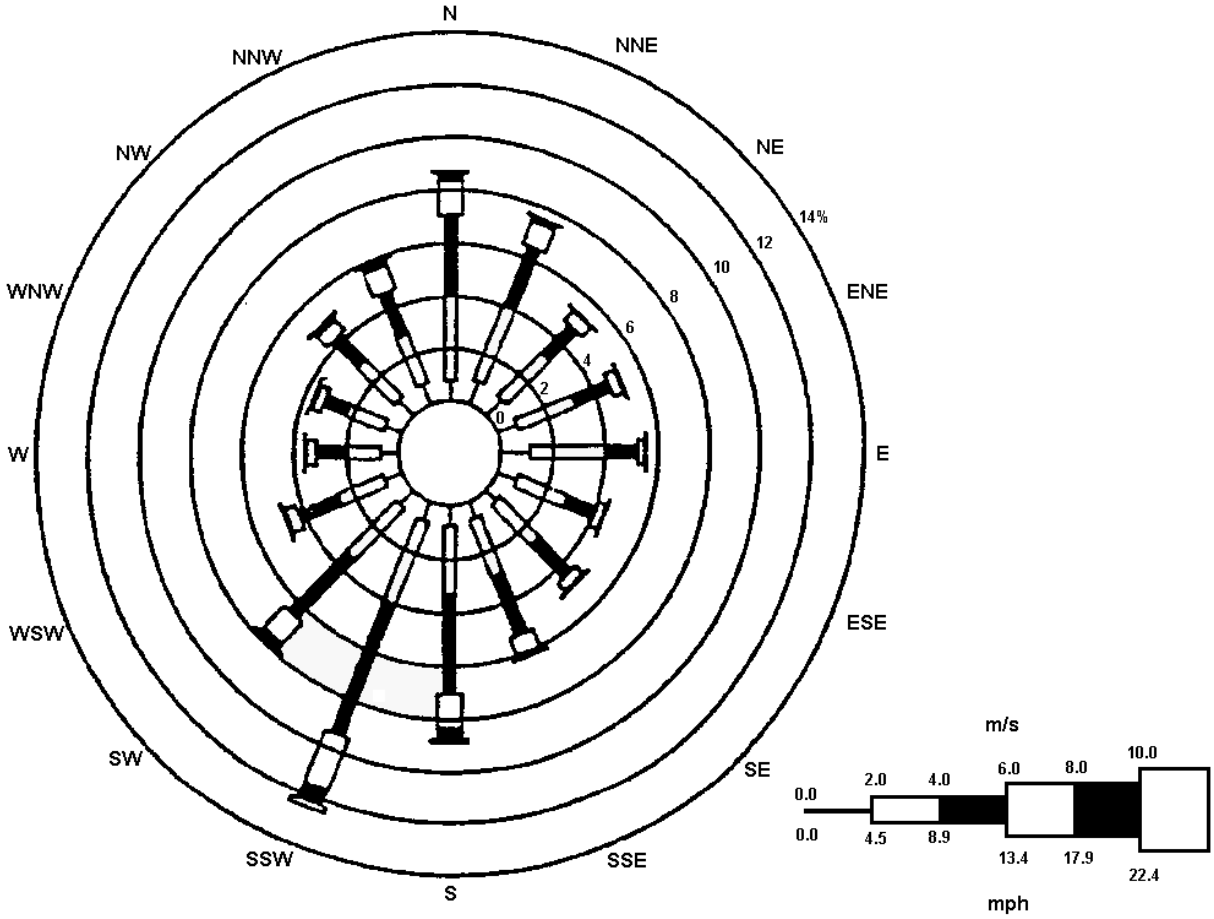

Figure 2.3-1c. Average wind rose at 197 ft level at PGDP for 1988-1992.

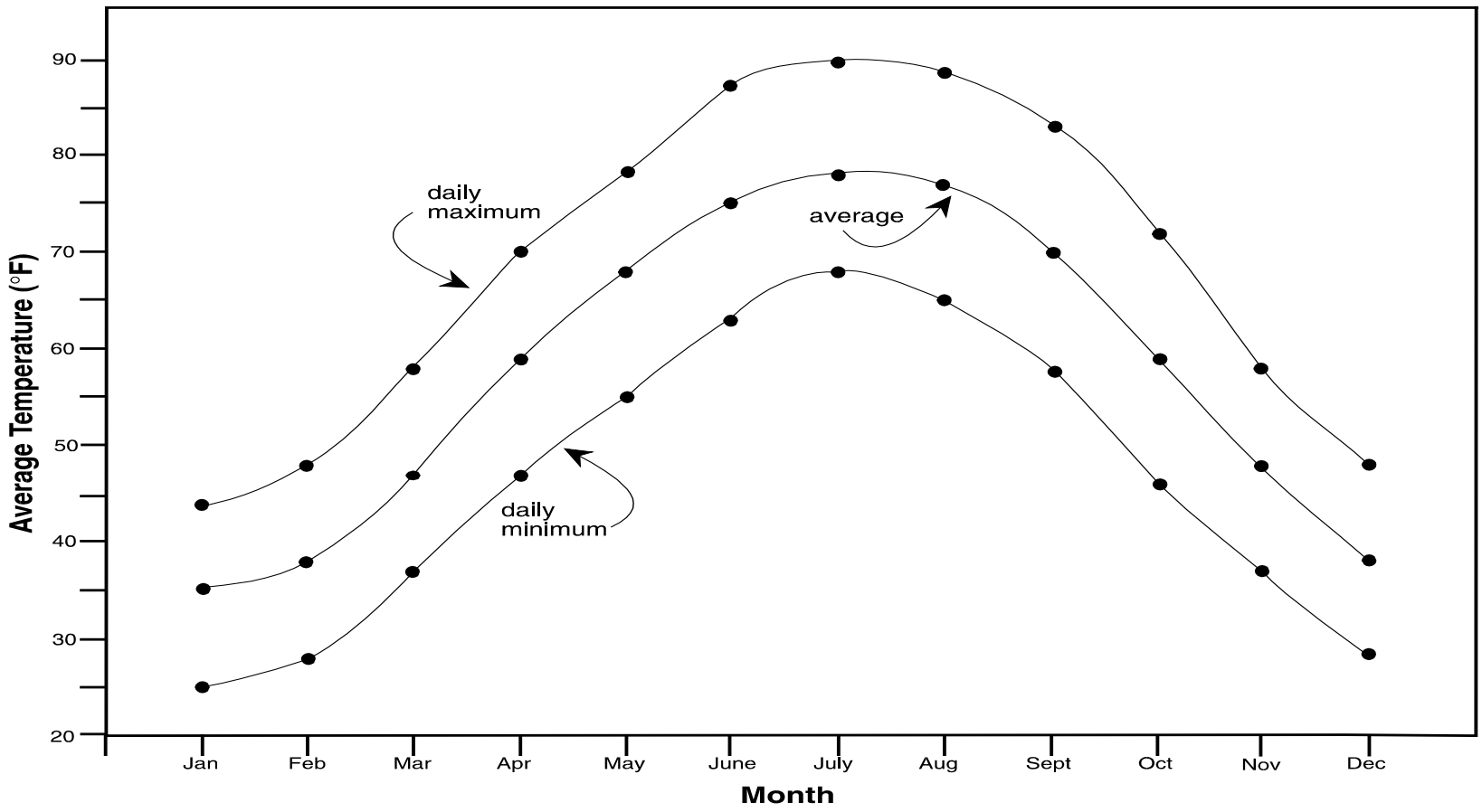

Figure 2.3-2. Monthly mean temperatures averaged over the period from 1951 to 1980 at Paducah, Kentucky.

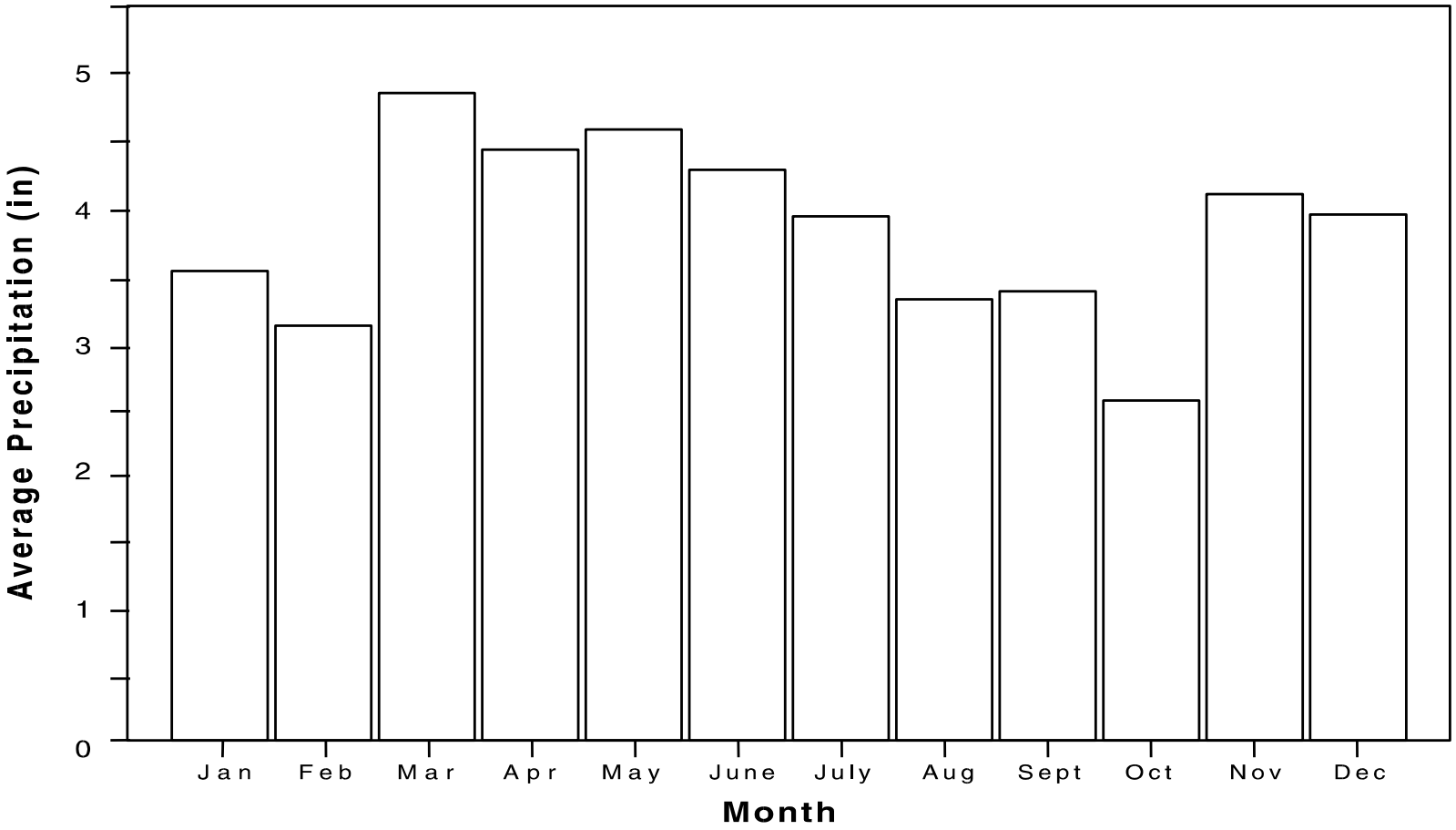

Figure 2.3-3. Monthly mean precipitation averaged over the period from 1951 to 1980 at Paducah, Kentucky.

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2.4 SURFACE HYDROLOGY

2.4.1 Hydrologic Description

2.4.1.1 Ohio River Basin

PGDP is located near the western edge of the Ohio River basin approximately 3.5 miles south of the Ohio River near river mile (RM) 946. The confluence of the Ohio River with the Tennessee River is 12.5 miles upstream from PGDP near RM 934.5, and the Cumberland River enters the Ohio River at RM 920.4 The Ohio River basin includes major portions of Ohio, Indiana, Kentucky, and West Virginia, substantial parts of Pennsylvania, Illinois, and Tennessee, and small areas of New York, Maryland, Virginia, and North Carolina. The Ohio River basin has about 170 major manmade reservoirs, many more small impoundments, and a few natural lakes. The total water surface area is about 1 percent or 1 million acres of the basin area. The confluence of the Ohio and Mississippi Rivers occurs downstream from PGDP at RM 981.

Twenty dams are on the 981-mile main stem of the Ohio River. The closest three dams to PGDP are Locks and Dams No. 52 and 53 and Smithland. They are also the most downstream locks and dams on the Ohio River. Dams 52 and 53 are low-head structures, built in the 1920's to facilitate navigation, and are submerged during medium to high streamflow conditions.

Based on United States Geological Survey (USGS) data from the Metropolis, Illinois, gauging station, between Dams 52 and 53, average annual discharge between 1928 and 1987 was 271,000 cfs. The maximum discharge of record was 1,780,000 cfs on February 1, 1937, and the minimum discharge was 15,000 cfs on July 30, 1930.

Two municipal water supply intakes, one for Paducah and one serving Cairo, Illinois (population about 6,000), are on the segment of the river from Smithland Lock and Dam to the confluence of the Ohio and Mississippi Rivers. In the same segment, there are two industrial intakes: TVA's Shawnee Steam Plant at RM 946.0, and Electric Energy Plant at RM 952.2. The Shawnee Steam Plant, about 3 miles north of PGDP on the Ohio River, withdraws about 2,410 cfs for cooling and sanitary purposes, and Electric Energy Plant withdraws 815 cfs. PGDP withdraws cooling water through a separate structure at the TVA intake structure. The amount of water withdrawn depends on the production levels and power demands. The average water withdrawal for PGDP is 19 cfs. At a maximum power usage of 3,040 MW, water withdrawal would be about 45 cfs. At zero power consumption, the amount of water withdrawn corresponds to sanitary usage of about 4.3 cfs.

The ground surface elevation decreases in the direction from PGDP toward the Ohio River. A portion of the groundwater seepage discharges as backflow into the Ohio River.

2.4.1.2 The PGDP Area

PGDP is located within the drainage areas of Big and Little Bayou Creeks, which meet about 3.5 miles north of the site and discharge into the Ohio River near RM 948. Big Bayou Creek is a perennial stream, and drainage from this creek extends from approximately 2.5 miles south of PGDP to the Ohio

River. Little Bayou Creek originates in the wildlife management area and flows north toward the Ohio River along a 6.5-mile course that includes parts of the eastern boundary of the plant. Big Bayou Creek has a 11,910-acre drainage basin, and the watershed for Little Bayou Creek consists of about 6,000 acres. Site surface hydrology is shown in Figure 2.4-2. In the absence of discharge from the plant, these creeks can be expected to have minimal to no flow on a number of days from May through June and October through November. On other days, the creeks may discharge many millions of gallons per day to the Ohio River. Effluents from PGDP operations constitute about 85 percent of the normal flow in Big Bayou Creek and near 100 percent of the normal flow in Little Bayou Creek. Average discharge from PGDP — including blowdown from the cooling towers, sewage discharge, once-through cooling and storm water runoff — to the Ohio River via the two creeks is 6.3 cfs. Little Bayou Creek also receives an average of 0.1 cfs as storm water runoff from the Shawnee Power Plant.

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No domestic, commercial, or industrial water withdrawals are known to occur from either Big Bayou or Little Bayou Creek. These creeks cannot be relied upon for a noninterruptible source of water supply. The creeks interact with the groundwater system near and beneath PGDP. The interaction depends locally on the surface water levels and on the sizes, elevations, and hydraulic properties of the bottoms of the creeks.

2.4.1.3 Site and Facilities

The nominal, top-of-grade elevation at PGDP is 380 ft above MSL, about 80 ft above the average water level of the Ohio River near the plant. The PGDP site drains to multiple outfalls (see Figure 2.4-3) that discharge into the Big Bayou and Little Bayou Creeks. The total flow during normal plant operation is about 20.6 cfs. The storm sewer system which drains much of the plant connects to the outfalls either directly or through a series of ditches and culverts.

There are tunnels beneath buildings that carry instrument cables and provide telemetry for process control. The minimum floor elevation in these tunnels is 362.5 ft, but there is no direct pathway for flood waters to enter these tunnels other than underground seepage.

The patrol road that parallels the security fence at PGDP has been built on a slightly raised berm. The elevation of the road ranges from 367.8 to 380.2 ft above MSL. These elevations are compared with various flood stages in later sections. Culverts are installed beneath the patrol road.

2.4.2 Flood History

Ohio River streamflow data from the Metropolis, Illinois, station shows that the average annual discharge between 1928 and 1987 is 271,000 cfs. The maximum discharge of record is 1,780,000 cfs observed on February 1, 1937. The stage of the 1937 flood was 342 ft above MSL. The historical high water mark near PGDP and elevations for floods with three recurrence intervals estimated by the U.S. Army Corps of Engineers are presented in Table 2.4-1.

The facilities at PGDP have all been built on ground ranging in elevation from 367 to 381 ft above MSL and are about 25 to 39 ft above the historical high water level for the Ohio River in the area. The 340-ft contour, which has about the same elevation as the historical high mark, extends up Big and Little Bayou Creeks to a point near the northern boundary of PGDP. The occupied portion of the PGDP site itself has not been affected by Ohio River flooding.

2.4.3 Probable Maximum Flood

PGDP uses a deterministic, probable maximum flood (PMF) analysis as outlined in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59 [Reference 118] and in American National Standards Institute/American Nuclear Society Standard ANSI/ANS-2.8-1981 [Reference 4] to assess the potential consequences of a major regional flood at PGDP. The objective is to provide an initial evaluation of the flooding potential at a given site. These results are discussed in Section 2.4.3.2.

The failure of dams upstream from PGDP, which would be a consequence of the PMF, is not considered significant for the following reasons. Failure of either the Kentucky or Barkley Dam, coincident with a PMF, is an unlikely event because spillway capacity and dam structural integrity are sufficient to pass the PMF discharge. Coincident failure of the remaining dams upstream on the Ohio River and its tributaries, other than the Kentucky and Barkley Dams, would have a negligible effect on the PMF stage near PGDP. The run-of-the-river dams located along the main stem of the Ohio River are low-head structures that are under water during medium to high streamflow conditions. The storage capacity of these upstream, main stem, Ohio River dams is limited, and any commensurate flood wave would be substantially attenuated prior to reaching PGDP. Dams located along tributary rivers (other than the Cumberland and Tennessee Rivers) are very distant from PGDP and would not pose a threat to the plant given flood wave attenuation.

Simultaneous failure of both the Kentucky and Barkley Dams at full pool would result in an Ohio River discharge and peak stage near PGDP of 520,000 cfs and 321.6 ft, respectively. In accordance with ANSI/ANS-2.8-1981 [Reference 4], this discharge should be combined with that of either a 25-year flood or one-half of the PMF of the Ohio River. The discharge rate of a 25-year flood is about 1,070,000 cfs, and that of the PMF is about 4,000,000 cfs. The combined discharge rate of the above-mentioned dam failure with a 25-year flood is 1,590,000 cfs, and that with one-half PMF is 2,520,000 cfs. In either case, the combined discharge rate is smaller than that of the PMF. The PMF is, therefore, the bounding event in determining the design loads from flooding for PGDP.

2.4.3.1 Effects of Local Intense Precipitation

Storm Intensities and 10,000-Year Storms

The U.S. National Weather Service has published values of the total precipitation reaching the ground for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. The results for the geographic locale, including Paducah and PGDP, are summarized in Table 2.4-2. Values for 10,000-year storms are extrapolated from smaller duration values using a least-squares method. The rainfall intensity for a given storm listed in Table 2.4-2 can be obtained by dividing the precipitation by the duration.

The intensity vs. duration relation for 10,000-year storms at PGDP is required to predict the influx of rainwater that is conveyed by hydraulic structures. This was accomplished by adopting an established empirical equation in conjunction with a nonlinear least-squares methodology to determine the values of the parameters. The resultant intensity vs. duration graph for 10,000-year storms at PGDP is shown in Figure 2.4-4. At small durations, although the intensities are high, the total precipitations are small. At large durations, the trend is reversed.

Results for Creeks

Peak discharges for the Big Bayou and Little Bayou creeks during a 10,000-year storm were found to be 9,900 cfs and 5,580 cfs, respectively, as shown in Table 2.4-3. The corresponding water levels were found to be 370.8 ft in Big Bayou Creek, and 363.6 ft in Little Bayou Creek. The main process buildings would not be inundated by Big Bayou and Little Bayou Creeks during a 10,000-year storm because their top-of-slab elevations are either equal to or greater than 380 ft. This ponding would not adversely impact facility operations.

Results for Storm Sewers

The results indicate that PGDP is expected to undergo local ponding during a 10,000-year storm. The depth of water around the entrances and base of the main process buildings as well as ground level air intakes was calculated to range from 1.64 to 5.89 in. The existing storm sewer system would require from approximately 0.2 to 8.5 hours to drain the excess storm water to the outfalls.

The effect of a clogged storm sewer system on the ponding depth has been considered. Because the storm sewer flow is approximately 25 percent of the total 10,000-year storm flow, the overland drainage system is the dominant factor in determining the water depth at the base of the buildings. This means that local ponding levels can be controlled by keeping natural surfaces within the security fence grassed, mowed, and free of high weeds and debris.

The most likely portion of PGDP that could be affected by a 10,000-year storm would be tunnels beneath buildings that carry instrument cables and provide telemetry for process control. The minimum floor elevation in these tunnels is 362.5 ft. Flooding of these tunnels would only create an operational inconvenience and would not result in a safety concern. A second area at PGDP that would be prone to local flooding during an extreme storm would be along the north/south diversion ditch. This ditch lies west of the C-335 Building and actually flows over the top of the Outfall 001 ditch. The storm would locally inundate the area due west of the C-335 Building and flood any tunnels that were not watertight. Water level elevations would, however, be below the top-of-slab elevations of the main process buildings and the switchyards, which are the only entrance points into the tunnels. Some of the storm water that overflowed the north/south diversion ditch would be passed into the Outfall 001 and Outfall 015 ditches. This would ensure that flooding of the main process buildings and switchyards would not occur. It would not relieve the potential for tunnel inundation.

Results for Ditches and Culverts

The PGDP storm sewer system drains to a series of ditches that convey storm water to outfalls located along the Big Bayou and Little Bayou Creeks. Flooding would occur if storm water in these ditches overbanked the sidewalls.

Several of the ditches cannot convey a 10,000-year storm flow. The north/south diversion ditch overbanks during a 10,000-year storm between the storm sewer system discharge point and the security fence (west of the C-335 and C-337 Buildings). The ditch conveying storm water to Outfall 016 would also be over its banks during a 10,000-year storm. These ditches, however, are located too far from the main process buildings to be a flooding concern.

Culverts convey the storm flow in the ditches beneath roads and railroad tracks. These culverts would cause the level of storm water to rise above the culvert entrances, and in extreme cases, to flow over the road or railroad. Each culvert that drains storm water away from facilities has been evaluated. The culvert receiving the discharge from Outfall 010, which passes beneath Patrol Road No. 3, has insufficient capacity to prevent local flooding. Rainwater would back up behind this culvert during a 10,000-year storm and could cause ponding around the main process buildings and switchyards.

Effects of Ice and Snow

Less than 2 percent of the annual precipitation falls as snow. The mean annual snowfall is about 10 in. The maximum monthly snowfall was 22.6 in. measured in January 1978, and the maximum 24-hr snowfall was 13.6 in. measured in the same month. If an average density of 0.1 in. of water per inch of freshly fallen snow is assumed, these snowfalls correspond to 2.18 and 1.36 in. of rainfall, respectively.

2.4.3.2 Probable Maximum Flood on Rivers

The maps and the procedure outlined in Section B.3.2.2 of NRC Regulatory Guide 1.59 were used to estimate the PMF discharge. By use of this procedure, the PMF discharge corresponding to the Ohio River drainage area above Cairo was found to be 3,900,000 cfs. The extrapolated PMF was rounded up conservatively to 4,000,000 cfs.

The PMF elevation near PGDP was calculated to be 360.6 ft when natural conditions in the Mississippi River were assumed. However, flow in the Mississippi River immediately downstream from Cairo and the confluence of the Mississippi and Ohio Rivers is controlled by the Birds Point/New Madrid Floodway. When the effects of this floodway were taken into account, the calculated PMF elevation became 365.0 ft. Since whether the floodway would be intact cannot be known a priori, the appropriate PMF stage elevation at PGDP is taken to be 365.0 ft at a discharge of 4,000,000 cfs.

Coincident Wind Wave Activity

A conservatively high wind velocity of 40 mph blowing over land from the most adverse direction was adopted to associate with the PMF elevations at PGDP in accordance with Alternatives I and II in Appendix A of NRC Regulatory Guide 1.59. The fetch length near PGDP during the PMF of the Ohio River was estimated from USGS topographic quadrangle maps having a 1:24,000 scale to be 3.4 miles. The increase of flood elevations of the Ohio River near PGDP due to this wind wave activity was estimated from a published chart to be 3 ft. The PMF plus this coincident wind wave activity would have a flood stage of 368.0 ft.

Comparison of Flood Levels With PGDP Elevations

The nominal, top-of-grade elevation at PGDP is 380 ft, about 12 ft above the PMF plus wind wave activity flood stage of 368.0 ft. The top-of-slab floor elevations for the process buildings have values ranging from 380.0 to 384.0 ft. These buildings, therefore, would not be inundated by the Ohio River during a PMF superimposed with wind wave activity.

The only conceivable portion of PGDP that could be affected by the PMF would be tunnels beneath buildings that carry instrument cables and provide telemetry for process control. The minimum floor elevation in these tunnels is 362.5 ft. However; there is no direct pathway for flood waters to enter these tunnels. The patrol road that parallels the security fence at PGDP has been built on a slightly raised berm or foundation, 368 to 380 ft, and the elevations along the top of the roadway exceed PMF water levels. While some increased groundwater seepage might enter the tunnels, PMF inundation would not occur.

2.4.4 Potential Seismically Induced Dam Failures

Two reservoirs that are relevant to the safety of PGDP are Kentucky Lake on the Tennessee River and Lake Barkley on the Cumberland River, located 31 miles southeast of PGDP (Figure 2.4-1). Kentucky Lake is formed by Kentucky Dam located at RM 22.4 on the Tennessee River. It has a total level pool capacity of 3,090,000 cfs-d at the top-of-gates elevation of 375 ft. Lake Barkley is formed by Barkley Dam located at RM 30.6 on the Cumberland River and has a top-of-gates elevation also of 375 ft. The total level pool capacity of Lake Barkley is 1,049,600 cfs-d. The two lakes are interconnected by a 1.75-mile long canal at a point 2.2 miles upstream from Barkley Dam. Note that the nominal grade elevation of PGDP is 380 ft.

Many other reservoirs exist in the Ohio River Basin. However, they are located on various tributaries and are too far from PGDP to pose a threat to the safety of the plant.

Several dam failures are considered in this section. The domino-type failure of the 20 Ohio River main-stem run-of-the-river dams would only result in a flood elevation of 320 ft near PGDP because these dams are low-head structures and have limited capacities. The simultaneous failure of the Kentucky and Barkley Dams, on the Tennessee and Cumberland Rivers, respectively, would produce a flood elevation of 321.6 ft on the Ohio River near PGDP. Dams located along Ohio River tributaries other than the Tennessee and Cumberland Rivers are very distant from PGDP and would not pose a threat to the plant given flood wave attenuation. Thus, dam failures would result in lower flood levels on the Ohio River than that of the PMF discussed in Section 2.4.3.2.

The simultaneous occurrence of PMF and an earthquake capable of failing the upstream dams is not considered because each of these events considered singly has a low probability of occurrence. Alternatives I and II from Regulatory Guide 1.59 and Section 9.2 of ANSI/ANS-2.8-1981 are considered in determining water levels at the site: the simultaneous failure of Kentucky and Barkley dams coincident with either a 25-year flood or one-half of the PMF of the Ohio River. The combined discharges for these two events were estimated to be 1,590,000 cfs and 2,520,000 cfs respectively. The corresponding flood levels were estimated to be 345 ft and 353 ft, respectively. The conservative assumption for the PMF calculation that the Birds Point/New Madrid Floodway was not breached was also used in this case.

The simultaneous failure of Kentucky and Barkley dams and a Kentucky-Barkley dam failure coincident with either a 25-year flood or one-half of the PMF of the Ohio River would all result in a flood level lower than that of the PMF of the Ohio River. A comparison of the PMF stage with the PGDP elevations is given in Section 2.4.3.2.

2.4.5 Channel Diversions and Ice Flooding

Channel diversions on the lower stem of the Ohio River are unlikely. The Ohio River from near Maysville, Kentucky, to Cairo, Illinois, is essentially in its original location with the exception of some changes occurring at locations such as Cincinnati, caused by glaciation. Ice on the Ohio River main stem occurs more frequently in the upper reaches. However, the river seldom freezes over for its full length, and flooding due to ice dams in the area of PGDP is unlikely.

2.4.6 Low Water Considerations

Water used at PGDP is proportional to cascade power level plus potable water usage and is supplied from the Ohio River by TVA at the Shawnee Steam Plant. The pumping station at the Shawnee Steam Plant can supply up to 30 MGD to PGDP. At the Metropolis, Illinois, gauging station, which is approximately 2 miles upstream from PGDP, the minimum discharge of 15,000 cfs was recorded in July 1930. This volumetric river flow is much greater than the PGDP water use.

2.4.7 Dilution of Effluents

The average discharge of the Ohio River near PGDP is 271,000 cfs. This large discharge rate potentially has a large capacity for reducing the concentration of received contaminants. For example, the uranium discharged from PGDP during 1990 through the local drainage system to the Ohio River is estimated to have been 440 lb. However, they are below the derived concentration guide for uranium. From groundwater modeling results, the discharge from the groundwater in the modeled area to the Ohio River is estimated to be 5.49 cfs, mostly through the regional gravel aquifer (RGA). Therefore, the concentration of any contaminants reaching the RGA from the overlying PGDP facilities and carried to the Ohio River by the groundwater would be drastically reduced by the Ohio River.

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2.4-6b

Table 2.4-1. The historical high mark and elevations for floods with three recurrence intervals estimated by the U.S. Army Corps of Engineers.

	Elevation	
Recurrence Interval	Meters	Feet
10-year flood	99.5	326.6
50-year flood	101.1	331.6
100-year flood	101.6	333.2
Historical high mark	104.2	341.7
PGDP nominal grade	115.8	380.0

Table 2.4-2. Precipitation in inches as a function of recurrence interval and storm duration for PGDP.

	Storm Duration (hr)						
Recurrence Interval Year	0.5	1	2	3	6	12	24
1	1.08	1.30	1.66	1.85	2.23	2.65	3.06
2	1.26	1.56	1.91	2.14	2.61	3.08	3.53
5	1.55	1.98	2.38	2.67	3.20	3.69	4.38
10	1.80	2.23	2.75	3.02	3.66	4.33	4.97
25	1.99	2.57	3.13	3.44	4.18	4.83	5.71
50	2.23	2.82	3.46	3.83	4.62	5.53	6.42
100	2.45	3.13	3.83	4.24	5.02	5.97	6.88
10,000[a]	3.80	4.94	5.99	6.59	7.85	9.32	10.85

a. Extrapolated values calculated using least-squares methodology.

Table 2.4-3. Flood levels in local creeks at PGDP during a 10,000-year storm.

Parameter	Big Bayou	Little Bayou
Drainage area (km^2 [$mile^2$])	18 (11)	6.4 (4)
Slope (%)	0.231	0.317
Manning's n	0.15	0.15
Discharge (m^3/s [cfs])	280 (9,900)	156 (5,580)
Stage (m [ft])	113.0 (370.8)	110.8 (363.6)
Intensity (cm/hr [in/hr])	9.53 (3.75)	11.91 (4.69)
Duration (min)	90	66
Precipitation (cm [in])	14.3 (5.63)	13.1 (5.16)
PGDP grade elevation ([m] ft)	115.8 (380)	115.8 (380)

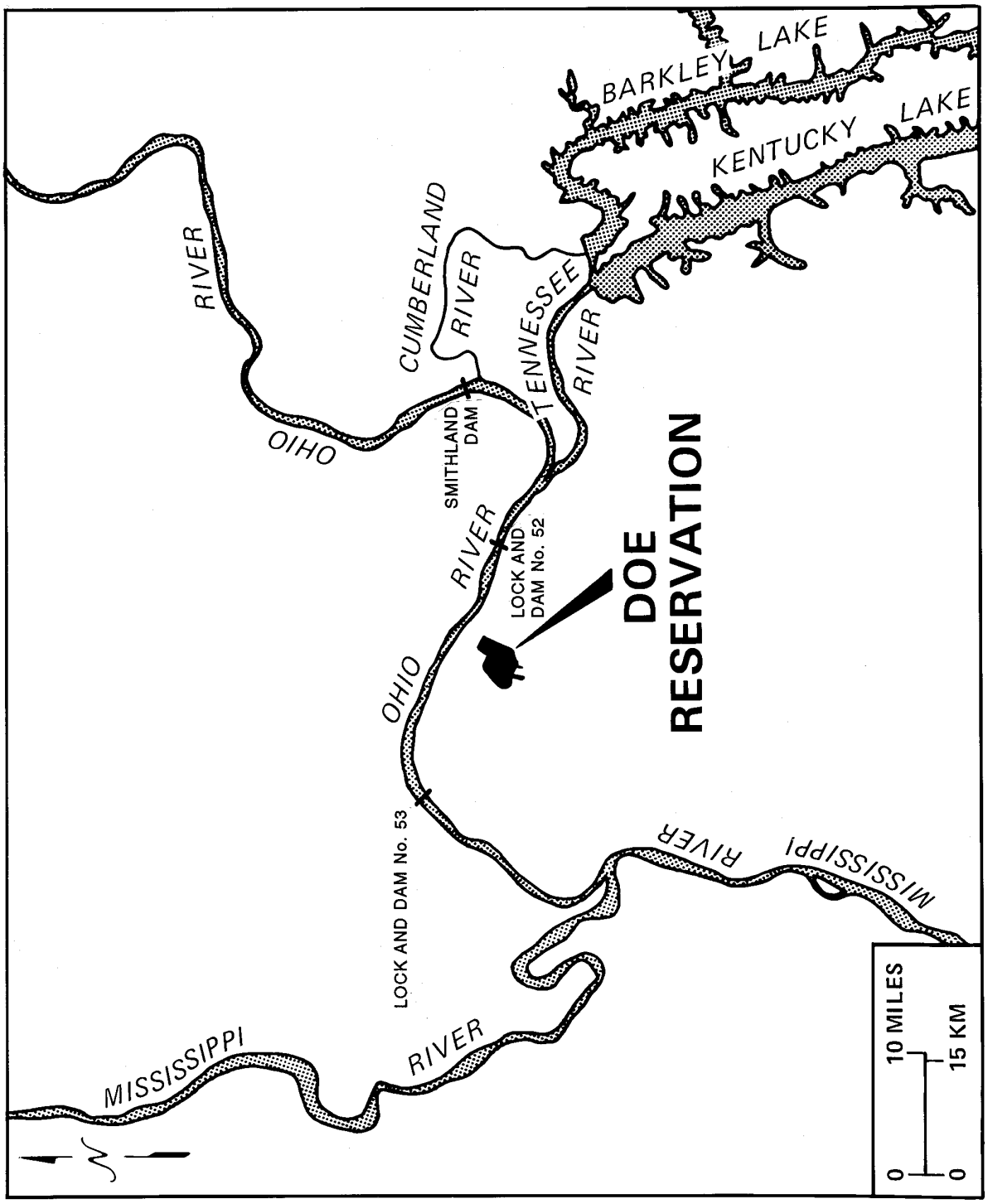

Figure 2.4-1. Regional area primary surface hydrology.

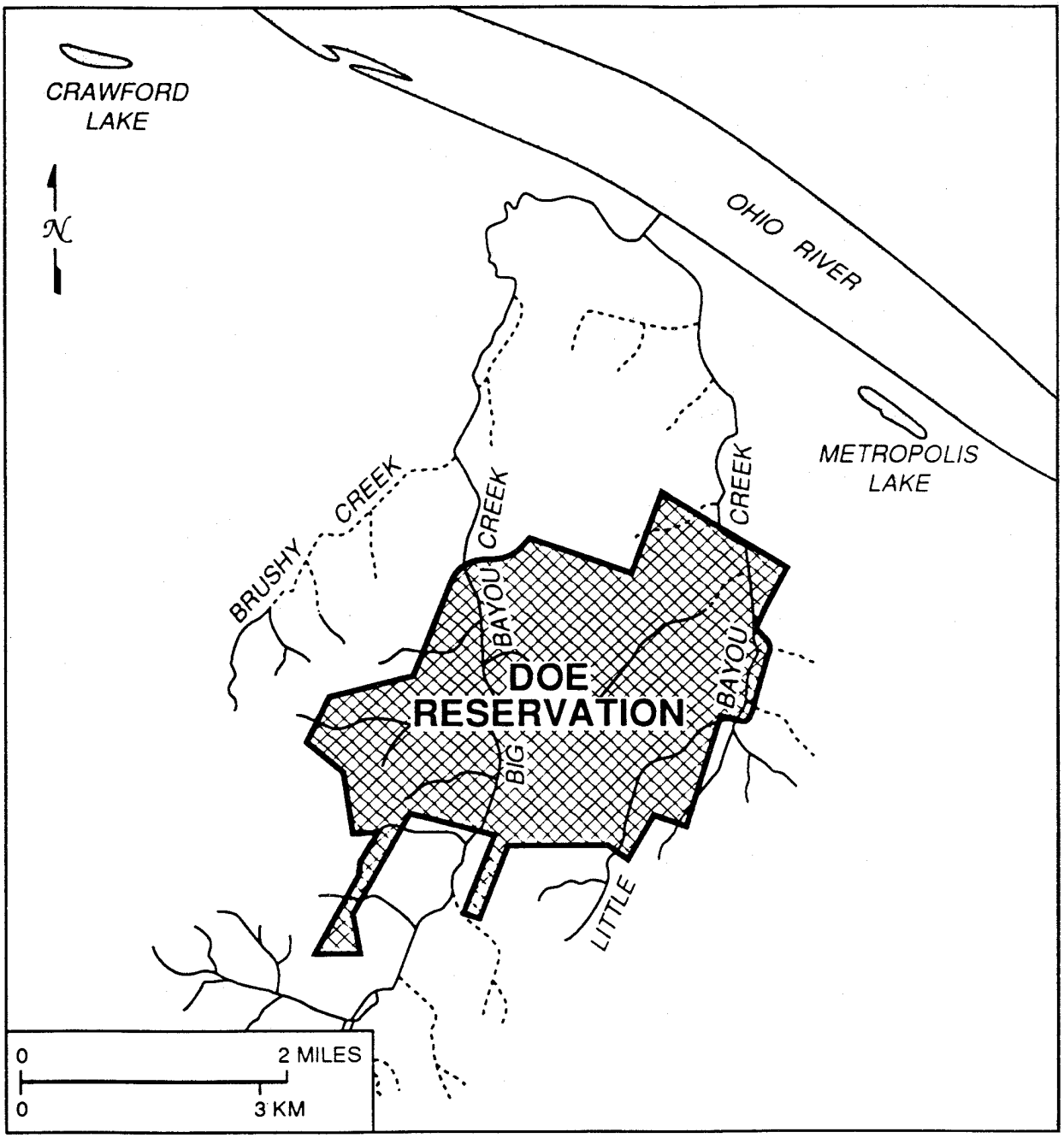

Figure 2.4-2. PGDP site surface hydrology systems.

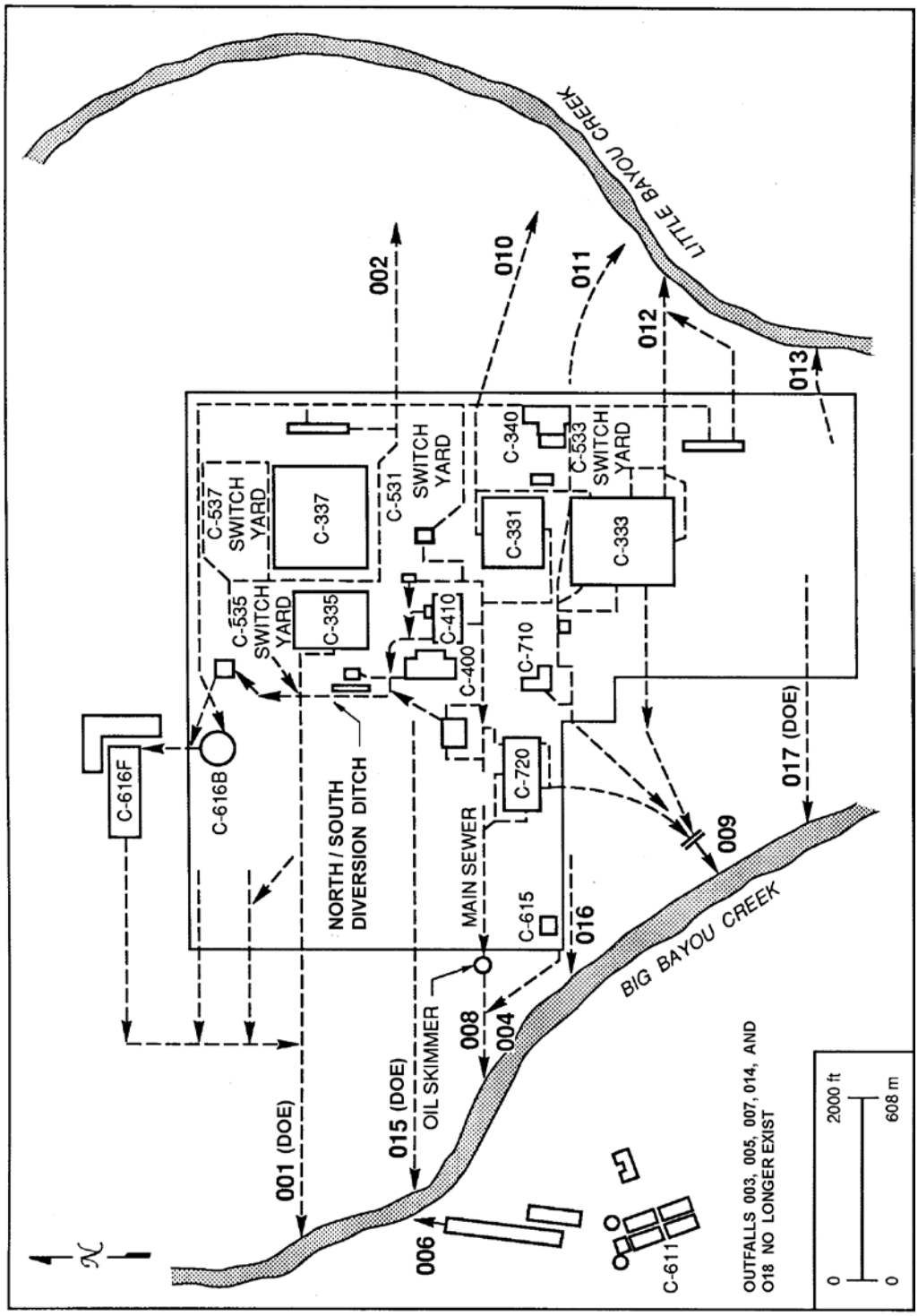

Figure 2.4-3. Effluent outfall locations at PGDP. The north direction of the plant coordinates is shown in the figure.

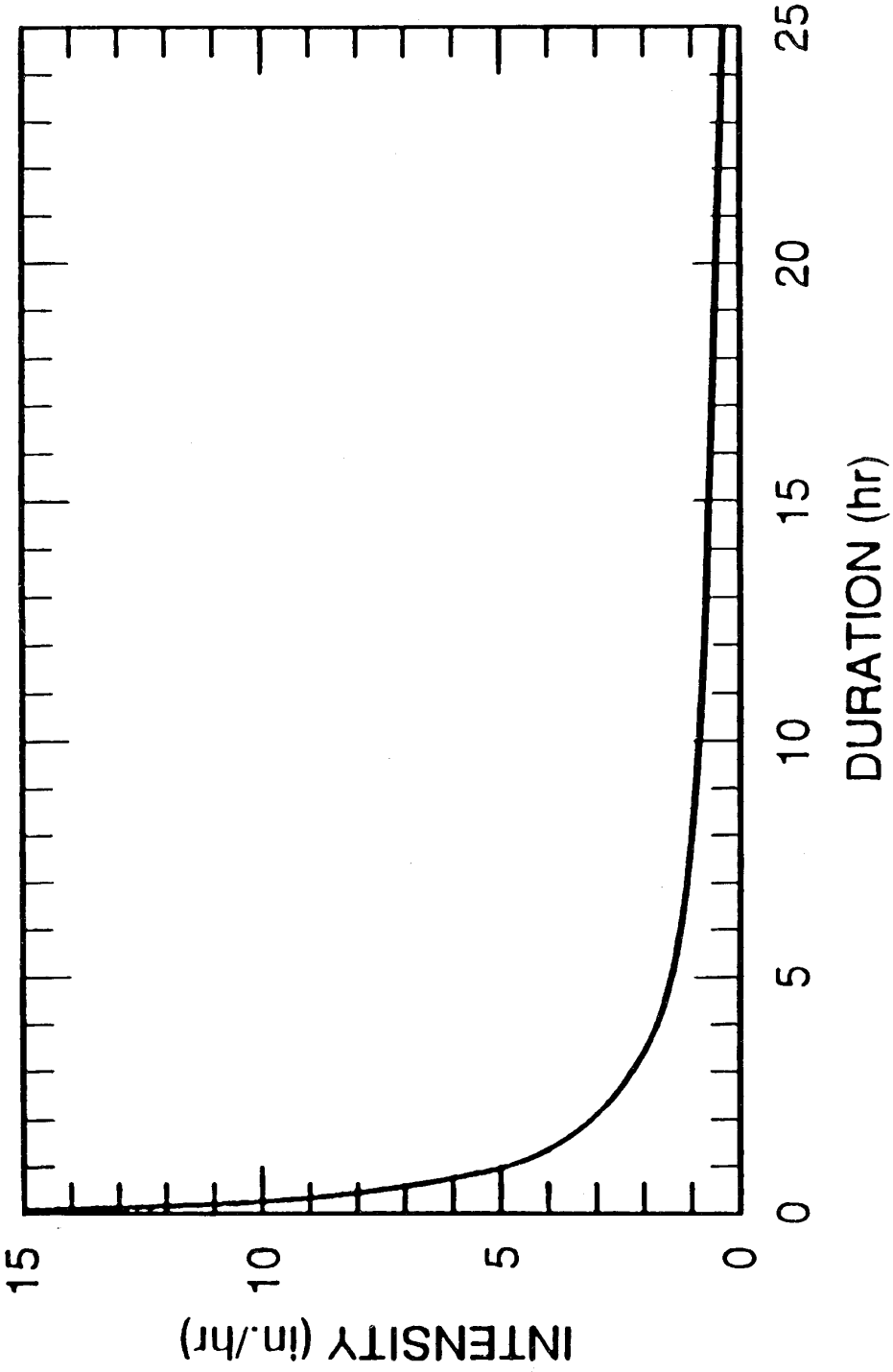

Figure 2.4-4. The 10,000-year precipitation intensity vs. duration graph for PGDP.

2.5 SUBSURFACE HYDROLOGY

This section describes characteristics of the subsurface hydrogeologic system underlying PGDP.

2.5.1 Regional and Area Characteristics

Precipitation is the primary source of aquifer recharge in the vicinity of PGDP. Rainwater reaches the water table by infiltration and moves laterally to areas of discharge. In the bedrock and unconsolidated sediments aquifers, recharge occurs in areas of outcrop; in the alluvial aquifer, recharge is from infiltration from adjacent aquifers. Recharge is estimated to be 10 to 15 percent of annual precipitation, or approximately 4.8 to 7.2 in. per year at Paducah, Kentucky. Near surface geology and thinned and eroded Cretaceous and Tertiary deposits contribute to the locally complex aquifer characteristics that are potentially significant to the site.

2.5.1.1 Aquifers

The subsurface hydrologic system in the region can be separated into three hydrogeologic units: alluvial deposits, unconsolidated sediments, and bedrock. The alluvial deposits include (a) localized Quaternary silts, sands, and gravels that are found in the major stream valleys and larger tributaries, and (b) extensive, Plio-Pleistocene sands and gravels that form the principal regional aquifer near PGDP. The aquifer in unconsolidated sediments includes the Cretaceous and Tertiary sands, silts, and clays that make up the southward-thickening deposits in the Mississippi Embayment. The bedrock aquifer includes all Paleozoic sedimentary rocks underlying the unconsolidated sediments. Near PGDP, the most important hydrogeologic unit is the alluvial deposits.

PGDP is underlaid by about 100 ft of nonindurated deposits that include, from the surface down, local fill, loess, and interbedded clay, silt, sand, and gravel of Pliocene-Pleistocene age known as continental deposits (see Figure 2.5-1). The Plio-Pleistocene continental deposits at PGDP can be divided into three basic hydrogeologic units. Laterally discontinuous sands with occasional gravels in the upper continental deposits comprise an unconfined shallow groundwater system. Silt and clay deposits, which are locally thin to absent, separate these shallow sands from the regional gravel of the lower continental deposits and confine the underlying gravel aquifer. Of the three basic units, the gravels of the regional groundwater aquifer (RGA) are the most laterally continuous. Aquifer recharge is accomplished by infiltration of precipitation through the two upper layers, collectively called the upper continental recharge system (UCRS), and discharge is to the Ohio River. The continental deposits rest unconformably on about 300 ft of Tertiary and Cretaceous age sediments of both marine and nonmarine origin (The McNairy formation). The bottom of the Cretaceous sediments slopes southward on the truncated subcrop of Paleozoic bedrock, which structurally dips northward toward the Illinois Basin.

2.5.1.2 Regional Groundwater Use

The Quaternary alluvial aquifer is used locally in southeastern Missouri and southern Illinois. Areas of use are limited to major river valleys in the region. In southeastern Missouri, the aquifer is commonly used for irrigation; reported annual quantities for rice irrigation are between 30,000 and 40,000 acre-ft. The aquifer is also used in that region for municipal and industrial

purposes. In the Jackson Purchase region, the estimate is 1.82 MGD for municipal use. In southern Illinois, Cache and Ohio River alluvium is used for industrial and municipal supply. Data on domestic or agricultural use are unavailable.

Groundwater use from the Continental deposits at the base of the alluvial aquifer is generally limited to areas where the deposits are sufficiently thick to yield 0.70 to 1.4 MGD. These areas are in the northern and northeastern portions of the Jackson Purchase. The estimate is only 0.03 MGD withdrawal for municipal use in the Jackson Purchase. Data on domestic or agricultural use are unavailable.

The unconsolidated sediments aquifers are the most widely used aquifers in the Mississippi Embayment. In southeastern Missouri, the McNairy aquifer is used exclusively for municipal water supply because of the large artesian head and small iron and hardness concentrations of the water. However, in the southeast part of the area use of water from this aquifer has declined because of higher sodium concentration and elevated water temperature. The total withdrawal from this aquifer in Missouri probably is less than a few thousand acre-feet per year. In the same region, the Wilcox aquifer is currently used only for municipal supplies and is the preferred source in the southeastern part of the region. In the Jackson Purchase region, the estimate is 9.96 MGD withdrawal from the McNairy and Wilcox aquifers, 78 percent of which is derived from the Wilcox. Total withdrawals are 6.8 MGD, 0 MGD, and 4.5 MGD from the McNairy in 1980 for domestic, municipal, and industrial uses for Missouri, Illinois, and Kentucky, respectively. It is estimated that there is a 51,800 km^2 potential McNairy water use area and an estimated withdrawal of about 20 MGD. In southern Illinois, thick accumulations of the unconsolidated sediments are geographically limited but provide excellent sources of groundwater where they are present.

Because of its great depth below the surface, the bedrock aquifer is not commonly used as a groundwater source in the southern Jackson Purchase region or Mississippi Embayment. It is estimated that there is a 16,835 km^2 area of aquifer use in the Mississippi Embayment with an estimated withdrawal of about 10 MGD. It is estimated that there is a 0.17 MGD withdrawal from the bedrock aquifer for industrial and municipal use in the Jackson Purchase region. In southern Illinois, wells drilled to depths of from about 100 to 900 ft to the bedrock aquifer provide municipal and industrial supplies. Although Pennsylvanian bedrock is believed to have been removed by erosion in southern Illinois, a well reported to be in Pennsylvanian bedrock is used by the city of Brookport, Illinois, for municipal supply.

Available information indicates the region contains three large industries that use more than a million gallons of groundwater per day. These are General Tire Company in Mayfield, Kentucky; a chemical industry in Calvert City, Kentucky; and Allied Chemical Company in Metropolis, Illinois. All three maintain their own wells.

Municipalities and water districts are largely dependent on groundwater. A few, such as Golconda and Cairo, Illinois, and Paducah and Wickliffe, Kentucky, use treated river water. Vienna, Illinois, uses a city reservoir.

There are few published data on the use of groundwater for irrigation and other agricultural purposes. Some groundwater is used for irrigation in the eastern portion of Mississippi County, Missouri.

2.5.1.3 Flow in the Regional Aquifers

In the Jackson Purchase region, precipitation is the primary source of aquifer recharge; infiltration reaches the water table and moves laterally to areas of discharge. In the bedrock and unconsolidated sediments aquifers, recharge occurs in areas of outcrop; in the alluvial aquifer, recharge is from infiltration or from adjacent aquifers. Recharge is estimated to be approximately 10 to 15 percent of annual average precipitation.

Because many of the available data are obtained from relatively localized areas and are temporally variable, few regional trends are apparent. Groundwater elevation data suggest the McNairy and bedrock aquifers act as an interconnected hydrogeologic unit. Apparent regional geochemical variability in the McNairy may be attributed to the seismo-tectonic setting of the New Madrid seismic zone and not to an inherent characteristic of the aquifer. The general flow direction for the McNairy is to the northwest, except near the Ohio River, where flow is to the north. Discharge in the Wilcox aquifer is to tributaries of the Mississippi River (generally to the west and south); in the gravel aquifer, to alluvial deposits in the nearest surface water body; and in the Quaternary alluvial aquifer, from valley edges to surface water.

Near-surface geology and thinned and eroded Cretaceous and Tertiary deposits contribute to locally complex aquifer characteristics potentially significant to the PGDP site. Figure 2.5-1 illustrates a conceptualization of the shallow geological conditions at the PGDP site that include an erosional unconformity and interpreted paleo-channels.

The potential for environmental contaminants from PGDP facility operations and waste disposal practices to enter and migrate in subsurface aquifers is the most important characteristic of the subsurface hydrogeologic system. In terms of access to aquifers, the lower gravel and upper silty portions of the Plio-Pleistocene continental deposits are considered most significant to the site. The McNairy and Wilcox aquifers are important locally, where they are in direct contact with the continental deposits. The lenticular nature of lithologies in the upper silty portion of the continental deposits and the presence of localized perched water above the gravel aquifer may enable infiltration directly to the gravel and McNairy aquifers.

Under normal conditions, the primary contaminant pathway can be expected to be along the base of the gravel aquifer to the Ohio River (see Figure 2.5-1). A secondary pathway is in the perched, shallow groundwater system of the upper silty portion of the Continental deposits. Lateral migration there is expected to be localized and comparatively slow. Vertical migration to the gravel aquifer would occur principally where confining clay lenses terminate or grade laterally into sand facies. The reported hydraulic contrast between the gravel and the McNairy aquifers and the northerly flow in the gravel and the McNairy to the Ohio River suggest that widespread aquifer contamination in the McNairy aquifer is not likely.

2.5.2 Site Characteristics

PGDP is located on a local drainage divide between Little Bayou Creek to the east and Big Bayou Creek to the west. The plant nominal elevation is about 380 ft MSL, 90 ft above the normal pool elevation of the Ohio River (290 ft MSL), which is about 3.5 miles to the north. PGDP is underlain, from the surface down, by loess, Pliocene-Pleistocene continental deposits, Tertiary and Cretaceous sediments (Porters Creek clay and McNairy formation), and Mississippian bedrock (see Figure 2.5-1 and Table 2.5-1). The thickness of loess deposits ranges from 5 to 25 ft, averaging about 15 ft. The continental deposits can be subdivided into different hydrogeologic units. The UCRS is formed by laterally discontinuous but correlatable sands with occasional pebbles (referred to hereafter as the shallow sand). This unconfined, shallow groundwater system is underlain by a sediment unit that varies from all clay to all sand, but that usually is predominantly clay, silt, or clayey silt. This unit forms a confining layer separating the UCRS from the underlying RGA. The RGA is in the lower facies of continental deposits. It is predominantly gravel with silt and sand, but is found locally as all sand or as a cobbley gravel. It has an average thickness of 30 ft and is the major aquifer in the area. A discontinuous but identifiable layer of sand directly overlying the RGA is considered as part of the RGA. The continental deposits rest unconformable on the Tertiary and Cretaceous sediments, which have a total thickness ranging from 225 ft to the north of PGDP to 300 ft to the south of PGDP (Figure 2.5-1). The bottom of the Cretaceous sediments slopes southward on the truncated subcrop of Mississippian bedrock, which structurally dips moderately to the northeast toward the Illinois Basin.

2.5.2.1 Aquifers Beneath the Site

The RGA is the major aquifer in the area. It is recharged by the infiltration of rainfall through the UCRS and the confining layer, and it discharges to the Ohio River. As can be seen from Figure 2.5-1, this groundwater recharge-discharge route can be a potential pathway for PGDP contaminants to reach areas outside the plant and the Ohio River.

The RGA (lower continental deposits) terminates at the slope formed by the Porters Creek clay beneath the southern part of PGDP. The shallow Pliocene terrace gravels, found at elevations higher than 350 ft above MSL, and Eocene sands that overlie Porters Creek clay are poorly connected hydraulically to the RGA to the north. The hydraulic conductivity of the connecting region determines the amount of recharge through underflow from the terrace gravel unit into the RGA.

The UCRS transmits precipitation to the RGA, which acts as the major conducting path for groundwater discharge to the Ohio River. The groundwater flow in the UCRS is primarily downward, as suggested by the observed decreasing hydraulic head with increasing well depth. The head difference between the UCRS and the underlying RGA ranges from more than 10 ft just north of the main plant area to about 0 ft near the Ohio River (see Figure 2.5-2). The lateral groundwater flow locally in the UCRS can be large if the unit is thick and/or extensive. This, together with the areal variation of thickness of the underlying confining layers, probably makes the recharge of the RGA quite nonuniform.

Although both the Wilcox Group (Eocene sand) and the McNairy formation form regional aquifers in the Jackson Purchase Area, the Wilcox Group terminates near the southern boundary of PGDP. North to the center of PGDP, the RGA is in direct contact with the McNairy formation. The hydraulic

communication between the RGA and the McNairy aquifer is unclear. However hydrographs of two wells just north of PGDP show that the hydraulic heads of the two aquifers fluctuated correlatively during 1991 and 1992, and that the head in the McNairy is 2 to 4 ft lower.

2.5.2.2 Aquifer Properties

Hydraulic Conductivity

Hydraulic conductivity ranges for major lithologic units at PGDP and the surrounding area have been summarized and are listed in Table 2.5-1. These older values, based on both field and laboratory measurements, display a hydraulic conductivity contrast of nine orders of magnitude. Significantly higher conductivities are observed in the RGA and the UCRS, and very low conductivities are observed in the confining layer overlying the RGA and the Porters Creek clay.

More recently, slug tests and pumping tests have been performed on wells completed in various hydrogeologic units. Table 2.5-2 summarizes the hydraulic conductivity values derived from the slug tests.

Storage Coefficient

The RGA behaves like a leaky aquifer. Testing from the C-404 area indicates that the transmissivity of the RGA ranges from 1,300 to 2,700 ft^2d, and the storativity is approximately 0.03. Storativity values from the C-537 test are in the order of 0.001 to 0.01, and those from the C-333 test are in the order of 0.001.

Recharge

The heaviest rainfall occurs in the spring and the lightest in the fall. In the GEOTRANS groundwater flow models, the recharge used was 4.7 in. per year for the entire modeled area, including buildings and paved surfaces. Recharge to the groundwater system may also occur through manmade surface water features such as ditches, ponds, and lagoons. Because of the low permeability of the near surface geologic units, the net infiltration is expected to be low. Groundwater withdrawals occur through isolated pumpage. Small volumes of water are also being withdrawn at rural residences scattered throughout the area surrounding PGDP.

2.5.2.3 Groundwater Flow

While groundwater may exist in almost all hydrogeologic units in the vicinity of PGDP, some of the units form a main flow system transporting groundwater northward toward the Ohio River. The units are, from south to north, the Eocene sand (Wilcox), the Pliocene terrace gravels, the RGA, and the Holocene alluvium near the Ohio River. Figure 2.5-3 shows the groundwater elevations within this main flow system together with different hydrogeologic units indicated by shaded areas. Each of these units may not be the shallowest groundwater unit in its dominated area. For example, the RGA is part of the main flow system, but it is overlain by the UCRS. These units form a main flow system because of their relative locations, their high hydraulic conductivities, and the topography of the area.

Starting from the groundwater divide (local maximum head surface) in the Eocene sand southwest of PGDP, a groundwater flow path can be visualized from the water level contours. The flow is first into the Pliocene terrace gravels that separate the Eocene sands from the RGA and then through the RGA to the Holocene alluvium and the Ohio River. The high hydraulic gradient region between the Eocene sands and the RGA is a combined result of the poor hydraulic connection between the Pliocene terrace gravels and the RGA, and the steep slope at the subcrop of the Porters Creek clay (Figure 2.5-1). The large space between the 320- and 310-ft contours in Figure 2.5-3 is a result of the high hydraulic conductance of the RGA, the relatively flat base of the conductance of the RGA, and the relatively flat base of the RGA.

Near PGDP, the water table is within the UCRS, although the major aquifer is the underlying semi-confined RGA. The large range of observed water levels (330 to 370 ft above MSL) during the period of July 1991 to June 1992 over the main plant area probably reflects the discontinuity of the UCRS and/or the different recharge/discharge conditions at different locations. The water levels are about 10 to 50 ft below the plant nominal elevation of 380 ft MSL.

Figure 2.5-2 is a potentiometric surface map of the RGA around the PGDP site based on groundwater elevation data collected in July 1991. The contours reflect the general direction of groundwater flow toward the Ohio River in the RGA. The accompanying hydrographs show that the downward gradient between the UCRS and the RGA becomes smaller for regions closer to the Ohio River. Regional water elevations in the McNairy formation are shown in Figure 2.5-4. Near PGDP, the groundwater flow within the McNairy formation is toward the Ohio River.

To evaluate the extent to which contamination from the facility operation could migrate through the groundwater, a calibrated groundwater flow and contaminant transport model was developed and used to determine contaminant transfer. The model is a numerical representation of the available data and the current understanding of the hydrogeologic system beneath the plant.

The groundwater flow and contaminant transport model is based on the finite difference code FTWORK developed by GeoTrans. The size of the rectangular study area is about 18 square miles with a width of about 3.5 miles and a length of about 5.2 miles. The model also uses the Ohio River as the northern boundary and consists of four layers: the sand comprising the shallow groundwater system (the shallow sand), the intermediate confining unit (the upper clay), the RGA, and the Cretaceous sediments (the McNairy formation). Together, the shallow sand and the upper clay correspond to the upper continental deposits. Only the upper 30 ft of the McNairy formation immediately below the RGA is included in the model as the fourth layer.

Figures 2.5-5 through 2.5-7 show the calculated potentiometric surfaces in the upper three model layers. Hydraulic heads in the bottom layer are almost identical to those in the overlying RGA because of the model grid setup and similar boundary conditions used for the two layers. The RGA system depicted in Figure 2.5-2 shows the south to north regional groundwater flow direction. Although the groundwater directions in the top two layers are generally also from south to north, they are complicated by the interaction between creeks and the groundwater system and by the zero recharge from precipitation in some areas.

Calculated heads are compared with observed heads at the 75 target wells in Table 2.5-3. In general, the agreement is better in the RGA than the upper continental deposits (UCDs). This trend is also reflected in the calibration statistics listed in Table 2.5-4. As can be seen from this table, the root mean square difference is 1.66 ft for the RGA and 6.67 ft for the UCD.

Table 2.5-5 summarizes the hydraulic properties obtained from the model calibration. The horizontal conductivity for the RGA, 560 ft/day, is somewhat higher than but comparable to the value of 425 ft per day obtained from the GEOTRANS model. The vertical conductivity of 0.00092 ft/day for the confining clay is similar to the value of 0.000875 ft/day obtained in the GEOTRANS Model. The water budget of the steady-state groundwater flow model is shown in Tables 2.5-6. The recharge is mostly from precipitation and the discharge is mainly to the Ohio River, specified as having a constant head.

Figures 2.5-8 through 2.5-10 show the plume configurations in the RGA at the end of 10, 20, and 30 years, respectively. The transport time for the contaminant from the northwest corner of PGDP to the Ohio River is about 30 years, a value in qualitative agreement with the existing northwest plume. The bending of the plume to the east near the Ohio River is due to the use of constant head blocks for the loading docks of the Shawnee Steam Plant in the groundwater flow model. The spread of the plume in the shallow sand and upper clay is very small because the conductivities in these layers are much smaller than in the RGA, and because the groundwater flow is mainly in the downward direction. This small plume spread is shown in Figure 2.5-11 for the shallow sand layer as an example.

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Table 2.5-1. Ranges of hydraulic conductivity values, in ft/day, for major lithologies near PGDP.

Loess		2.8E-4	to	2.8E-1
Upper Continental Deposits (Sand)		2.8E-2	to	2.8E+1
Upper Continental Deposits (Clay)		2.8E-5	to	2.8E+0
RGA		2.8E-1	to	2.8E+3
Porters Creek Clay		2.8E-6	to	2.8E-4
McNairy Formation	<	2.8E-3	to	2.8E+0

Table 2.5-2. Hydraulic conductivity values, in ft/day, derived from slug tests near PGDP.

	Low	High	Geometric Mean
UCRS	2.9E-5	1.4E+1	3.6E-2
RGA	9.2E-2	3.0E+2	1.7E+1
Terrace Gravels	1.5E-1	4.2E+1	6.8E-1
Porters Creek Clay	1.6E-3	8.6E-1	1.2E-1
McNairy Formation	8.1E-2	5.5E-1	2.4E-1

Table 2.5-3. Comparison of calculated heads with observed average heads

Number	Column	Row	Layer	Average Observed Head (ft)	Calculated head (ft)
			Regional Gravel Aquifer		
1	21	10	3	314.62	312.53
2	15	14	3	319.13	316.12
3	21	14	3	319.48	315.46
4	5	15	3	316.45	316.88
5	19	16	3	319.32	316.70
6	26	16	3	316.89	315.45
7	29	16	3	315.08	314.64
8	18	17	3	320.05	317.24
9	29	18	3	316.34	315.94
10	25	19	3	318.72	317.17
11	20	20	3	320.56	318.22
12	35	20	3	317.17	316.57
13	20	24	3	322.20	319.84
14	9	25	3	323.80	320.92
15	27	27	3	321.55	321.48
16	34	27	3	318.71	321.33
17	18	30	3	323.83	323.30
18	4	32	3	325.44	323.73
19	18	33	3	324.43	324.83
20	30	33	3	326.45	324.44
21	38	34	3	324.57	324.79
22	20	37	3	325.38	326.01
23	25	37	3	325.74	325.90
24	27	38	3	326.74	326.17
25	12	39	3	325.79	326.56
26	24	40	3	326.17	326.73
27	32	40	3	326.41	326.70
$F_2$28	17	41	3	325.86	327.13

Table 2.5-3. Comparison of calculated heads with observed average heads. (Continued)

Number	Column	Row	Layer	Average Observed Head (ft)	Calculated head (ft)
29	41	42	3	325.91	327.12
30	8	43	3	326.18	327.32
31	19	45	3	327.12	327.95
32	24	45	3	327.20	327.81
33	35	45	3	326.73	327.88
34	29	46	3	326.30	327.92
35	16	47	3	326.78	328.39
36	21	48	3	327.04	328.49
37	16	49	3	327.27	328.73
38	18	49	3	327.58	328.75
39	18	50	3	327.40	328.96
40	21	50	3	327.52	328.92
41	25	50	3	327.03	328.70
42	26	50	3	327.47	328.90
43	15	52	3	327.35	329.27
44	20	52	3	326.99	329.40
45	21	52	3	327.72	329.39
Upper Continental Deposits					
1	27	27	2	327.16	329.42
2	4	33	1	332.71	336.45
3	18	33	1	349.29	351.89
4	25	37	1	339.96	347.78
5	24	40	1	355.72	349.84
6	17	41	1	345.07	361.61
7	8	43	1	344.18	352.52
8	35	45	2	331.58	337.68
9	15	45	1	362.42	361.40
10	16	45	1	365.05	362.44
11	16	45	1	364.47	362.44

Table 2.5-3. Comparison of calculated heads with observed average heads. (Continued)

Number	Column	Row	Layer	Average Observed Head (ft)	Calculated head (ft)
12	19	45	1	365.10	353.21
1v3	24	45	1	342.55	352.06
14	16	46	1	367.24	363.20
15	18	47	1	364.18	359.80
16	19	47	1	364.43	357.84
17	15	48	1	363.76	364.54
18	19	48	1	367.32	358.88
19	16	49	1	363.95	363.78
20	17	49	1	365.28	362.32
21	18	49	1	358.84	361.40
22	18	49	1	358.12	361.40
23	19	49	1	362.97	359.43
24	20	49	1	368.54	358.09
25	26	50	2	338.85	342.34
26	22	51	2	348.17	342.20
27	16	51	1	360.93	365.47
28	20	52	2	334.28	345.05
29	21	52	2	342.68	344.11
30	15	52	1	355.71	365.92

Table 2.5-4. Model calibration statistics.

Layer	Number of Targets	rms Difference (ft)	Average Difference (ft)
Upper Continental Deposits	30	6.67	0.80
RGA	45	1.66	0.00
Total	75	4.41	0.32

Table 2.5-5. Hydraulic conductivities used in the calibrated model.

	Conductivity (ft/day)	
Layer	Horizontal	Vertical
Shallow Sand (Layer 1)	3	3
Upper Clay (Layer 2)	1	0.00092
RGA (Layer 3)	560	560
One-ft Regional Gravel Aquifer (Layer 3)	400	400
McNairy (Layer 4)	0.01	0.01

Table 2.5-6. Water balance of the calibrated model in ft^3/day.

From Precipitation (4.7 in./year)	470,878
From Constant Head	1,595
To Constant Head	441,022
From Creeks	1,895
To Creeks	33,145
Total Recharge	474,368
Total Discharge	474,168

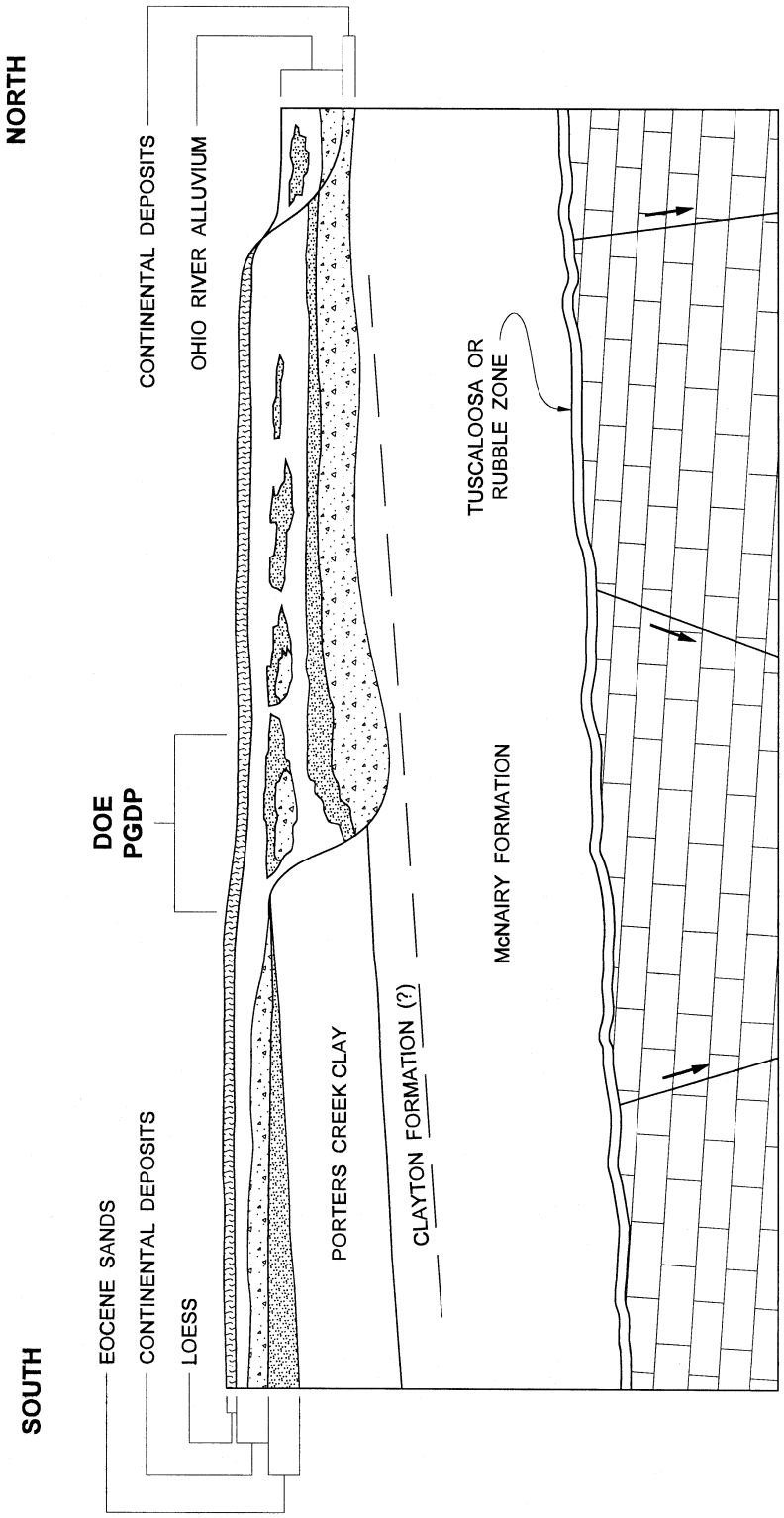

Figure 2.5-1. Schematic north-south section showing regional stratigraphic relationships (not to scale).

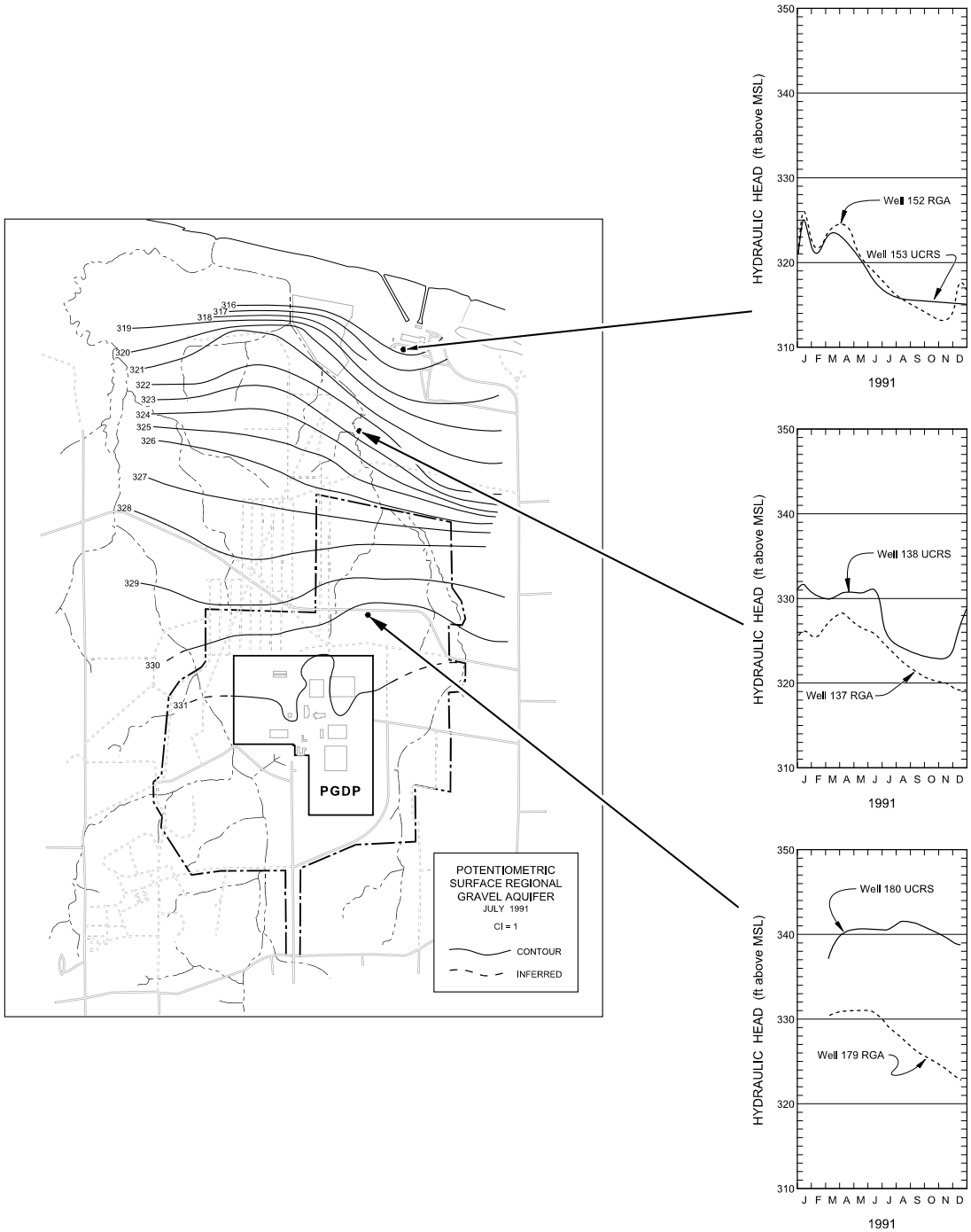

Figure 2.5-2. Potentiometric surface map of RGA.

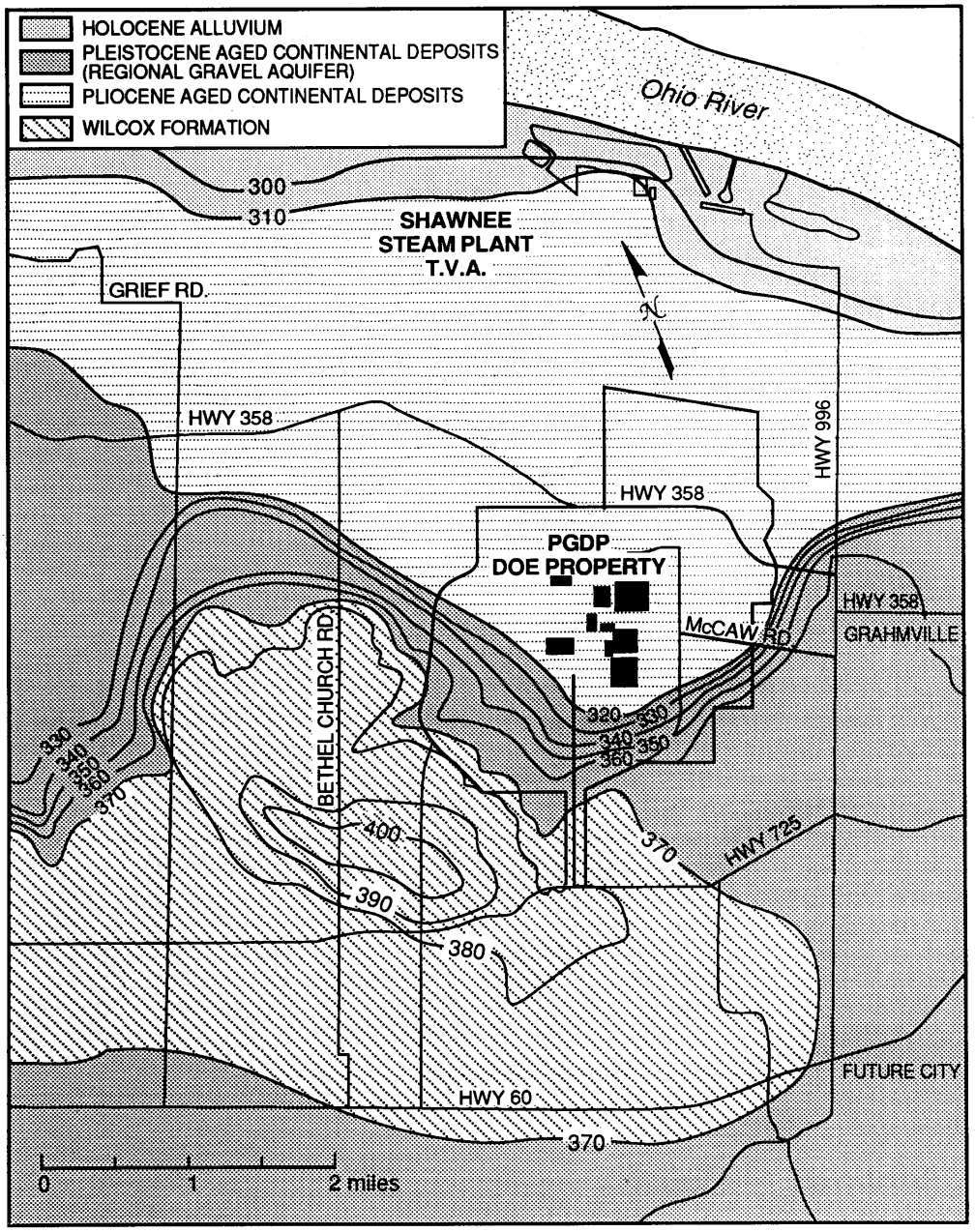

Figure 2.5-3. Water level elevations and geologic components of the local flow system.

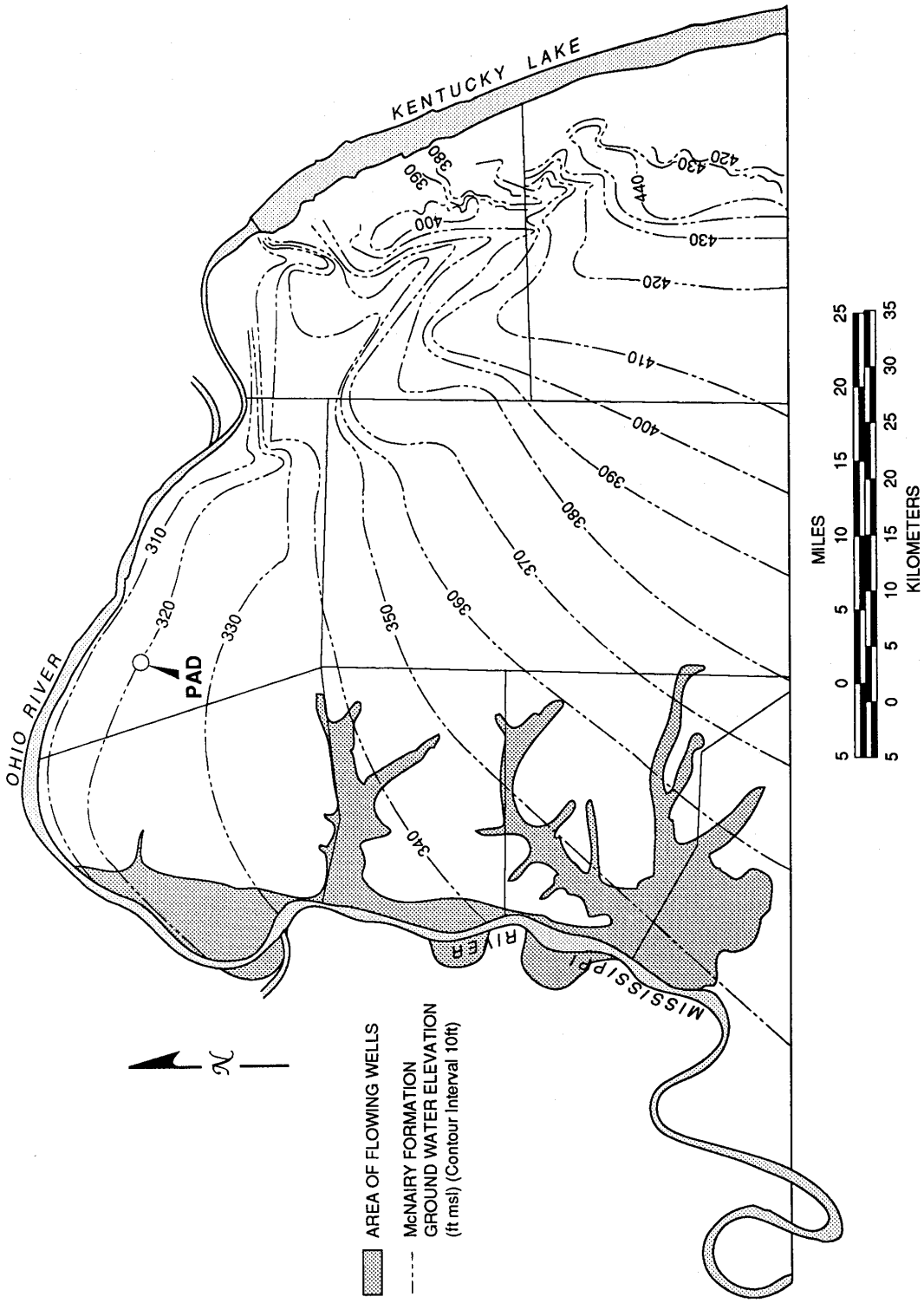

Figure 2.5-4. Potentiometric surface and thickness map of the McNairy aquifer in the Jackson Purchase region.

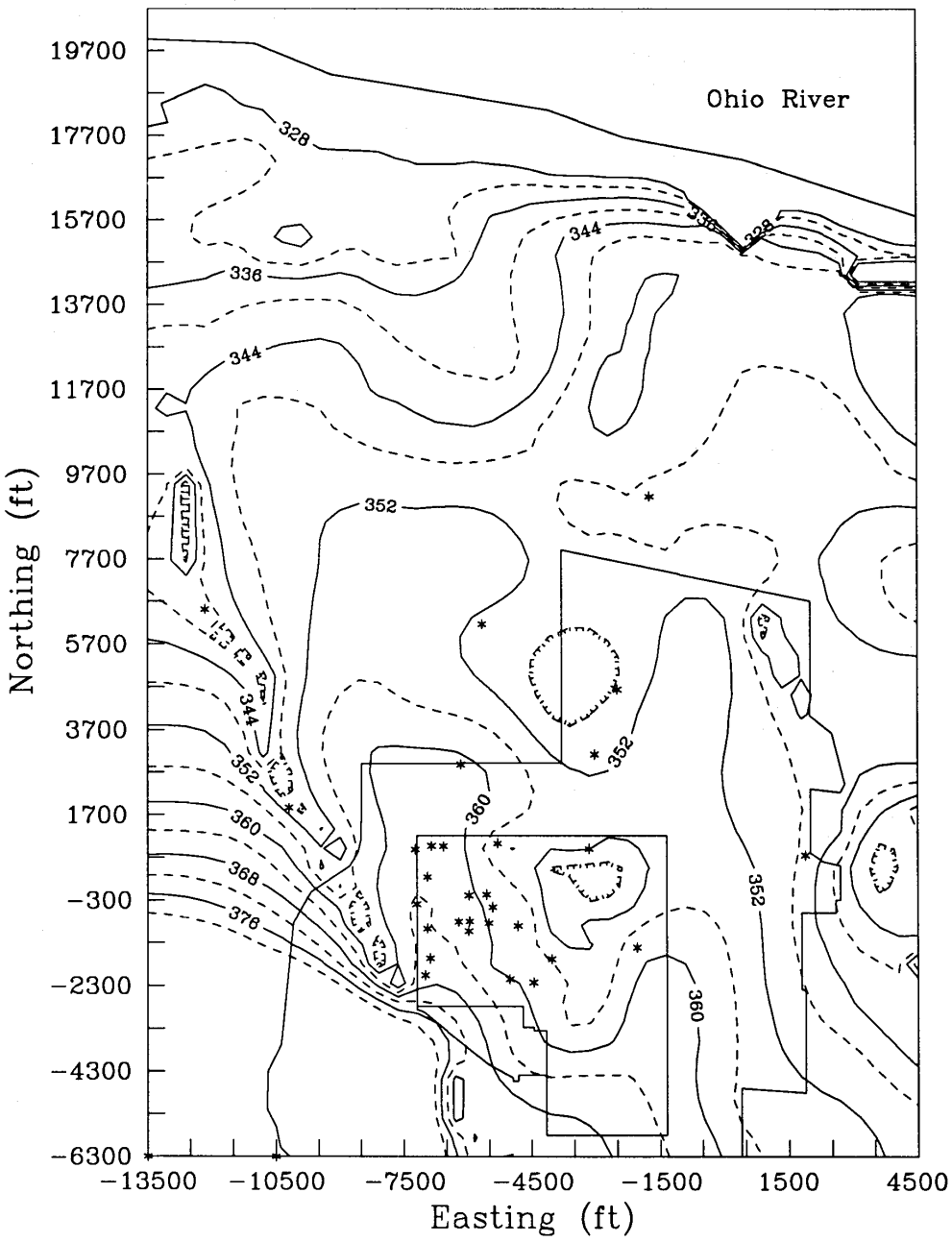

Figure 2.5-5. Calculated potentiometric surface in the shallow sand.

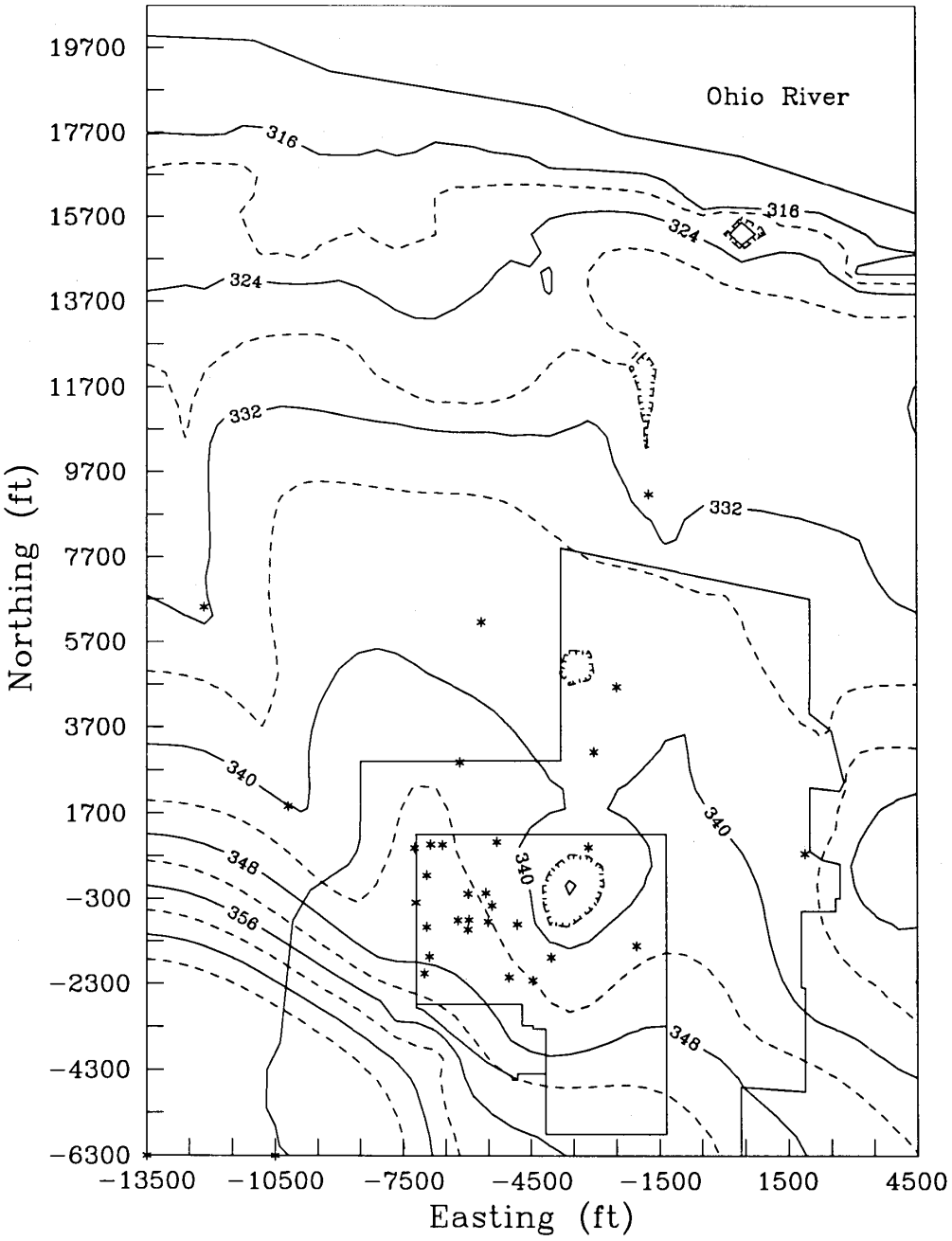

Figure 2.5-6. Calculated potentiometric surface in the upper clay.

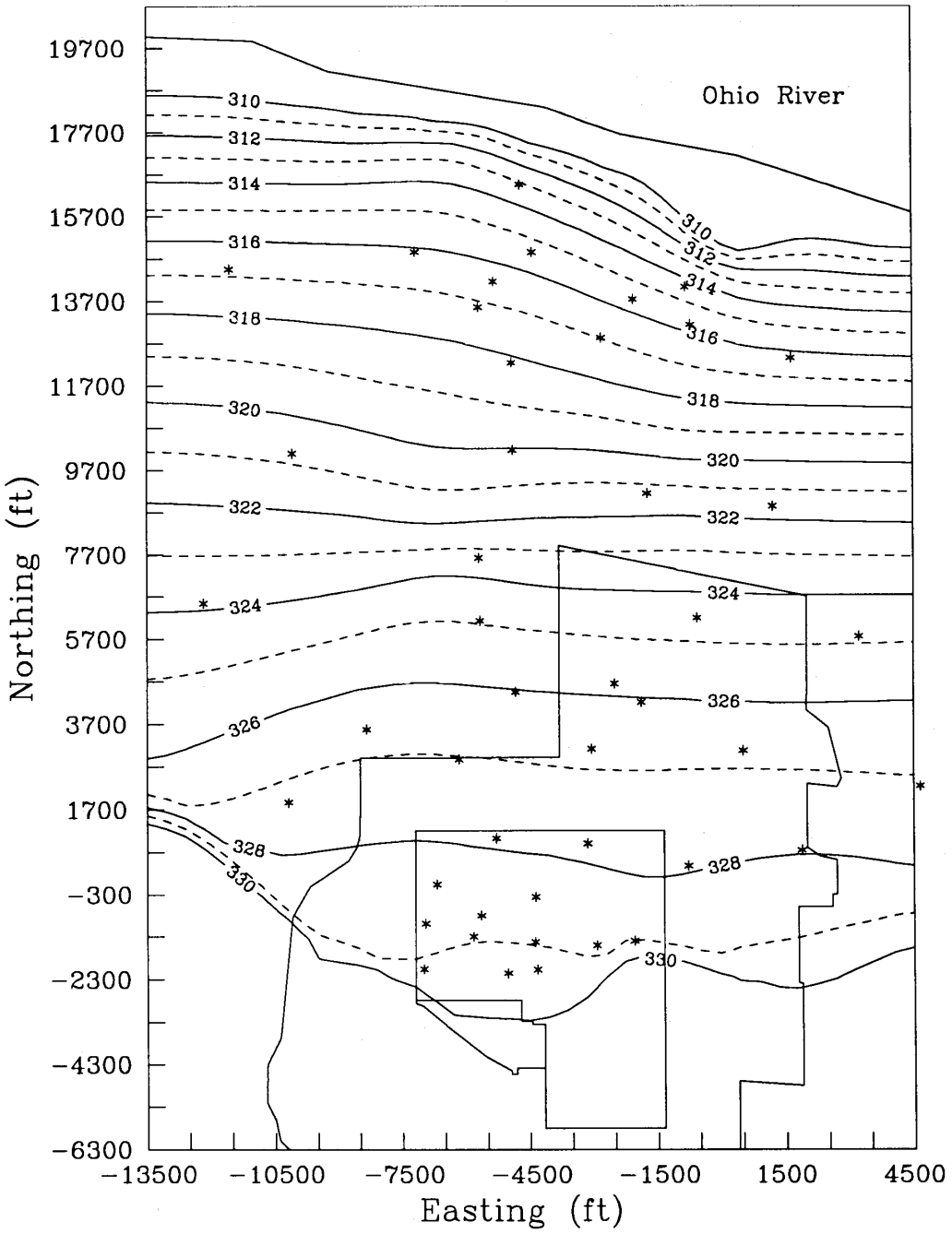

Figure 2.5-7. Calculated potentiometric surface in the RGA.

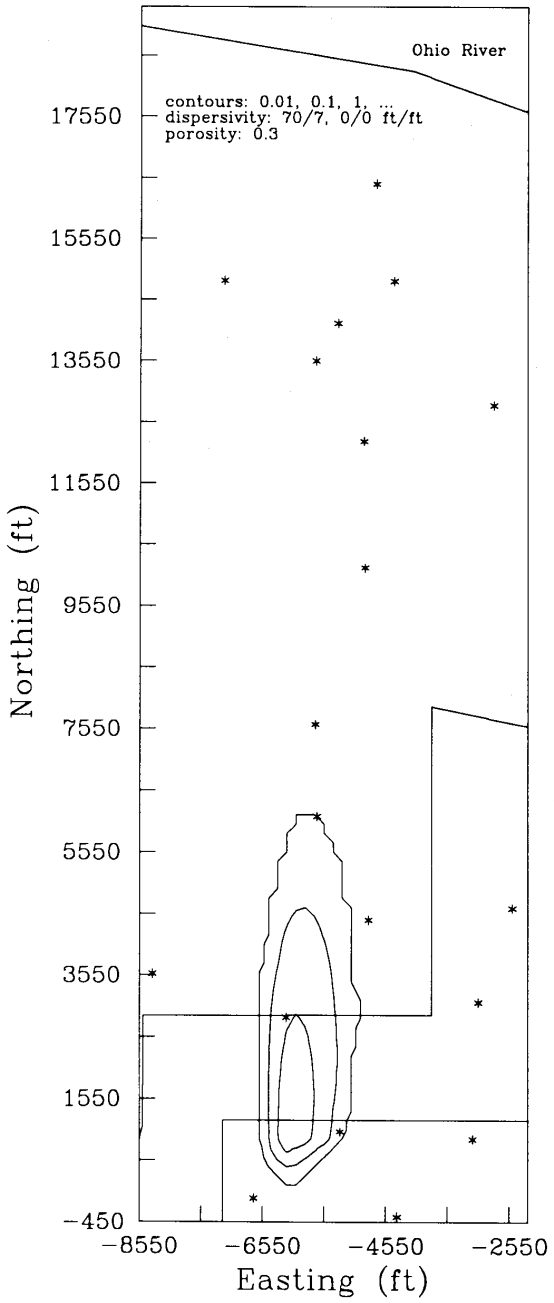

Figure 2.5-8. Calculated northwest plume in the RGA at the end of the 10th year.

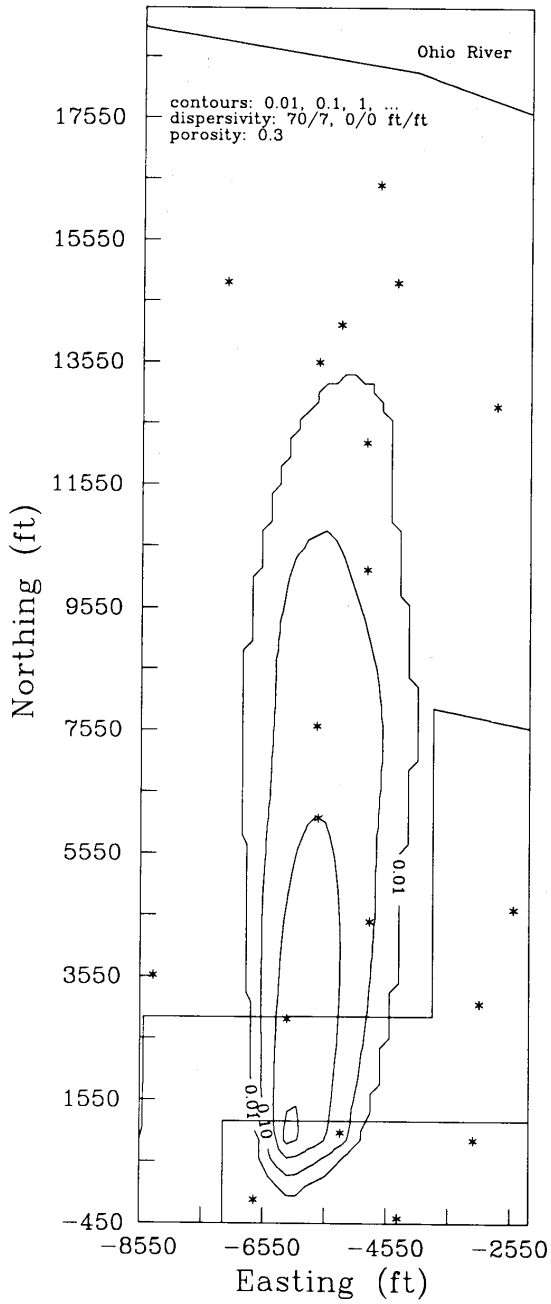

Figure 2.5-9. Calculated northwest plume in the RGA at the end of the 20th year.

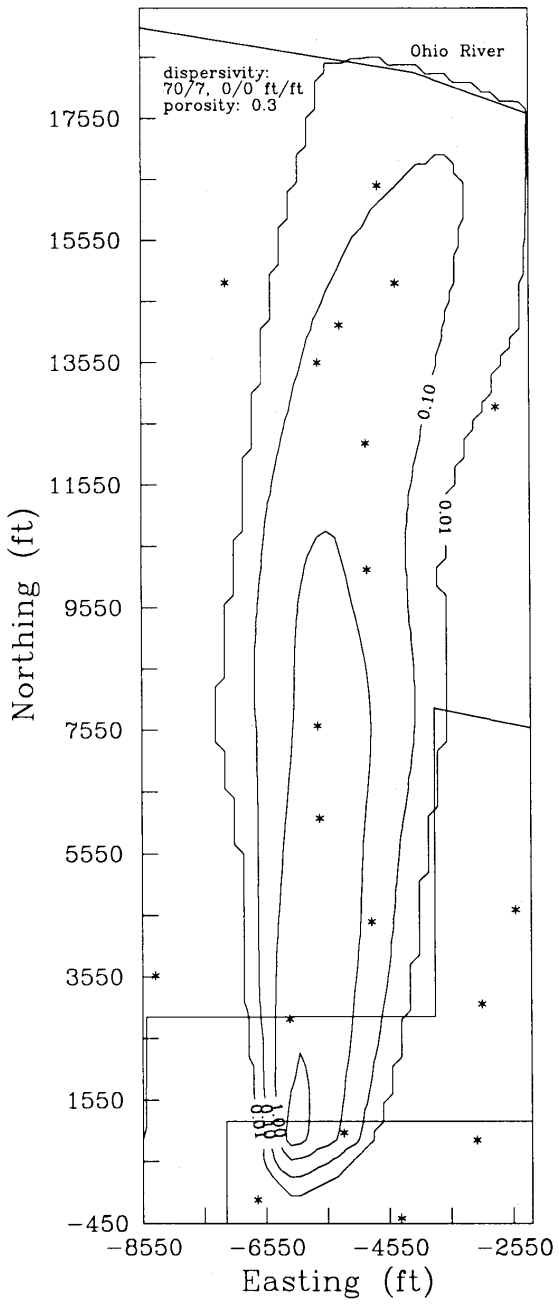

Figure 2.5-10. Calculated northwest plume in the RGA at the end of the 30th year.

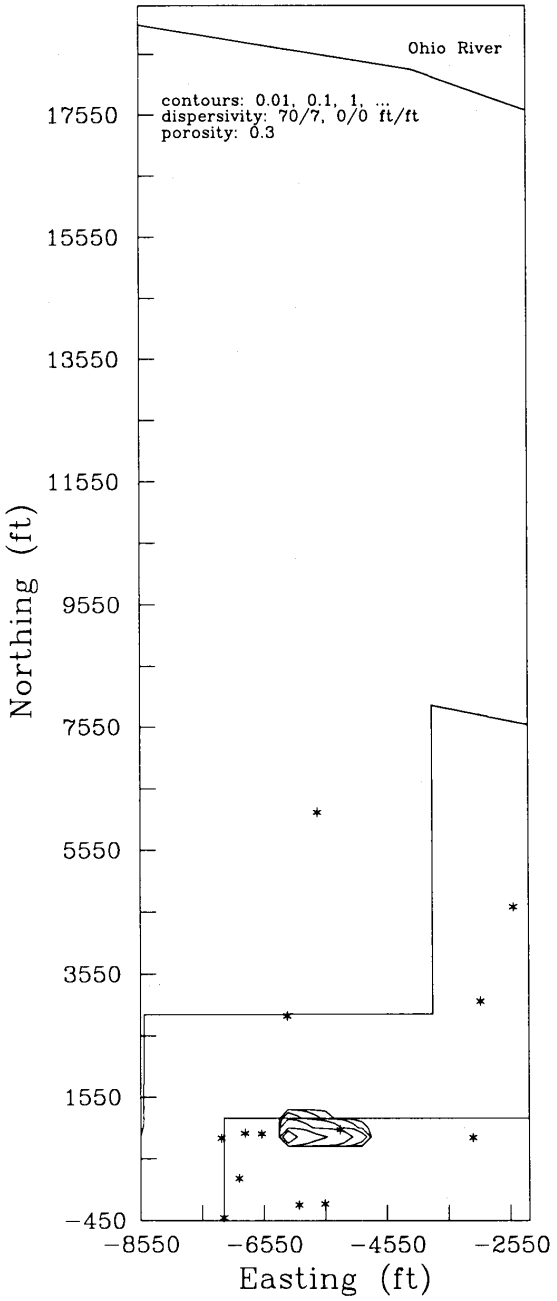

Figure 2.5-11. Calculated northwest plume in the shallow sand at the end of the 30th year.

2.6 GEOLOGY AND SEISMOLOGY

This section describes the geology and seismology, vibratory ground motion, surface faulting, and geologic structures at the PGDP. Regional and site-specific physiography, stratigraphy, geologic history, structural setting, and engineering geology are described. Information on earthquake history and seismic hazards analysis is provided as well.

2.6.1 Basic Geologic and Seismic Information

2.6.1.1 Regional Physiography

The DOE PGDP reservation encompasses 3,423 acres located in the Jackson Purchase region of western Kentucky; approximately 650 acres of the reservation lie within the Controlled Access Area. Figure 2.6-9 shows PGDP with respect to nearby politicial jurisdictions. PGDP is located about 9 miles northwest of downtown Paducah and 3.5 miles south of the Ohio River. Charleston, Missouri, is 30 airline miles southwest of the reservation. PGDP is located near the northern limit of the Mississippi alluvial plain portion of the Coastal Plain physiographic province. It is bordered to the north by the Central Lowland Province, to the east by the Interior Low Plateaus, and to the west by the Ozark Plateaus. Figure 2.6-1 shows the relationship of these provinces.

The Coast Plain province is underlain by relatively flat-lying, unconsolidated Cretaceous, Tertiary, and Quaternary age sediments. Both the Central Lowland and Interior Low Plateaus are underlain by flat-lying Paleozoic limestone and shale. The Ozark Plateaus are largely underlain by mostly flat-lying Cambrian and Ordovician dolomite. The site is south of the region glaciated during the Pleistocene epoch. Figure 2.6-1a presents the geologic time scale with the various eras, periods, and epochs and their duration and time before present.

The ground surface in the site area is relatively flat. Surface elevations range from about 290 ft amsl to 430 ft amsl over a distance of several miles. For reference, the normal pool of the Ohio River is 290 ft amsl. The region is currently undergoing gradual erosion.

2.6.1.2 Regional Geologic History and Geology

The region within a 200-mile radius of the PGDP is a portion of the eastern interior of the craton in which Paleozoic and younger sedimentary rocks were deposited upon granitic and rhyolitic rocks of the Precambrian basement. Granite rocks are exposed in the St. Francois mountains in the Ozarks some 100 miles to the west-northwest. The history of the region during the Precambrian is poorly understood because rocks of that period are largely concealed, and interpretations of tectonic activity affecting those rocks are based on a relatively small amount of deep drilling and seismic profiling. The picture derived from those investigations suggests a complex history of faulting and rifting of major proportions. Some of these features were reactivated in older (as well as the contemporary) stress fields.

Since Precambrian time, the regional history consists of the deposition of primarily marine and inland sea sediments punctuated by an occasional gap in the depositional record resulting when the area (or portions of it) was uplifted above sea level, as it is presently.

A number of significant structural features (domes, basins, etc) are recorded in the geological record of the paleozoic (see Figure 2.6-2), and several have been interpreted as refelecting Precambrian structures and influences that persisted well into the Paleozoic era. During the early part of the Paleozoic, several of those structurally positive and negative elements exerted significant control over the subsequent depositional history of the region.

The Ozark dome to the west and the Cincinnati arch to the east were connected across the southwest by the Pascolar arch, which flanks the Illinois basin the north. A cumulative thickness of approximately 3 miles of Paleozoic sediment was deposited in the deepest part of the Illinois basin near PGDP. Atherton states that previous investigators have found indications that Pennsylvanian sediments totaling about 1 mile in thickness have been removed by erosion. The sedimentary record, therefore, is not complete in any part of the region. Some positive structural elements, such as the Nashville dome/Cincinnati arch/Pascola arch have an incomplete stratigraphic sequence resulting from intermittent deposition and erosion. The Ozark dome has apparently been undergoing erosion to a much greater degree; to a large extent, Paeozoic sediments have been removed from the crest and are now preserved mainly on the flanks and basins.

The Mesozoic depositional and tectonic history of the region has great significant to the PGDP site. The northeast trending axis of the Mississippi embayment lies directly across the axis of the Pascolar arch. The trend of the embayment, which began subsiding during the Mesozoic, may reflect earlier faulting, possibly even involving a speculative “failed third arm” of a triple junction (the intersection of three postulated late-Precambrian rift zones). Most of the region, however, was probably a structurally positive area in the late Paleozoic and through much of the Mesozoic. Little Permian age sedimentary or igneous rock and no Triassic or Jurassic rock is found in the region.

During the late Mesozoic, Cretaceous sediments were deposited in a southward-thickening wedge of sediment within the embayment, beginning with the Tuscaloosa gravel. The Tuscaloosa was deposited on an old soil horizon (paleosol) that is now commonly referred to as “Little Bear Soil.” Subsequent marine sands and clays were deposited in the embayment concurrent with fauling and subsidence along the Reelfoot rift. Development of a complex of high angle faults (the Kentucky-Illinois Mineral District fault zone) north of the embayment is considered to be related to the development of Reelfoot rift. Apparently, the Kentucky-Illinois fault zone does not offset the east-west trending Rough Creek fault zone (Figure 2.6-4). The relationship to the Wabsh Valley fault zone is unclear.

Subsidence and subsequent deposition continued throughout the Cenozoic, with unconformities marking intermittent periods of uplift and erosion. Figure 2.6-6 shows contours on the post-Paleocene erosional surface; other erosional surfaces are known. Glaciation during the Pleistocene resulted in the deposition of sediment in some areas to the north, and soil and rock was scoured from other areas. To the south, a layer of freshwater continental deposits was deposited during the Pliocene and Pleistocene. The Pleistocene was closed by the deposition of a blanket of wind-blown silt and clay (loess). During the past 10,000 years (Holocene), higher elevations have been eroded and sediments from them deposited in river and stream channels. A regional geologic map is presented in Figure 2.6-7.

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2.6-1b

2.6.1.3 Regional Stratigraphy and Lithology

The region has good geologic map coverage. Existing state geologic maps show nomenclature agreement satisfactory for general correlation of geologic units across the region. The regional stratigraphy is shown by Figure 2.6-8. Figure 2.6-3 is a generalized geologic cross section depicting the regional stratigraphy.

Recent alluvium (Holocene age) consisting of clay, silt, sand, and gravel is distributed throughout the region along the floodplains of all major streams and their tributaries. Evidence of ancestral streams and altered stream courses is found in the form of higher stream cut terraces and remnants of terrace deposits, which have been partially cannibalized and redeposited by younger stream stages. Within the region, these deposits lie on or within older materials ranging in age from Precambrian to Pleistocene.

The central portion of the region near the PGDP site has large areas covered with loess (wind deposited silt and clay) of Pleistocene age overlying continental deposits of Pliocene to Pleistocene age. The continental deposits consist of fresh waster deposited silt, sand, clay, and gravel that may represent part of a large alluvial fan and consist partly of reworked glacial outwash from nearby glaciated regions to the north and east. These deposits are apparently similar to, and may be partly the same as, the Lafayette gravel described by Ross.

Pliocene-Pleistocene deposits uncomfortably overlie several Cretaceous and Tertiary sedimentary units in the northern end of the Mississippi embayment. The Cretaceous and Tertiary sedimentary units were apparently terraced and beveled during the Mid-Tertiary because no Miocene or Oligocene sediments are reported from the central part of the region. Currently the Cretaceous and overlying Tertiary sediments are found mainly within the limits of the Mississippi Cretaceous and overlying Tertiary sediments are found mainly within the limits of the Mississippi embayment (Figures 2.6-2 and 2.6-7) as a downwarped wedge of synclinal deposits that thicken to the south and toward the axis of the embayment. The depositional environment of that area during the upper Cretaceous (Tuscaloosa formation) probably is best described as a southward-plunging through that was open to the sea on the southwest and received finer detrital material (sand, silt) from uplands to the east and northwest (Nashville dome and Ozark dome).

Underlying the Mississippi embayment sediments is Paleozoic rock ranging in age from Mississippian through Cambrian. A profound unconformity is represented by the pre-Cretaceous/ post-Paleozoic Little Bear soil (or Rubble Zone) that developed on the Paleozoic rock now covered by younger sediments. Mainly limestone and olomite with some sandstone and shale were deposited in the region over a period of 300 million years, with certain portions of the region receiving and preserving a much more nearly complete depositional record. The most nearly complete section is preserved in the northern portion of the region in the Illinois basin (Figure 2.6-2) where deep drilling has penetrated Paleozoic rocks of Pennsylvania through Cambrian age.

In portions of the region, it is generally accepted that Cambrian-age rocks (LaMotte, St. Simon) lie directly on granite and felsic rocks of the Precambrian basement. There are surface exposures of these in the St. Francois Mountains region of the Ozark dome where the overlying sedimentary rocks have been removed by erosion or never deposited.

Thick sequences of pre-Mt. Simon sediments have been encountered by deep drilling in the southeastern Missouri, eastern Arkansas, and western Tennessee (probably the Reelfoot rift zone) and in the Rough Creek graven in southern Illinois.

The stratigraphic record indicates a significant probability that the zone(s) of weakness present in the Mississippi embayment-Rough Creek fault zone may existed in early Cambrian or in Precambrian time.

2.6.1.4 Regional Structural Setting

PGDP is bordered by the Illinois basin to the north, the Ozark uplift to the west, the Reelfoot rift and Pascola arch to the southwest, the Nashville dome to the southeast, and the Cincinnati arch to the east (Figure 2.6-2). In addition to these structures, Figure 2.6-4 shows that six major fault zones are recognized in the region. Although many local names are used in the literature to identify these fault zones, the terms used below have been selected for this report:

1. The Rough Creek fault zone — a westerly trending fault system that extends from near Lexington, Kentucky, across western Kentucky and southern Illinois. Relative alignments of faults within a regional lineament are traceable across southern Illinois and into Missouri suggesting a continuation of the Rough Creek system westward.

2. The Ste. Genevieve fault zone — a zone of northwest-southeast trending faults that begins south of St. Louis, Missouri, and trends southeastward into Illinois, where it intersects the Shawneetown fault zone near Paducah.

3. The Cottage Grove fault zone — a zone of faults traceable across southern Illinois to the Mississippi River, where it may end against the Ste. Genevieve system and its branches.

4. The Shawneetown fault zone — a zone of faults in western Kentucky which align with the western end of the Rough Creek zone and turn southward northeast of Paducah, Kentucky. This zone is complex and dominated by high-angle reverse faulting.

5. The Wabash Valley fault zone — a zone of faults north of the Shawneetown fault zone consisting of nearly symmetrical hoists and grabens and trending northeast along the Illinois-Indiana border.

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2.6-2b

6. The Illinois-Kentucky Mineral District—a zone of mineralized faults in southeastern Illinois and western Kentucky. This zone lies just south of the western end of the Rough Creek fault zone and east to northeast of Paducah. The zone consists of a complex series of northeast-southwest trending faults. These faults likely continue beneath the upper cretaceous sediments of the Mississippi embayment.

In addition to these regional fault zones, there are other faults of more local extent, particularly in the Ozark dome and Illinois basin. The relationship of these faults to the regional systems has not been clearly established; a number of these faults are of Precambrian and Paleozoic age, which the age of others cannot be determined from the available geologic evidence.

2.6.2 Site Physiography and Geology

2.6.2.1 Site Physiography

PGDP is located on an upland surface of western Kentucky. The area upland has been dissected by Little Bayou Creek to the north and east and by Brushy and Bayou creeks to the west. About 1952, the area within the security fence was graded; the ground surface in this developed area ranges from approximately 370 ft amsl to 380 ft amsl. Figure 2.6-10 shows the topography within and surround the plant site as it existed in 1978. The area within the security fence is relatively level, and no slopes have an inclination greater than 3:1; therefore, there is a very low potential for landslides. There is no documentation of local subsidence or uplift, nor is there any evidence of cavernous or karst development at the site. Since limestone is only present at depths of more than 300 ft below the existing ground surface, the development of cavernous or karst terrains is unlikely.

2.6.2.2 Site Geologic History

The facility lies near the northern limit of the Mississippi Embayment. The Mississippi Embayment consists of unconsolidated sediments of Cretaceous to Quaternary age that dip gently downward to the south. The following is a brief summary of the geologic history as it relates to the PGDP site.

1. Subsidence and uplift of continental proportions resulted in the formation of numerous basins,

   domes, and arches in the mid-continent during the Paleozoic Era.

2. Several thousand feet of Paleozoic limestone and dolomite interbedded with shale and sandstone

   accumulated within the basins, over the arches and domes. These sedimentary rocks are the bedrock of the mid-continent and the PGDP site.

3. The area was eroded during the Mesozoic Era.

4. The Mississippi Embayment syncline, whose axis roughly coincides with the course of theMississippi River, was developed by regional downwarping, thereby creating a shallow marine sea in the late Mesozoic.

5. Sands, silts, and clays were deposited in the Mississippi Embayment creating the Clayton, McNairy,
and Porters Creek Formations.

6. Subsequent uplift and erosion during the early Cenozoic Era produced a gap in the sequence of formations.

7. Subsidence occurred again and sand, silt, and clay were deposited creating the Claiborne and Wilcox Formations.

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2.6-3b

8. Uplift occurred again in the late Cenozoic, and the shallow marine sea (the ancestral Gulf of Mexico) retreated to the south.

9. Freshwater Continental Deposits of Quaternary Age (gravel, sand, silt, and clay) were deposited on an erosional surface cut on the Claiborne, Wilcox, and Porters Creek Formations at the southern portion of the site and on the Clayton and McNairy Formations to the north.

10. A blanket of loess (silt and clay) was deposited over the Continental Deposits during the Pleistocene and Holocene epochs. This loess is the surficial soil now exposed throughout the site.

2.6.2.3 Site Stratigraphy and Lithology

Several subsurface investigations have been performed at the PGDP site since the initial investigation was performed by the U. S. Army COE in 1951. A series of borings was completed in 1988 and 1990 by ERCE [Reference 51]. Other borings and wells were drilled in late 1989 and 1990 by CH2M Hill (1991) [Reference 24] and by D'Appolonia and Geoteck (1983) [Reference 34]. Although other available subsurface data were reviewed, these investigations were the primary sources used to assess the subsurface conditions at the site.

Figure 2.6-11 shows the general stratigraphic section beneath the site, while Figure 2.6-3 shows the general stratigraphic relationships for the site area. Figure 2.6-3 shows that although the pre-Cretaceous formations are present at depth running north to south. The Porters Creek clay and Eocene sands (Claiborne, Wilcox formations) present immediately to the south of the security area have been eroded to the north and replaced by continental deposits. Each formation or unit beneath the site is discussed below in order of increasing geologic age and increasing depth below the present ground surface.

Alluvium — Recent and Pleistocene age alluvium is present only in the floodplains of the adjacent creeks and the Ohio River. It consists of fresh water deposits of silt, sand, and gravel, most of which are unstratified. The alluvial gravel consists of chert and sandstone fragments. Although the alluvium is thin in the nearby creeks, it ranges up to 40 ft in thickness, with the greatest thickness occurring with the flood plain of the Ohio River. Alluvium was not encountered in some borings because the plant is situated on a relatively undissected plateau.

Loess — The surficial soil at the reservation consists of up to 40 ft of unstratified loess (wind-deposited material), which consists of silt and silty clay. Some of the loess below an elevation of 400 ft amsl may have been reworked by flood waters during Pleistocene time. The base of the loess within the reservation is generally at 350 to 360 ft amsl. This material often grades imperceptibly into the finer portions of the continental deposits.

Continental Deposits — These Pleistocene and/or Pliocene nonmarine sediments consist of up to 95 ft of unstratified to poorly stratified interbedded and interlensed sand, gravel, silt, and clay. As a generalization, the upper portion appears to contain more clay, silt, and sand; the lower portion is more coarsely textured, containing significant amounts of gravel. This interval characterized by unstratified silty, clay, and sand with some gravel and cobbles. The available exploratory borings show considerable lateral and horizontal variability of this upper unit.

The lower portion of the continental deposits consists of sand, gravel, and cobbles, up to 8 inches across, which also exhibit rapid changes in thickness and character, both vertically and horizontally. Clay lenses occur locally, and thin intervals of the sand and gravel are cemented by iron oxide. Available data show the base of this granular interval (referred to as the regional gravel aquifer) ranges from 265 to 290 ft amsl. The regional aquifier is a source of groundwater and may increase in thickness toward the north.

Claiborne and Wilcox Formations — These marine formations of Eocene age are present to the south of the PGDP where they have been removed by erosion. They cannot be differentiated on lithology. They are composed of interbedded and interlensing micaceous fine sand, silt, and clay.

Porters Creek Clay — The Porters Creek clay is present beneath the southern portion of the PGDP and extends northward in a few areas where it has not been removed by post-Paleocene erosion. Classification tests show that the Porters Creek clay is actually a clayey silt. One boring encountered 84 ft of this formation on the southern side of the reservation.

Clayton-McNairy Formations — These marine formations underlie the entire plant area, being composed of interlensing and interlaminated clay, silt, and sand. The aggregate thickness of these formations ranges from 212 to 223 ft. They extend downward from about elevation 260 ft amsl to the erosional unconformity on the Paleozoic bedrock (17 to 49 ft amsl).

Tuscaloosa Formation — Although not documented by drilling in the plant area, the Tuscaloosa formation of late Cretaceous age is present to the north and overlies the Little Bear soil. Normally, this formation is 20 to 30 ft thick, but a well at Metropolis encountered up to 168 ft of chert gravel with a clay-sand matrix through to represent the Tuscaloosa formation. Greater thicknesses reported at the Metropolis well may represent infilling of sinkholes or channels developed on the Paleozoic bedrock surface.

Little Bear Soil (Rubble Zone) — The Little Bear soil or Rubble Zone is present in many areas and marks an unconformity between the underlying indurated Paleozoic rocks and the younger, softer Mesozoic and Cenozoic sediments. This clay was penetrated at the Shawnee Steam Plant to the north. One on-site boring penetrated about 27 ft of siliceous limestone and chert fragments that may represent this rubble zone. In some areas, material thought to be the Little Bear soil consists of chert rubble and is similar to the Tuscaloosa formation. The Little Bear is generally believed to grade downward into residual chert derived from the underlying limestones.

Mississippi Limestone — There are a few places in the site area where indurated (hard or consolidated) bedrock has been penetrated. A well near Heath High School penetrated rubble and bedrock, presumably of Mississippian age, at about elevation +5 ft amsl. Three wells near Metropolis, Illinois, penetrated “lime and shale,” presumably of Mississippian age, at elevations ranging from +105 ft amsl to -80 ft amsl. Further, one deep boring at the TVA Shawnee Steam Plant encountered limestone of the Warsaw formation at +6 ft amsl.

Several on-site borings encountered limestone at depths of 334 ft and 322 ft, respectively, below the ground surface indicating bedrock elevations ranging from -17 ft amsl to +49 ft amsl.

2.6.2.4 Site Structural Setting

There are a few surficial geologic structures in the immediate area of PGDP that are particularly significant. The facility rests on essentially flat-lying unconsolidated sediments more than 300 ft thick, which lie unconformably on Paleozoic limestone that dips gently to the north. While there is extensive faulting in the Paleozoic formations north of the site, there is only one hypothetical fault mapped within 5 miles of the site. The Paducah West Geologic Quadrangle Map shows a hypothetical fault starting a little less than 3 miles east of the site near Chiles and trending northeast under the Ohio River. Eight other faults are shown on the Paducah West, the Lovelaceville, the La Center, and the Bandana Geologic Quadrangle Maps. Six of these eight faults are based on boring data and are hypothetical. The two remaining faults are shown as small surface faults on the Paducah West Geologic Quadrangle and are apparently pre-Pleistocene in age.

Although all but two of the faults mentioned above are shown as hypothetical, the unconsolidated and easily weathered nature of the thick Tertiary and Quaternary deposits of the Mississippi embayment make detection of faults within these sediments difficult. The degree to which faulting has occurred in post-Paleocene sediments is unclear. Kolata (1981) [Reference 87] asserts there is no clear evidence that faulting of post-Paleocene sediments has occurred in the Mississippi embayment in southern Illinois. Ross (1963) [Reference 146], however, claims evidence of post-Paleocene faulting and states that "the fault system which cuts the Paleozoic strata at the head of the Mississippi Embayment extends for a considerable distance southwestward beneath the Embayment sediments and has remained active to the present."

2.6.2.5 Engineering Geology

The thick unconsolidated cover of sediments that underlie the facility are essentially undeformed; there is no evidence of zones of alteration, irregular weathering, or structural weaknesses aside from the normal weathering of sediments at the ground surface and presumably at unconformable stratigraphic contacts.

There is a clastic dike reported within the Porters Creek formation at about coordinates S4000 and W7000 that may indicate infilling of a desiccation crack created by erosion of the Porters Creek Clay during the post-Paleocene, or it may represent sand from the underlying Clayton-McNairy formation. The presence of sand from the Cayton-McNairy formation may indicate injection during a previous earthquake (sand-blow, liquefaction).

The potential for seismically induced liquefaction of unconsolidated sediments at the site represents the most significant engineering geology consideration. Based on the results of a recent study, a zone of potentially liquefiable sediments has been identified. These unconsolidated sediments are a part of the freshwater Continental Deposits. Liquefaction potential is discussed in Section 2.7.1.1.

The presence of unrelieved residual stresses in the bedrock is unknown. Current theory does, however, indicate the eastern interior United States is currently under compression because of continental margin subduction (Braile et al. 1984) [Reference 17]. Zoback (1992) [Reference 188] further describes the contemporary stress-field of eastern North American and attributes this stress-field to sea-floor

spreading along the Mid-Atlantic Ridge. According to Zoback the contemporary stress-field is horizontal compression and oriented about N63°E±28°. Favorably oriented deep-seated normal faults in ancient rift valleys and deep-seated transform faults may occasionally reactivate in the contemporary stress-field. Senses of motion along these reactivated faults may be either strike slip or reverse slip. Strike slip may be left- or right-lateral, depending on the fault's orientation with respect to the contemporary stress-field.

Several recent publications describe post-Paleozoic crustal responses to the contemporary stress-field in nearby southern Illinois and Indiana. Ault et al. (1985) [Reference 5] and Nelson and Bauer (1987) [Reference 116] discuss numerous thrust faults in coal mines in southwestern Indiana and southern Illinois, respectively. All these thrust blocks strike nearly north-south and overridge lower strata both to the east and west. Characteristics of these thrust blocks suggest compressive stress oriented in a more or less east-west direction and compatability with the contemporary stress-field as described by Zoback (1992) [Reference 188]. Ault (1989) [Reference 6] suggests that bedrock joints in the northern two-thirds of Indiana also may have been caused by the contemporary stress-field. Staub and Hardee (1993) [Reference 159] summarizes a number of post-Paleozoic crustal responses to the contemporary stress-field throughout the eastern United States.

Langer and Bollinger (1991) [Reference 97] investigated numerous aftershocks that followed the June 10, 1987, earthquake in southern Illinois. The aftershocks had a vertical distribution between 5.9 and 7.5 miles deep. Composite focal plane solutions of the aftershocks suggest that the predominant mode of faulting is reverse slip with some strike-slip motion.

Tables 2.6-1 through 2.6-7 present static and dynamic properties of the soil underlying the site. Table 2.6-8 gives estimated bedrock characteristics.

There has been no subsurface mining in the immediate PGDP area, nor has there been any local oil or gas production.

2.6.3 Analysis of Geologic Stability

2.6.3.1 Earthquake History

Little evidence exists concerning the behavior of the surficial geologic materials or site subsurface strata during recent earthquakes. However, the facility has performed without damage or interruption of operations since its opening and there have been no observed ground ruptures, sand boils, or subsidence at the site. During the New Madrid earthquakes of 1811-1812, however, historical records (Street & Nuttli 1984) [Reference 160] and aerial photographs (Jibson et al. 1984) [Reference 81] indicate various modes of ground failure occurred over a wide area — large fissures, extensive and large sand blows, slumping and landslides, subsidences and uplifting, and caving of river banks. Holocene ground failures have been reported as far north as the Wabash Valley of southern Illinois and Indiana (Obermeier et al. 1993) [Reference 124]. These ground failures centered around Vincennes, Indiana, and suggest that Holocene earthquakes have occurred in the Wabash Valley that are larger than any historical earthquakes recorded there. Nevertheless, the majority of ground failures occurred within Quaternary alluvial deposits in the New Madrid, Missouri, region. The clastic dike within the Porters Creek clay mapped by Olive (1966) [Reference 125] at about S4000, W7000 may reflect liquefaction of older

subsurface strata. The age of speculative sand boils in the Porters Creek clay is unknown but younger than Paleocene. Similar dikes in the Porters Creek formation in western Tennessee have been attributed to earthquakes during the Eocene era (56 million years ago) that caused fissures and the simultaneous injection of sand from underlying sources (Russell and Parks 1975) [Reference 151].

During the winter of 1811-1812, 4 major earthquakes and 203 damaging aftershocks occurred in the central Mississippi Valley. Since the 1811-1812 earthquakes, only 20 damaging earthquakes have occurred in the Mississippi Valley. The majority of these earthquakes had estimated Modified Mercalli intensities of VI-VII, and no event since the 1811-1812 earthquakes has exceeded an intensity of IX. The Charleston, Missouri, earthquake of 1895 had an intensity of IX. By comparison, the four major earthquakes of 1811-1812 had intensities of X-XI, X-XI, X-XI, and XII, respectively. ERCE's (1990) [Reference 51] Appendix B provides a chronological listing compiled by USGS of all earthquakes with epicenters within 200 miles of the site. For earthquakes that occurred prior to 1816, earthquake intensities and magnitudes are largely unavailable. From 1816 to 1960, intensities and some magnitudes (based on felt area) are given. Data since 1960 of measured magnitudes and some intensities are given. Table 2.6-9 lists all recorded earthquakes with modified Mercalli intensities ≥VI with epicenters within 200 miles of the site since 1951. (The historical record of smaller earthquakes is less reliable.) Table 2.6-10 lists all recorded earthquakes since 1951 with epicenters within 50 miles of PGDP. Although earthquake activity near Paducah since 1951 is somewhat less than that of surrounding regions, the recent historical record is too short to reveal any significant trends.

The earthquake of February 7, 1812, which destroyed the town of New Madrid, Missouri, was the largest recorded earthquake in the New Madrid seismic zone (NMSZ). The approximate epicenter was roughly 60 miles southwest of the PGDP site. The approximate northern limit of the NMSZ is approximately 19 miles southwest of the PGDP site.

Figure 2.6-4 shows the general relationship between the regional seismotectonic provinces and epicenters of historical earthquakes within 200 miles of the PGDP site. The most significant correlation between seismicity and tectonic structures occurs in the NMSZ at the intersection of the northeast trending Mississippi Embayment Syncline (and the associated Reelfoot Rift) and the northwest trending Pascola Arch. This intersection has been the location of the most frequent seismic activity and was the location of two of the four major earthquakes in 1811-1812. The dispersed seismic activity outside the area of intense seismic activity has not been definitely linked to any major fault zones. Seismotectonic provinces and epicenters are shown in Figure 2.6-12.

PGDP operating personnel indicate that the facility has performed without damage or interruption to its operations from those seismic events, which have occurred since its opening, and that there have been no observed ground ruptures, sand boils, or subsidence at the site.

2.6.3.2 Identification and Description of Capable Faults

No surface fault or part of a surface fault greater than 1000 ft long is known within 5 miles of the site. Faults, probably part of the Fluorspar Area Fault Complex (FAFC) as postulated from drill data, are shown on the Paducah West Geologic Quadrangle that trend toward the site area. These postulated faults are concealed by younger sediments. There is no documentation of surface offset along these faults, and no evidence of any movement on the faults during the past 35,000 years. Several faults of the FAFC mapped northeast of the site in Illinois show directional trends generally toward the PGDP area. They are not known to be “capable faults.” Small earthquakes occasionally occur within the fluorspar region, but none has been related to bedrock faults, and quakes are no more concentrated in the FAFC than elsewhere in southern Illinois or western Kentucky. A “capable fault” is one that has exhibited movement at or near the surface during the past 35,000 years, or movement of a recurring nature during the past 500,000 years. [Reference 117]

Geologic maps of the various states within 200 miles of PGDP show numerous (over 533) fault systems, zones, and individual faults. Fault studies by the TVA contains information on over 445 of these faults. The published literature show only three mapped faults that may be considered capable:

1. An unnamed fault 60 miles southeast of the PGDP in Stewart County, Tennessee, is 0.4 miles long and trends near east-west. Its offsetting gravel beds are considered to be of Quaternary age, although assigning Quaternary age to these deposits has been questioned.

2. A fault is located adjacent to the Reelfoot Scarp in Lake County, Tennessee. It is described by Russ [Reference 150] as “the only tectonic faulting in the upper Mississippi Embayment known to displace surficial sediments of Holocene age.” It is approximately 6 miles in length, trends roughly north-south, and lies approximately 55 miles southwest of PGDP.

3. The English Hill Fault in Scott County, Missouri, has loess (Pleistocene Age) faulted against Wilcox (Eocene Age) sediments in a graben that trends N 30°E. Its length in Missouri is approximately 6 miles, and it may extend into Illinois. The fact that the loess is affected by the fault shows late movement in the area. This location lies near Charleston, Missouri, and 35 miles west of the Paducah site.

2.6.3.3 Surface Faulting

Geotechnical studies performed at the site and the published geologic quadrangles of the site do not indicate any evidence of fault offset at or near the ground surface within a 5-mile radius. The absence of surface faults in the vicinity of the plant area reduces the likelihood of nearby earthquakes capable of producing near-field strong motion and surface rupture.

2.6.3.4 Stability of Subsurface Materials

There are no known areas of subsurface subsidence, uplift, or collapse resulting from tectonic depressions. Soluble bedrock is present at a considerable depth below the ground surface and the groundwater; there is a low probability of carbonate solution that would affect the plant. Further, the soil column is composed predominantly of low solubility detrital material (siliceous gravel and sand, silt, and clay).

There has been no extraction of oil or gas near the plant; the nearest exploratory well drilled in McCracken County was completed and abandoned. There is some hydrocarbon production to the south and east in Trigg and Calloway counties in Kentucky. Adequate reserves of sand and gravel are available nearby and there are no other known mineral resources of current economic value in the formations that underlie the facility.

The area within the security fence is relatively level and there are no slopes with an inclination greater than 3:1. Therefore, there is a very low potential for landsliding. There is no documentation of local subsidence or uplift, nor is there any evidence of cavernous or karst development at the site. Because limestone is present at depths of more than 300 ft below the existing ground surface, the development of cavernous or kast terrains is unlikely.

The engineering properties of the materials underlying the site are provided in Tables 2.6-1 through 2.6-8. These values are based on results from geophysical exploration, laboratory testing, and standard penetration tests. Also included are estimated values where specific measurements were not made (i.e., density of gravels).

2.6.3.5 Slope Stability

The area within the security fence is relatively level, and there are no slopes with an inclination greater than 3:1. Therefore, there is a very low potential for landsliding. There is no documentation of local subsidence or uplift, nor is there any evidence of cavernous or karst development at the site. Because limestone is present at depths of more than 300 ft below the existing ground surface, the development of cavernous or karst terrains is unlikely.

Table 2.6-1. Engineering properties of the loess.

Character	Unified Soil Classification System	
	CL	ML
Compressional wave velocity ft/s[a]	3349	3349
Shear wave velocity, ft/s[a]	719	719
Shear modulus, psi[a]	1.406×10^4	1.406×10^4
Bulk modulus, psi[a]	3.782×10^4	3.782×10^4
Poisson's ratio[a]	0.44	0.44
Compression index[b]	0.069	0.047
Recompression index[b]	0.028	0.021
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	91.2, 112.1, (104.9)	93.2 106.1, (101.8)
Natural moisture content, % (min, max, [avg])[b]	10.7, 27.6, (19.7)	15.8, 26.2 (21.3)
Plastic limit (min, max, [avg])[b]	17, 26, (20)	21, 24, (22)
Liquid limit (min, max, [avg])[b]	25, 43, (31)	25, 30, (27)
Porosity, %[b]	41	41
Undrained shear strength, psi[c]	8.9	12.7
Consistency[c]	Stiff	Stiff

a. Based on results from geophysical exploration. 1 fps = 0.3048 m/s. 1 psi = 6.895 kPa.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Source: ERCE 1990.

Table 2.6-2. Engineering properties of the soil interval between the loess and the shallow aquifer.

Character	Unified Soil Classification System	
	CL	ML
Compressional wave velocity ft/s[a]	5654	5654
Shear wave velocity, ft/s[a]	947	947
Shear modulus, psi[a]	2.385×10^4	2.385×10^4
Bulk modulus, psi[a]	4.620×10^4	4.620×10^4
Poisson's ratio[a]	0.48	0.48
Compression index[b]	0.074	0.056
Recompression index[b]	0.022	0.022
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	103.3, 121.5, (110.3)	107.0, 113.7, (111.4)
Natural moisture content, % (min, max, [avg])[b]	9.8, 18.2, (16.8)	11.1, 29.7, (14.1)
Plastic limit (min, max, [avg])[b]	14, 20, (`7)	16, 17, (16)
Liquid limit (min, max, [avg])[b]	21, 39, (28)	21, 23, (22)
Porosity, %[b]	37	33
Undrained shear strength, psi[c]	14.2	NA
Consistency[c]	Very stiff	NA

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-3. Engineering properties of the soil within the shallow aquifier.

Character	Unified Soil Classification System		
	SC	SM	GC, GM, GP, GW
Compressional wave velocity ft/s[a]	5558	5558	NA
Shear wave velocity, ft/s[a]	1150	1150	NA
Shear modulus, psi[a]	3.550×10^4	3.550×10^4	NA
Bulk modulus, psi[a]	1.258×10^4	1.258×10^4	NA
Poisson's ratio[a]	0.49	0.49	NA
Compression index[b]	NA	NA	NA
Recompression index[b]	NA	NA	NA
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	105.4, 118.1, (111.8)	117.2, 124, (120.6)	NA
Natural moisture content, % (min, max, [avg])[b]	10.5, 38.9, (16.8)	6.5, 21.8, (12.6)	NA
Plastic limit (min, max, [avg])[b]	9, 27, (14)	12, 18, (15)	NA
Liquid limit (min, max, [avg])[b]	14, 48, (26)	14, 25, (20)	NA
Porosity, %[b]	NA	NA	NA
Angle of internal friction (deg)[c]	35	35	NA
Relative density[c]	Medium	Medium	NA

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-4. Engineering properties of the soil interval between the shallow and the regional aquifers.

Character	Unified Soil Classification System	
	SC, SM	CL, ML
Compressional wave velocity ft/s[a]	5140	5245
Shear wave velocity, ft/s[a]	1442	1148
Shear modulus, psi[a]	3.898×10^4	4.271×10^4
Bulk modulus, psi[a]	1.087×10^4	9.512×10^4
Poisson's ratio[a]	0.42	0.45
Compression index[b]	0.050	0.076
Recompression index[b]	0.014	0.028
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	78.7, 112.9, (102.1)	61.7, 106, (87.9)
Natural moisture content, % (min, max, [avg])[b]	11.9, 25.6, (18)	7.5, 63.2, (26.5)
Plastic limit (min, max, [avg])[b]	11, 24, (15)	11, 38, (20)
Liquid limit (min, max, [avg])[b]	16, 29, (24)	22, 53, (34)
Porosity, %[b]	37	39
Angle of internal friction (deg)[c]	33	NA
Relative density[c]	Medium	NA
Undrained shear strength, psi[c]	NA	NA
Consistency[c]	NA	Very stiff

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-5. Engineering properties of the soil within the regional aquifers.

Character	Unified Soil Classification System	
	SC, SM	GC, GM, GP, GW
Compressional wave velocity ft/s[a]	5812	5245
Shear wave velocity, ft/s[a]	1559	1350
Shear modulus, psi[a]	4.428×10^4	4.790×10^4
Bulk modulus, psi[a]	1.144×10^4	3.754×10^4
Poisson's ratio[a]	0.44	0.47
Compression index[b]	NA	NA
Recompression index[b]	NA	NA
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	NA	NA
Natural moisture content, % (min, max, [avg])[b]	NA, NA, (21.3)	NA
Plastic limit (min, max, [avg])[b]	13, 24, (19)	NA
Liquid limit (min, max, [avg])[b]	27, 31, (28)	NA
Porosity, %[b]	NA	NA
Angle of internal friction (deg)[c]	33	NA
Relative density[c]	Medium	NA

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-6. Engineering properties of the Porters Creek formation.

Character	Unified Soil Classification System
	MH, SM
Compressional wave velocity ft/s[a]	5662
Shear wave velocity, ft/s[a]	1060
Shear modulus, psi[a]	2.782×10^4
Bulk modulus, psi[a]	4.400×10^4
Poisson's ratio[a]	0.47
Compression index[b]	NA
Recompression index[b]	NA
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	64.4, 71, (67.7)
Natural moisture content, % (min, max, [avg])[b]	51.5, 55.3, (54)
Plastic limit (min, max, [avg])[b]	75, 81, (78)
Liquid limit (min, max, [avg])[b]	88, 106, (95)
Porosity, %[b]	NA
Undrained shear strength, psi[c]	>30
Consistency[c]	Hard

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-7. Engineering properties of the Clayton-McNairy formations.

Character	Unified Soil Classification System	
	CL, ML	SM
Compressional wave velocity ft/s[a]	5718	5718
Shear wave velocity, ft/s[a]	1689	1689
Shear modulus, psi[a]	4.647×10^4	4.647×10^4
Bulk modulus, psi[a]	2.871×10^4	2.871×10^4
Poisson's ratio[a]	0.46	0.46
Compression index[b]	NA	NA
Recompression index[b]	NA	NA
Dry unit weight, lb/ft^3 (min, max, [avg])[b]	NA, NA, (106.6)	NA
Natural moisture content, % (min, max, [avg])[b]	22.2, 41.6, (31.8)	22.7, 30, (26.4)
Plastic limit (min, max, [avg])[b]	21, 34, (26)	Nonplastic
Liquid limit (min, max, [avg])[b]	28, 43, (36)	25, 29, (27)
Porosity, %[b]	37	NA
Angle of internal friction (deg)[c]	NA	35
Relative density[c]	NA	Dense
Undrained shear strength, psi[c]	>30	NA
Consistency[c]	Hard	NA

a. Based on results from geophysical exploration.
b. Based on results from laboratory setting.
c. Based on empirical correlations to standard penetration test results.

Table 2.6-8. Engineering properties of the bedrock.

Character	Type of Bedrock	
	Rubble Zone Boring Z-16	Unweathered Limestone Boring Z-12
Compressional wave velocity ft/s	NA	15,000 est.
Shear wave velocity, ft/s	2,000 est.	5,000 est.
Shear modulus, psi	NA	NA
Bulk modulus, psi	NA	NA
Poisson's ratio	NA	NA
Dry unit weight, lb/ft^3	125 est.	0.4 est.
Natural moisture content, %	NA	4 est.
Porosity, %	NA	NA
Unconfined compressive strength, psi	NA	12,000 est.
Consistency	Dense	Hard
Undrained shear strength, psi[c]	>30	NA

Table 2.6-9. Earthquake epicenters within 200 miles of the site having modified Mercalli intensities equal to or greater than VI.

Date	Magnitude	Intensity	Radial Distance (miles)
07/16/52	0	6	76
09/11/53	4.1 FA	6	135
01/25/55	0	6	133
01/25/55	4.5 FA	6	91
03/29/55	4.0 FA	6	85
04/09/55	4.3 FA	6	94
01/29/56	4.0 FA	6	108
11/26/56	4.4 FA	6	88
11/08/58	4.4 FA	6	101
8/12/59	0	6	177
02/02/62	4.2 Mw	6	63
06/27/62	5.5 Mb	8	44
07/23/62	3.6 Mn	6	80
03/03/63	4.8 Mn	6	75
08/14/65	5.0 Mb	7	21
10/21/65	5.1 Mb	6	120
12/19/65	5.3 Mb	7	91
07/21/67	3.9 Mb	6	93
11/09/68	5.3 Mb	7	60
11/17/70	3.6 Mb	6	107
04/03/74	4.5 Mb	6	107
05/13/74	4.3 Mb	6	39
06/13/75	4.3 Mb	6	62
12/03/75	2.8 Mn	6	58
03/25/76	4.9 Mb	6	140
01/03/77	5.0 Mb	6	59
12/02/80	3.8 Mn	6	73
08/07/81	4.0 Mn	6	81
06/29/84	4.1 Mn	6	45
06/10/87	4.9 Mb	6	120
04/27/89	4.6 Mb	6	93
08/20/89	3.6 Mb	6	176

Table 2.6-9 Earthquake epicenters within 200 miles of the site having modified Mercalli intensities equal to or greater than VI. (continued).

Date	Magnitude	Intensity	Radial Distance (miles)
09/26/90	5.0 Mn	6	43
05/04/91	5.0 Mn	6	68
07/07/91	4.0 Mn	6	160
06/18/02	5.0 Mn	6	89

Mb = body-wave magnitude
Mn = local or regional magnitude
Mw = moment magnitude
FA = felt area magnitude

Table 2.6-10. Earthquake epicenters within 50 miles of the site since 1951.

Date	Magnitude	Intensity	Radial Distance (miles)
05/06/53	0	3	22
05/15/53	0	3	22
04/11/55	0	2	42
03/26/57	3.3 FA	5	11
01/28/58	4.2 FA	5	21
02/16/62	0	4	9
06/27/62	5.5 Mb	0	44
03/31/63	3.0 Mn	0	17
05/02/63	3.1 Mn	0	50
08/03/63	3.0 Mb	5	9
01/16/64	4.5 Mb	0	40
08/14/65	5.0 Mb	7	21
08/15/65	5.1 Mb	5	38
05/16/67	2.8 Mn	0	48
10/25/67	2.7 Mn	0	50
12/24/70	3.4 Mn	4	49
06/19/72	4.5 Mb	4	16
05/13/74	4.3 Mb	6	39
07/07/74	2.5 Mn	0	24
08/26/74	2.6 Mn	0	49
12/05/78	2.5 Mn	0	25
07/08/79	3.1 Mn	4	30
03/29/80	2.9 Mn	0	15
02/11/81	2.7 Mn	4	18
06/09/81	3.4 Mn	5	50

Table 2.6-10 Earthquake epicenters within 50 miles of the site since 1951 (continued).

Date	Magnitude	Intensity	Radial Distance (miles)
12/27/81	2.6 Mn	0	28
08/11/82	3.0 Mn	3	11
01/29/83	2.5 Mn	0	49
02/23/83	2.9 Mn	0	4
05/08/83	2.5 Mn	0	46
06/26/83	2.7 Mn	0	39
10/21/83	2.5 Mn	0	48
11/22/83	2.5 Mn	0	13
12/20/83	2.8 Mn	0	44
12/31/83	2.6 Mn	0	12
02/13/84	3.2 Mn	4	13
02/14/84	2.6 Mn	0	12
02/16/84	2.5 Mn	0	13
02/25/84	3.0 Mn	0	13
03/01/84	2.9 Mn	0	12
03/11/84	2.6 Mn	0	9
06/29/84	4.1 Mn	6	45
09/19/84	2.5 Mn	0	12
09/27/84	2.8 Mn	0	12
02/15/85	3.3 Mn	0	29
07/10/85	2.9 Mn	0	44
10/04/85	2.7 Mn	0	50
07/07/87	3.6 Mn	3	27
09/29/87	4.6 Mb	5	24
10/14/87	3.8 Mn	5	4
03/10/88	2.6 Mn	0	44
08/07/90	3.0 Mn	4	30

Table 2.6-10 Earthquake epicenters within 50 miles of the site since 1951 (continued).

Date	Magnitude	Intensity	Radial Distance (miles)
09/26/90	5.0 Mn	6	43
09/27/90	3.3 Mn	5	45
10/30/90	2.3 Mn	NA	45
10/03/91	3.1 Mn	3	40
12/29/91	2.4 Mn	3	35
05/11/92	2.6 Mn	NA	23
03/02/93	3.1 Mn	4	49
03/31/93	3.3 Mn	5	41
04/02/93	2.5 Mn	4	13
04/02/93	2.6 Mn	4	14
07/29/93	2.6 Mn	NA	16
02/05/94	4.2 Mn	5	27
03/21/94	2.9 Mn	NA	27
09/26/94	3.6 Mn	5	15
12/15/94	2.5 Mn	NA	40
04/27/95	2.8 Mn	NA	48
04/08/98	3.2 Mn	NA	17
05/11/98	2.6 Mn	NA	22
07/15/98	3.1 Mn	NA	49
07/06/99	2.1 Mn	NA	6
04/28/00	2.9 Mn	NA	44
06/27/00	3.0 Mn	NA	4

Mb = body-wave magnitude
MD = duration or code length magnitude
Mn = local or regional magnitude
FA = felt area magnitude
NA = not available

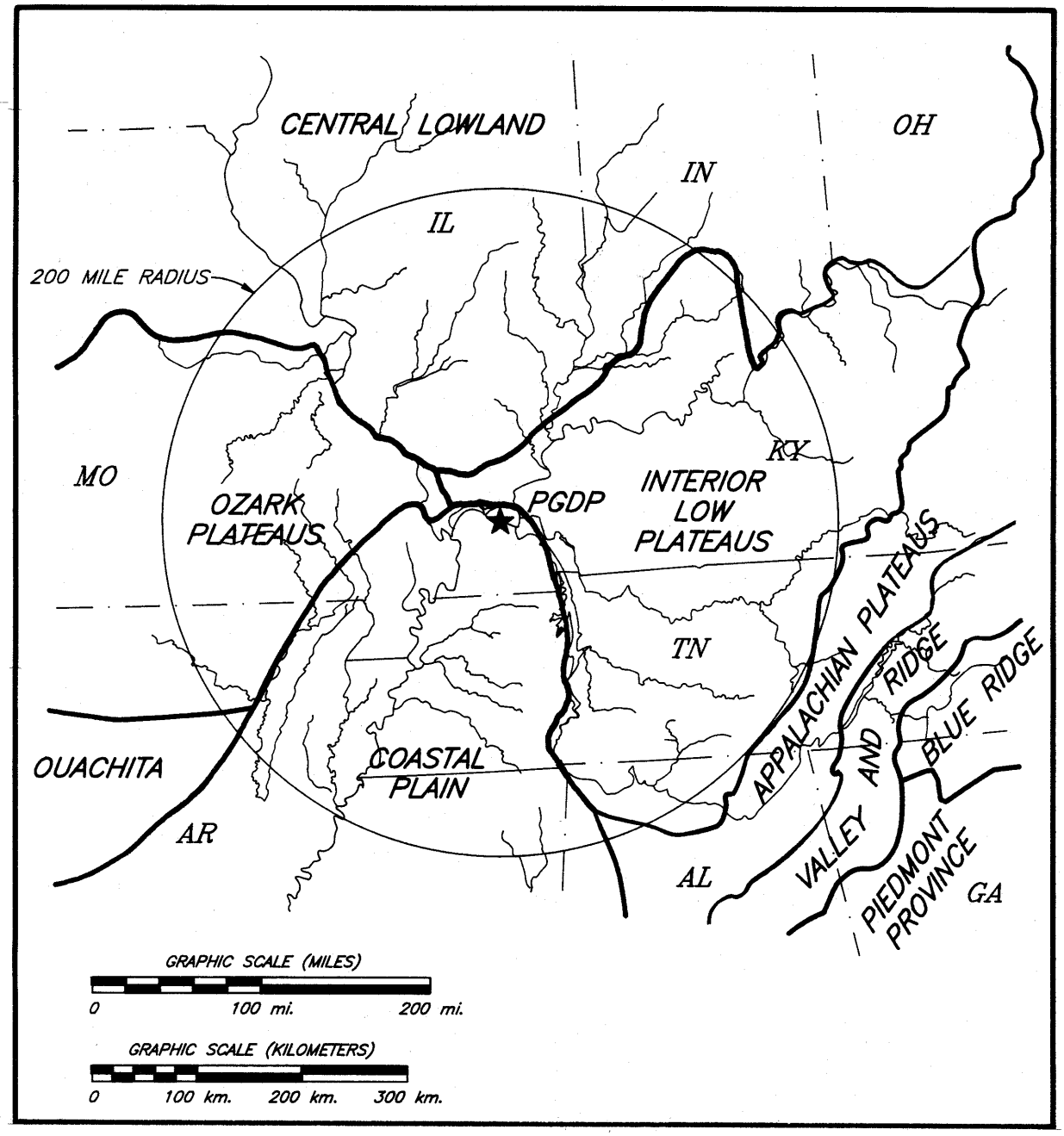

Figure 2.6-1 Regional physiographic map.

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2.6-11a

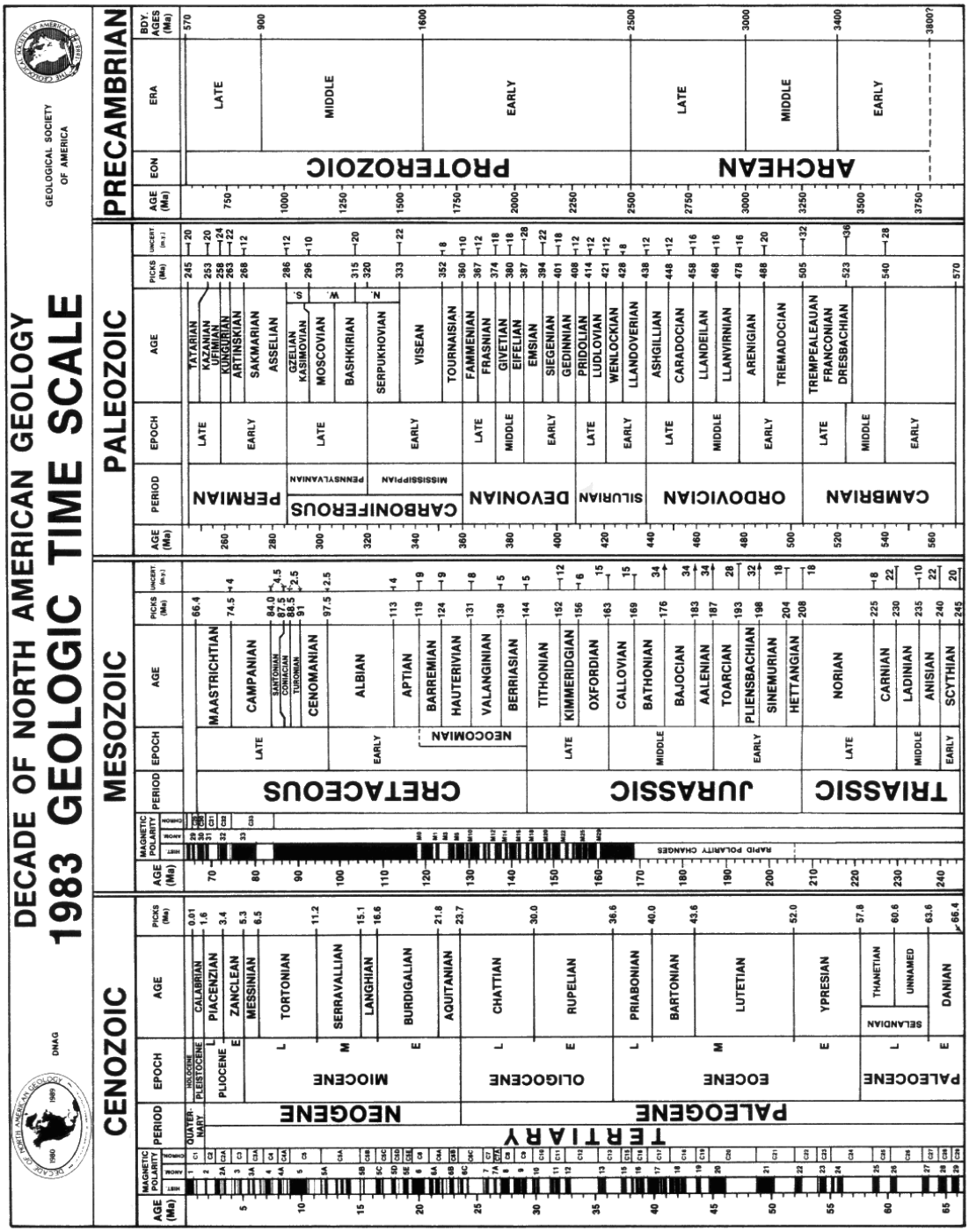

Figure 2.6-1a. Geologic time scale

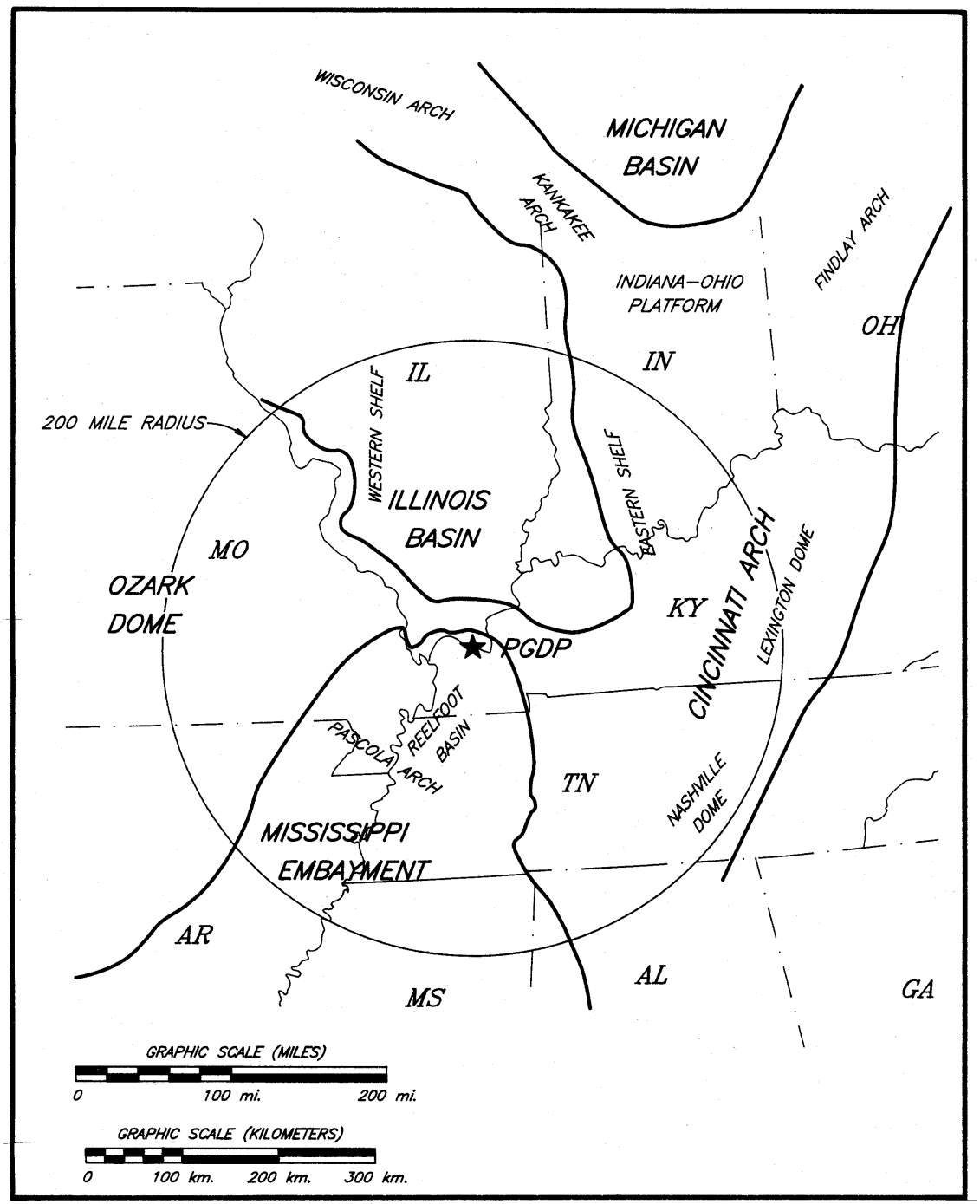

Figure 2.6-2 Regional geologic setting.

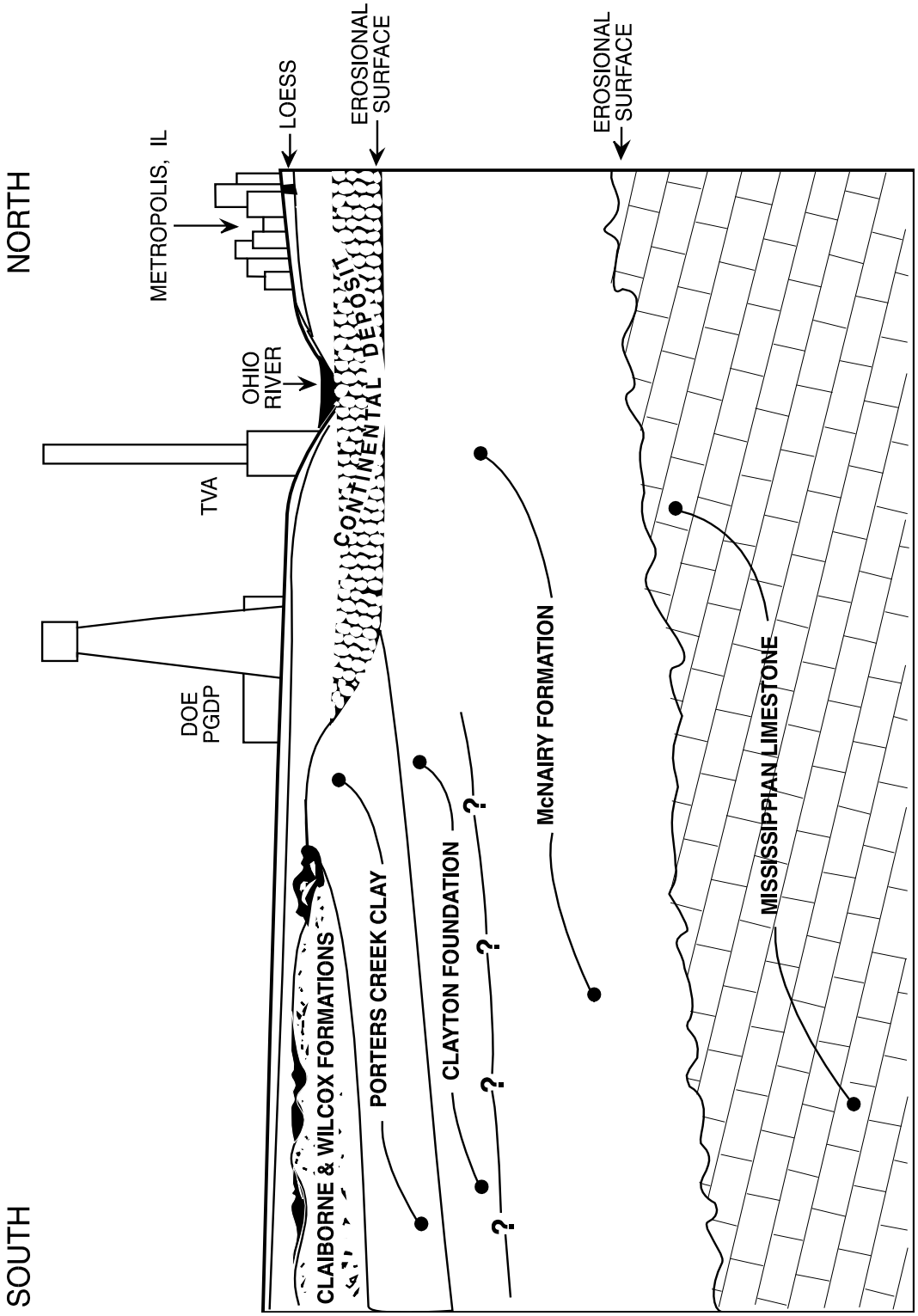

Figure 2.6-3. North-south section showing stratigraphic relationship in the U.S. DOE Paducah Gaseous Diffusion Plant reservation area (not to scale).

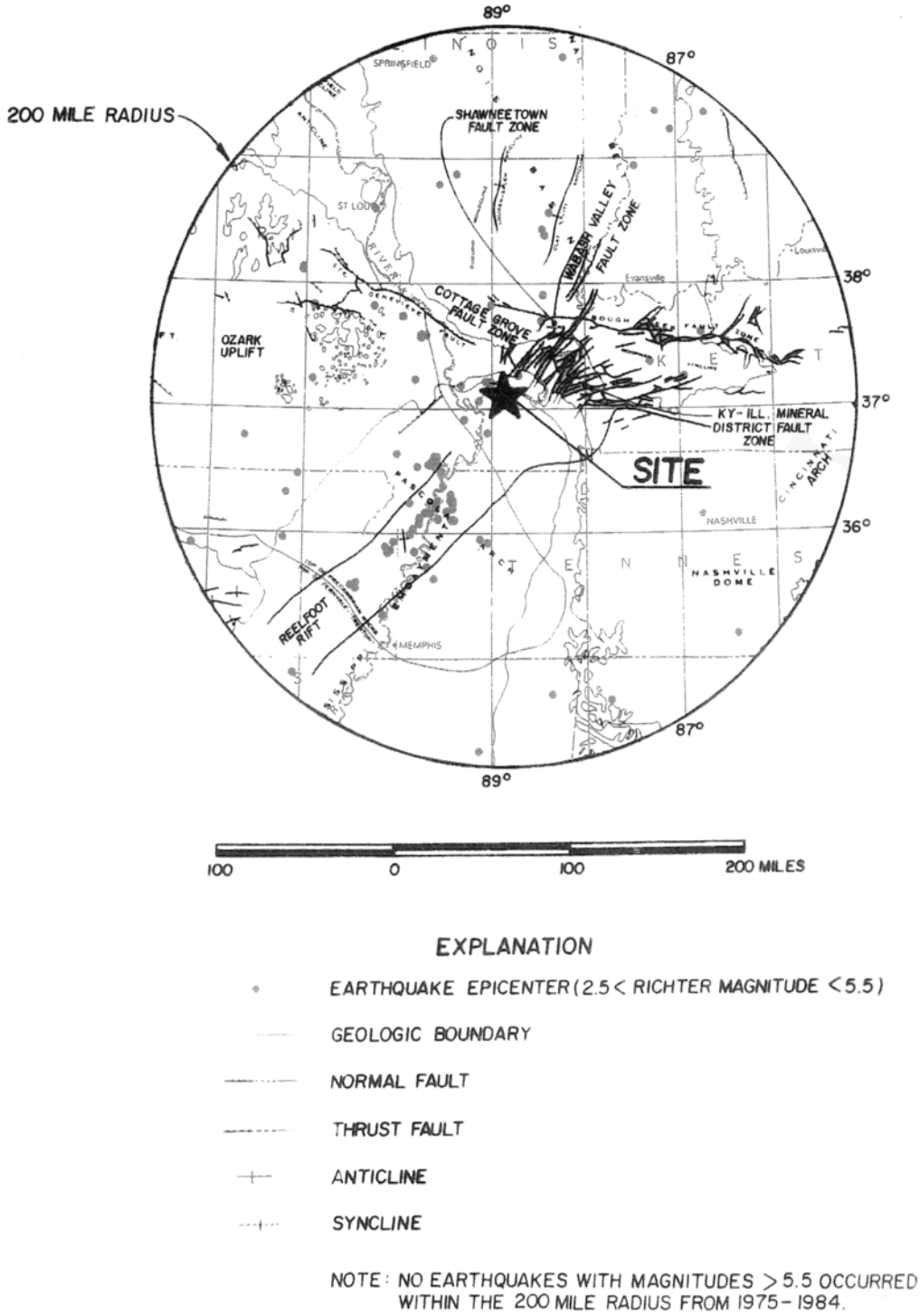

Figure 2.6-4. Regional tectonic structures and seismicity 1975 to 1984.

Figure 2.6-5. Figure deleted.

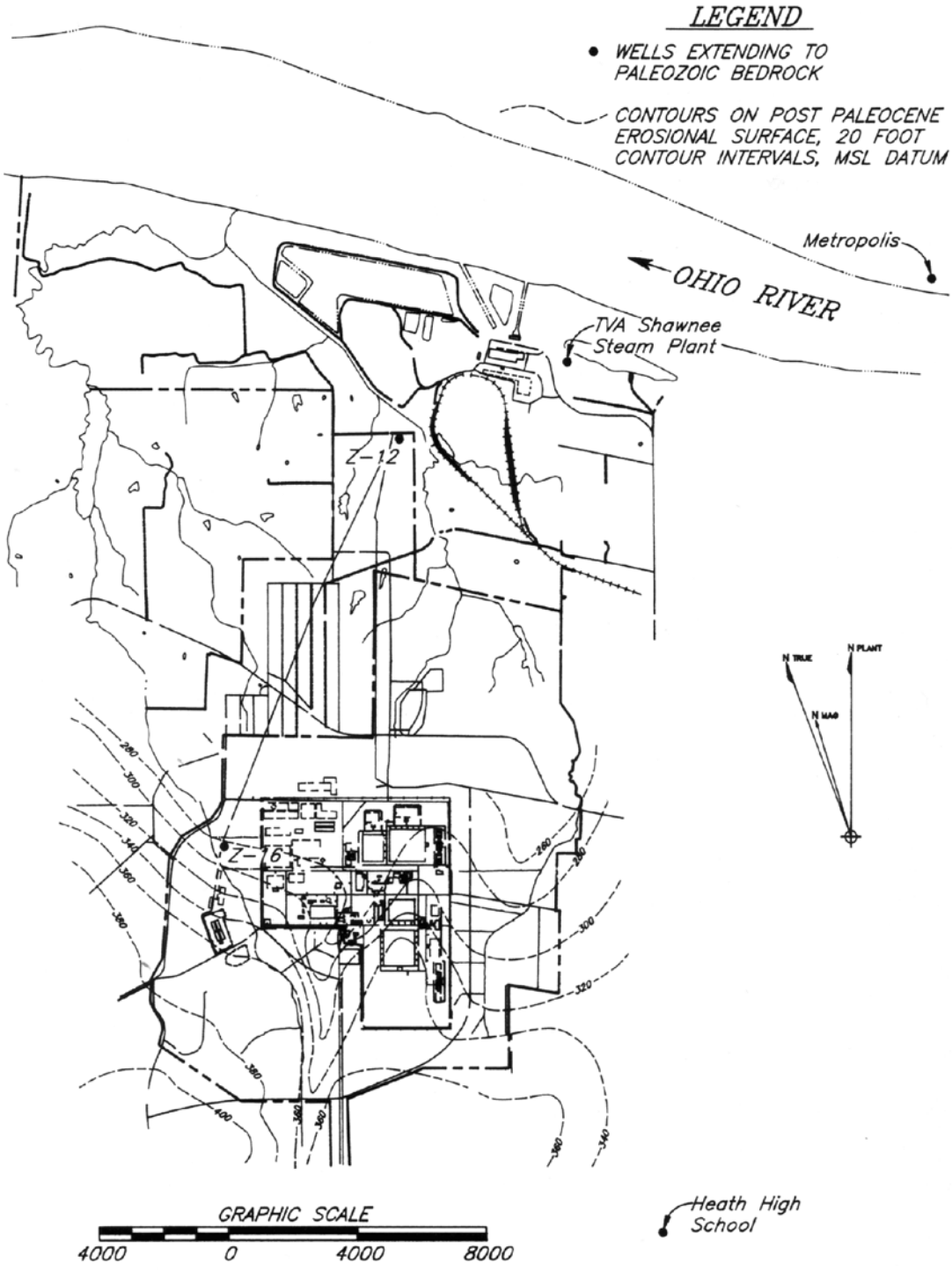

Figure 2.6-6. Contours (MSL) on the post-Paleocene erosional surface.

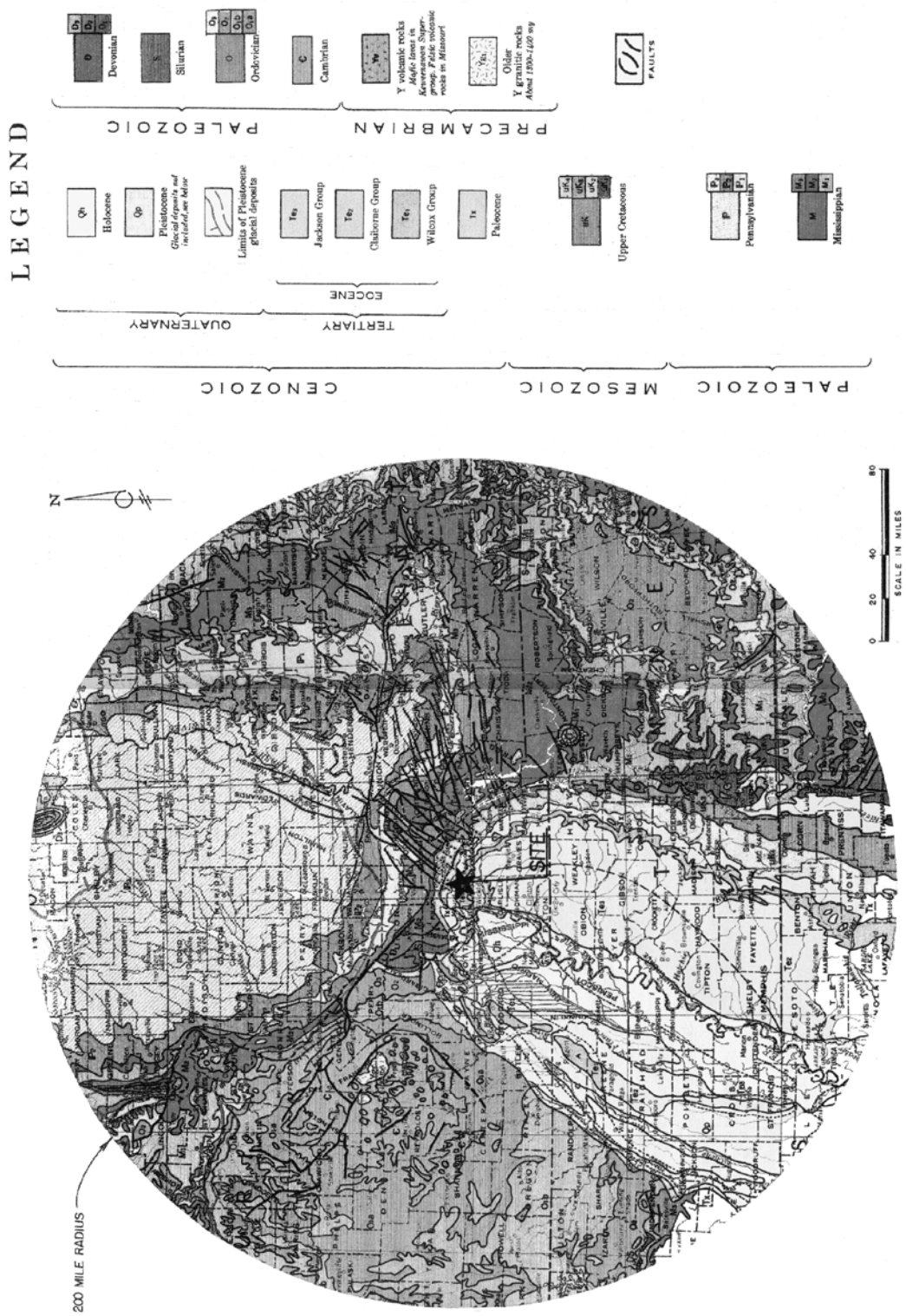

Figure 2.6-7. Regional geological map.

ERA	PERIOD	EPOCH	MAJOR ROCK TYPES	MISSISSIPPI EMBAYMENT (NORTH)	ILLINIOS BASIN (SOUTH)	CINCINNATI ARCH (SOUTH)	OZARK DOME
CENOZOIC	QUATERNARY	HOLOCENE	SAND, GRAVEL, SILT	RIVER & TRIBUTARY ALLUVIUM	RIVER & TRIBUTARY ALLUVIUM GLACIAL SEDIMENT	RIVER & TRIBUTARY ALLUVIUM GLACIAL SEDIMENTS	RIVER & TRIBUTARY ALLUVIUM
		PLEISTOCENE	SAND, GRAVEL, SILT, CLAY	LOESS & CONTINENTAL DEPOSITS	LOESS & CONTINENTAL DEPOSITS	?	ABSENT
	TERTIARY	PLIOCENE	SAND, GRAVEL, SILT, CLAY	CONTINENTAL DEPOSITS	ABSENT	ABSENT	ABSENT
		MIOCENE	—	ABSENT			
		OLIGOCENE	—	ABSENT			
		EOCENE	SANDSTONE, SHALE, SILTSTONE, CLAY	JACKSON, CLAIBORNE, WILCOX, MIDWAY			
		PALEOCENE	CLAY, SAND, GRAVEL	PORTERS CREEK / CLAYTON–MCNAIRY			
MESOZOIC	CRETACEOUS		SAND, CLAY, SILT		ABSENT	ABSENT	ABSENT
			SAND, CLAY, GRAVEL	TUSCALOOSA			
	JURASSIC		—	LITTLE BEAR SOIL ABSENT	ABSENT	ABSENT	ABSENT
	TRIASSIC		—	ABSENT			
PALEOZOIC	PERMIAN		IGNEOUS INTRUSIVES	ABSENT	IGNEOUS DIKES		
			SHALE, SILTSTONE		MAUZY FM.		
	PENNSYLVANIAN		SHALE, SANDSTONE	ABSENT	UNDIFFERENTIATED	ABSENT	ABSENT
	MISSISSIPPIAN	UPPER	SHALE, SANDSTONE, LIMESTONE	ABSENT OR CONCEALED	CHESTERIAN SERIES: UNDIFFERENTIATED	ABSENT	ABSENT
		MIDDLE	CARBONATES	ST. GENEVIEVE ST. LOUIS WARSAW	MAMMOTH CAVE: ST. GENEVIEVE, ST. LOUIS, SALEM (WEST), WARSAW, KEOKUK, BURLINGTON (EAST)	MAMMOTH CAVE: ST. GENEVIEVE, ST. LOUIS, WARSAW	ABSENT
		LOWER	SILTSTONE, SHALE	KNOBS MEGAGROUP: FORT PAYNE, NEW PROVIDENCE	KNOBS MEGAGROUP: ABSENT, BORDEN	KNOBS MEGAGROUP: FORT PAYNE, MAURY, CHATTANOOGA	ABSENT
	DEVONIAN	UPPER	SILTSTONE, SHALE	KNOBS MEGAGROUP: NEW ALBANY	KNOBS MEGAGROUP: NEW ALBANY		
		MIDDLE & LOWER	CARBONATES	HUNTON MEGAGROUP	HUNTON MEGAGROUP	ABSENT	ABSENT
	SILURIAN					BROWNSPORT GROUP DIXON WAYNE GROUP OSGOOD BRASSFIELD	
	ORDOVICIAN	UPPER	SHALE	MAQUOKETA GROUP	MAQUOKETA GROUP	RICHMOND MAYSVILLE EDEN LEXINGTON (KY) NASHVILLE (TN)	GIRARDEAU ORCHARD CREEK THEBES MAQUOKETA FERNVALE
		MIDDLE	CARBONATES	KIMMSWICK PLATTIN PECATONICA JOACHIM DUTCHTOWN	GALENA PLATTEVILLE JOACHIM	TYRONE "PENCIL CAVE" HIGH BRIDGE (KY) STONES RIVER (TN)	KIMMSWICK PLATTIN JOACHIM
			SHALE	GLENWOOD?	GLENWOOD	ABSENT	ABSENT
			SANDSTONE	ST. PETER	ST. PETER	ABSENT	ABSENT
		LOWER	DOLOMITE	EVERTON SMITHVILLE POWELL CUTTER JEFFERSON CITY ROUBIDOUX GASCONADE GUNTER	PRAIRIE DU CHIEN GROUP: SHAKOPEE, NEW RICHMOND, ONEOTA, GUNTER	KNOX MEGAGROUP: UPPER KNOX, ROSE RUN	EVERTON SMITHVILLE POWELL COTTER JEFFERSON CITY ROUBIDOUX GASCONADE GUNTER
	CAMBRIAN	UPPER	DOLOMITE	EMINENCE POTOSI ELVINS (UPPER)	EMINENCE POTOSI FRANCONIA	KNOX MEGAGROUP: COPPER RIDGE	EMINENCE POTOSI DERBY DOE RUN ELVINS GROUP
			SANDSTONE SILTSTONE SHALE CARBONATES	POTSDAM MEGAGROUP: ELVINS (LOWER) BONNETERRE LAMOTTE PRE–LAMOTTE SEDIMENTARY ROCKS?	POTSDAM MEGAGROUP: FRANCONIA EAU CLAIRE MT. SIMON	POTSDAM MEGAGROUP: CONASAUGA ROME TOMSTOWN ANTIETAM	POTSDAM MEGAGROUP: DAVIS BONNETERRE LAMOTTE
PROTERO–ZOIC	PRE–CAMBRIAN		IGNEOUS AND METAMORPHIC ROCKS	UNKNOWN	UNKNOWN	UNKNOWN	FELSIC VOLCANIC ROCKS & OLDER GRANITIC ROCKS

Figure 2.6-8. Regional stratigraphy.

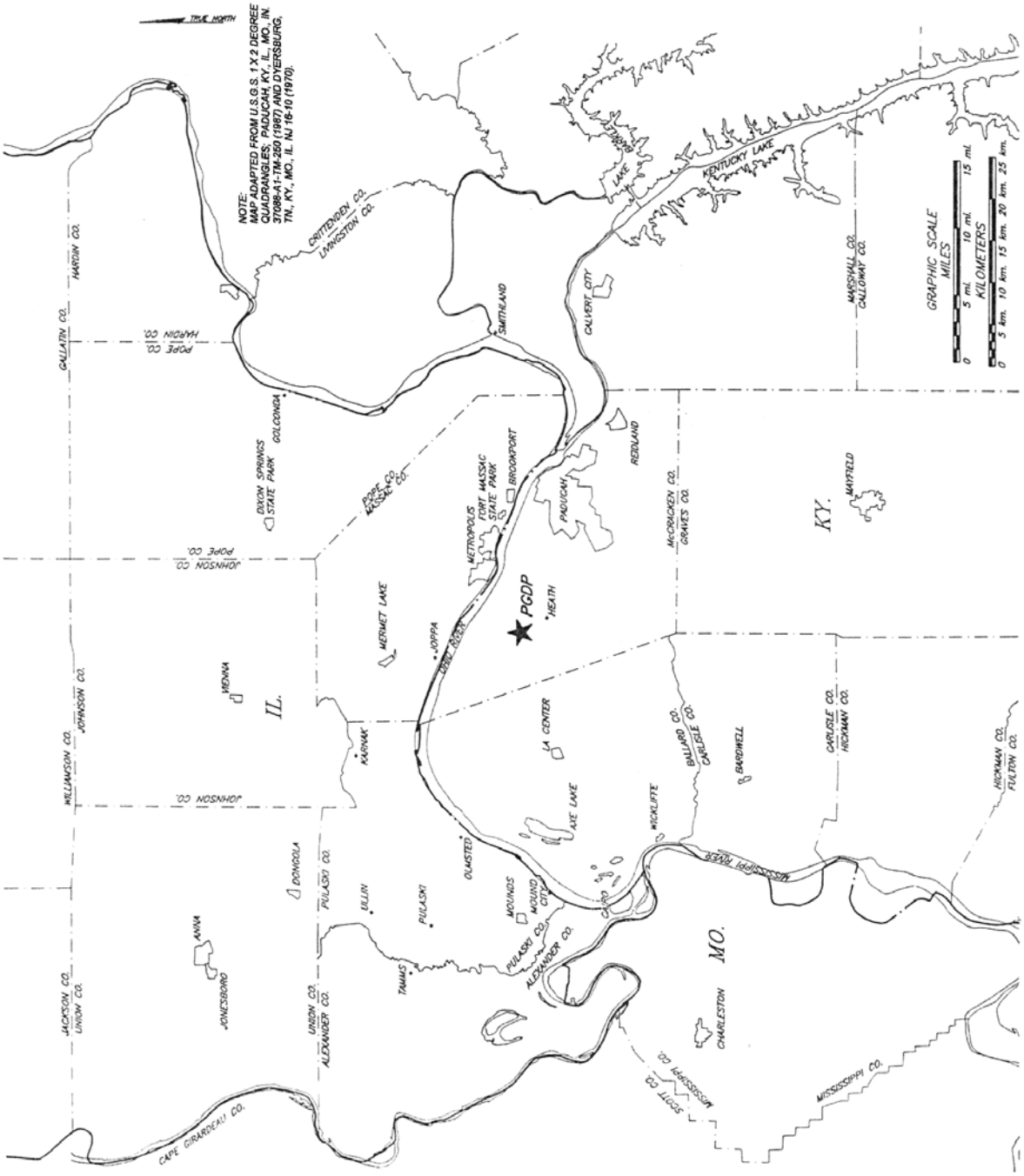

Figure 2.6-9. Site location map.

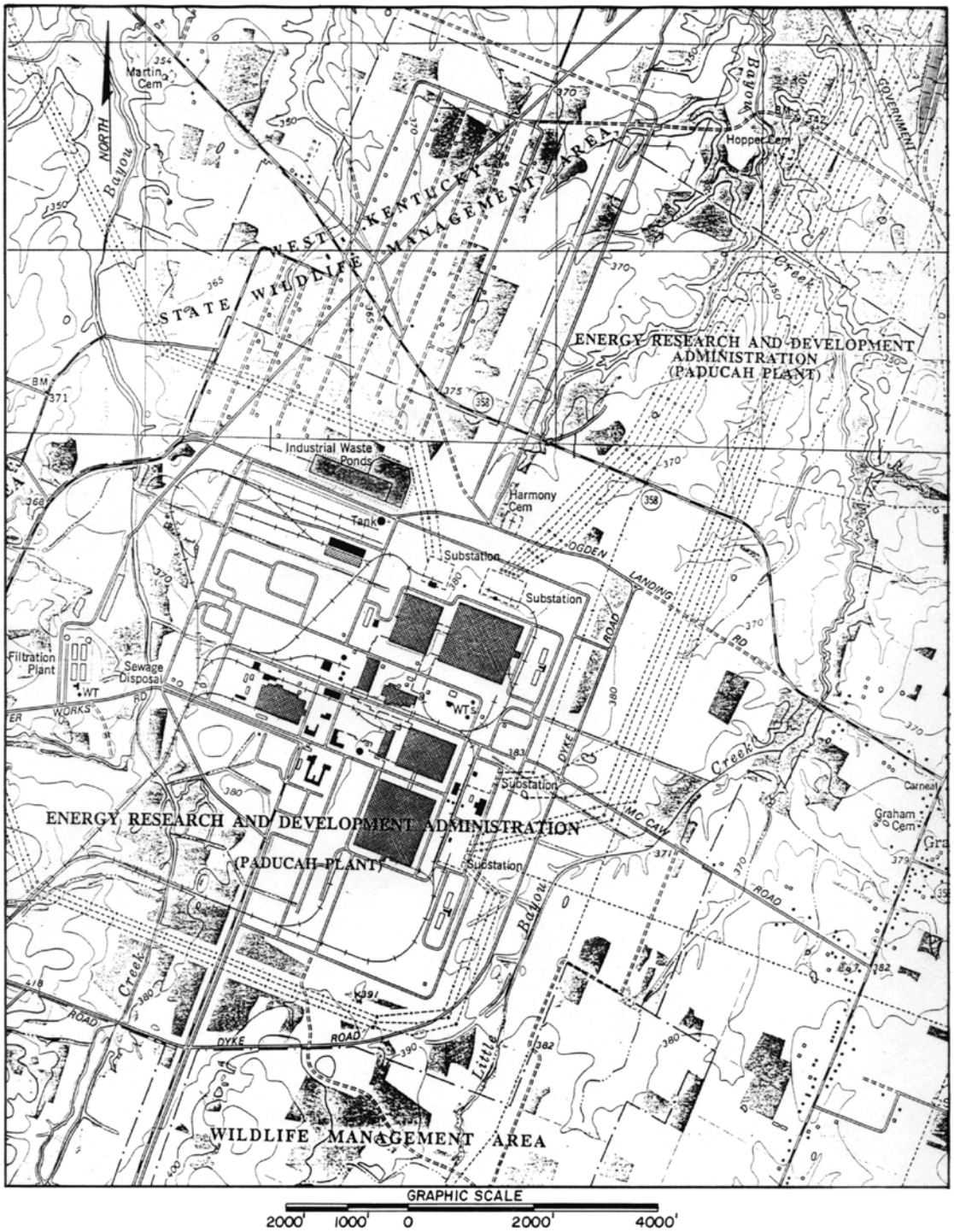

Figure 2.6-10. Site topography.

Time Ma[a] 0	Era	Period	Epoch	Formation	Description	Approximate Thickness[b]
	Cenozoic	Quaternary (1.6)	Holocene (.01)	River & tributary alluvium	Fresh water deposits of silt, sand, and gravel	Absent
			Pleistocene (1.6)	Loess	Wind-blown clayey silt and silty clay	15-25 ft
		Tertiary (64.8)	Pliocene (3.7)	Continental deposits	Nonmarine interbedded and interlensed sand, gravel, silt, and clay	21-95 ft
			Miocene (18.4)	Absent	Absent	Absent
			Oligocene (12.2)	Absent	Absent	Absent
			Eocene (21.2)	Claiborne, Wilcox	Absent	Absent
			Paleocene (8.6)	Porters Creek	Marine micaceous clay with intervals of fine sand in part glauconitic	84 ft
66.4				Clayton	Marine interlaminated and interlensed clay and fine sand	212-223 ft
	Mesozoic	Cretaceous (78)		McNairy		
		Jurassic (64)		Little Bear Soil "Rubble Zone"	Silty clay with chert fragments and limonite nodules	31 ft
				Absent	Absent	Absent
245		Triassic (37)		Absent	Absent	Absent
	Paleozoic	Permian (41)		Absent	Absent	Absent
		Pennsylvanian (34)		Absent	Absent	Absent
		Mississippian (40)		St. Louis and Warsaw limestones	Limestone	Unknown

a. Millions of years ago.
b. Approximate thicknesses based on Z-series borings. Deepest boring terminated in Mississippian limestone.

Numbers in parenthesis are duration of time interval in millions of years.

Figure 2.6-11. Site stratigraphy.

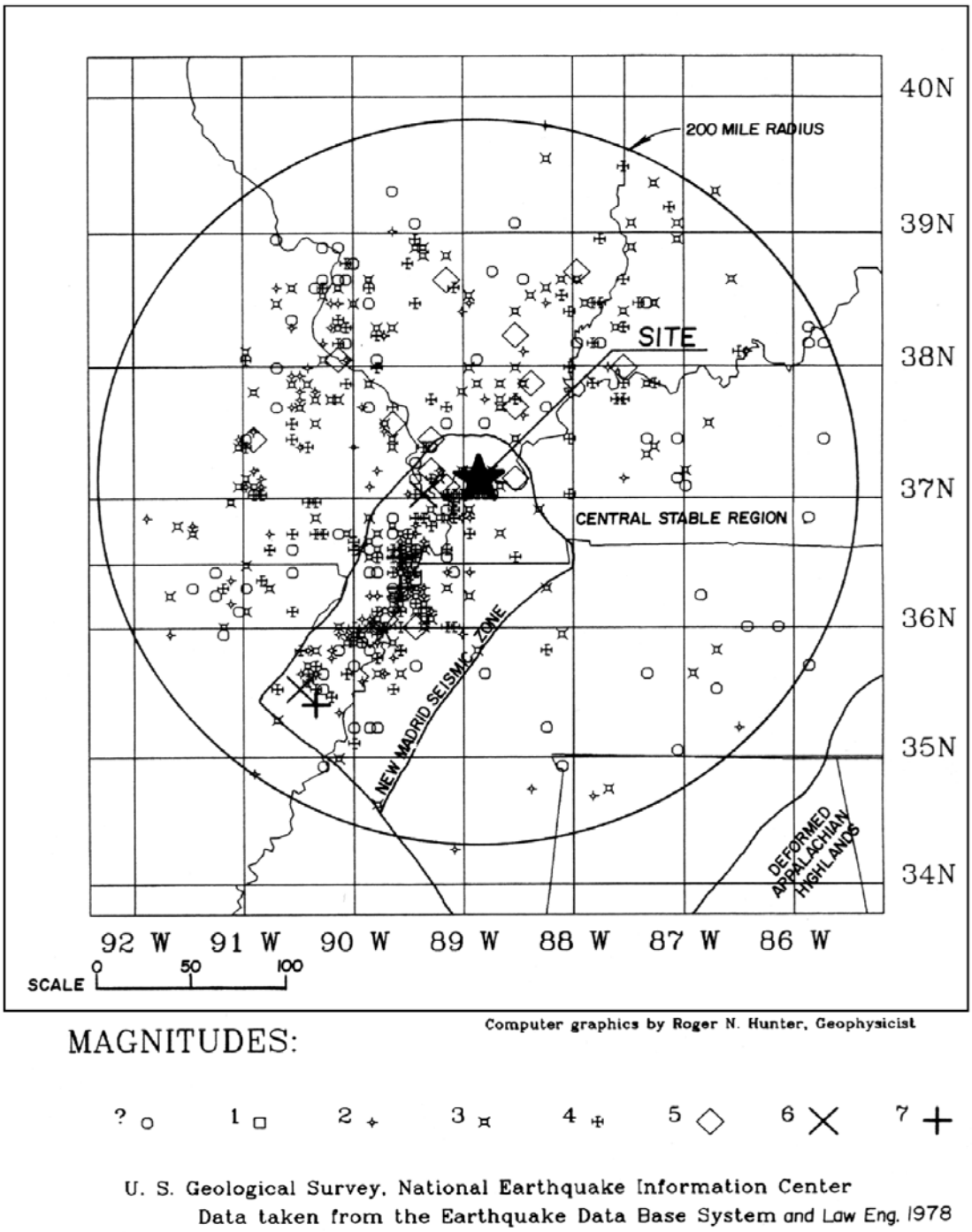

Figure 2.6-12. Seismotectioic provinces and epicenters of historical earthquakes, 1699-1990.

2.7 NATURAL PHENOMENA THREATS

The natural phenomena (NP) hazards described in this section are earthquake, wind, and flood. The NP hazards were evaluated to determine the evaluation basis levels in accordance with DOE requirement documents. The NP hazard evaluations and evaluation basis levels are described in the following sections.

2.7.1 Earthquake Hazard

DOE completed site-specific studies in 1993 to define the evaluation basis earthquake (EBE) for the Paducah site. These studies used up-to-date geological and seismological data and analysis techniques existing at that time. USEC updated this seismic hazard analysis in 1999 to include consideration of all available regional and site-specific data published by the U.S. Geological Survey. Summaries of these studies and their results are given below.

2.7.1.1 DOE Seismic Hazard Studies

The earthquake hazard (defined as the annual probability of the exceedance of earthquake ground motions) was evaluated by performing site-specific studies. The site-specific studies included performing probabilistic and deterministic seismic hazard analyses to define rock outcrop motions and soil amplification analyses to determine the evaluation basis earthquake (EBE) ground surface motions.

The site is located near the north end of the Reelfoot rift — a large crustal feature that is associated with the large New Madrid earthquakes of 1811 through 1812. The seismic hazard analyses considered the possibility of large-magnitude earthquakes (with ruptures as long as 30 miles), as required for sites in California. In addition, the analyses considered large uncertainties in seismicity, maximum magnitudes, and ground-motion attenuation, as required for other sites in the central and eastern United States. The Electric Power Research Institute (EPRI) and Lawrence Livermore National Laboratory (LLNL) seismic hazard methodologies [discussed in Reference 141] were modified for this site to consider the NMSZ as a fault source, as opposed to the point source approach. These methodologies were applied to the site to quantify the relative contributions of the New Madrid and other sources and to serve as a baseline for the extended source model. The EPRI and LLNL geological and seismological supporting studies were also used as the basis to develop the source geometries and seismicity parameters for the fault source model of the NMSZ (referred to as the extended source model). The results from the extended source model were used to define the seismic hazard for rock outcrop motions at the site. The probalistic seismic hazard analysis considering the NMSZ as a fault source, as opposed to the point source approach, is described in Reference 141.

For the extended source model, the NMSZ is represented by a system of parallel faults that cover the Reelfoot rift. The northern extent of the New Madrid source is critical to the calculated seismic hazard at the site and was treated as an uncertain parameter. Based on the EPRI and LLNL interpretations of source zones, four equally likely geometries for the New Madrid faults were defined where the faults terminate as follows: (1) 6.2 miles north of the site, (2) 6.2 miles south of the site, (3) 12 miles south of the site, and (4) 25 miles south of the site. A fifth interpretation, in which the New Madrid source contains the site and extends 30 miles north of the site, was also considered. This

interpretation represents the unlikely hypotheses that the Reelfoot rift extends further to the north. Interpretations 1 through 4 were each given a weight of 23.75 percent, and the fifth interpretation was given a weight of 5%.

Independent calculations and review of the probablistic seismic hazard analyses for the site were performed by USGS. [Reference 179] The independent review of the seismic hazard results by the USGS indicated that the seismic sources, recurrence rates, maximum magnitudes, and the attenuation functions used in these analyses are representative of a wide range of professional opinion and are suitable for obtaining probabilistically-based seismic hazard estimates. The USGS independent calculations for peak horizontal rock acceleration at the annual hazard probability of 1×10^{-3} were in excellent agreement with the extended source model results. The USGS uniform hazard response spectra are in reasonable agreement with the uniform hazard spectra from the extended source model. The differences can be attributed mainly to the attenuation functions used. The USGS attenuation function appears to be more representative of a stiff soil site than a rock site.

Because of the proximity of the site to NMSZ, special deterministic analyses were also performed to determine the ground motions at the site for the recurrence of the 1811 to 1812 New Madrid earthquakes to support the conclusions derived from the probabilistic seismic hazard analyses. The site is within 50 miles of the location the very large New Madrid earthquakes of 1811 to 1812. Because of their size, moment magnitude $M_Q = 7.5$, the possible recurrence of these earthquakes is a major element in the deterministic assessment of the seismic hazard at the facility. The large earthquakes are modeled by specifying the earthquake fault and its orientation with respect to the site and by specifying the rupture process. The results of the deterministic analyses [Reference 72] were similar to the probabilistic seismic hazard results for the probabilities associated with the recurrence of the New Madrid earthquake of 1811-12.

Based on the rock outcrop motions defined by the probabilistic analyses, soil amplification and liquefaction evaluations were performed. Soil amplification analyses [Reference 162] were performed to calculate a reasonable range of expected site-specific, free-field earthquake responses to the rock outcrop motions of three hazard level earthquakes, a 500-year, a 1,000-year, and a 5,000-year event. Four individual soil columns were derived from recent geotechnical and geophysical investigations. Also, an average soil column was created to conduct sensitivity studies. The average soil column is intended to represent the overall site.

The geotechnical study at the site did not include a site-specific evaluation of the variation of shear modulus and damping ratio with shear strain. Rather, standard relationships published by others were used that typically represent a best-estimate fit of numerous data compiled from investigations conducted throughout the United States and are considered appropriate for use at this site. In the absence of site-specific data, these relationships have proven to work well in most applications for site amplification analyses. The results of Atterbert Limit and grain size distribution tests were used to select the best-suited relationships. Confining pressure has been shown to affect the normalized modulus and damping ratio relationships. As the confining stress increases, the normalized modulus and damping ratio relationships shift to the right (larger shear strains required to produce same modulus or damping). At low confining stresses, the relationships shift to the left. These confining pressure effects were considered in the analyses.

The computer program SHAKE was used to perform the solid amplification analysis and calculate the free-field ground motions for each of the four soil columns and the average soil column. The predominant site period is in the range of 0.9 to 1.1 s. Secondary response peaks occurred at periods around 0.2 and 0.4 s. Sensitivity studies were also conducted using the average soil column. The effects of including a measured velocity inversion in the soil above bedrock and reasonable ranges of impedance ratio, depth to bedrock, and modulus relationships were investigated and found to be negligible to small.

The results from SHAKE include acceleration and shear strain time histories of the soil response at the various soil layers, ground surface response spectra, and ratios of the free-field ground surface acceleration spectra to the rock outcrop acceleration spectra. The ratios of the free-field ground surface acceleration response spectra to the rock outcrop acceleration spectra from the average solid column varying the soil properties according to the NRC were used to determine the EBE ground surface response spectra. The ratios were applied to the uniform hazard rock response spectra to obtain the uniform hazard free-field ground surface response spectra. The liquefaction evaluation [Reference 163] demonstrated that liquefaction was not a concern for the EBEs with an annual probability of exceedance greater than 1×10^{-3} (1,000-year return period or less) at the site.

Based on the seismic hazard analyses and soil amplification evaluation, the seismic hazard curve for peak ground surface acceleration and the EBE ground response spectra were determined. The EBE return period to be used for the site is specified to be 250 years.

The justification for continued use of an approximate 250 year return period for the evaluation basis earthquake developed by DOE demonstrated that the risk of serious injuries or deaths per year from a conservative estimate of the releases from a collapse of major cascade buildings was low in comparison to normal societal risks. In addition, the plant is not expected to operate for a large number of additional years. Considering the remaining life of the facilities, a DOE-sponsored Lawerence Livermore National Laboratory study (Reference 169a) found the seismic risk to be low and that continued operation only represents a moderate risk.

Based on a return period of 250 years, the EBE peak ground acceleration was found to be 0.15 g. The EBE response spectra were determined by scaling the 500-year return period response spectra by the ratio of the peak

ground acceleration of the 250-year return period earthquake divided by the peak ground acceleration of the 500-year return period earthquake. The linear scaling was judged to be appropriate because the response of the solid deposits becomes linear as the ground motions become smaller. The vertical earthquake ground motion was taken to be two-thirds of the horizontal ground motion. [Reference 141] Earthquake time histories representative of the EBE ground response spectra were also developed for use in structural and equipment evaluations.

2.7.1.2 Updated Seismic Hazard

Since completion of the DOE seismic hazard study in 1993, continuing research of the NMSZ has provided seismotectonic data that needed to be reviewed to ensure that the seismic hazard results were not adversely impacted. A DOE review [Reference 52] concluded that the continuing research has not had any significant impact on the seismic hazard. However, regardless of this DOE conclusion, USEC updated the seismic hazard analysis to include consideration of all available regional and site-specific data published by the U.S. Geological Survey. The updated seismic hazard analysis [Reference 190] was approved by NRC in January 2000 [Reference 191] and defines the EBE used for all seismic evaluations in this Safety Analysis Report.

Development of the updated probabilistic seismic hazard built upon the previous DOE analysis with a few notable differences in approach. Recent intensive studies of the causes and characteristics of earthquakes and ground motions in the central U.S. were reviewed and incorporated into this study. This information was used to define the seismic sources, to quantify the rates of occurrence for large earthquakes, to specify the magnitudes for these sources, and to develop weights for alternative sources and parameters. Only earthquakes with moment magnitudes greater than 5.0 were considered to contribute to the seismic hazard. Seven fault zones and two background sources were taken into account.

The basic seismic hazard model for probabilistic seismic hazard analysis (PSHA) is well established in the literature and requires specification of the source geometry, seismicity, and the attenuation function. Both epistemic (resulting from imperfect information) and aleatory (resulting from randomness of physical processes) uncertainties were considered. This study followed the guidance of the Senior Seismic Hazard Analysis Committee on the treatment of uncertainty and the use of experts in PSHA. Uncertainty in seismic source characterization is quantified by considering multiple alternative geometries, multiple magnitude-recurrence parameters, and multiple maximum magnitudes. Uncertainty in attenuation equations is quantified by considering four alternative sets of equations which represent a range of models for the source and path characteristics of earthquakes in the central and eastern U.S. Considering these four attenuation equations with their weights is analogous to considering multiple attenuation equations developed by different experts.

The attenuation equations used for rock were a slightly revised version of those developed by the Electric Power Research Institute (EPRI) in 1993. Ground surface response was calculated using a random vibration theory (RVT) computational scheme. The primary difference from the SHAKE program used in the DOE analysis described above is that the effects of material nonlinearities are addressed by an RVT equivalent-linear formulation that is based on the frequency domain rather than the time domain. This approach is more robust in that it is fundamentally probabilistic in nature and

parametric uncertainties can be assessed using a Monte Carlo approach by randomly varying dynamic material properties. This results in a smooth response spectra or amplification factors at the surface.

Vertical ground motion was calculated independent of the horizontal motion using the computational approach of EPRI to determine the ratio of vertical motion (V) to horizontal motion (H). While the amplitude of horizontal motions diminishes as a result of nonlinearity, the vertical motion does not. This approach results in higher V/H ratios at higher frequencies (i.e., greater than the standard assumption that vertical is ⅔ of horizontal at frequencies above about 10 Hz).

Results were calculated for return periods of 250, 500, 1000, and 5000 years. The resulting seismic hazard curve is shown in Figure 2.7-1. The peak ground acceleration for the EBE is 0.165g. The horizontal and vertical ground response spectra for 5% damping are shown in Figure 2.7-2. Assumptions were made to assure greatest accuracy for the 250-year return period (EBE) and at lower frequencies typical of PGDP process buildings. Therefore, these results are only applicable to earthquakes whose return periods are less than 500 years.

2.7.2 Flood Hazard

The flood hazard was evaluated by performing site-specific river flooding from a PMF and flooding from local intense site precipitation. [References 84, 19, and 85]

The intent of the river flooding study was to calculate the stage of the Ohio River near the plant site during a PMF. This was done by first obtaining the profiles of the channel cross sections at selected stations between Metropolis and the confluence of the Ohio and Mississippi rivers and a stage-discharge relationship at the furthest downstream location. The Ohio River discharge corresponding to PMF was calculated as a function of drainage area of the watershed, and the stage-discharge relation was extrapolated from this calculation to obtain an initial stage based on this flow rate. With the geometry of the stream bed, the river discharge, and an initial stage, Bernoulli's equation was used to calculate the stage of PMF near the plant site. The calculated stage can them be compared against elevations of critical safety-related structures at the plant to determine if flooding is a hazard. The nominal plant grade at Paducah is about 380 ft. The calculated range of PMF is about 12 ft below this nominal plant grade. Therefore, river flooding is not a concern.

A local drainage analysis was also performed for the plant site. The intent of this study was to determine whether local flooding from creeks, ditches, storm sewers, culverts, and roof drainage systems during an extreme storm having an approximate recurrence interval of 10,000 years poses a serious concern. The task was accomplished by performing hydraulic and hydrologic analyses of creeks, ditches, storm sewers, culverts, and roof drainage systems using standard methods to determine if the influx of rainwater that occurs during an extreme storm can be conveyed away from critical, safety-related structures. The results of the study indicated that the local intense precipitation also does not cause any safety-related structures to flood. The effects of roof ponding from the local intense precipitation are considered in the structural evaluation where it is feasible for ponding to occur. These evaluations are described in Chapter 4.

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2.7.3 Wind Hazard

The wind hazard was evaluated by performing a site-specific analysis. The site-specific study is documented in UCRL-15910, *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards* (Kennedy et al. 1990) [Reference 86]. LLNL has developed wind hazard models for DOE sites using experts in wind hazards. The results of these hazard model studies are reported in UCRL-15910 [Reference 169].

The wind hazard curve is shown in Figure 2.7-3. The evaluation basis wind (EBW) return period to be used for the site was specified by DOE (Jackson 1995) [Reference 79] to be 250 years. Based on a return period of 250 years, EBW has a wind speed of about 70 mph (minimum wind speed permitted by UCRL-15910).

The justification for use of an approximate 250 year return period for wind was based (by DOE) on the same rationale as the seismic return period. Wind damage at the plants is less likely to result in a significant release of hazardous material than the direct failure of cascade equipment under seismic loading. Wind is more likely than seismic loads to cause exterior damage to the buildings without extensive damage internally. In addition, high winds will rapidly disperse any hazardous material released as well as reduce exposure times downwind. Therefore, the risk of serious injuries and/or deaths is substantially lower for high winds than an equivalent seismic event. Given the much lower risk of public health consequences with high wind damage than from a seismic event and the short life of the facilities, modifications would not achieve significant benefit.

Extreme wind dominates in the 250 year frequency range for the PGDP. As noted above, the extreme wind value used in this study and tornado wind loadings are not considered. Tornados do occur in Western Kentucky; however, specific analysis of the frequency of tornados in the region show that they are rare. Recent analysis covering a 32 year period for the US and PGDP show an estimated strike frequency within the fenced area of the plant of approximately 1 event per 10,000 years at PGDP. Although tornados are extremely destructive in a localized area, the actual damage expected to cascade internal equipment and structures is also expected to be substantially less than the seismic event and may be minimal on the cell floor due to the large reservoir of air between the building roof and the cell floor of each building. Thus, given the short operating life of the plants and the expectation of risk far less than a seismic event, a 250 year return period excluding tornadoes is believed justified.

The wind hazard curve is shown in Figure 2.7-3. The evaluation basis wind (EBW) return period to be used for the site was specified by DOE to be 250 years. Based on a return period of 250 years, EBW has a wind speed of about 70 mph.

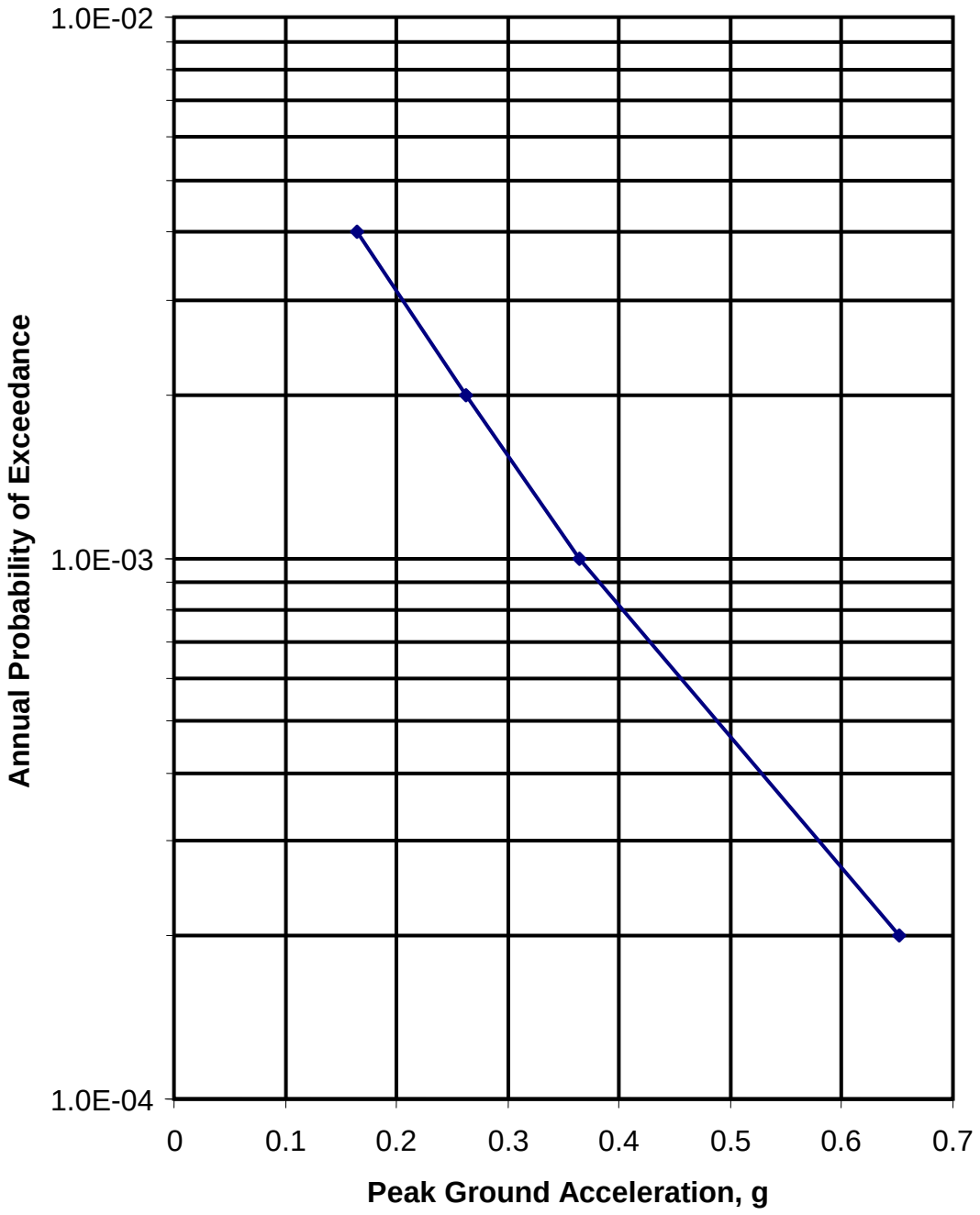

Figure 2.7-1. Mean seismic hazard curve for the Paducah area

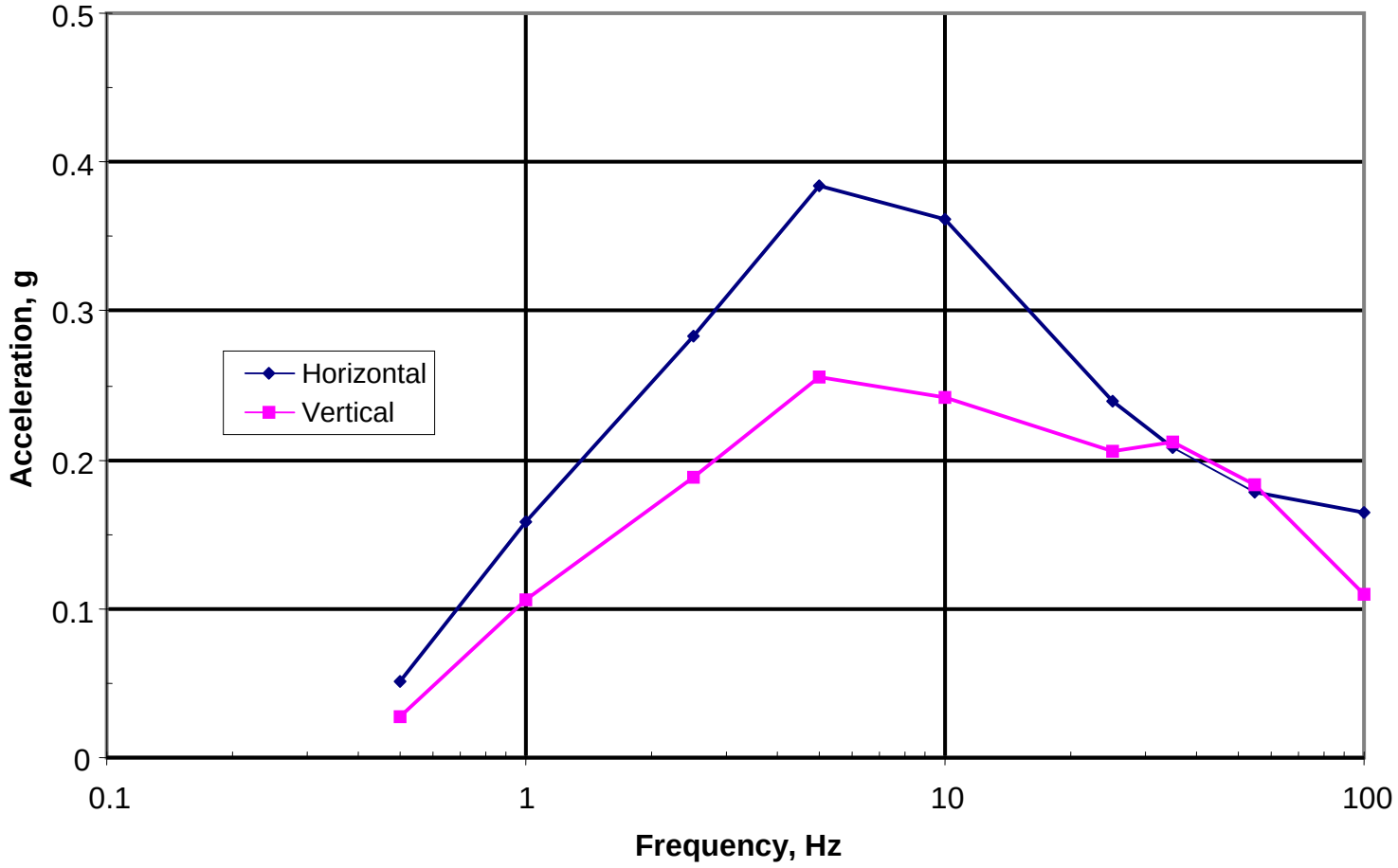

Figure 2.7-2. Evaluation basis earthquake for Paducah - 5% damping.

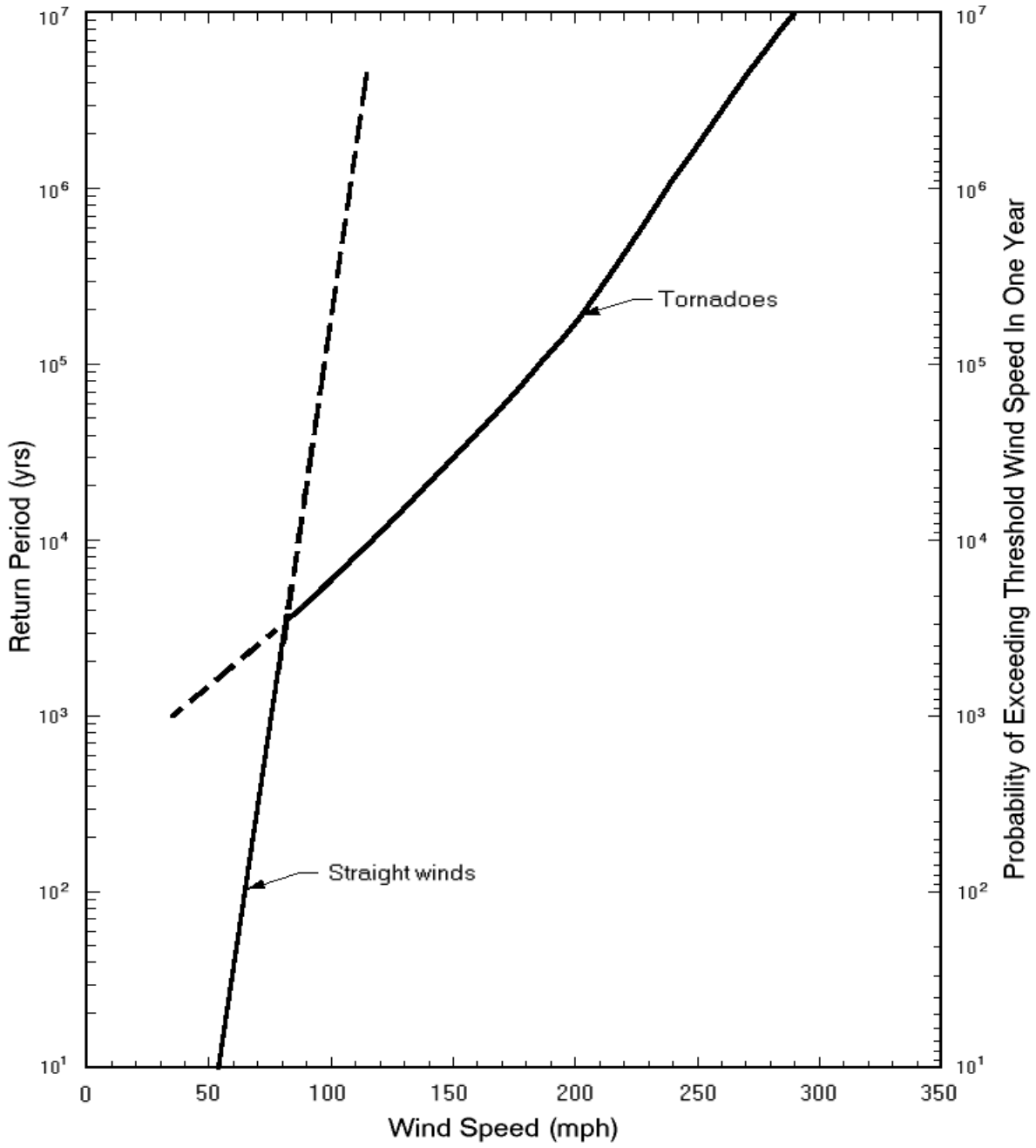

Figure 2.7-3. Wind hazard for the Paducah area.

2.8 EXTERNAL MAN-MADE THREATS

A number of man-made threats external to the PGDP facilities was identified for further study with regard to their potential impact on the operation of the plant. Specifically, these threats include aircraft flying nearby that could crash on the plant site, transportation accidents on nearby public highways resulting in explosions affecting the facility, transportation accidents involving barge traffic on the Ohio River that could result in an explosion affecting the facility, the rupture of natural gas transmission pipelines located near the plant, and the release of toxins or asphyxiants that could affect plant operations personnel due to an accident.

2.8.1 Aircraft Crashes

An in-depth analysis was performed to study the probability of aircraft crashes resulting in damage to the plant facilities. This analysis was based on a methodology established in the NRC Standard Review Plan. [Reference 3] It is based primarily on the distance between the site under evaluation and the various sources of aircraft hazards. These sources include, but are not limited to, airports, heliports, federal airways, holding patterns, approach patterns, restricted airspaces, military training routes, and military operation areas.

This analysis shows that the largest structures evaluated (the process buildings) each have an annual frequency of 9.1×10^{-6} per year of being struck by an aircraft. This frequency is considered below the risk of concern when compared to other risks associated with operation of PGDP.

2.8.2 Highway Accidents Near the Facility

Traffic accidents on public highways near the plant were considered as having the potential to affect plant structures due to over pressures that could reach the site as the result of an explosion. A calculation was performed using the contents of an eighteen-wheel tanker truck carrying gasoline as the worst case source of an overpressure event. This calculation was performed using accepted principles of overpressure calculations set forth in *DOD Ammunition and Explosives Safety Standards.*

The results of this calculation show that the plant is located a sufficient distance from the nearest highway likely to encounter tractor-trailer traffic (U.S. Highway 60, which is roughly 3 miles from the plant) such that an explosion being initiated from an accident of this type would not affect the plant site.

2.8.3 Barge Traffic Accidents on the Ohio River

Barge accidents resulting in the explosion of material being transported on the Ohio River were considered as having the potential to effect plant structures due to over pressures. A calculation similar to the one performed for Section 2.8.2 using information on barge shipments and quantities provided by COE shows that the plant is located far enough from the path of the barge traffic (the plant being approximately 3½ miles from the Ohio River) such that potential over pressures occurring on barges have a minimal impact on the facility. Data for barge traffic use at the PGDP site is provided in Table 2.8-1.

2.8.4 Natural Gas Transmission Pipelines

Natural gas is used as a backup to supplied coal for fueling the PGDP steam plant (C-600). Gas is delivered by a 6-in. pipe spur from a trunk gas pipeline located several miles north of the plant site along highway 996. The 6-in. line runs almost due south across the north site boundary and parallel to building C-335 about 500 ft away. The pipeline has a shut-off valve located inside the security fence which can be closed in an emergency. The pipeline pressure is nominally 150 psig and is reduced by a control valve to 15 psig as it enters C-600. Therefore, a pipeline rupture inside building C-600, in the pipe run from the site boundary to the steam plant, or in the pipeline spur could have an impact on the plant.

2.8.5 Toxins and Asphyxiants Affecting Operations Personnel

Accidental releases of toxins or asphyxiants that could incapacitate plant operations personnel were studied. A Gaussian model was utilized to quantify the concentrations of material that would be present on site as a result of such an accidental release.

A full tanker transporting chlorine by rail was considered. Using a 16-ton tanker, a release of 10 percent of the material before freezing occurred, and assuming a 6-in. line break for a tanker on the main rail transportation line (about 6 miles from the plant), the concentrations on the plant site were found to be within the allowable limits.

2.8.5.1 DUF_6 Conversion Facility

The Doe regulates the operation of a depleted uranium hexafluoride (DUF_6) conversion facility that is located on the DOE reservation south of the PGDP site. The conversion facility processes involve various toxic materials such as: UF_6 (typically with a depleted ^{235}U assay), uranium oxide, hydrogen fluoride (HF), potassium hydroxide (KOH), etc. Based on the DOE-approved documented safety analysis (Reference 192), operation of the DUF_6 conversion facility will not involve mitigated accident scenarios that would adversely affect NRC-regulated operations at PGDP.

Table 2.8-1. Barge traffic past milepoint 946 on the Ohio river for inflammable cargo — calendar year 2001.

Direction	Commodity	Tonnage	Trips	Average barge load (tons)
Downbound	Gasoline	33,845	19	1,781
	Distillate fuel oil	279,826	148	1,891
	Benzene and toulene	60,227	41	1,469
	Other hydrocarbons	10,857	7	1,550
Upbound	Ammonia	66,939	27	2,479
	Gasoline	497,571	173	2,876
	Distillate fuel oil	359,327	151	2,380
	Liquid natural gas	22,937	9	2,459
	Benzene and toulene	7,461	4	1,865
	Phosphatic fertilizer	1,590	1	1,590
	Other hydrocarbons	270,092	124	2,178

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3. FACILITY AND PROCESS DESCRIPTION

3.1 URANIUM AND URANIUM HEXAFLUORIDE PROPERTIES, PROCESS, AND FACILITIES DESCRIPTIONS

The purpose of this section is to provide a brief explanation of the properties of uranium (U) and uranium hexafluoride (UF_6), the process by which UF_6 is enriched in the ^{235}U isotope and the facilities used in this process. This section will serve as an orientation as the reader progresses through the more detailed descriptive sections to follow.

3.1.1 Uranium and Uranium Hexafluoride Properties

Uranium, element number 92, is a naturally occurring radionuclide. Natural uranium is a mixture of ^{238}U (99.3%), ^{235}U (0.7%), and ^{234}U (0.006%). The isotopes of uranium have extremely long physical half-lives: 4.5×10^9 years for ^{238}U, 7.1×10^8 for ^{235}U, and 2.5×10^5 years for ^{234}U. Uranium and its daughter products decay primarily through the emission of alpha particles; some beta and gamma radiations are also emitted.

Uranium-234 (^{234}U), Uranium-235 (^{235}U), Uranium-236 (^{236}U) and Uranium-238 (^{238}U) are alpha emitters of widely varying specific activity. ^{234}U has a specific activity approximately 2,900 times that of ^{235}U and 18,000 times that of ^{238}U. Consequently, ^{234}U has the greatest radiation toxicity potential. For example, at 5.5 wt % ^{235}U enrichment, the ^{234}U represents only 0.085 wt % of the total uranium present, but it is responsible for more than 85% of the total radiation dose. In general, the radiation toxicity of soluble uranium compounds is insignificant when compared with its chemical toxicity.

Alpha particles have a range of only a few centimeters in air and can be stopped by a single sheet of paper. When emitted from uranium that is external to the body, no radiation hazard exists because the alpha particle cannot penetrate the skin of a human. If ingested, uranium can present a radiological hazard. Emission of the alpha particle transforms ^{238}U into Thorium-234 (^{234}Th); ^{234}Th decays to Protactinium-234 (^{234}Pa) with a half-life of 24.1 days via the ejection of a beta particle. Beta particles can penetrate the outer layer of skin but cannot irradiate internal organs. A sheet of aluminum 1/16-in. thick will stop virtually all beta particles emitted by uranium's daughter products. ^{234}Pa decays almost immediately to ^{234}U by beta emission. ^{234}U decays with the emission of alpha, beta, and gamma radiations. Gamma are the most penetrating of these three types of radiation and can reach internal organs. However, very little gamma radiation is emitted because natural uranium eventually decays to the stable isotopes of lead.

Outside of the special configuration of some nuclear reactors, a self-sustaining nuclear chain reaction, or criticality, can theoretically occur whenever the abundance of ^{235}U exceeds 1% by weight of the total uranium. Many factors influence criticality including the mass, geometry, assay, density, moderation, concentration, reflection of the uranium assembly, and the use of nuclear poisons. If these factors are properly controlled, a criticality is not possible. The effect of an accidental criticality would be a greatly increased radiation level within the vicinity of the critical configuration. Neutrons and gamma rays would be the primary radiation. Neutrons are more penetrating than gamma rays and are between 3 and 10 times more damaging to tissue. Depending upon the physical characteristics of the criticality, the intensity of the radiation could vary greatly.

Most nuclear power reactors require uranium that has been enriched in the ^{235}U isotope. Gaseous diffusion is the enrichment process now in use in the United States. UF_6 is the only known compound suitable for use in a gaseous diffusion plant. The production of feed for diffusion plants starts with the mining of ores that contain up to 1.0% uranium. This ore is concentrated, leached, and processed to uranic oxide (UO_3). The oxide is converted to UF_6 by fluorination. Uranium enters PGDP as solid UF_6.

UF_6 is a solid compound at room temperature and atmospheric pressure but can be maintained in the gaseous phase under controlled temperature and pressure conditions. A phase diagram of UF_6 is shown in Figure 3.1-1, and significant characteristics of the compound are summarized in Table 3.1-1. The triple point pressure of 22 psia and a temperature of 147°F is the only combination of pressure and temperature where all three phases exist simultaneously in equilibrium. Regardless of its isotopic content, pure UF_6 will follow the phase diagram. Impure UF_6, under pressure will be influenced by a factor that is directly related to the phase relationships of the impurity .

Although UF_6 is a stable compound, it has some chemical properties that add to handling complexities. It reacts chemically with water to form UO_2F_2 and HF which are water soluble reaction products. It is not compatible with organics, such as lubricating oils, and the reaction with hydrocarbon oil can be violent at elevated temperatures. UF_6 is very corrosive to some metals, but exposure to clean and dry aluminum, copper, Monel, nickel, and aluminum bronze does not result in excessive corrosion. Mild steel cylinders are acceptable for transport and storage. UF_6 does not react with oxygen, nitrogen, or dry air, and its reactivity with most saturated fluorocarbons is very low.

Aside from nuclear considerations, UF_6 can be handled safely in essentially the same manner as any other corrosive and/or toxic chemical by employing procedures developed to accommodate the characteristics of the material.

If UF_6 were released at room temperature, only the gas and solid phases of the UF_6 would be involved, producing a cloud of dense “smoke” in the area. The smoke is composed of UF_6, HF, and UO_2F_2 produced from the reaction of UF_6 and moisture in the air. The reaction products of 1 mg of UF_6 in moist air produces a visible white cloud.

If a container of liquid and gaseous UF_6 at a temperature of 160°F and a pressure of 27 psia were released, the pressure would suddenly reduce to atmospheric, which is 7.3 psi below the triple point, and a noticeable cloud of gaseous and solid UF_6, HF, and UO_2F_2 would be released. This would occur because the liquid cannot exist at a pressure below 22 psia, so it rapidly releases its heat of fusion and returns to the solid state. This liberated heat is absorbed as heat of sublimation by the newly formed solid UF_6, which causes the evolution of gaseous UF_6. Not all of the solid will be vaporized because the heat of sublimation is two and one-half times greater than the heat of fusion. Thus, the quantity of UF_6 gas released under this circumstance would be greater than the quantity of gas existing prior to the accident. This release would be much larger than the cold release because of the additional heat content of the material prior to the accident. However, the important additional point is that there can be no liquid UF_6 at atmospheric pressure.

Another physical characteristic that must be considered is the liquid density of UF_6 as a function of temperature. Consider a container which is filled with liquid UF_6 to 95% of its capacity at a temperature

of 160°F and sealed. If the container is then heated to some temperature above 160°F, the 5% free volume will gradually decease because at higher temperatures each lb of liquid UF_6 occupies more volume. In this example, when the UF_6 reaches a temperature of 213°F, the container will be completely full. Any further heating will cause the confined liquid to develop hydraulic pressures, which can cause the container to rupture.

3.1.1.1 Other Major Chemicals In the Cascade

The following chemicals represent the major chemicals and/or byproducts associated with the gaseous diffusion process at PGDP.

3.1.1.1.1 Uranyl Fluoride and Its Hydrates (UO_2F_2•H_2O)

One of the products of the UF_6/H_2O reaction is uranyl fluoride (UO_2F_2). In a pure form, UO_2F_2 is a water-soluble, white solid. When hydrated, UO_2F_2•H_2O turns yellow in color. When exposed to moisture (atmospheric humidity), it hygroscopically adsorbs water. Its exact coloring and particle size depend upon the degree of hydration.

3.1.1.1.2 Hydrogen Fluoride

One of the products of the reaction between UF_6 and moisture is hydrogen fluoride (HF). HF may be encountered in the process for many reasons, including wet-air inleakage, feed stream impurities, etc.

HF is a clear, colorless, hygroscopic liquid that vaporizes readily, producing corrosive vapors with an intolerable pungent odor. The compound boils at approximately 20°C (68°F) to form a colorless vapor. Hydrofluoric acid is a clear, colorless, corrosive liquid formed by dissolving HF in water.

3.1.1.1.3 Chlorine Trifluoride

Chlorine Trifluoride (ClF_3) is a powerful oxidizing agent, igniting many organic compounds on contact and reacting violently with water. The reactivity has led to the use of ClF_3 as a fluorinating agent during cell treatments and may be used for removing uranium oxyfluoride deposits.

At room temperature and pressure, ClF_3 is a colorless gas, having a density of 3.14 times that of air. The gas is highly corrosive; its odor is sweet and suffocating; it is highly irritating even at low concentrations.

3.1.1.1.4 Fluorine

Fluorine (F_2) is used along with ClF_3 as a fluorinating agent for conditioning new equipment surfaces prior to UF_6 exposure and may be used to dry equipment after exposure to wet air. Under atmospheric conditions, fluorine is a pale yellow diatomic gas that has a pungent, penetrating, irritating odor. Fluorine also is an oxidizing agent.

3.1.1.1.5 Dichlorotetrafluoroethane (Commonly R-114, $C_2Cl_2F_4$)

R-114 is used as an intermediate heat transfer fluid in the cooling of the process gas. As described above, UF_6 reacts with water, so the potential consequences of water inleakage to the cascade are undesirable. R-114 is used to keep the UF_6 and the recirculating cooling water (RCW) fluids separated. R-114 is one of many industrial refrigerants whose chemistry and hazards of use are well documented. It has an atmospheric boiling temperature of approximately 40°F. The principal characteristics of R-114 include nonflammability, low toxicity, excellent thermal and chemical stability, and high density coupled with low boiling point, viscosity, and surface tension. R-114 hydrolysis in water is quite limited. R-114 poses a very low toxicity and explosion hazard.

3.1.1.1.6 Technetium

Technetium (^{99}Tc) was introduced to the cascade as part of feed material derived from reactor returns. ^{99}Tc is a low-energy beta emitter of high specific activity that is produced by the fission of ^{235}U. The specific activity of ^{99}Tc is 17 mCi/g. The radiological hazard of ^{99}Tc is approximately 700 to 5,000 times less than that of uranium based on the annual limit for exposure via inhalation.[1] No toxicological effects are identified in the Merck Index (9th edition). There are no exposure control standards based on chemical toxicity of technetium or its compounds.

3.1.1.1.7 Transuranics

Transuranic elements were introduced into the cascade as part of feed material derived from reactor returns. These elements migrated through the cascade and most of them were removed during the processing of UF_6. However, trace amounts of these transuranic elements are present in the operating cascade components.

3.1.2 Process Description

This section will present a brief explanation of the theory, requirements, configuration and efficiency associated with the gaseous diffusion process.

3.1.2.1 Theory

The theoretical principles upon which the gaseous diffusion process is based have been well known for some time. As early as 1846, Graham showed that at the same pressure and temperature the rates at which different gases flowed through a very small opening were inversely proportional to the square roots of the molecular weights of the gases. Later, when the kinetic theory was formulated, a theoretical explanation was readily found.

[1] Code of Federal Regulations, 10CFR20, Appendix B, Revised as of January 1, 1998, Table 1, Pages 334 and 365.

According to the kinetic theory, in mixtures of gases at constant temperature, all of the molecules of each gas have the same average kinetic energy or energy of motion

$$E = 1/2mv^2$$

where:

E = kinetic energy,
m = mass of the molecule, and
v = root-mean-square velocity of the molecule.

If a gas mixture contains molecules of two masses, M and m, and if their energies are equal, their respective molecular velocities V and v , must be related by

$$\frac{1}{2}MV^2 = \frac{1}{2}mv^2$$

or

$$\frac{v}{V} = \left[\frac{M}{m}\right]^{1/2}$$

A mixture of UF_6 gas made from natural uranium ore will contain 1 part $^{235}UF_6$ (molecular weight = 349) to 140 parts $^{238}UF_6$ (molecular weight = 352). By using the relationship just shown and allowing α to equal the ideal point separation factor of

$$\alpha = \frac{v}{V} = \left[\frac{M}{m}\right]^{1/2}$$

we find that

$$\alpha = \left[\frac{M}{m}\right]^{1/2} = 1.0043$$

With the two isotopically pure gases under identical temperature and pressure conditions, the same small opening would ideally allow 10,043 molecules of the lighter $^{235}UF_6$ to pass in the time required for 10,000 molecules of $^{238}UF_6$. The enrichment of the lighter gas in the diffusion product from the natural isotopic mixture is small, but the process can be repeated as many times as necessary to obtain any desired degree of separation, that is, desired degree of ^{235}U enrichment. Each repetition of the process is called a stage, while an assembly of separating stages is termed a cascade.

3.1.2.2 Requirements

At least three basic requirements must be met in order to apply the gaseous diffusion process to a separation task: a stable process gas, a porous membrane, and a driving force to effect separation.

3.1.2.2.1 Process Gas

The material to be separated must exist in a gaseous form at the operating temperature and pressure. The difference between the molecular weights of the gaseous compounds to be separated should be as large as possible to obtain the largest theoretical isotope separation factor.

For the separation of uranium isotopes, UF_6 has many advantages and relatively few disadvantages. For example, it is one of a very few stable uranium compounds with an appreciable vapor pressure at moderate temperatures. Furthermore, the fluorine atoms in the molecule have only one natural isotopic weight and therefore the difference in masses of the $^{235}UF_6$ and $^{238}UF_6$ molecules is due entirely to the uranium isotopes. Note that the gaseous diffusion process separates gases only on the basis of differing molecular weights, regardless of whether the molecule contains only one multi-isotopic element or many. In the case of UF_6, fractionation by molecular weight separates only uranium isotopes. From the point of view of disadvantages, UF_6 is reactive chemically and is easily reduced to nonvolatile compounds. Its use in the gaseous diffusion process necessitates special materials of construction, special operating techniques and places limitations on the operating temperatures and pressures that may be used. Other volatile uranium compounds, notably organic compounds, have been examined for use in the diffusion process but none has been found superior to UF_6.

3.1.2.2.2 Barrier

While the gaseous diffusion process actually requires only a single very small opening to accomplish the separating effect, from the perspective of the amount of material that can be processed in a given time, it is highly advantageous to use a porous membrane or barrier containing a very large number of these elementary separating openings or pores. Each of these pores would theoretically act independently to enrich the product gas by the same amount in the lighter component, but the total amount of gas so processed would be multiplied greatly.

The kinetic theory places some limitations on the size of the pores that will be effective, in that it stipulates that the pore diameter must be small compared to the mean free path of the diffusing molecules at the operating temperature and pressure.

Workable gaseous diffusion barriers must have a stable, efficient pore structure in the corrosive atmosphere yet operate at a high enough pressure to produce a practical amount of enriched material. Corrosion effects limit very high temperature operation, while production considerations limit low pressure operation. The resulting compromise roughly defines a range of temperatures and pressures within which it is economically feasible to operate the gaseous diffusion plants and for which it is also feasible to manufacture the required barrier in large quantities with uniform, controlled characteristics.

3.1.2.2.3 Gas Compressors

Finally, the process requires some driving force to cause the gas molecules to diffuse through the barrier pores predominately in one direction so that the enriched product can be collected. This is accomplished by creating a pressure difference across the barrier with a gas compressor. Like the barrier, these machines must operate in an atmosphere of hot corrosive gas for long periods to be economically feasible.

3.1.2.3 Configuration

The gaseous diffusion process requires equipment configured to meet process as well as practical considerations. The barrier material is constructed in tubes, which are arranged in a tube bundle and installed in a converter. The gas compressor discharges into the converter where a portion of the process gas diffuses though the barrier tube wall and passes on to the next compressor as the "A" stream, which is slightly enriched in the ^{235}U isotope. The gas that does not diffuse through the barrier material leaves the converter as the "B" stream, which is slightly depleted in the ^{235}U isotope. The configuration of a motor, compressor, converter, "B" stream control valve, associated piping, and controls is called a stage.

A configuration of several stages in series is called a cell. A cell usually contains 8 to 10 stages, a coolant system to remove the heat of compression and block valves to isolate the cell from the rest of the cascade. A cell is the smallest section of the cascade that can be isolated from the rest of the cascade.

3.1.2.4 Efficiency

The gaseous diffusion process for uranium isotope enrichment by its very nature has an extremely low overall thermodynamic efficiency. The reason for this poor efficiency lies in the fact that the individual diffusion stages are not thermodynamically reversible; that is, energy must be externally added and dissipated at each stage and is not readily recoverable for reuse. The electrical energy supplied to the compressor motor is used to increase the gas pressure for feed to the barrier, but the energy also appears as heat of compression that must be removed. As the compressed gas diffuses through the barrier, it expands without performing useful mechanical work and must be recompressed for feed to the next stage. The large amounts of power supplied to a single diffusion stage, therefore, perform only the small change in isotope concentration.

3.1.3 Paducah Gaseous Diffusion Plant

Paducah Gaseous Diffusion Plant (PGDP) is operated by the United States Enrichment Corporation and enriches uranium in the ^{235}U isotope using the gaseous diffusion process. The UF_6 feed to the cascade may range in assay from partially depleted material up to and including the plant assay limit. PGDP is authorized to produce product up to a nominal 5 wt % ^{235}U. The accident analyses presented in Chapter 4 have been evaluated for an enrichment assay of 5.5 wt % ^{235}U.

The UF_6 feed for PGDP is received by truck or rail at C-360, Toll Transfer and Sampling Building, C-333A, Feed Vaporization Facility or C-337A, Feed Vaporization Facility, or C-400, Cleaning Building and Appurtenant Structures. The feed can be received in 2.5-, 10-, and 14-ton cylinders with the UF_6 in the solid state. The received feed cylinders are unloaded, inspected, weighed, and cold pressure checked prior to heating. A statistically determined number of the feed cylinders are liquified in a steam-heated containment-type autoclave in C-360 for sampling to ensure conformance with feed material specifications and for uranium accountability. The cylinders of UF_6 are then removed from the autoclaves and permitted to resolidify by ambient cooling in an interim storage area. Upon receipt of acceptable analytical results, the feed cylinders are approved for feeding into the cascade at C-333-A,

Feed Vaporization Facility, or C-337-A, Feed Vaporization Facility. The cascade feed vaporization involves heating the feed cylinders in a steam-heated containment-type autoclave to convert the solidified UF_6 to liquid with a relatively high vapor pressure. The pressurized vapor is drawn off and controlled by valves and flow-measuring devices to maintain distribution of UF_6 gas through heated piping to appropriate points in the enrichment cascade.

A second source of feed for PGDP comes from UF_6 tails material withdrawn from the gaseous diffusion cascades with ^{235}U assay above the current tails limit. This material, is transported from the tails storage area to the feed vaporization facility in C-333-A or possibly to the feed vaporization facility in C-337-A. The cylinders are weighed, inspected visually, pressure checked, and placed in steam-heated containment-type autoclaves for vaporization and feeding to the cascade. When emptied, these cylinders may be transported to the tails withdrawal facility for filling with depleted tails material for long-term storage.

The PGDP enrichment facility consists of about 1800 operating stages arranged in two parallel cascades. The cascade buildings are designated as C-331 Process Building, C-333 Process Building, C-335 Process Building, C-337 Process Building, and C-310 Purge and Product Building, and C-315, the Surge and Waste Building. The number of stages typically required to span from 0.711% to the product assay varies with the desired product assay. For example, to span from 0.711% to 5.0% assay would require approximately 1000 stages between the feed and product point. These stages are called the enricher. Furthermore, the overall economic trade-off between cost of natural uranium feed material and cost of diffusion plant operation and equipment requires that additional diffusion stages be used to substantially strip the ^{235}U isotope from the normal feed material so that the tails removed from the plant will normally contain only about 0.2 to 0.4 wt % ^{235}U. This stripping requirement adds additional stages. These stages are called the stripper. The total requirement of 1,200 to 1,800 stages is made up from an appropriate number of cells, which may contain different numbers of stages per cell (see Figure 3.1-2).

A number of factors influence the cascade shape. A cascade with very efficient barrier will be shorter than one with less efficient barrier. A cascade producing a high product rate must have higher flow rates between stages than one producing a lower product rate. Stages in the middle of a cascade must have higher flow rates than those near the ends of the cascade if the power is to be used efficiently. The schematic representation of an efficient cascade is usually drawn with a diamond shape to illustrate that the flow rates are largest near the middle and smallest at the ends (see Figure 3.1-2).

UF_6 product in the gaseous state is normally removed from the enrichment cascade through heated piping to C-310 and C-310-A, Product Withdrawal Building, where it is further compressed to a pressure of approximately 30 psia and cooled for condensation to the liquid phase. Accumulators are located in the line to act as a surge volume for the liquid UF_6. Liquid UF_6 is then drained into product cylinders in C-310. The compression and liquefaction steps are performed in C-310 and C-310-A, and the cylinder filling operations are performed in C-310. The filled cylinders are transported outside the building on an air-powered scale cart, lifted by a 20-ton bridge crane, and moved to a cool-down area adjacent to the building. After the UF_6 has solidified, gaseous contaminants are removed by venting through chemical traps. Cylinders containing solidified UF_6 will be transported to C-400 and shipped to PORTS or transported to C-360. If sent to C-360 the cylinders are sampled, and may be transferred to 2 ½- or 10-ton cylinders and shipped to PORTS or directly to a customer. A representative sample of cylinders are sent to C-360 where they are sampled before being moved to C-400 for shipment to PORTS or shipment directly to a customer.

All full product cylinders containing UF_6 at > 1% ^{235}U are shipped in protective packages called "overpacks."

An overview of the UF_6 enrichment process is shown in Figure 3.1-3

The assay of the contents of all product cylinders can be determined by laboratory analysis of a UF_6 sample collected by an automatic sampler during cylinder filling operations or other approved methods such as in-line mass spectrometers. Those cylinders shipped to C-360 to be liquid-sampled are placed in containment-type autoclaves and heated to convert the UF_6 from solid to liquid. Liquid samples are withdrawn for analyses to ensure conformance with the enriching services contract. The liquid UF_6 can be transferred to cylinders, which are cooled at ambient temperature to convert the contents to a solid at sub-atmospheric pressure and shipped. The product cylinders are removed from the autoclaves, weighed, and cooled prior to returning to the C-310 product withdrawal facility for refilling. Partially empty cylinders are removed from the autoclaves, cooled and shipped to one of the vaporizers for refeeding to the cascade or returned to C-310 for refilling.

The UF_6 tails, which are depleted in ^{235}U, are continuously withdrawn from the diffusion cascade through heated piping to the tails withdrawal facility in C-315. The UF_6 gas is compressed and condensed as liquid UF_6 and drained as a hot liquid at above atmospheric pressure into 10- or 14-ton tails storage cylinders. The filled tails cylinders are weighed and moved outside the building where they are permitted to cool at ambient conditions until their contents are solidified. These cylinders are then transported to long-term storage yards or may be sent to customers who process depleted UF_6.

3.1.4 Cascade Improvement and Uprating Programs

In the early 1970s major improvement and uprating programs, called the Cascade Improvement Program (CIP) and the Cascade Uprating Program (CUP), were initiated at PGDP. The result was to increase the production capacity of PGDP from about 7.3×10^6 to 11.5×10^6 separative work units per year.

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Table 3.1-1. Pertinent Characteristics of UF_6

Characteristics	Value
Chemical formula	UF_6
Molecular weight — $^{235}UF_6$	349
— $^{238}UF_6$	352
Sublimation point at 14.7 psia	133.8°F (56.6°C)
Vapor pressure at melting point (147.3°F, 64.1°C)	22.0 psia (152×10^3 Pa)
Density of solid at 68°F (20°C)	317.8 lb/ft^3 (5091 kg/m^3)
Critical temperature	446.4°F (230.2°C)
Triple point data:	
Temperature	147.3°F (64.1°C)
Pressure	22 psia (152×10^3 Pa)
Density of liquid	227.7 lb/ft^3 (3647 kg/m^3)
Heat of sublimation at 147.3°F (64°C)	58.2 btu/lb (135×10^3 J/kg)
Heat of fusion at 147.3°F (64°C)	23.5 btu/lb (54.7×10^3 J/kg)
Heat of vaporization at 147.3°F (64°C)	35.1 btu/lb (81.6×10^3 J/kg)
Thermal conductivity:	
41°F, solid (5°C)	2.84×10^{-1} btu/hr ft°F (4.91×10^{-1} W/m°K)
162°F, liquid (72 °C)	9.27×10^{-2} btu/hr ft°F (1.60×10^{-1} W/m°K)

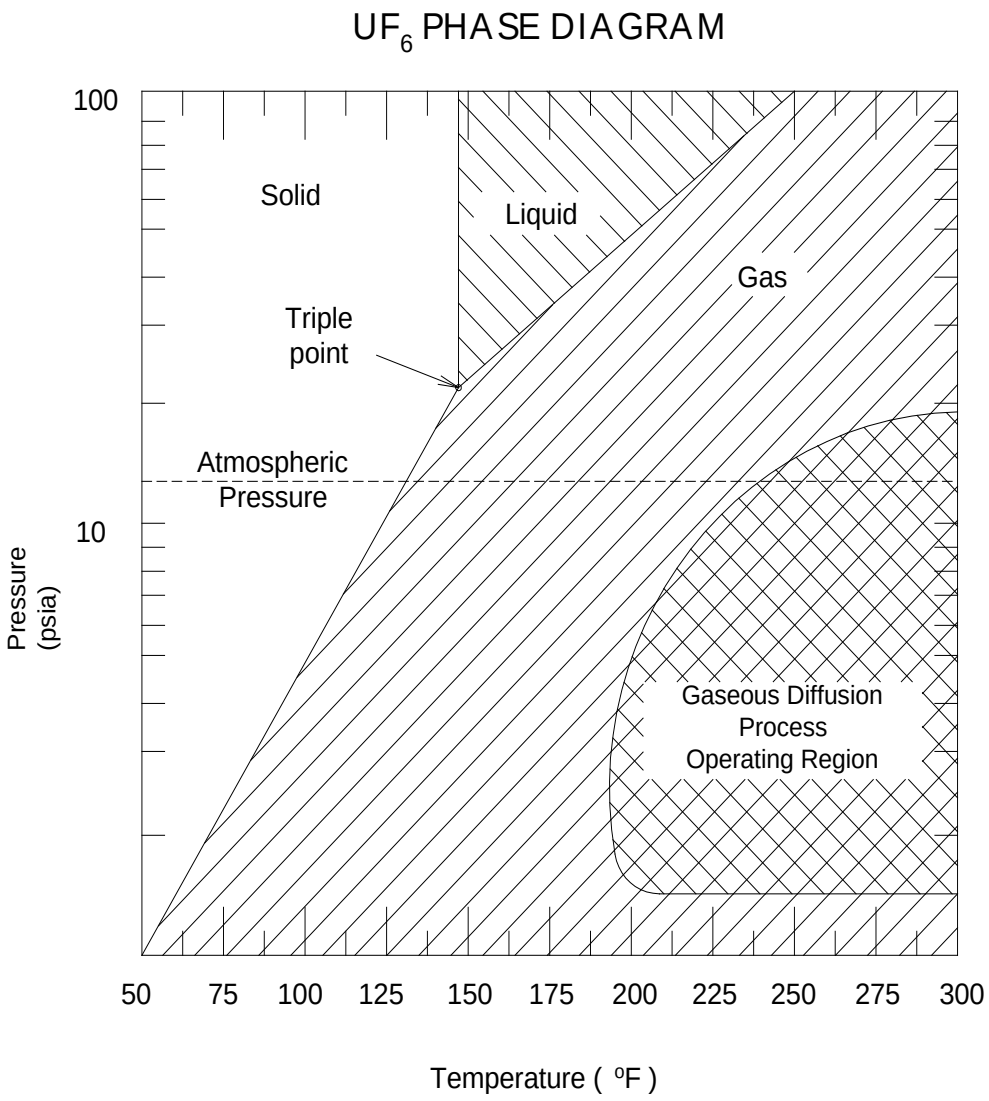


Figure 3.1-1. Phase Diagram for UF_6

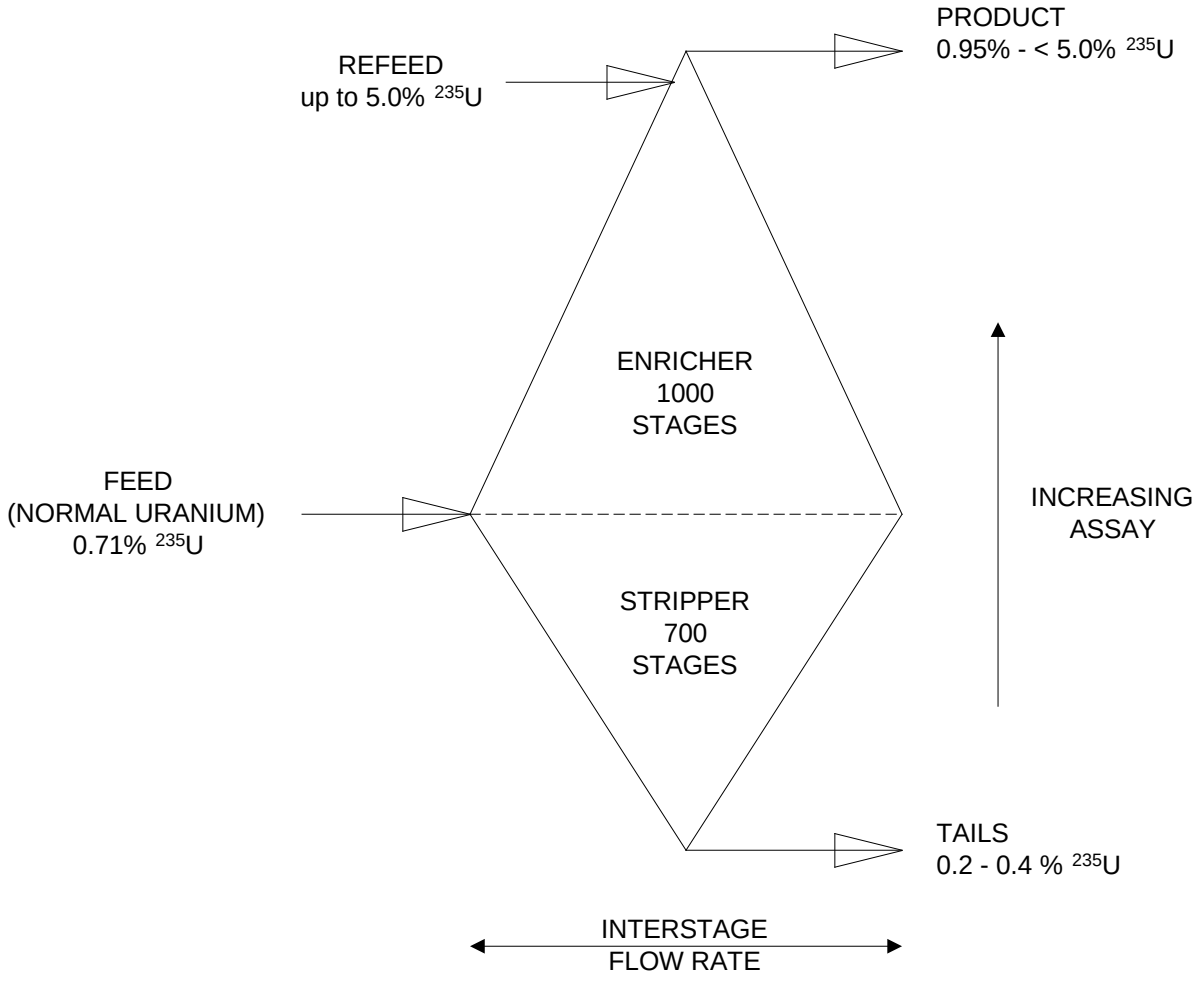
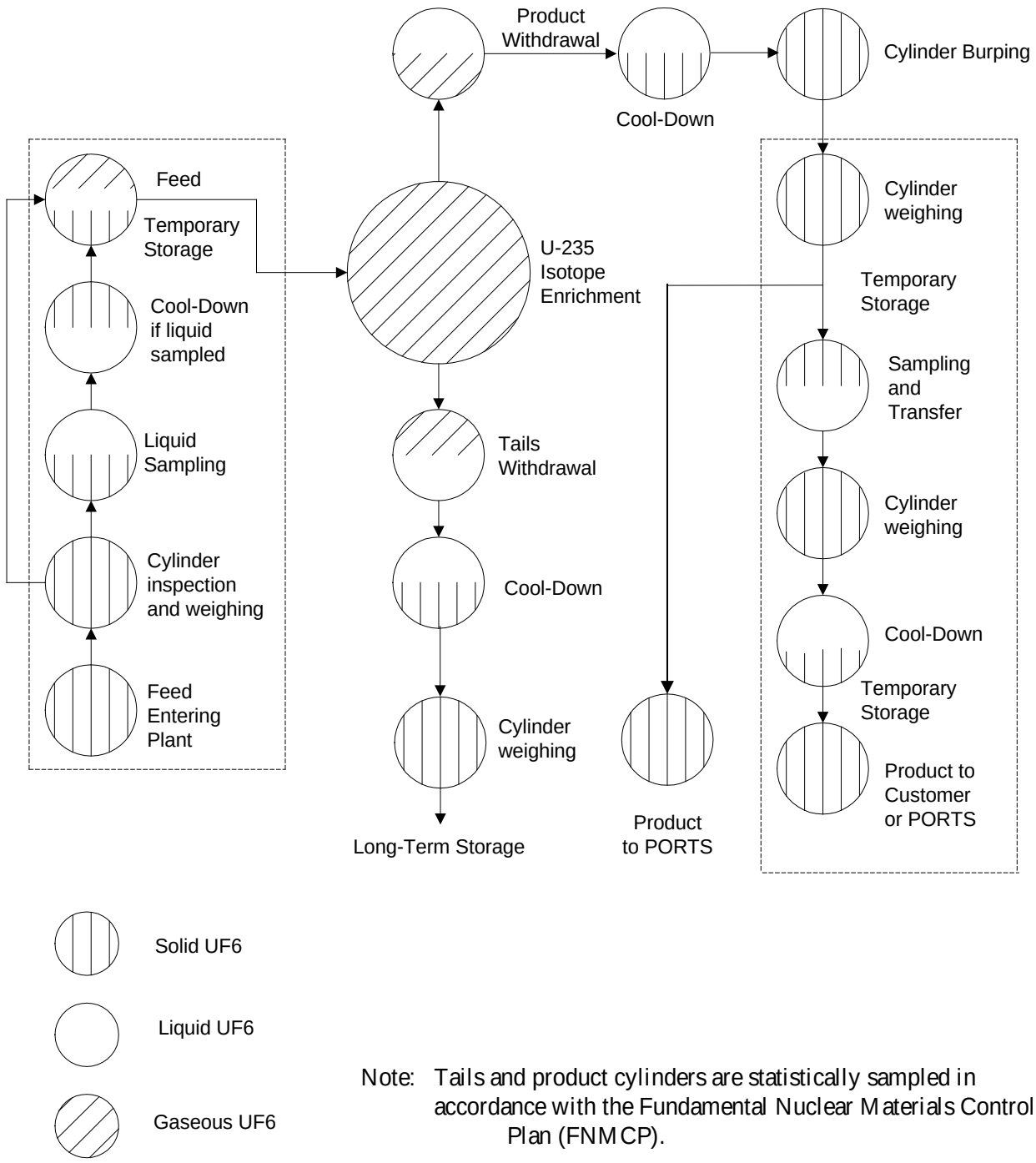


Figure 3.1-2. Example PGDP Diffusion Cascade Shape and Separation Process



Note: Tails and product cylinders are statistically sampled in accordance with the Fundamental Nuclear Materials Control Plan (FNMCP).

Figure 3.1-3. UF_6 Process/Handling at PGDP

3.2 UF_6 FEED FACILITIES

The feed vaporization systems at PGDP are located in the C-337-A Feed Vaporization Facility and the C-333-A Feed Vaporization Facility. Feed material for the PGDP diffusion cascade is manufactured from mined uranium, or partially depleted or enriched UF_6 withdrawn from gaseous diffusion plants.

3.2.1 Description

Feed material at PGDP is in cylinders that contain UF_6 in the solid state. In order to transfer this material to the diffusion cascade, the cylinder must be heated to transform the solid UF_6 to a gaseous state. The UF_6 gas flows from the cylinder through a connecting UF_6 cylinder pigtail to UF_6 feed headers that deliver the gaseous feed material to the appropriate assay points in the diffusion cascade. UF_6 cylinders can be vaporized in the feed facilities for direct withdrawal without enrichment and are handled the same as any other feed cylinder.

The types of activities that take place in the feed facilities are described below.

3.2.1.1 Preheating

Material is not introduced into the enrichment cascade unless assurance is obtained that it meets feed composition and weight specifications. An external inspection is performed on each cylinder to detect any physical damage that may be present. If serious damage is detected, the cylinder is not heated until corrective actions have been completed and verified by a certified inspector.

Feed cylinders are placed in containment-type autoclaves in C-337-A or in C-333-A. If the feed cylinder is a large cylinder (2 ½ ton or larger), the cylinder is placed horizontally in the autoclave with the cylinder valve at the twelve o'clock position. If the feed cylinder is a small cylinder (12B or smaller), the cylinder is placed vertically in the autoclave with the cylinder valve at the top. The cylinder valve is connected to a manifold with a UF_6 cylinder pigtail (see Section 3.2.4 for a discussion of UF_6 cylinder pigtail fabrication and testing). The cylinder valve and UF_6 cylinder pigtail are checked for clarity. If valve clarity is not established, the cylinder will not be heated and is removed from the autoclave. If the cylinder valve and pigtail pass the clarity check, the cylinder pressure is noted and recorded. An indicated pressure less than or equal to 10 psia indicates that the cylinder does not contain significant amounts of impurities and is acceptable for feed. A cylinder pressure of above 10 psia indicates noncondensibles or impurities in the cylinder. With supervisory approval, the cylinder can be cold burped in order to lower the pressure to below 10 psia.

Fill limits for UF_6 cylinders are established to allow adequate room for UF_6 expansion upon heating. For cylinders other than tails cylinders, the limits are calculated based on 250º F maximum UF_6 temperature, certified minimum internal volume for the cylinder model and a minimum cylinder ullage of 5%. If it is discovered that a cylinder exceeds these fill limits, the TSRs may still allow heating the cylinder as long as the required 5% ullage is maintained. Cylinders are designated as Category A if calculations show that at least 5% ullage can be maintained during heating based on the actual cylinder volume (rather than the minimum volume for the cylinder model) and assuming a maximum UF_6 temperature of 235º F. Cylinders are designated as Category B if the required 5% ullage can be maintained based on the actual cylinder volume and a lower temperature value of 230º F assumed for maximum UF_6 temperature. For Category B cylinders, autoclave steam pressure is adjusted to ensure that the assumed maximum UF_6 temperature is not exceeded during cylinder heatup. For cylinders filled

with high purity tails, fill limits for in-plant tails storage and for Category A and B designations are calculated similarly to those described above except that fill limits for in-plant tails storage are based on 235º F maximum UF_6 temperature rather than 250º F and fill limits for heating as Category A or B are based on maintaining 3% ullage during heating rather than 5%. TSRs also allow heating of certain 48OM cylinders which do not have certified volumes, provided that the volume of the cylinder, based on measured dimensions, either exceeds the minimum volume of the cylinder type and the weight of material in the cylinder is less than 26,000 pounds, or the calculated volume with the actual weight of UF_6 in the cylinder meets minimum ullage requirements. Such a cylinder has been verified to contain greater than 7% ullage when heated to 235º F. The additional ullage is provided to compensate for the fact that the actual cylinder volume is based on measured dimensions rather than a certified volume.

Category C cylinders are damaged or overfilled cylinders, which are fed by either the controlled feeding or the cold feeding mode. For the controlled feeding mode, temperature and pressure controls (i.e., a maximum cylinder wall temperature of 142.9°F [61.6°C] and maximum cylinder pressure of 22 psia [152 kPa]) are used such that the UF_6 will remain below the UF_6 triple point even under credible accident conditions. Cylinders must pass the cold pressure check to be fed using the controlled feeding mode. In the cold feeding mode, cylinders are only subjected to the heat provided by the ambient temperature of the building atmosphere. No steam is applied during the cold feeding mode.

3.2.1.2 Heating

Autoclave temperature is controlled by using a cascade control scheme within a feedback loop controller. Information from the autoclave pressure and temperature instruments is used to control the temperature. The steam pressure is limited to a maximum of 8 psig, which corresponds to a saturated steam temperature of 235ºF. The temperature may be adjusted to accommodate the type cylinder being heated but will never exceed 235ºF. The pressure within a cylinder in an autoclave is an indication of the purity of the contained UF_6 and the rate of pressure increase indicates the clarity of the cylinder valve or UF_6 cylinder pigtail connection. A timed start-up system provides the warning mechanism to protect against a plugged valve or UF_6 cylinder pigtail. If the cylinder pressure fails to reach a set pressure within a specified time frame, the steam supply isolation valves and the thermovent line block valve are closed and alarms are sounded. Cylinders that have been heated and have had the cycle interrupted must be allowed to cool a minimum of three days for a 12B or 2½-ton cylinder or five days for a 10-ton or 14-ton cylinder prior to movement to ensure solidification of the UF_6.

The amount of standing water in the autoclave would be quite high during the initial moments of heating a cylinder since the autoclave control scheme calls for an autoclave temperature of 220ºF with a maximum pressure of 4 psig. The thermal inertia of the cold cylinder causes condensate to form on the surface of the cylinder (rarely to the extent that the Water Inventory Control System is actuated, however). At this stage of heating, the actual water inventory is of little, if any, safety concern since the cylinder's contents are at well below atmospheric pressure.

As the cylinder warms, its pressure increases, but the level of standing condensate decreases accordingly since the cylinder no longer requires as much energy input, and thus a lower steam demand is required. At the time when water level is of its highest safety concern (cylinder contents liquefied, mobile and pressurized), the water level is actually at its lowest since the only steam demand necessary is to make up for ambient heat losses.

The C-337-A feed facility autoclaves 5E and 5W have been modified to allow the controlled feeding of Category C cylinders. Instead of the autoclave temperature and pressure control scheme described above, the actual cylinder wall temperature is monitored with a pair of magnetically mounted thermocouples. The autoclave temperature control system maintains the cylinder wall temperature below the UF_6 triple point temperature. During controlled feeding, the steam pressure control system is not required to be operable. Cold feeding can be done from any autoclave in C-333-A or C-337-A. Cylinders that have been heated in the controlled feed mode do not require the usual 3 or 5 day cooldown (assuming the cylinder temperature remained below the UF_6 triple point temperature). Cylinders that have been placed in an autoclave for cold feeding do not require the cooldown periods before removal from the autoclave.

3.2.1.3 Feeding

Each feed station in the feed vaporization facilities is equipped with flow metering. The flow is monitored in support of the Nuclear Materials Control and Accountability (NMC&A) program as described in the Fundamental Nuclear Materials Control Plan (FNMCP). Flow monitoring is also used in controlling the feed flow through each feed system. The flow metering equipment includes a flow element, a flow transmitter, and a flow indicating totalizer. This instrumentation is part of the inventory instrumentation required for nuclear material accountability and is identified as important to safety in Section 3.15.

During controlled feeding and cold feeding modes of operation, the flow metering equipment will not accurately measure the feed rate due to the low feed pressures and flow rates. Due to the limited number of cylinders targeted for controlled feeding, NMC&A will not require close monitoring of the exact UF_6 feed rate during the controlled feeding or cold feeding mode of operation. NMC&A requirements can be met by planning around the bimonthly UF_6 inventory.

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3.2.1.4 Heeling

Cylinder evacuation, or "heeling," is accomplished by connecting the nearly empty cylinder to an evacuation source. Typically, the evacuation source is obtained by connecting the nearly empty cylinder to the throat of a venturi jet station and routing through the venturi UF_6 from another cylinder that is currently being fed to the cascade. This will remove the residual UF_6 from the cylinder. Heeling can also be accomplished by connecting the nearly empty cylinder to other low pressure sources (e.g., cascade surge drums, purge and evacuation pumps, etc.). When the cylinder is acceptably heeled, the steam supply and the cylinder valve (except 12B and smaller cylinders) are closed. The autoclave pressure is reduced to near atmospheric pressure by jetting the autoclave through a steam venturi, after which the autoclave may be opened. After UF_6 cylinder pigtail purging and evacuation, the empty cylinder is removed from the autoclave with the bridge crane and transferred to the storage yard.

3.2.2 Buildings

C-337-A is located near the midpoint of the east face of the C-337 process building along the east truck alley. C-337-A is enclosed on all but the south side. A cylinder storage area on the south side of C-337-A is served by two 20-ton overhead bridge cranes.

C-333-A is located near the midpoint of the south face of the C-333 process building along the south truck alley. C-333-A is enclosed on all but the east side. A cylinder storage area on the east side of C-333-A is served by two 20-ton overhead bridge cranes. The overhead bridge cranes in C-333-A and C-337-A are described in Section 3.7.

There are five feed stations in C-337-A and four feed stations in C-333-A. These stations permit simultaneous feeding of material with different assay levels. Each feed station has two containment-type autoclaves, a feed metering device, an evacuation jet, and associated headers and valves. Vapor feeding from one position can continue while another position is being heeled, changed, or preheated for feeding. The C-337-A jet station barrier frame protects the piping from damage that might be inflicted by a swinging cylinder being transported by overhead cranes. The jet station in C-333-A is located in an area outside the cylinder movement path. The C-333-A and C-337-A structures are important to safety as described in Section 3.15.

3.2.3 Autoclaves

Each containment-type autoclave in the feed facilities is essentially a cylindrical pressure vessel approximately 22 ft long with an internal diameter of 6 ft, which is mounted with its long axis horizontal. The autoclaves are designed to provide steam heating of cylinders of UF_6. A section of the autoclave (head) is mounted permanently, while the remaining section (shell) is moved with a hydraulic ram on a track system. This movement is required to permit introduction and removal of the UF_6 cylinders. The moveable shell of each autoclave is secured to the fixed head with a hydraulically operated locking ring, which is sealed with a gasket. An interlock prevents opening the autoclave shell if pressure in the

autoclave exceeds atmospheric pressure by a set amount. A typical autoclave and its associated piping and valves are shown in Figure 3.2-1.

The autoclaves have been evaluated and shown to meet the evaluation basis earthquake performance criteria. The autoclaves are designed to satisfy the requirements of Section VIII, Division 1, of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The autoclaves are containment-type autoclaves with a maximum allowable working pressure (MAWP) of 200 psig at 250ºF that were hydrostatically tested at 150% of the MAWP by the manufacturer. Autoclaves are designed to minimize standing water inventory to contain the products of a "worst case" UF_6 release.

The autoclave shell and the head assembly are mounted on a sub-base, which in turn is mounted to the floor. The sub-base is made from heavy steel beams and provides a means of leveling the autoclave to prevent the accumulation of condensate. Hydraulically operated work platforms are provided on each side of the autoclave shell. A dished head is attached to the back end of the shell section of the autoclave. The shell assembly is mounted on a horizontal floor track parallel to the cylindrical axis. A hydraulic ram moves the shell assembly against the permanently installed front head. The shell hydraulic cylinders stop the shell prior to the sealing flange making contact with the stationary head sealing flange. The final sealing of the O-ring sealed flanged closure is accomplished by the locking ring, which rotates and locks the autoclave shut. The containment-type of feed vaporization autoclave has a rupture disc and a pressure relief valve series combination that will relieve any pressure within the autoclave in excess of 110% of the MAWP of the autoclave to atmosphere through a vent line, which extends above the roof. Cylinder rotation relative to the autoclave cylinder support frame during heating is limited by the autoclave cylinder restraint system which consists of structural members attached to the cylinder support frame. These structural members act as stops to limit cylinder rotation. The stops also give added assurance that the cylinder valve closure mechanisms will function properly and prevent possible UF_6 cylinder pigtail damage due to cylinder rotation.

Each autoclave has a cylinder valve closer that consists of an air motor outside the autoclave head and a telescoping shaft to connect to the cylinder valve. When a cylinder is placed in the autoclave, the telescoping shaft is connected to the cylinder valve stem when the valve is opened. The valve can then be closed from outside the autoclave by pressing the air motor start button. The autoclave cylinder valve closer is not utilized when feeding small UF_6 cylinders (less than 500 lbs. UF_6).

The containment type autoclave is the primary protection system against gross releases of UF_6 to the environment. Service lines penetrate the autoclave head and are closed by two, automatically operated, in-series isolation valves or by normally shut passive devices (rupture discs, relief valves, manual valves, etc.) to prevent the escape of reaction products in the event of a UF_6 release inside the autoclave. The service lines that penetrate the head include the steam supply line, conductivity cell steam sample lines, UF_6 feed line, condensate drain line, the thermovent line, and two pressure taps leading to pressure sensing instrumentation. The autoclave pressure relief line connects to the rupture disc and relief valve. A cylinder valve closer shaft containing packing and flanges to prevent leakage, a pressure tap, and temperature probes also penetrate the stationary head.

Each autoclave is designed to withstand the reaction pressure developed by the exothermic reaction of UF_6 with the steam vapor and the condensate present.

Because the quantity of an accidental release of UF_6 from a cylinder inside an autoclave cannot be controlled, the maximum pressure generated by the reaction can best be controlled by limiting the amount of water present for a given volume or by providing an additional volume for expansion. By limiting the amount of water present for a given volume, a maximum reaction pressure can be determined in an autoclave of a given volume. To ensure that the maximum allowable water inventory of the autoclave is never exceeded, two condensate level probes are mounted at the same elevation in the condensate drain at the top of the drain line, slightly below the autoclave shell. Any abnormal accumulation of condensate in the drain line reaching the level of these probes automatically shuts the steam supply isolation valves and the thermovent line block valve to prevent the addition of more water. These probes are used to ensure an acceptable water inventory. In the event of a UF_6 release, excessive water inventory could lead to autoclave over-pressurization or a nuclear criticality.

As a protection against overpressure, each autoclave is provided with a rupture disc backed by a pressure relief valve. The relief valve is set to relieve in accordance with ASME Code, Section VIII, and is designed to handle a 40% UF_6, 60% HF mixture resulting from a UF_6 release rate of 1,786 lbs of UF_6/min. Pressure sufficient to open the relief valve will vent the autoclave to the atmosphere. The maximum leak from a feed autoclave under accident conditions is estimated to be 210 lbs/min of HF. This relief system would function only if there were an excessive amount of water in the autoclave at the time of a UF_6 release within the autoclave.

In addition to the important to safety systems described in Sections 3.2.4, 3.2.5, and 3.2.6, the following systems are present to support operational control of the autoclaves:

3.2.3.1 Conductivity Monitoring

Each autoclave is provided with two separate conductivity cells that monitor the atmosphere within the autoclave. These conductivity cells detect the presence of small concentrations of HF. These small concentrations would result from a small release of UF_6 that would not produce an appreciable autoclave pressure increase. Steam is withdrawn from the autoclave through a single small diameter line and passed through a condenser. Each conductivity cell measures the electrical conductivity of the condensate. The HF formed by a UF_6 leakage into the autoclave results in high conductivity. If either cell detects conductivity above the setpoint, the system initiates containment shutdown and activates alarms at the autoclave local control panel, in the autoclave facility Operations Monitoring Room (OMR), in the ACR of the adjoining process building and in the C-300, Central Control Facility. The autoclave penetrations and their associated containment isolation valves activated by this system are the same as those associated with the Autoclave High Pressure Isolation System and are described in Section 3.2.5.3. The conductivity monitoring system is not functional during the controlled feeding or cold feeding modes of operation. The autoclave shell pressure is too low during these modes to provide flow through the system.

3.2.3.2 Low Cylinder Pressure System

The low cylinder pressure system is designed to minimize the potential for heating a cylinder when unobstructed flow of UF_6 through the UF_6 cylinder pigtail and the UF_6 manifold is not assured. Conditions under which this could occur include the cylinder valve being closed or the UF_6 cylinder pigtail not being connected. The system consists of a pressure element connected to a pressure switch that signals the steam supply block valves and the thermovent line block valve to close if the cylinder pressure (i.e., UF_6 manifold pressure) does not increase to a specified minimum value within a specified time following initiation of the heating cycle. Activation of the system actuates alarms at the autoclave control panel, in the autoclave facility OMR and in the ACR of the adjoining process building. The components of this system are the timer, pressure element, pressure transmitter, pressure switch, steam supply isolation valves, thermovent line block valve, and associated relays, solenoids, and switches. The low cylinder pressure system is not operable during the controlled feeding mode or the cold feeding mode of operation. During the controlled feeding mode, the cylinder is maintained below the UF_6 triple point temperature and pressure. During the cold feeding mode, no heat is applied to the cylinder so the UF_6 pressure will be below atmospheric.

3.2.3.3 Cylinder Pressure Relief System

The cylinder pressure relief system relieves pressures in excess of 100 psig (lowest MAWP of the cylinders heated) from the feed cylinder and closes the steam isolation valves and the thermovent line block valve. The components of this system are two pressure relief rupture discs on the feed line relief branch, a pressure element located between the rupture discs, a pressure transmitter, two pressure switches (low and high), the steam supply isolation valves, the thermovent line block valve, and associated relays, solenoids, switches.

During normal operation, the line between the rupture discs is maintained at approximately atmospheric pressure and the low and high pressure switches are closed. If the pressure sensing instrumentation detects pressure below the setpoint of the low pressure switch, or above the setpoint for the high pressure switch, the corresponding switch opens. If either the low or the high pressure switch opens, steam shutdown is initiated (closing the steam supply isolation valves and the thermovent line block valve), and alarms are actuated in the ACR of the adjoining process building, at the autoclave control panel, and in the autoclave facility OMR. If the feed header pressure exceeds 100 psig, both rupture discs rupture relieving header pressure to surge drums and the high pressure switch opens actuating the alarms and initiating steam shutdown.

3.2.3.4 Autoclave Opening Prevention System

The autoclave opening prevention system consists of two pressure sensing channels and is used to prevent the opening of an autoclave unless the internal autoclave pressure is close to atmospheric pressure. System components are the pressure elements, pressure transmitters, pressure switches, and associated relays and switches that operate off of the two internal pressure taps for each autoclave. When the autoclave pressure is less than the setpoint for the pressure switches, the switches are closed and the circuit to the hydraulic system is completed, allowing normal hydraulic control function. If either pressure sensing channel senses pressure above the setpoint, the pressure switch opens, which interrupts the circuit to the hydraulic control system preventing opening of the locking ring.

3.2.4 UF_6 Primary System

The UF_6 Primary System includes (1) UF_6 process piping and valves from, but not including, the second autoclave containment valve out to, but not including, the first isolation valve inside the associated cascade building, and (2) UF_6 cylinder pigtails from the cylinder to the autoclave penetration (for autoclaves in the open mode). The following are descriptions of systems and components identified as important to safety in Section 3.15.

3.2.4.1 Piping

Autoclaves are connected to the cascade feed station by piping. Where needed, the UF_6 piping is enclosed in heated housings or steam-traced to prevent freeze-out of UF_6. Feed lines, equipped with rupture discs rated at the lowest MAWP of the cylinders heated, relieve to relief drums or to the cascade to prevent cylinder overpressure. Product cylinders with assay $ 1.0 wt. % ^{235}U enrichment to be fed into the cascade will be fed at C-337A. Controls and design features have been established that allow the C-337A process piping and components to be operated and maintained consistent with the double contingency principle and its implementation in PGDP procedures at an assay as high as 5.5 wt. % ^{235}U.

All autoclave piping (out to the outside containment valve) is installed according to national standards and engineering piping specifications with a pressure rating of 200 psig minimum. Piping downstream of the containment valves is installed with pressure rating equivalent to its intended service.

3.2.4.2 Valves

UF_6 valves installed in the feed facilities are designed and tested to engineering specifications and have a bellows stem seal. Pneumatically operated valves have air to open-spring to close-type actuators. The actuators on containment isolation valves are required to always fail to the closed position. Actuators are equipped with limit switches that indicate the open or closed position of the valve on a local panel. Valve bodies are of steel or monel construction, corresponding to pipe size material specifications.

Isolation valves are suitable for UF_6 gas or liquid service and a temperature range from 70ºF to 300ºF. Pressure ratings are 200 psig for all valves that are used as primary containment valves. Valves located downstream from these valves are installed with a pressure rating sufficient for its intended service (see Figure 3.2-1).

3.2.4.3 UF_6 Cylinder Pigtails

The UF_6 cylinder pigtails that are classified as important to safety comprise a UF_6 cylinder pigtail assembly and gaskets. A UF_6 cylinder pigtail assembly is fabricated of metal tubing equipped with fittings on either end that allow the UF_6 cylinder pigtail to be attached to a manifold at one end and the cylinder at the other end. After fabrication, UF_6 cylinder pigtails are stress-relieved. Gaskets are used between the sealing surfaces of the UF_6 cylinder pigtail assembly and the cylinder and equipment to which it is connected

A specific UF_6 cylinder pigtail design is employed for UF_6 feed operations in C-333-A and C-337-A. The UF_6 cylinder pigtails are important to safety as defined in Section 3.15. Refer to Section 3.15 for a discussion of the safety classification and boundary definition of UF_6 cylinder pigtails.

All UF_6 cylinder pigtails are subjected to acceptance inspection and testing prior to certification for use. UF_6 cylinder pigtails are given a post-fabrication visual inspection to ensure that quality and design requirements are met. UF_6 cylinder pigtails are subjected to a hydrostatic test after fabrication and prior to certification for use. UF_6 cylinder pigtails that have been certified for use are provided with a metal certification tag with an identification number. There are no certification retest requirements stated because plant experience has demonstrated that the UF_6 cylinder pigtails will fail the pre-operational positive pressure leak rate test and vacuum check due to thread wear or will fail visual inspection long before there is any structural weakness in the UF_6 cylinder pigtail. The only normal maintenance performed on certified UF_6 cylinder pigtails is replacing the gaskets prior to making a new connection. Prior to connecting a certified UF_6 cylinder pigtail, it is visually inspected for defects, and a new UF_6 cylinder pigtail gasket is installed on each disconnected end fitting. The UF_6 cylinder pigtail is then attached to the cylinder valve and the UF_6 manifold. All newly made UF_6 cylinder pigtail connections are vacuum checked and leak rate tested per applicable procedure prior to admitting UF_6 to the affected connection.

3.2.5 Autoclave Important to Safety Systems

The following are descriptions of autoclave systems and components identified as important to safety in Section 3.15. Other important to safety systems and components are discussed separately in Sections 3.2.4 and 3.2.6.

3.2.5.1 Autoclave Water Inventory Control System

The Autoclave Water Inventory Control System activates to stop the input of steam and sound appropriate alarms if the condensate approaches a specified actuation level in the condensate drain line. The accident analysis assumes that the amount of water available to react with UF_6 is limited to the amount of water that is normally present inside the autoclave during heating operations. The system maintains the initial condition assumed by the accident analysis by closing the steam supply isolation valves and the thermovent line block valve if a high water level is detected.

The maximum pressure generated in an autoclave from an accidental UF_6 release and subsequent reaction with the available water is best controlled by limiting the water in the autoclave shell. In the event of a release of UF_6 inside an autoclave, HF gas would be produced by the reaction of UF_6 with water. The amount of HF produced would be directly proportional to the amount of water available to react with the UF_6. To prevent excessive accumulation of condensate inside the autoclave, two water level probes are installed in the condensate drain line at the top of the drain line, slightly below the autoclave shell. Each level probe consists of a level sensing element that drives an associated level switch. These switches are closed when the water level is normal and open when a high level is detected. If either probe detects high water level, and this condition persists for at least five seconds, the system causes the steam supply isolation valves and the thermovent line block valve to close. The time delay feature is designed to prevent activation of the system in the event of a false alarm.

Activation of this system produces audible and visual alarms at the autoclave local control panel, in the feed facility OMR and in the ACR of the adjoining process building.

3.2.5.2 Autoclave Steam Pressure Control System

The autoclave steam pressure control system is used during the normal heating operations to ensure that the UF_6 cylinder temperatures will not exceed the initial conditions of the accident analysis assumed for different cylinder types when steam is being supplied to the autoclave environment. The autoclave steam pressure control system is not required during controlled feeding and cold feeding modes of operation. During controlled feeding, the steam pressure in the closed autoclave is controlled by the autoclave temperature control system. During cold feeding, the UF_6 cylinder is only exposed to ambient conditions and no steam is applied to the autoclave.

The autoclave shell head is penetrated by two separate pressure tap lines, each of which is equipped with pressure sensing instrumentation. Steam shutdown can be initiated by either pressure channel sensing internal autoclave setpoint pressure, thereby causing the pressure switch associated with that channel to open the control circuit to the PLC for that autoclave. PLC output de-energizes the solenoid valves that operate the actuators for the steam isolation valves and the thermovent line block valve, thereby causing these valves to close.

Activation of this system produces audible alarms at the autoclave local control panel and audible and visual alarms in the feed facility OMR and in the ACR of the adjoining process building.

3.2.5.3 Autoclave High Pressure Isolation System

The Autoclave High Pressure Isolation System causes the autoclave to go into the containment mode and activate alarms if the internal pressure of the autoclave reaches the setpoint for the system. In addition, the system disables the hydraulic system required to open the autoclave shell, thereby preventing the autoclave from opening until the alarm condition has been cleared.

The autoclave shell head is penetrated by two separate pressure tap lines, each of which is equipped with pressure sensing instrumentation. Containment isolation can be initiated by either pressure channel sensing internal autoclave setpoint pressure, thereby causing the pressure switch associated with that channel to open the control circuit to the PLC for that autoclave. PLC output de-energizes the solenoid valves that operate the automatic containment valve actuators, thereby causing the containment valves to close. Automatic containment valves actuated by this system are present on the following shell head penetrations:

- UF_6 line with branches for the feed header, the evacuation header, the relief drums, and purge air,
- Steam supply and steam exhaust,
- Condensate drain,
- Thermovent line, and
- Steam sample line.

This system does not require any support systems. The system

is fail safe in that all automatic containment valves fail to the closed position on the loss of electrical power or the plant air system.

Activation of this system produces audible and visual alarms at the autoclave local control panel, in the feed facility OMR, in the ACR of the adjoining process building and in the C-300.

3.2.5.4 Autoclave Primary Containment System

The Autoclave Primary Containment System includes the autoclave vessel and all penetrations out to and including the required isolation valves. The autoclave penetrations and associated isolation valves are described in the preceding discussion of the Autoclave High Pressure Isolation System. In addition, the autoclave instrument lines and the autoclave pressure relief line up to and including the rupture disc are included in the system.

Piping penetrations to the autoclaves are protected by one of the following methods: (1) two automatic isolation valves, (2) the autoclave pressure relief system configuration, or (3) a closed piping system outside the autoclave (e.g., instrument lines and instruments) whose components are rated for the same pressure as the autoclave.

3.2.5.5 Autoclave Pressure Relief System

Each autoclave is equipped with an Autoclave Pressure Relief System to prevent the internal pressure from exceeding 110% of the maximum allowable working pressure (MAWP) as determined by Section VIII of the ASME Pressure Vessel Code. This system consists of a relief valve and a rupture disc, each rated at the MAWP for the autoclave on which they are installed. The rupture disc prevents constant exposure of the relief valve to steam that is present during normal operation. Such constant exposure could cause undesirable corrosion and scaling of the relief valve, which, in turn, could cause the valve to weep or otherwise fail to perform its design function. Pressure instrumentation is located between the rupture disc and relief valve to monitor back pressure in this trapped space. Trapped back pressure will change the relief pressure and may result in the system not protecting the vessel at the proper relief pressure.

Pressure above the rating of the relief valve would be vented to the atmosphere through a vent line above the roof. All autoclave relief paths join to a common header. This common header contains a butterfly valve that is verified open. The relief valve is designed to close when the autoclave pressure drops to a set value below the MAWP to limit the amount of any release. Reaction products would not be released through the relief valve at pressures below the set point of the valve. This relief system could only be caused to function if there were an excessive amount of water (see Section 3.2.5.1) in the autoclave at the time of a UF_6 release within the autoclave.

The rupture disc performs a passive safety function as a component of the Autoclave Primary Containment System.

3.2.5.6 Autoclave Manual Isolation System

The Autoclave Manual Isolation System contains three manual actuation devices, one in the feed facility OMR, one at the crane bay exit near the local cylinder yard, and one in the ACR of the adjoining

cascade building. The actuation of the manual switch inputs a signal into the PLC. The PLC controls the solenoids which in turn operate the autoclave containment valves. When one of these devices is actuated, containment valve closure is initiated for each facility autoclave. The system is used upon confirmed UF_6 outleakage to mitigate the release.

Activation of this system produces audible and visual alarms at the autoclave local control panel, in the feed facility OMR, in the ACR of the adjoining process building and in the C-300.

3.2.5.7 UF_6 Detection Systems

The UF_6 Release Detection Systems monitor the autoclave facilities and provide alarms at the facility and the corresponding process building ACR.

Detectors in these low voltage systems cover the autoclave heated housings, the autoclave heads above the pipe trenches, the jet stations, and the building C-337-A west wall. The detectors are connected to control panels in the respective facility OMR that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate alarm indications. Multiple detector heads may be connected to a control panel for redundant detector coverage.

System alarms alert facility personnel to take appropriate mitigative action in the event of a UF_6 release as discussed in Section 4.3.2.2.4, Evacuation of the UF_6 Handling and Storage Facilities (External Event).

The system control units consist of supervisory circuits for monitoring the status of the detectors circuits, a supervised audible alarm signal circuit, and a power supply for converting 120 VAC power to 24 VDC for the detector circuit. Trouble alarms are activated in the event that the voltage drop across a supervised circuit indicates a malfunction or discontinuity. The control panel also contains relays to activate the alarm devices. An output signal from a detector energizes an alarm circuit relay that latches in the “on” position until manually reset.

Detector actuation in building C-333-A results in audible and visual alarms at the detector system control unit in the C-333-A OMR, rotating beacons are illuminated and the valve position indicator lamps begin to flash on the control panels of the #1N and #1S autoclaves. In addition, audible and visual alarms are activated in the C-333 ACR.

Detector actuation in building C-337-A results in audible and visual alarms at the detector system control unit in the C-337-A OMR, activation of rotating beacons and flashing of the valve position indicator lamps on the control panels of the #1E and #1W autoclaves. In addition, audible and visual alarms are activated in the C-337 ACR.

C-337A is equipped with a UF_6 Release Detection System that provides a trip signal for isolation of UF_6 if a large release to atmosphere occurs in that facility. Isolation of a large UF_6 release will mitigate the potential for a nuclear criticality by limiting the mass of material that could be available to collect in an unsafe geometry. The UF_6 Release Detection System is designed to energize the Autoclave Manual Isolation System in the event that four or more output signals are received from UF_6 detector head actuations in C-337A. This system may be bypassed using a manual bypass key switch. When the system is bypassed, its safety function is accomplished by continuous monitoring by operations. In the event of a large UF_6 release, operators would then actuate the Autoclave Manual Isolation System. The Autoclave Manual Isolation System is discussed in Section 3.2.5.6.

This system is composed of the UF_6 detector heads at each autoclave, the piping trench, and the jet station in C-337A. The detector heads utilize 24 VDC power that in turn relies on 120 VAC power. The 24 VDC supply and its 120 VAC source are electrical support systems.

The Feed Vaporization Facilities UF_6 Release Detection Systems have the following alarm indications.

- Detector actuation illuminates an alarm lamp on the PG system control panel in the OMR.
- Detector actuation causes audible and visual alarms to actuate in the local area.
- Detector actuation causes audible and visual annunciation in the OMR, the process building ACR.

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Loss of DC power between the control panel and the detectors would result in a trouble indication on the local detector system control panel, in the OMR.

3.2.5.8 High Cylinder Pressure System

The High Cylinder Pressure System detects cylinder pressure and isolates the steam supply before allowable cylinder pressures are exceeded. The system consists of a pressure transmitter connected to the UF_6 line in the manifold housing, a pressure converter, and a high pressure switch. The high pressure switch signals the steam isolation block valves and the thermovent line block valve to close if the cylinder pressure reaches the high cylinder pressure setpoint.

Activation of this system produces audible and visual alarms at the autoclave local control panel, in the feed facility OMR and in the ACR of the adjoining process building.

3.2.5.9 Autoclave Temperature Control System

The autoclave temperature control system is designed to control the temperature of the cylinder in the autoclave by limiting the steam input to the autoclave shell. The system is used only during the controlled feeding mode of operation. The system will provide alarm and steam isolation if the cylinder wall temperature reaches the specified actuation point above the control temperature. This system ensures that initial conditions assumed in the accident analysis are met by limiting the maximum temperature of the cylinder wall to a level that will prevent UF_6 liquefaction during the controlled feeding mode of operation.

The autoclave temperature control system consists of a pair of thermocouples that are magnetically attached to the cylinder wall. The thermocouple outputs are connected to high temperature switches that are calibrated to initiate an isolation signal for the steam supply block valves if the temperature exceeds a specified set point. The signals are fed to a PLC that processes the information and provides a signal to the steam supply block valves and thermovent line block valve. Loss of signal from the PLC will result in isolation of the steam supply.

Activation of the system provides an audible alarm at the autoclave local control panel and audible and visual alarms in the operations monitoring room (OMR) and C-337 area control room (ACR).

3.2.6 UF_6 Cylinder Handling

The cylinder handling equipment in the feed facilities includes scales, scale carts, and cranes. Cylinders are normally empty or contain UF_6 in a solid state. Administrative controls prohibit the handling of liquid UF_6 in these facilities. The scales and cranes are identified as important to safety in Section 3.15.

UF_6 feed is delivered to the feed facilities and stored in an interim storage yard until a particular cylinder assay is needed for feed. Cylinders are weighed and checked against fill limits. Each cylinder is inspected externally for damage prior to placing in an autoclave for feed.

Scales and scale carts are discussed in Section 3.7.

3.2.6.1 Cranes

Overhead bridge cranes move cylinders with solid UF_6 from the storage areas to the scale carts and scales for weighing and to the autoclaves for the feed operation and empty cylinders from the autoclaves to the scale carts and scales and to the storage area. The C-333-A east and west bridge cranes operate on the same crane rail system and both cranes are not loaded and/or operated at the same time.

Cranes, lifting fixtures, and rigging are discussed in Section 3.7.

3.2.6.2 Short-Term Storage

Both facilities contain cylinder yards for the short-term storage of both full and empty cylinders. The yards are equipped with saddles and racks for cylinder storage. Storage yards are discussed in Section 3.7.

3.2.7 Administrative Controls

In addition to the Administrative Controls in Chapter 4 and those controls covered by programs and plans, the following facility-specific Administrative Control ensures safe operation of the UF_6 feed facilities. Additional general Administrative Controls for cylinders are listed in Section 3.7.6.

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1. The weight of UF_6 cylinders that have been liquefied and material that has been removed/added shall be verified prior to leaving the facility. This supports operations at other on-site facilities.

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Upon detection of a plugged line or loss of heating to a particular area, the following administrative controls are in place to prevent applying excessive heat:

1. A line clarity check shall be performed to determine if clarity exists prior to reapplying or increasing any heat to the affected area.

2. If existing heat > 140° F is still available to the area, the heat source is not increased until line clarity is confirmed. If existing heat < 140° F is available in the affected area, a gradual increase in temperature up to 140° F may be applied to sublime the material in the plugged line.

3. Administrative controls ensure that temperature is monitored on a regular basis during the process of clearing the plugged area.

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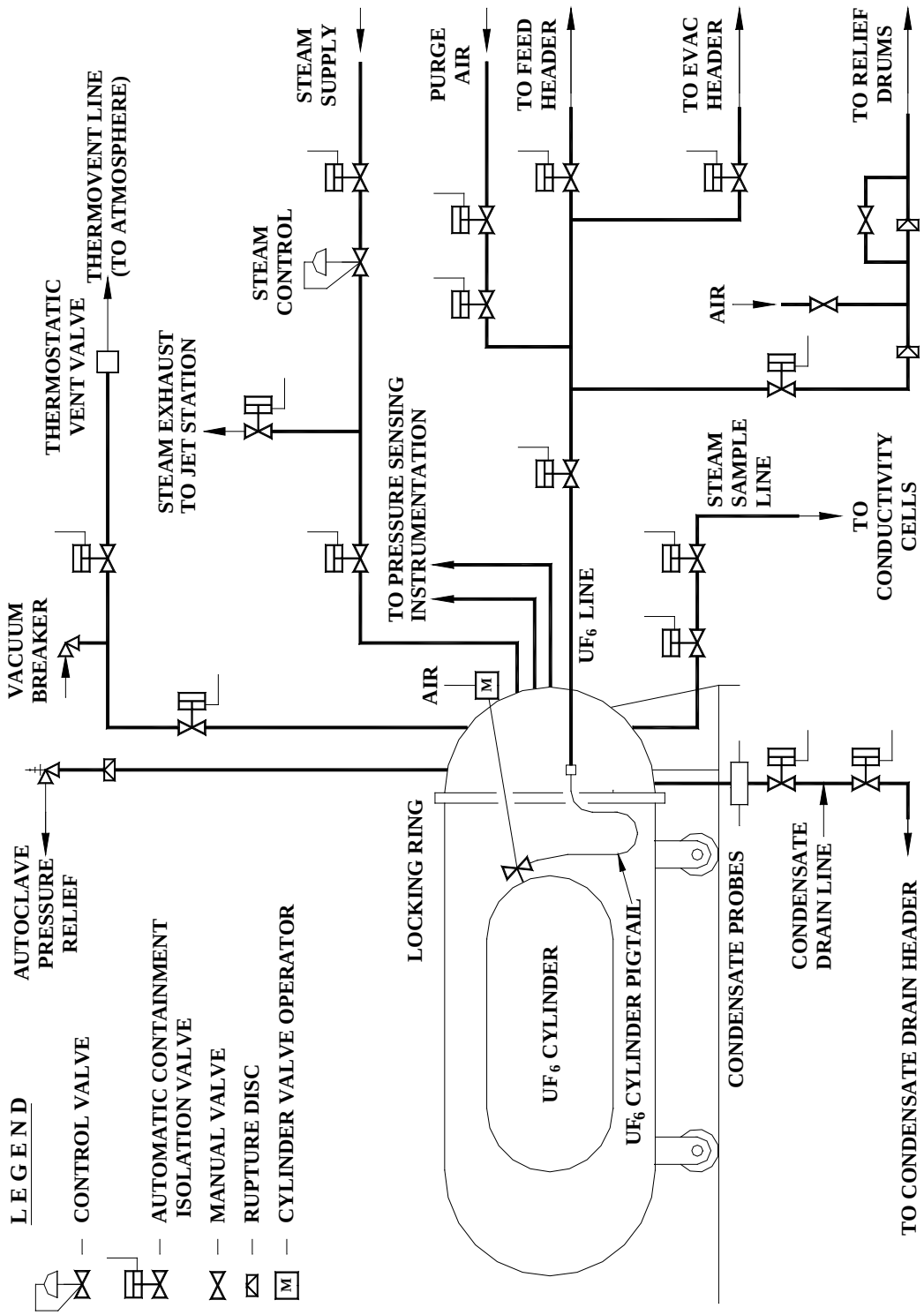

Figure 3.2-1 Simplified Schematic of a Typical Feed Facility Autoclave and Associated Piping

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3.3 UF_6 ENRICHMENT FACILITIES

The primary purpose of the enrichment facilities at PGDP is to produce uranium enriched in ^{235}U assay and to strip uranium partially depleted in ^{235}U content to an economically feasible assay. The PGDP enrichment facility consists of about 1,800 stages arranged in two parallel cascades for products up to 2.75 wt % ^{235}U. For higher assay products, up to 5.5 wt % ^{235}U, the stages are arranged more in series than in parallel configuration. The cascade buildings are designated as follows: C-331, Process Building; C-333, Process Building; C-335, Process Building; C-337, Process Building; and C-310, Purge and Product Building. The C-315, Surge and Waste Building is not a cascade building and does not contain any operating stages.

3.3.1 Facility Description

3.3.1.1 Cascade Shape

The term "cascade shape" typically refers to the process gas flow configuration among the various cells and units. Several factors influence the cascade shape. A cascade producing at a high product rate must have higher interstage flow rates between stages than one producing at a lower product rate. To use power efficiently, the stages in the middle (or near the feed point) must have higher total flow rates than those at the ends. Thus, the cascade shape is typically illustrated as a diamond configuration, with larger flow rates near the center of the cascade and lower flow rates near the withdrawal points (see Figure 3.1-2). The cascade is tapered by appropriate sequencing of the different equipment sizes and by adjusting or varying the pressures across each size of equipment.

As discussed in Section 3.1, the degree of isotopic enrichment in an efficiently operating diffusion cascade is a separation factor of about 1.002 per stage. Consequently, between 500 and 1000 stages are required between the feed point and product withdrawal point to enrich uranium from normal feed at 0.71 wt % ^{235}U to a product ranging from 0.95 to 2.75 wt % ^{235}U (about 1,000 stages are needed to produce 5.5 wt % ^{235}U to obtain 5.0 wt % ^{235}U final product). These stages are called the enricher. An additional 400 to 700 stages are used to strip the ^{235}U isotope from normal feed to a tails withdrawal assay of 0.2 to 0.4 wt % ^{235}U (see Figure 3.3-1). These stages are called the stripper.

The flow taper required for efficient use of power can be achieved either by holding constant the stage equipment volume and gradually changing the pressure level from stage to stage or by holding pressure constant and gradually changing the equipment geometry. In practice, both means of tapering are used. The middle part of the cascade, where the feed is introduced, contains the largest, highest pressure cells which results in the maximum interstage flow rate near the feed point. The flow taper is achieved in successive cells of the same equipment size by gradually reducing the pressure from cell to cell. At some point in the cascade, several hundred stages away from the feed point, the pressure will have been reduced to such a low level that it becomes more economical at that point to change the equipment to a smaller size and to raise the pressure to compensate for the smaller equipment. If the equipment size were reduced by a factor of two, for example, the pressure would be increased by a similar factor. Throughout the smaller equipment, the pressure would again be tapered down toward the cascade ends to achieve efficient power usage. For cascades producing commercial reactor-grade enriched uranium for light water reactors, only about two, or possibly three, equipment sizes are needed, depending on the economics. Longer cascades designed to produce more highly enriched product might be designed with four or five equipment sizes. A schematic diagram of a cascade tapered with two equipment sizes

would appear as in Figure 3.3-1. The width of the blocks shown in the diagram is proportional to the interstage mass flow rate, which can be adjusted by changing pressure and/or equipment size. The length of the blocks shown might represent five cells with ten stages per cell. The electrical components that provide power to the stage compressors must also be tapered in accordance with the flow taper in the UF_6 system. The capacity of the coolant condensers and the recirculating cooling water (RCW) flow rates must also conform to the UF_6 flow taper.

The foregoing illustration of a cascade flow taper and overall shape applies to a very much simplified separation task involving only one feed stream, one product stream, and one tails stream. The actual makeup of feed and withdrawal streams for the cascade is somewhat more complex. The total product withdrawal can be made up of two streams at different assays, and the feed can be made up of two or three streams of different assays. At every point in the cascade where there is a feed or an intermediate withdrawal, the flow taper required for the most efficient power utilization must take into account the sudden change in cascade flow conditions at those points. A different taper would be required for other feed and withdrawal conditions. The number of cells in operation may vary as the product assay changes. In actual practice, cells are started up or shut down, and the cascade is retapered routinely to maintain high efficiency when the product assay is changed.

In the event that product withdrawal capacity is lost, the cascade can be put into “recycle”. Operation in this manner will cause the assay in the top cells in C-310 to increase. As actions are taken to control the assay at the top of the cascade, the assay in the other portions of the upper cascade will increase. Eventually, the assay in the various portions of the cascade will increase to the approved limits. Some means of controlling the assay in the cascade is required. This may be done by diverting product from the top of the cascade to surge drums, diversion of the product stream to a lower point in the cascade to mix assays, lowering the top assay, or diverting a lower assay stream such as the Bottom Overlap or feed material to the top of the cascade to downblend the assay. Bottom Overlap (BOL) carries the enriched stream from the lower or bottom cascade, and Top Overlap (TOL) carries the depleted stream from the upper or top cascade, utilizing booster stations between the two parallel cascades to allow transfer of material from one side to the other in order to maximize efficiency (see Figure 3.3-2). During blending operations, the cascade assay is monitored by analyzing samples of the gas stream to ensure compliance with assay limits.

A similar situation will occur in the event that tails withdrawal capability is lost. In this instance, the assay of the cascade will tend to decrease with time and thus there is no hazard of an unacceptable increase in assay and no need to intentionally mix assays.

3.3.1.2 PGDP Cascade

The PGDP enrichment cascade is arranged in two parallel cascades, one side (the lower cascade) consisting of C-331 and C-333 and the other side (the upper cascade) consisting of C-335 and C-337, as depicted in Figure 3.3-2. This figure shows a typical configuration for a maximum plant power load of 3,040 MW and a product assay of 5.0 wt % ^{235}U. The exact tie-in points of the overlaps may change, depending upon available power, desired product, or tails assay, etc., but are matched to an appropriate assay point to avoid mixing losses. The enrichment cascade is arranged in this parallel configuration to maximize efficiency and throughput while at the same time limiting product assay within established limits. Each stage is connected to the next upper and lower stage throughout the cascade. Bypass piping

is provided for both cells and units, but individual stages cannot be isolated or bypassed separately. The cells and/or whole units, however, can be isolated.

The largest equipment in use in the PGDP cascade is designated as “000” sized equipment. The first size reduction in the cascade sends the process gas into “00” sized equipment, and a final reduction near the top of the cascade takes the process gas into 2X sized equipment. Both “000” and “00” stages use axial flow compressors to provide the motive force to move the process gas through the system, while the smallest (2X –sized) equipment in the C-310 purge cascade uses centrifugal compressors (commonly referred to as pumps). The stage size designations are predominantly due to the converter designations as 2X, “00”, and “000” (in order from smallest to largest).

As discussed above, the cascade is tapered by using the equipment size reductions. These transitions in the cascade occur at the interfaces between buildings. Buildings C-331 and C-335 contain “00” equipment, while C-333 and C-337 contain “000” equipment. Only C-310 contains 2X sized equipment. The buildings are arranged with the enrichment equipment on the second, or cell floor, with most of the auxiliary equipment and electrical support equipment located on the ground floors of the buildings. The enrichment equipment is enclosed in housings to retain heat so that the UF_6 is maintained in the gaseous state in order for the process to function.

Piping between buildings is referred to as tie lines. Tie lines are used to adjust the length of the cascade as required, and provide a means to move process gas from building to building without the need for withdrawal and feed facilities in each building. The tie lines, which are enclosed in elevated, heated housings, are connected to the facilities as shown in the general configuration of Figure 3.3-3.

At those points in the cascade where there is a change in equipment size and a transition in pressure level, the gas pressure can be increased by passing it through a booster station. These stations are also used at the product and tails withdrawal points and at the junction with the purge cascade. The compressors are either axial or centrifugal, depending on the volumetric flow rate and pressure ratio required. In general, axial compressors are used to boost the “A” (enriched) stream, while centrifugal compressors are used to boost the “B” (depleted) stream. An axial compressor is used to boost the bottom overlap to the upper cascade, while centrifugal compressors are used on the top overlap. Spiral-vane Normetex pumps are used in the withdrawal areas. The compressors used in the booster stations are generally variations of existing diffusion stage compressor designs. See Figure 3.3-2 for the configuration of the Bottom Overlap (BOL) and the Top Overlap (TOL) with respect to the enrichment facilities.

Also included in the cascade process gas system are surge drums and freezer/sublimer (F/S) units to provide surge volume for inventory fluctuation, power availability fluctuations, and for evacuation holding volume. F/S units are located in certain cells in the process buildings (except C-310 and C-315) and can be operated separately or in conjunction to remove excess UF_6 inventory. Surge drums are located in all of the process buildings except for C-310.

All cascade feed streams are supplied through feed headers connecting the cascade with feed autoclaves in C-337-A, Feed Vaporization Facility and C-333-A, Feed Vaporization Facility. Product streams are withdrawn through headers connecting the cascade with condensation facilities located in C-310. The tails withdrawal facility is located in C-315 where the tails stream is drained as a liquid following the compression liquefaction process.

3.3.2 Buildings, Housings, and Cranes

PGDP contains four large process buildings, which are referred to as the cascade buildings. These are designated C-331, C-333, C-335, and C-337. Two small buildings, C-310, and C-315, provide: 1) the purge and product withdrawal, and 2) the surge and waste (tails) withdrawal functions, respectively. See Figure 3.3-3 for the configuration of the enrichment facilities.

The four main process buildings are grouped in two pairs, C-331 and C-333 (lower cascade), and C-335 and C-337 (upper cascade), and are located in the eastern portion of the plant site. Such a grouping permits easy connection of the multitude of overhead and underground piping and service lines required between the process buildings. The purpose of the process buildings is to house the equipment and much of the support systems necessary for the isotopic separation of uranium. See Section 3.3.4 for a detailed description of the equipment and systems housed within these buildings. All process buildings are connected by tie-line piping to configure the cascade for desired production.

All of the process buildings have a Fire Protection System, which consists of automatic sprinkler systems supplied by the high pressure fire water system (HPFWS). This system is important to safety as described in Section 3.15 and is further discussed in Section 3.9.2.5. This Fire Protection System provides sufficient fire suppression capability for the cascade process buildings to minimize the likelihood of a large fire and provides fire suppression for the withdrawal facilities in areas associated with handling liquid UF_6 to minimize the likelihood of a fire large enough to cause a breach in the UF_6 Primary System. There are two major fire hazards in the process buildings. The first major fire hazard is the quantity of lube oil used in the process buildings. The second major fire hazard is the roof deck. The construction is a typical metal deck roof assembly with a combustible vapor barrier/adhesive, insulation board, built-up tar and felt covering, covered with ballast gravel. These fire hazards and hazard evaluation are discussed further in Section 5.4.

The process buildings also contain UF_6 Release Detection Systems. These systems are important to safety as described in Section 3.15 and are further discussed in Section 3.3.5.9.

A radiation warning system, Criticality Accident Alarm System (CAAS), continually monitors the Enrichment Facilities for nuclear excursions. The CAAS is important to safety, as discussed in Section 3.15 and is discussed further in Section 3.12.6.

3.3.2.1 C-331 and C-335, “00” Type Buildings

The C-331 and C-335 process buildings are windowless, two-story buildings framed of structural steel and roofed with pitch, felt, and gravel over an insulated steel deck. Floors throughout the building are of finished concrete with steel reinforcement. Exterior walls consist of siding attached directly to each building's steel frame and terminating in low parapet walls capped with extruded aluminum fascia. Prominent exterior features include exhaust air ducts, large air louvers, a depressed truck/railroad spur alley with individual loading platforms, interbuilding tie-line piping, and an enclosed manbridge. The original structural framing is American Society for Testing Materials (ASTM) A-7 steel, which has a minimum initial yield stress of 33,000 psi. The minimum 28-day compressive strength of the concrete is 2,500 psi.

The enrichment facility structures of C-331 and C-335 are important to safety as described in Section 3.15. The process buildings provide a significant role in minimizing both the on-site and off-site consequences of any releases of UF_6 and ensure that the following safety functions are accomplished:

- Provide limited holdup of UF_6 releases to allow deposition of uranium and slower release rates to the atmosphere.

- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF_6 Primary System (see Table 3.15-10 for the natural phenomena capacities of the buildings).

The C-331 and C-335 buildings are approximately 804 ft x 640 ft in overall plan dimensions and are approximately 68 ft in height. Each overall building actually consists of eight individual structural sections separated by expansion joints. Two of these structural sections (along with associated equipment) form what is referred to as a unit. Each building consists of a ground floor on grade, a cell floor, crane bays clear to the soffits of the trusses, and mezzanine bays between the crane bays. Each unit has two crane bays at the cell floor level separated by a mezzanine bay. Each unit is separated from the others by a mezzanine bay. In addition, the two end units have a bay, which serves as a perimeter aisleway for pedestrian and vehicular traffic.

3.3.2.1.1 Ground Floor

The ground floors of C-331 and C-335 are open areas interrupted by structural steel columns, numerous mechanical, electrical, and instrumentation facilities, which service the cell floor equipment, three major room groupings, and contain 13 open steel stairways connecting the ground and cell floors. The floor is reinforced concrete slab on grade. Walls are predominately siding on exposed structural steel. The ceiling is approximately 22 ft 6 in. above the ground floor and is actually the cell floor supported on exposed structural steel beams and columns. Numerous pipes of various diameters, connecting portions of systems located on the ground floor with portions located on the cell floor, crisscross the ceiling. This piping includes lube oil, coolant, water, air, nitrogen, instrumentation, steam, and condensate lines. Sprinkler piping, ventilation ductwork, and electrical conduit are also present.

The primary purpose of the ground floor is to house the equipment and room groupings required to provide auxiliary services to the cell floor process equipment. The ground floor equipment is in four distinct groupings, one for each unit. Each grouping is oriented lengthwise beneath the unit it serves and contains the following equipment:

- Lube oil equipment - lube oil drain tank, recirculating pumps, and water-cooled heat exchanger

- Process substations - transformers and switchgear

- Auxiliary power substations - transformers and switchgear

- Valve control centers

- Auxiliary power control centers

- Instrumentation cubicles
- Air supply fans, motors, and ductwork.

Other equipment housed on the ground floor, but not located in each equipment grouping, includes exhaust fans and ductwork, booster power substations, backup generators and associated control cubicles, and a coolant drain (storage) tank.

Three room groups are located along the center of the ground floor. The first room group consists of a maintenance area for servicing mechanical, electrical, and instrument equipment and a changehouse and utility facilities. The second or central room group consists of the area control room (ACR), small offices, a datum station, a kitchenette, and a restroom. The third and largest room group is the cell servicing area, which includes a surge drum room, a holding drum room, and an out of service cold recovery room. The holding drums in C-331 are currently out of service and the holding drums in C-335 are used in conjunction with coolant recovery. Also on the ground floor of C-331is another surge drum room located west of the cell servicing area. This room houses five drums, four of which are surge drums. In C-335, the additional surge drum room is located north of the cell servicing area and contains 20 surge drums. In addition, each of these buildings contains ten air intake rooms that bound the ground floor.

3.3.2.1.2 Cell Floor

The cell floors (or second floors) of C-331 and C-335 house the equipment necessary for the actual isotopic separation of uranium. Each cell floor plan consists of four cascade units. Each unit consists of two parallel rows (one in each crane bay) of five equipment groupings called cells. Each cell is composed of ten stages, each comprised of a converter, a compressor, a compressor motor, a control valve, and associated piping. The piping arrangement allows a cell to be bypassed (flow routed around the cell) and isolated for maintenance. The cascade cell is the smallest grouping of enrichment cascade equipment that is isolable from the remainder of the cascade (see Figure 3.3-4). There are a total of 400 stages within each building of this type.

Each stage is connected by piping with the next upper and lower stage throughout the cascade. In addition, bypass (BP) piping is provided for both cells and units. Cell BP piping runs lengthwise above the cell floor through the mezzanine bay separating each unit into halves. Unit BP piping runs perpendicular to the Cell BP piping above the cell floor at one end of each building. Booster stations are located on the cell floor (see Section 3.3.3.1 for a description).

Other equipment on the cell floor includes coolant condensers, lube oil supply tanks, and cranes. Each cell is served by a coolant condenser. Each coolant condenser is mounted on its own grating platform above the cell floor. There are five condensers and platforms along each of the perimeter aisles and ten (five on each side) along the mezzanine bays separating each unit.

A steel cylindrical lube oil supply tank is housed in an enclosure located approximately at the center of each unit above the cell BP housing.

3.3.2.1.3 Housings

Cells, booster stations, and UF_6 piping are enclosed in a housing of ribbed galvanized sheet metal and non-metallic sheets attached to steel framing. The housing retains heat so that the UF_6 is maintained in the gaseous state as required by the process. The framing and housing enclosing cells and booster stations are not part of the building framing and are supported by the cell floor.

The Cascade Equipment Housings in buildings C-331 and C-335 are important to safety as described in Section 3.15. These housings provide a barrier (impede the flow) in case of the release of UF_6 from a UF_6 Primary System failure within the housing. This function is attributed to the cascade piping and equipment housings in areas of the cascade that are intended to be operated above atmospheric pressure.

The cell BP housing is supported above the cell floor by the continuous steel framing of the mezzanine separating each unit into halves. Unit BP housing is supported by the steel framing running the length of the building. A system of grating platforms, connected by grating walkways, is provided above the cell BP housing. Stairways provide access to the platforms and walkways from the cell floor.

3.3.2.1.4 Cranes

The cell floor area of each building is served by eight permanent 15 ton overhead bridge cranes. The cranes travel on rails supported by the building columns and can travel the entire length of each unit. These cranes are used to handle heavy process equipment during maintenance, modification, repair, and/or replacement. They are also used to transport equipment to and from the cell floor through floor hatches located over the truck alley. When not in use, the cranes are normally stationed over the truck alley.

Temporary 2 ton cranes may be installed in each mezzanine bay between cell rows when heavy valves and/or equipment in this area must be handled. If left in place for an extended period of time, these cranes are stationed over the truck alley when not in use. These cranes are also capable of traveling the unit's length, but rail stops prevent them from traveling over the unit BP housing.

The cranes in the “00” buildings are not important to safety since they are restricted from moving heavy equipment above and/or around cascade equipment that is operating above atmospheric pressure.

3.3.2.2 C-333 and C-337, “000” Type Buildings

Just as in the “00” buildings, the enrichment facility structures of C-333 and C-337 are important to safety as described in Section 3.15. The process buildings provide a significant role in minimizing both the on-site and off-site consequences of any releases of UF_6 and ensure that the following safety functions are accomplished:

- Provide limited holdup of UF_6 releases to allow deposition of uranium and slower release rates to the atmosphere.

- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF_6 Primary System (see Table 3.15-10 for the natural phenomena capacities of the buildings).

Also, the Cascade Equipment Housings in buildings C-333 and C-337 are important to safety as described in Section 3.15. The housings provide a barrier (impede the flow) in case of the release of UF_6 from a UF_6 Primary System failure within the housing. This function is attributed to the cascade piping and equipment housings in areas of the cascade that are intended to be operated above atmospheric pressure. See Section 3.3.2.1.3 for a discussion on housings.

These buildings are very similar in construction to the C-331and C-335 buildings. The description of the C-331and C-335 buildings and their two floors generally applies to C-333 and C-337, with the following exceptions.

The C-333 and C-337 buildings are approximately 1,098 ft x 970 ft in overall plan dimensions and are approximately 83 ft high. Each building consists of 30 individual structural sections arranged in a 5 x 6 column matrix. Each section is separated by expansion joints. Four complete and two partial structural sections form a building unit . These buildings have six such units. Each building consists of a ground floor on grade, a cell floor, and a three-level mezzanine bay. The mezzanine levels are located at 40 ft, 50 ft, and 64 ft, respectively, above ground level. In addition, crane bays that permit crane movements are located approximately 68 ft above grade. Each of these buildings consists of five individual structures in series. The two end frames consist of two crane bays, two mezzanine bays, and a exterior bay. The first interior frame (one on each side) consists of two crane bays and two mezzanine bays. The center frame consists of two 62 ft wide crane bays, one 96 ft wide crane bay, and two mezzanine bays.

3.3.2.2.1 Ground Floor Differences

The C-333 and C-337 ground floors measure approximately 1,052 ft x 970 ft and the ceilings are approximately 28 ft 6 in. above the floors. The ground floor portions of building columns are encased in concrete.

Basically, the equipment housed on this floor is the same as that housed on the C-331 and C-335 ground floors. However, in C-333 and C-337 the equipment is in six distinct rectangular groupings, one for each unit. Each lube oil pit contains two lube oil drain tanks. The coolant transfer/recovery station includes two coolant drain (storage) tanks. The cell servicing area includes two surge drum rooms, a holding drum room, and an out of service cold recovery room. The holding drums and cold recovery equipment in C-333 and C-337 are currently out of service.

In addition, C-333 and C-337 have 12 air intake enclosures, 30 open steel stairways connecting the ground and cell floors, and two depressed truck/railroad spur alleys with five individual loading docks at the ground floor level.

3.3.2.2.2 Cell Floor Differences

These buildings each have 6 units, each unit consisting of 10 cells. Each cell consists of 8 stages for a total of 480 stages per building. Two typical “000” cells are shown in Figure 3.3-5.

Cell BP piping and housing runs between units and unit BP piping extends through the center of the buildings.

Each cell is served by two coolant condensers. The condenser platforms are at a different height and arrangement in the “000” buildings.

3.3.2.2.3 Cranes

The C-333 and C-337 cell floors are served by 15 permanent overhead bridge cranes per building. Each main bay has one crane for a total of 11 cranes per building. The remaining four cranes are located in mezzanine (high) bays . In addition, a small temporary bridge crane may be installed in the remaining mezzanine (high) bays. The cranes are capable of traveling the entire length of the building and each serves a portion of three units. All main bay cranes, except the center main bay crane, may be operated as single or double trolley bridge cranes. When operated as single trolley cranes, they have a 23 ton capacity; as double trolley cranes, their capacity is 36 tons. The center main bay crane is a single trolley bridge crane with a 23 ton capacity. Each mezzanine bay crane (permanent or temporary) is a single trolley bridge crane with a 15 ton capacity. When not in use, a crane is stationed over the truck alley(s) with exception of the center main bay crane, which is stationed at the building's center when not in use.

One crane in each of the “000” buildings that is normally parked over the unit bypass piping is important to safety as described in Section 3.15. The failure of either of these cranes could impact the UF_6 Primary System and initiate a large UF_6 release. The cell floor process building cranes shall not fail in a manner that will cause a large UF_6 release during the following occasions:

- Normal operation,
- Natural phenomena events with the cranes in the parked position, and
- A release of the crane controls during an evacuation event.

3.3.2.2.4 Lube Oil Supply Tank Differences

The lube oil supply tanks are housed in rooms located on the building's roof. Each unit has one room located approximately at its center, and each room houses one supply tank.

3.3.2.3 C-310 Purge and Product Building

The purge cascade is located in building C-310. The functions of the purge cascade include isotopic enrichment of ^{235}U and separation of lighter molecular weight contaminant gases from the UF_6 for safe venting to the atmosphere. See Section 3.3.6 for further discussion on the functions of the purge cascade.

The C-310 building is a windowless two-story steel framed structure with reinforced concrete floors. The walls are of siding attached to the structural steel and the roof is a built-up roof over a precast steel-edge concrete deck. An enclosed bridge connects the cell floors of C-310 and C-331.

Just as in the “00” and “000” buildings, the Purge and Product Building structure of C-310 is important to safety as described in Section 3.15. This building provides a significant role in minimizing both the on-site and off-site consequences of any releases of UF_6 and ensures that the following safety functions are accomplished:

- Provide limited holdup of UF_6 releases to allow deposition of uranium and slower release rates to the atmosphere.

- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF_6 Primary System (see Table 3.15-10 for the natural phenomena capacities of the buildings).

A small basement beneath the ACR houses electrical cabinets and provides access to an underground tunnel connecting C-300, Central Control Building; C-310; and C-331.

3.3.2.3.1 Ground Floor

The C-310 building has two floor levels, which are referred to as the cell floor and the ground or operating floor. Instrument cubicles and valve control centers are located on the ground floor in two rows running north and south. The row east of the building center line serves the odd-numbered cells and the west row serves the even-numbered cells. The booster controls are located at the south end of these cubicles. A F_2 header runs the length of the building along the inside of the east wall. This header provides F_2/N_2 from C-350, Drying Agent Storage Building, to C-331 and the sodium fluoride (NaF) trap systems in C-310 as needed. A computer room in the northwest corner of the building houses the cascade automated data processing (ADP) system mainframe. Another trap room on the north wall houses the heated NaF trap housings for the north NaF trap system, which is used to burp cylinders, and a NaF oven, which is used to prepare NaF. The south NaF trap system is located along the east wall of the ground floor. The product withdrawal room, which houses three withdrawal positions/scales for filling product and/or side withdrawal cylinder(s), is located in the northeast corner. The NaF trap system and product withdrawal systems are discussed in Section 3.4.

The ground floor also contains the ACR, which houses the assay spectrometer room, monitoring and control for the purge cascade, and showers and locker room. The lube oil system drain tank and pumps, seal exhaust pumps, withdrawal stations, the switchgear, and most of the auxiliary equipment are also on the ground floor.

3.3.2.3.2 Cell Floor

The cell floor contains the cascade equipment, which includes compressors, converters, condensers, Normetex product withdrawal pumps, tops purge pumps, and “B” booster stations.

The cell floor layout consists of ten cells, each containing six in-line stages. The 60 converters are arranged side by side, with 30 converters along each side of the building from north to south. Twelve centrifugal pumps serve each cell, two pumps per converter. Six pumps are situated along each side of the cell with three designated as “A” pumps for the enriched stream and three designated as “B” pumps for the depleted stream. Two Normetex product withdrawal pumps are installed at the north end of cell 10 and one Normetex pump is at the north end of cell 9.

Bypass piping, feed, and evacuation piping pass overhead above the cell floor through the center of the building.

The tops purge system is located in the southwest corner of the cell floor. The tops purge system consists of essentially two main parts, the tops booster station located on the cell floor and the purge equipment located directly beneath cell 2 on the ground floor. A booster station is located in the

southeast corner of the building on the cell floor. This station is designated as the "B" booster station consisting of two centrifugal compressors. A motor test stand is also located next to the booster station.

3.3.2.3.3 C-310-A Product Withdrawal Building

The product withdrawal condensation system is located in C-310-A. This building is located at the northeast corner of C-310. C-310-A is a windowless two-story steel-framed structure similar to C-310.

Just as in the process buildings, the Product Withdrawal Building structure of C-310-A is important to safety as described in Section 3.15. This building provides a significant role in minimizing both the on-site and off-site consequences of any releases of UF_6 and ensures that the following safety functions are accomplished:

- Provide limited holdup of UF_6 releases to allow deposition of uranium and slower release rates to the atmosphere.

- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF_6 Primary System (see Table 3.15-10 for the natural phenomena capacities of the buildings).

The building contains three condensers and two accumulators for the condensation of UF_6 product gas to a liquid for draining into UF_6 product cylinders located in the C-310 withdrawal area (see Section 3.4).

3.3.2.3.4 Cranes

C-310 is equipped with two 6 ton capacity overhead cranes, which traverse above cell housings, facilitating maintenance work on motors, pumps, valves, and other cell equipment located on the cell floor. Hatches in the cell floor at the extreme north end of the building open over a rail and truck alley to facilitate the movement of equipment to the cell floor. In addition, two 20 ton overhead cranes are maintained on the east side of the C-310 building to facilitate the movement of UF_6 cylinders to and from the withdrawal stations (see Section 3.7).

The C-310 process building cranes transit over the Normetex pumps and their discharge piping. The discharge piping from the Normetex pumps crosses from C-310 to C310A underneath the east process building crane. Both C-310 process building cranes are normally parked over or near the Normetex pumps. These cranes are important to safety as described in Section 3.15. The failure of these cranes could impact the UF_6 Primary System and initiate a large release that could exceed EBE off-site exposure guidelines. These process building cranes shall not fail in a manner that will cause a large release during the following occasions:

- Normal operation,

- Natural phenomena events with the cranes in the parked position, and

- A release of the crane controls during an evacuation event.

3.3.2.4 C-315 Surge and Waste Building

Just as in the other process buildings, the Surge and Waste Building structure of C-315 is important to safety as described in Section 3.15. This building provides a significant role in minimizing both the on-site and off-site consequences of any releases of UF_6 and ensures that the following safety functions are accomplished:

- Provide limited holdup of UF_6 releases to allow deposition of uranium and slower release rates to the atmosphere.

- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF_6 Primary System (see Table 3.15-10 for the natural phenomena capacities of the buildings).

This building, located east of the C-331 building, has three systems which are directly associated with the principal process of the plant. These are the surge system, process tails withdrawal system, and a dry air plant (which is numbered C-620, Air Compressor Room).

The central portion of the building is a three-story section. This section contains the tails withdrawal system, the process gas stream, and the control room. The north section, which is the tallest one-story section, contains the surge drums (Hortonspheres). The south section, which is one story, contains the dry air plant and the electrical switchgear for all three sections. An extension for switchgear and battery rooms is located on the west side.

The one-story sections are steel-framed with siding and a built-up roof. The central section consists of a reinforced concrete structure up to the second floor with steel framing for the upper section. The roof over this area consists of a built-up roof on a steel deck.

3.3.2.4.1 Ground Floor

The control room, located on the ground floor, contains instrumentation necessary to monitor and control the process equipment. The tails withdrawal stations are located on the east side of the center section of the building. The remainder of the ground floor contains the C-620 air plant, the surge drums (Hortonspheres), change house, lube oil drain tank, lube oil pumps, and electrical switchgear.

3.3.2.4.2 Second Floor

The second floor of the central portion of the building contains the four centrifugal pumps and three Normetex pumps, which are used to compress the UF_6 for liquefaction for tails withdrawal. The centrifugal pumps, two UF_6 accumulators, and associated piping are enclosed in a heated housing to prevent freeze-out of UF_6. The electrical motors that drive the pumps are not enclosed for temperature considerations.

3.3.2.4.3 Third Floor

The third floor area contains the three UF_6 condensers used for UF_6 liquefaction and a portion of the ventilation system. The Coolant/RCW Heat Exchangers and Lube Oil Supply tanks are also located on this floor.

3.3.2.4.4 Cranes

Two semi-gantry cranes are located on the east side of the C-315 building. The 20 ton cranes are used to move cylinders to and from the scale carts to the cylinder storage areas (see Section 3.7). One 5 ton overhead crane is located on the second floor to facilitate removal of the Normetex pumps. Local jib cranes are placed at each centrifugal compressor to aid in removal of these items. This equipment is subsequently lowered through a hatch to the tails withdrawal room and then outside through the withdrawal position roll-up door.

One crane in the C-315 building that is normally parked over or near the Normetex pumps is important to safety as described in Section 3.15. The failure of this crane could impact the UF_6 Primary System and initiate a large UF_6 release. This cell floor process building crane shall not fail in a manner that will cause a large UF_6 release during the following occasions:

- Normal operation,
- Natural phenomena events with the cranes in the parked position, and
- A release of the crane controls during an evacuation event.

3.3.3 Cascade Arrangement

A unit consists of ten cells. There are four units in the C-331 and C-335 “00” buildings and six units in the C-333 and C-337 “000” buildings. A cell contains eight stages in a “000” building and ten stages in a “00” building. Each stage contains a motor, compressor, converter, control valve, coolant system, and associated instrumentation.

A cell is the smallest group of stages that may be isolated and taken out of service at one time. The piping to a unit is arranged so that any unit or cell can be bypassed, evacuated, purged, and opened for maintenance work without shutting down any other cells. “Tie lines” are the interconnecting piping between buildings. The cascade shape can be changed to provide more length by arranging flow to different sections of the cascade. This is done by changing feed points and the top and bottom overlap points.

To provide the desired flow and pressure between buildings in the cascade, compressors called boosters are used to maintain the flow between buildings. Surge drums are used to maintain UF_6 inventory in C-315 and in the bottom of C-335.

3.3.3.1 Booster Stations

At those points in a diffusion cascade where there is a change in equipment size and/or a transition in pressure level, the gas pressure can be increased by passing it through a booster station.

Booster stations are used in locations where the gas must flow from a low pressure to a higher pressure within the same piping network. This condition generally occurs in the flow between buildings where there is a transition from one equipment size to another. The booster stations allow the cells on each side of the transition to operate at pressures that are more efficient for overall cascade operation. The booster stations consist of one or more compressors, gas coolers, recycle lines, control valves, block valves, and associated piping (see Figure 3.3-2). Axial compressors are used where large volumetric flows and compression ratios on the order of 5:1 are required. Centrifugal pumps are used where the volumetric flow is relatively small and compression ratios of about 3:1 are needed.

The plant has two axial booster stations with one standard “00” compressor in each station. One station, located in C-331, boosts the pressure in the “A” stream from the top stage in the building to “B” stream pressure. This flow is sent back to the top stage as “B” flow with a small portion of the flow being routed to the assay match point in the upper cascade (C-335 and C-337) as bottom overlap flow. This flow is essentially product flow from the lower cascade that becomes a feed stream for the upper cascade. The second axial booster, located in C-335, also boosts the pressure in the “A” stream from the top stage in C-335 to “B” stream pressure. Most of the flow is sent back to the top stage as “B” flow, with a portion routed to C-310 as interstage “A” stream flow.

The plant has a total of three “B” booster stations. Two of these stations are currently operational with the third in standby. The operational “B” booster stations both serve the same purpose, with one located in C-333 and the other in C-337. These stations boost the “B” stream from the bottom of the “000” buildings, which are at low pressure, to the top of the next downstream “00” unit, which is at a higher pressure in the adjacent “00” buildings. The third (standby) “B” booster station, located in C-310, can be used to boost the pressure in the “B” stream leaving the building or the “A” stream pressure when it arrives in C-310. The “B” booster stations in C-333 and C-337 consist of three centrifugal pumps, usually with two pumps in operation and the third in standby. The station in C-310 has two centrifugal pumps.

Both of the “00” buildings have a surge and waste booster station. Each station has two centrifugal pumps, usually one pump is operating and the other is in standby. The station in C-335 maintains the pressure in the bottom surge drums with a small portion of the flow through the pumps routed to the assay match point in the lower cascade as top overlap flow. This flow is essentially the tails flow from the upper cascade, which becomes a feed stream to the lower cascade. The surge and waste booster station in C-331 boosts the bottom “B” stream from C-331 to C-315.

C-310 has a tops booster station consisting of two centrifugal pumps that boosts the low pressure gases to a higher pressure where the flow is split. Part of the flow is recycled to the last intermediate cell in C-310 and the remainder is sent through the purge system to atmosphere. Both pumps are usually in operation.

3.3.3.2 UF_6 Inventory Control and Assay Monitoring

3.3.3.2.1 UF_6 Inventory Control

The inventory control system at PGDP consists of large Hortonsphere surge drums in the C-315 surge and tails withdrawal building, banks of surge drums in each "00" and "000" process building, and F/S units in the C-331, C-333, C-335 and C-337 buildings. The inventory control system is fundamentally a pressure control system with an automatic control valve in the "B" outlet pipe of every cascade stage. UF_6 inventory can be stored in the surge drums and/or F/S as needed and then returned to the cascade as required. Without the surge drums and/or F/S, the only means of inventory control would be through varying the feed and withdrawal rates. This type of control would be both sluggish and imprecise.

The C-315 building contains two 20,000 cubic foot Hortonspheres, that supply surge volume for handling inventory fluctuations in the cascade. Flow to the C-315 building is from C-331, normally through "B" stream surge and waste boosters.

Normally, one Hortonsphere is on-stream while the other Hortonsphere is maintained at a low pressure for use as a local process evacuation source. The on-stream Hortonsphere is controlled at a nominal 10 psia for High Speed Centrifugal operation and a nominal 5 psia for Normetex operation, while the inlet to the UF_6 condensers is controlled at approximately 30 psia to maintain the proper condensing pressure. Operation of the C-315 compressors and UF_6 condensers are discussed in Section 3.5.

Each "00" and "000" cascade building has surge drums, which are used for evacuation, purging and cell treatment activities. The surge drums are large cylindrical vessels made of steel mounted with their long axis horizontal. Surge drums that contain UF_6 are operated below atmospheric pressure. Surge drum pressures can be monitored from the C-300 Central Control Building and the appropriate ACR. No high or low pressure alarms or trips are associated with the surge drums. Surge drum temperature and pressure are controlled to maintain UF_6 in the gaseous phase so that uncertainty in the UF_6 inventory is minimized. See Section 3.3.5.9.7 for details regarding NMC&A reliance on surge drum pressure and room temperature instrumentation. See Section 3.3.5.1 for further discussion of surge drums.

Freezer/Sublimer (F/S) units installed in C-331, C-333, C-335, and C-337 buildings allow the excess UF_6 inventory to be removed from the cascade by solidifying it in storage vessels and then returning it to the cascade by sublimation when required. F/S are discussed in Section 3.3.4.6.

3.3.3.2.2 Assay Monitoring

The function of the mass spectrometers (also called assay machines) is to monitor assay. The mass spectrometer traps and analyzes the sample and then records the assay. This information can be used to control target assay.

The assay mass spectrometers use ionized UF_6 gas to measure the relative number of ^{235}U ions. Mass spectrometers are equipped with one mechanical vacuum pump and one chemical trap. These traps may be filled with sodium fluoride (NaF) or a mixture of rock salt, alumina and soda lime. The traps are in use when pumping the system down to vacuum conditions.

Mass spectrometers are utilized in the cascade buildings (C-310, C-331, C-333, C-335, and C-337). The C-310 mass spectrometers (one for normal use and one for backup use) function to monitor product assay limits. In C-331, one mass spectrometer is used to monitor the tails assay and one is used to monitor the BOL assay. The mass spectrometer in C-335 monitors the TOL assay. Buildings C-333 and C-337 have one mass spectrometer each to monitor assay limits.

The mass spectrometers are important to safety as described in Section 3.15. 120 VAC power supports the assay machine instrumentation, computer, and the solenoid isolation valves. Upon loss of power the assay machine has no indication, no power available lights, the computer screen is blank indicating to the operators that a problem exists, and the block valves fail shut. The assay monitoring system is therefore fail safe.

3.3.3.2.3 Inventory Instrumentation

The Inventory Instrumentation Required for Nuclear Material Accountability is important to safety as described in Section 3.15. Inventory instrumentation is used to monitor and account for special nuclear material that PGDP uses. The Inventory Instrumentation performs a safeguarding function by providing a means to demonstrate compliance with Nuclear Material Control and Accountability (NMC&A) requirements. (See the Fundamental Nuclear Materials Control Plan (FNMCP) for more details). Various types of inventory instruments are used to perform this function.

One component of the inventory instrumentation is the freezer/sublimer weight instrumentation. This weight monitoring instrumentation accounts for the amount of uranium in each vessel and ensures that the freezer/sublimer vessels are not overfilled which could result in a vessel rupture during subsequent sublimation. This system is discussed further in Section 3.3.4.

Another type of inventory instrumentation is the unit Datum System pressure instrumentation for cascade pressure control. The Datum System provides precise control and measurement of cascade pressures and is of primary importance to account for uranium in the cascade. This system is discussed further in Section 3.3.5.

The waste drum scales, located in C-310, C-333, and C-335 are also part of the inventory instrumentation for accountability. The waste drum scales are used to determine the total weight of drums containing contaminated waste material. Another component of the inventory instrumentation is the waste drum monitor, which consists of a computer system with detector processing software and associated hardware. Waste drum monitors are designed and maintained to characterize the uranium contained within waste drums to determine storage and spacing requirements for each drum.

Flowmeters are used while taking inventory to estimate the amount of material in a partially filled cylinder during the feeding process. The flowmeters are located in the feed facilities (C-333-A and C-337-A) and the readouts are in C-333 and C-337, respectively. These components are discussed further in Section 3.2.1.3.

3.3.4 Equipment Description

Cascade equipment is sized to correspond to its required function in the enrichment process. PGDP has three sizes of equipment: 2X, “00”, and “000”

The UF_6 Primary System is important to safety as described in Section 3.15. This system is the UF_6 containment barrier in the enrichment cascade and associated equipment. The safety function of the UF_6 Primary System is to provide primary system integrity for the processes that contain gaseous UF_6 in the enrichment and purge cascade facilities to prevent the release of UF_6 during normal operation, and to prevent gross failures during evaluation basis natural phenomena events.

The major pieces of equipment discussed in this section include converters, compressors, piping, valves, and process seals, which are part of the UF_6 Primary System. Additionally, motors and couplings are discussed in this section. The process coolant system, including condensers, is discussed in Section 3.3.5.5.

3.3.4.1 Converter

The stage converter is the key to the separation of isotopes by the gaseous diffusion process. A converter is designed to accomplish several primary functions:

- To support the barrier material in contact with the process gas stream.
- To separate the enriched fraction of the process gas stream from the portion depleted in lighter isotope.
- To remove the heat of compression of the process gas in the converter by the use of cooling coils.

The process gas enters the barrier region of the converter via a common inlet nozzle, where a portion of the process gas diffuses through the barrier tube wall and passes through the process gas cooler to the next compressor. The stream that diffuses through the barrier tube wall and is slightly enriched in the ^{235}U isotope is called the “A” stream. The gas that does not diffuse through the barrier tube walls and leaves the converter slightly depleted in the ^{235}U isotope is called the “B” stream. The “A” stream is routed to the next higher stage compressor in the cascade, while the “B” stream is routed to next lower stage compressor.

Converters, compressors, and connecting process gas piping are enclosed in housings so that they are constantly surrounded by heated air. This helps to minimize the likelihood of process gas freeze-out.

The main parts of the converter are the shell, barrier tube bundle, cooler, and heads. Three sizes of converters are designated as 2X, “00”, and “000”. The three sizes are similar except that the 2X converters have “AB” cooling which means the cooler is on the inlet side instead of the outlet side of the converter (see Figures 3.3-6, 3.3-7, and 3.3-8).

The converter head and shell are constructed of heavy nickel-plated steel. Converters are designed for 40 psia.

The barrier tube bundle is fabricated using tube sheets that support the barrier tubes. The inlet end of the tube sheet is secured and the outlet end is floating to allow longitudinal sliding, thereby overcoming the effects of differential thermal expansion and contraction. The barrier tubes are sealed tightly to the

tube sheets. The tubes are then leak tested to ensure that a satisfactory seal has been achieved between the ferrule and tube sheets.

The materials of construction for converters include Monel, copper, and nickel-plated steel. The use of unplated steel is minimized because steel does not acquire a uniform protective fluoride film as does nickel. Unplated steel produces unwanted lower uranium fluorides, such as UF_4 and UF_5, when exposed to process gases.

Strict cleanliness is maintained throughout the assembly process, since traces of oil or grease can react vigorously during the subsequent treatments with fluorine after installation in the cascade.

Preparation of a stage converter for cascade use includes a stabilization treatment with fluorine. The stabilization process serves two purposes:

- It removes any foreign material such as moisture absorbed on the barrier that might later react to consume UF_6.
- Bare metal surfaces are coated with a protective fluoride film, which reduces the rate of further reaction with UF_6 or fluorine.

As mentioned previously, the converter tube bundle is allowed to “float” on one end. This prevents the rupture of barrier tubes. Rupture of a large number of tubes could overload the upstream compressor and cause surging or possible compressor damage. Introduction of contaminants into, or the generation of contaminants within, the process system must be eliminated to avoid barrier plugging, which will reduce the “A” flow to the upstream compressor, resulting in possible overheating or compressor failure.

3.3.4.2 Compressors

In the gaseous diffusion process, stage compressors are used to supply the driving force for the movement of UF_6 through the process. Flow of gas through the barrier is continuous, and compressors are used to hold the fore and back pressures on the barrier constant and to transfer the UF_6 from stage to stage.

Each stage converter in a gaseous diffusion cascade accepts a feed stream of UF_6 and, through the diffusion process, divides this stream into a product stream ("A" stream) and a tails stream ("B" stream). Both of these streams leave the stage converter at a pressure lower than that of the feed stream. To transfer these gases as feed to other stages, both must be recompressed. This requirement can be met in one of two ways: the use of two separate compressors or the use of a single multiple effect compressor which can handle the compression of both streams and introduce the resulting gas stream as feed to a single stage converter. Two types of compressors used at PGDP are referred to as centrifugal and axial flow compressors. The axial compressors are used where large volumetric flows and compression ratios of up to 5:1 are required. The centrifugal compressors are used where relatively small volumetric flows and compression ratios of about 3:1 are necessary.

The compressors are equipped with a device to temporarily limit the inleakage of air or nitrogen during shaft seal replacement or bearing maintenance. Figure 3.3-9 shows the blowout preventor (BOP),

which is lever-actuated to seal against a tapered shoulder on the compressor shaft. With the BOP actuated, the shaft bearings and seal can be changed without evacuating and purging the cell.

3.3.4.2.1 Centrifugal Compressors

In a centrifugal compressor, the inlet gas flow is fed to the center of a rotating impeller, which accelerates the gas toward the rim of the compressor casing and through the discharge outlet. These compressors, which use Monel or cast aluminum impellers in steel casings, are internally nickel-plated for corrosion protection.

These compressors have a wide use in the C-310 purge cascade and as booster pumps throughout the cascade (see Section 3.3.6) and in the C-315 building (see Section 3.3.3.1) because of the variable operating conditions in those locations.

3.3.4.2.2 Axial Flow Compressors

In the “00” and “000” buildings, where the largest quantities of power are consumed and the largest volumes of UF_6 are processed, axial-flow compressors are used. In these buildings, both the “A” and “B” streams are compressed at each stage by a single axial-flow compressor that is controlled by a stage control valve. Each axial compressor has 3 nozzles: an “A” inlet, “B” inlet, and outlet. Some axial flow compressors have adjustable vanes to allow more efficient operation over a wide range of conditions. In particular, adjustable vane compressors assist in correcting changes in controllability of the process at varying power (and pressure) levels.

Axial flow compressors, shown in Figure 3.3-9, are used to move large volumes of gas in the cascade. These machines which are larger than the centrifugal compressors are designated as “00” and “000” size. The “00” compressor is used in C-331 and C-335. The “000” compressor is used in C-333 and C-337.

In the axial flow compressor, compression occurs as the gas passes through a series of fan-like blades set in the periphery of a rotating barrel or rotor. The shell surrounding the rotor also contains rows of stationary blades called the stator. Each set of blades (rotor-stators) constitutes a compression stage. Many stages can be combined efficiently to achieve high pressure ratios and high gas flow rates. Gas flow is generally at a constant distance from the axis of rotation, thus the name axial flow compressor.

3.3.4.2.3 Stage Buffering

When the compressors are in service, the spaces between the flange gaskets are kept buffered with dry air so that if a leak develops, dry (rather than humidified atmospheric) air will enter the cascade. Buffer gas is also provided for the stage control valves, blowout preventor (BOP) bellows, some of the double-walled expansion joints, and expansion joints with covers. Most of the buffer system has instrumentation that includes an alarm to warn of buffer gas flow, which is indicative of buffered component leakage. Each buffered item is provided with an isolation valve so that leaks can be located and/or isolated.

3.3.4.3 Process Motors

There are many process motors at PGDP. The process motors operate at various rpm ranges and voltage levels. The motor bearings are lubricated by a process building lube oil system (see Section 3.3.5.10).

The process motors are mounted on steel-reinforced concrete foundations adjacent to the compressors, or directly on the steel compressor frame itself.

The motors have provisions to dissipate normal operating heat by circulating cooling air through the motors utilizing blades on the rotors. Forced ventilation to circulate cooling air to the motors is provided by supply fans on the ground floor and exhaust fans on the building roof and/or exhaust fans and ductwork beneath the cell floor.

All connections to the motor for lubrication, power, and instrumentation lead to, and terminate at, the motor foundation where they are connected to the motor systems. The motor and its associated connections are located outside the cell enclosure.

3.3.4.3.1 Brakes

Without a brake unit, the great mass and inertia of the larger motor and compressor units would cause them to continue to rotate for a long period of time after electrical energy is shut off from the motor, until they gradually slow to a stop. In general, the motors for the axial flow compressors are equipped with brakes that stop rotation quickly.

The brake is attached to the motor shaft on the opposite drive end. It consists of a brake drum keyed to the rotor shaft and a brake mechanism. The brake mechanism presses two brake shoes against opposite sides of the drum periphery, using a large spring to force the shoes against the drum. The brakes are released, allowing the brake shoes to engage the drum, when an electromagnetic solenoid coil in the mechanism, that is large enough to overcome the force of the spring, is de-energized. The solenoid is energized from the same switchgear buswork that supplies the motors and the solenoid is energized when the motors are energized. The solenoid is supplied through a brake transformer in the switchgear that reduces the voltage to the coil operating level.

3.3.4.3.2 Compressor and Motor Couplings

The couplings between the motor and compressor shafts are metal, non-lubricated, laminated disc type couplings.

3.3.4.3.3 Monitoring and Protection System

3.3.4.3.3.1 UF_6 Compressor Motor Manual Trip Systems

The UF_6 Compressor Motor Manual Trip Systems are important to safety as described in Section 3.15. These trip systems perform the following safety functions by shutting down the applicable compressor motors described herein:

- Reduce the operating pressure/temperature to minimize the potential for UF_6 Primary System failure.

- Reduce the operating pressure to minimize the release of UF_6 and its reaction products to the atmosphere after a failure in the UF_6 Primary System integrity.

The UF_6 Compressor Motor Manual Trip Systems consist of the Cell Remote Manual Shutdown Systems and the trip systems for the interbuilding booster and purge and evacuation (P&E) compressor motors. The Cell Remote Manual Shutdown System accomplishes its safety function by shutting down, from the ACR or CCF, all of the enrichment cascade compressor motors within a cell for buildings C-331, C-333, C-335, and C-337, and by shutting down, from the LCP, all of the enrichment and purge cascade compressor motors within a cell for building C-310.

The UF_6 Compressor Motor Manual Trip Systems which have the capability to shut down individual interbuilding booster and purge and evacuation compressor motors are not required to accomplish the safety functions.

The Cell Remote Manual Shutdown System is supported by the DC Power Distribution System. The overall DC Power Distribution System is described in Section 3.9. That portion of the DC power distribution system which supports the Cell Remote Manual Shutdown System and is important to safety is described in Section 3.15 and in the following sections.

3.3.4.3.3.1.1 Cell Remote Manual Shutdown System – C-333 & C-337

The Cell Remote Manual Shutdown System shuts down the cell enrichment compressor motors by energizing the opening control valve coil to open the switch house 13.8 kVAC air circuit breaker (ACB). The opening control valve coil operates a valve on an air tank to supply air and open the ACB. The ACB supplies power directly to four stage motors, and supplies power to two stage motor circuit breakers that feed the other four stage motors (see Figure 3.9-1). The trip coil of the ACB can be energized through closure of a switch from either the building ACR or the CCF in C-300 (see Figure 3.9-4). Opening of the ACB removes power from all eight stage motors. The motors may also be shut down from the local control panel, unit substation, or switch house, but these switches are not required to accomplish the safety functions.

250 VDC power is supplied to the ACB control circuitry from DC distribution panels located in buildings C-533 (for C-333) and C-537 (for C-337). A 250 VDC battery bank and two battery chargers in each building are connected via circuit breakers to the DC distribution panel. A circuit breaker isolates the 250 VDC trip circuitry from the other control circuitry.

An indicator light is provided in the ACR to show when the ACB is tripped. This indicator and the ACR trip switch use 250 VDC power supplied from the switchgear circuitry. An indicator showing the trip position of the ACB is also available at the local control panel.

Power to the switch in the CCF is supplied by 125 VDC from a DC distribution cabinet in the battery room in C-300. A 480 VAC/125 VDC rectifier is the normal feed to the DC distribution panel. A 125 VDC battery bank and battery charger are also connected via a transfer switch to the DC distribution panel. The CCF switch energizes a relay whose contacts are in the 250 VDC trip circuit.

The ACBs are supplied compressed air from air tanks located in C-533 (for C-333) and C-537 (for C-337). The trip coil operates a valve from the air tank to open the ACB. Pressure switches and relay contacts in series with the valve coil allow trip operation if the pressure is above the pressure setpoint. The compressed air is a support system, which is important to safety as described in Section 3.15.

3.3.4.3.3.1.2 Cell Remote Manual Shutdown System – C-331 & C-335

The switch house 13.8 kVAC ACB normally remains closed and the stage motors are started or tripped using the 4.2 kVAC stage motor feeder electric circuit breakers located in the building substations. Each of the two stage motor circuit breakers supplies power to five stage motors (see Figure 3.9-2). The trip coils of the stage motor circuit breakers can be energized through closure of a switch from either the building ACR or the CCF in C-300 (see Figure 3.9-5). Energizing the two trip coils removes power from the ten stage motors. The motors may also be shut down from the local control panel or unit substation, but these switches are not required to accomplish the safety functions.

250 VDC power is supplied to the stage motor feeder circuit breaker control circuitry from DC distribution panels located in buildings C-331 and C-335. A 250 VDC battery bank and a battery charger in each building are connected via circuit breakers to the distribution panel. A circuit breaker in each panel separates the 250 VDC trip circuitry from the other control circuitry.

Indicator lights are provided in the ACR to show the position of the trip coils. These indicators and the two stage motor trip switches use 250 VDC power supplied from the unit substation control circuit. Indicator lights showing the motor trip coil position are also available at the local control panel.

The 125 VDC power source for the CCF trip switch is the same as described in Section 3.3.4.3.3.1.1. The switch energizes a relay whose contacts (one for each trip coil) use the substation unit 250 VDC.

3.3.4.3.3.1.3 Cell Remote Manual Shutdown System – C-310

The stage motors are normally started or tripped using the stage motor feeder electric circuit breakers located in the C-310 480 VAC switchgear. Each of the two stage motor circuit breakers supplies power to six stage motors (see Figure 3.9-3). The trip coils of the stage motor circuit breakers can be energized through closure of a switch from the local control panel (see Figure 3.9-6). Energizing the two trip coils removes power from the twelve stage motors. A shutdown switch is also available in the CCF in C-300 but is not required to accomplish the safety functions.

250 VDC power is supplied to the stage motor feeder circuit breaker control circuitry from a DC distribution panel located in the C-310 battery room. A 250 VDC battery bank and battery charger are connected via circuit breakers to the distribution panel. Circuit breakers in the DC panel separate the 250 VDC trip circuitry from the other control circuitry.

Indicator lights on the local control panel show the position of each circuit breaker. The circuit breaker trip switch and indicator lights on the local control panel use 250 VDC power supplied from the unit substation trip circuit.

3.3.4.3.3.2 Motor Load Indicators

Motor load indicators (ammeters) for the “00” and “000” building enrichment compressor motors are important to safety as described in Section 3.15. The primary function of the motor load indicators is to provide an early indication of abnormal compressor operation. Significant ampere load changes can be quickly investigated and appropriate action taken.

Ammeters for each enrichment cascade compressor motor are located in each building ACR. Ammeters in the CCF in C-300 read total cell current for the enrichment cascade compressor motors. Other ammeters exist for inter-building compressor motors and C-310 cell loads, but these are not required to accomplish the safety function.

A light and an audible alarm are provided in the respective ACR to indicate when any individual compressor motor or all compressor motors in a cell experience an overload or underload. A light and an audible alarm are also in the CCF to monitor any overload or underload in each cell. The affected stage motor load light also illuminates. These circuits use 125 VDC from the respective building alarm DC system. These features are not required to accomplish the safety function.

Current transformers attached to the input of each compressor motor provide an input to the ACR ammeter and overcurrent relay relative to the motor load. This is a closed loop circuit and requires no support power. For C-331 and C-335, the total cell current is provided to the CCF ammeter from an ACR current transformer that measures the sum of the individual inputs from the stage motor current transformers. For C-333 and C-337, a current transformer on the 13.8 kVAC bus feeding the stage motors supplies a total cell current input for the CCF ammeter.

3.3.4.4 Piping, Flanges, and Valves

Process piping, with its associated flanges, valves, and expansion joints, is the transport system that moves the UF_6 from compressor to converter, cell to cell, and building to building. The use of interbuilding process piping eliminates the need for cascade feed, product, and waste facilities in each process building.

Process piping is heated either by routing the piping through heated enclosures or by steam tracing and insulation, where heated housings are not practical, to maintain the UF_6 in a gaseous state.

The arrangement of stage equipment within process cells minimizes the length of connecting piping to minimize nonproductive process losses.

Connecting pipe headers called interbuilding tie lines are used to move UF_6 between buildings. These lines vary in length from a few hundred feet to several thousand feet and are elevated to clear obstacles such as roadways. Housings that enclose the tie lines are steam-heated to prevent UF_6 freeze-out.

Cell block valves and bypass valves are normally fully opened or closed and are only operated when equipment is taken off-stream or placed on-stream. Block valves are also occasionally used to control flow by pinching, or partially closing, the valve. Expansion joints are provided at appropriate locations to allow for thermal expansion and small misalignment of process piping.

3.3.4.4.1 Piping and Weld Joints

Cascade piping and process equipment are connected by flanged joints, which are referred to as Van-Stone flanges. Van-Stone flanges are made up of two mating flanges with or without a spacer with peripheral butt welds joining the flanges and spacer, if equipped, to provide a seal weld. This type of flange connection was adequate for sub-atmospheric operation but tests indicated that inadequate welds must be detected and repaired before operation at above-atmospheric pressure. (Cascade piping is installed and soap-tested to at least 5 psig.) The flanged joints on "B" line piping greater than 30 in. in diameter are reinforced with C-clamps unless the pipe flange is cut down to a 1 in. or less height and rewelded. The "A" line piping greater than 30 in. in diameter is clamped where the potential for exceeding atmospheric pressure exists. Cascade piping with Van-Stone flanges used in the PGDP cascade will withstand internal pressure up to the PGDP safety limit of 40 psia.

New fabrication that involves welded joints is performed by welders qualified in accordance with ASME Code (Section IX).

3.3.4.4.2 Interbuilding Piping

For obvious practical considerations, such as efficient equipment layouts, time of construction, and fire protection, the diffusion cascades are housed in multiple buildings with each building housing different equipment sizes and functions. The necessary operating facilities and auxiliary services are housed in the building with the cascade cells.

Because the process cells in separate buildings must be connected to form the cascade, the UF_6 process gas must be transported between buildings by means of interbuilding pipe lines. In some cases booster compressors are required to compensate for energy losses in long pipe lines. The interbuilding piping is always above ground and is contained in a thermally insulated housing provided with steam heat to prevent freeze-out of the process gas. The interbuilding piping consists of large "A" and "B" stream process lines between the buildings along with feed and evacuation lines. The largest interbuilding lines are those that transport process gas between the "000" size process equipment and the "00" size process equipment. At each "00"/"000" building interface, five lines, contained in two tie lines, are required. Two lines connect the top stage of the C-331 or C-335 stripping cells, and three lines connect the top stage of the C-333 or C-337 enriching cells with the bottom stage of the C-331 or C-335 enriching cells. A similar but smaller interbuilding line is required between the top stage of the C-335 cells and the bottom stage of the C-310 cells. Smaller lines are also used for the top overlap and bottom overlap lines. The UF_6 pressures in the "B" line streams can approach and go above atmospheric pressure as the power levels increase. Due to interbuilding tie-line support structure deficiencies, administrative controls ensure that interbuilding tie-line process piping that contains UF_6 is maintained below atmospheric pressure. The interbuilding process piping in the C-331/C-333 tie-line is exempt from this administrative requirement since deficiencies in the C-331/C-333 tie-line support structure have been corrected such that the tie-line structure will be adequate to resist service level and natural phenomena loading as described in the SAR for above atmospheric conditions.

3.3.4.4.3 Cell Block Valves

The function of the block valves in the system is to isolate cells or other major UF_6-containing process equipment (e.g., F/S), allowing the equipment to be taken out of service for repairs. The primary cell block valves in the system are large dual disc gate valves equipped with motor operators that allow the associated valves on a cell to be operated rapidly and in unison from a single push button when placing a cell on-stream or off-stream. Motor operated valve (MOV) closure time is dependent upon valve size with larger MOVs requiring more time to close than smaller MOVs.

Motor-operated Bayard block valves (Model G-17) are used in the cascade as cell block valves from 20 in. to a maximum size of 42 in. Bayard valves require large bonnet chambers to accommodate the

bellows and disc assemblies. The valve has a wedge at the bottom of the valve stem and is provided with guides so that the wedge assembly can only move up and down. The two seating discs are each fastened to spreaders, which move in slots on the inclined faces of the wedge. As the valve stem moves near the closed position, the spreaders contact a spreader rest and the vertical motion changes to a horizontal movement. The change of travel direction causes the discs to contact a valve seat and the valve becomes closed with an air-tight seal. Limit switches on the motor operator trip the power to the valve motor to stop the stem travel when the valve is closed. Cell block valves travel from fully open to fully closed in approximately 3 min. The block valves have bellows-sealed stems. Some are connected to a buffer system that supplies dry air to the bellows. Buffer flow instruments sound an alarm when the instruments detect buffer-air flow. The buffer flow alarm can indicate a leaking bellows.

3.3.4.4.4 Stage Control Valves

The primary purpose of the stage control valves is to establish and control stage pressures at desired levels. Stage control valves located on the "B" outlet line of each converter are modulated to maintain a nearly constant high-side pressure in the converter. The process control valves in "000" size equipment are pneumatically loaded, hydraulically operated, butterfly control valves. The hydraulic operator consists of a power cylinder enclosing a double-acting, hydraulic-operated piston that motivates the valve vane. A check valve prevents motion of the cylinder when the hydraulic oil pressure fails. The existing hydraulic oil system in each building is employed to supply the necessary hydraulic pressure. The control valves for the "00" cell equipment are pneumatically operated. The stage control valves in "00" and C-310 size equipment use air to load the positioner and change the valve position (pneumatic loading and operation). These valves are positioned by a pneumatic signal from a pressure indicating controller (PIC) to regulate the process gas (PG) pressure for each stage. In both cases a buffered Teflon shaft seal provides separation of the process and ambient conditions. If a control valve fails, it will go to a failsafe position. Instrumentation associated with each control valve allows it to be operated in a manual or automatic mode. In the automatic mode (normal), the PIC operates to maintain the pressure in the stage at a level determined by the set point of the instrumentation.

During testing it became necessary to modify the control valve vane to provide the required control capability. A significant reduction in pressure loss was achieved by replacing the massive aluminum butterfly vane with a thin-profile vane of reduced surface area. The reduced surface area of the control valve vane limits the range of control but serves to "trim" the cell pressure to achieve equilibrium conditions. Hence, the name trimmer valves is used when describing these valves. Both "00" and "000" cells have trimmer valves installed for pressure control.

Each stage control valve is controlled by an individual PIC on the local control panel. Stage control valves can be operated in automatic or manual mode but are normally placed on automatic to maintain the proper pressure for cell gradient purposes.

3.3.4.4.5 Expansion Joints

The cascade piping requires expansion joints to allow for some pipe misalignment and thermal expansion. The joints are of the Monel bellows-type.

On certain existing expansion joints, an external containment device is used to provide a means of actuating an alarm if a bellows failure occurs. This cover also provides a backup, positive pressure, dry air buffer, which prevents the escape of process gas if the inner bellows should fail. This containment device consists of a steel cover welded to the piping and spanning the expansion joint.

The expansion joint bellows are also subjected to flow-induced vibration as well as offset movement and expansion-contraction movement caused by temperature and pressure changes. To minimize this condition, internal sleeves were installed in some of the new or replacement expansion joints and existing joints that normally have gas flow.

Specific expansion joints have been replaced or modified to allow greater lateral and axial displacement at critical locations to maintain the integrity of the process piping system at ground accelerations up to the evaluation basis earthquake (EBE) (see Section 3.15).

3.3.4.5 Process Seals

The gaseous diffusion cascade centrifugal and axial-flow compressors require special seals, the intended function of which is to prevent outleakage of UF_6 and to minimize wet-air inleakage into the cascade. Each axial compressor requires two seals, the "A" seal at the low-pressure suction end and the "B" seal at the high-pressure discharge end. The pressure conditions for seal operation are therefore different for seals on each end of an axial compressor. Due to their design, centrifugal compressors require only one seal.

A process seal is comprised of three or four seal glands. "A" and "B" seals have a nitrogen-fed process seal closest to the process gas, a seal exhaust gland for removal of process seal gases, and a dry air-fed atmospheric seal. Each seal system requires feed lines of nitrogen (for the process seal) and dry air (for the atmospheric seal) and a seal exhaust line. The seal exhaust pressure is normally set slightly above process pressure and the seal feed pressures (both nitrogen and dry air) above the seal exhaust pressure. Seal exhaust is sometimes valved off to individual seals to facilitate operations. The seals are designed so that in the event of seal failure the process system pulls in nitrogen and dry air rather than either allowing atmospheric air inleakage (for sub-atmospheric operation) or UF_6 outleakage (for above-atmospheric pressure operation). Most "B" seals have a cap gland farthest from the process gas, which reduces the atmospheric seal feed leakage to atmosphere.

The process seal instrumentation system controls the pressures of the nitrogen seal feed, the seal exhaust, and the seal dry-air feed to ensure that the nitrogen and/or dry-air leak into the process through the seal during normal operation and upset conditions such as seal failure, rather than allowing UF_6 to leak out. In "A" seal systems and non-uprated "B" seal systems, the seal feed (nitrogen) pressure is controlled at a set level above the process pressure. The seal exhaust pressure is then controlled at a set level below the seal feed pressure. In this scheme, the seal feed pressure is termed the dominant pressure. Most "B" seal systems have been uprated so that the seal exhaust pressure was the dominant pressure. In these systems, the seal exhaust pressure is controlled at a set level above the process pressure and the seal feed is controlled from the seal exhaust pressure.

3.3.4.6 Freezer/Sublimers (F/S)

F/S systems are located in the C-331, C-333, C-335, and C-337 Process Buildings. The majority of the F/Ss are located in the "000" type buildings. The F/S vessels are located on the cell floor, while instrumentation and control equipment is on both the operating (ground) and cell floors.

Cascade inventory adjustments may be periodically required to accommodate changes in the available power. The F/S can be separately or jointly operated to remove excess UF_6 inventory, to conduct rapid power drops, to stop UF_6 outleakage, or to adjust the power load to maximize production and minimize cost.

To remove UF_6 from the cascade, the F/S is cooled with coolant (tube-side fluid), creating a low pressure/temperature vessel into which UF_6 (shell-side fluid) flows from the cascade "B" line. As the UF_6 cools to temperatures below the freezing point for the vessel pressure, it solidifies on the heat exchanger tubes. The specific volume change attendant with solidification maintains the F/S vessel at a pressure below "B" line pressure, thus providing the driving force for flow. The vent line valve is also kept open to "A" line. A control valve on the inlet line is used to control the rate at which UF_6 is added to the vessel commensurate with the rate at which cascade power load is being decreased. This weight control valve is positioned by the distributed process control system (DPCS) which takes input from the F/S weight and stage pressure measuring systems.

To remove UF_6 from the F/S and return it to the cascade, the freezing process is reversed. The vessel is heated with coolant and as the UF_6 temperature increases above the freezing point for the vessel pressure, the UF_6 changes phase from solid to gas (sublimation). The specific volume change on sublimation increases F/S vessel pressure above cascade "A" line pressure, and flow is established from the F/S to the "A" line via the same weight control valve used to control the freeze rate. F/S pressure is limited to less than the triple point by the cascade pressure to preclude UF_6 liquefaction during the sublimation process.

The DPCS provides for centralized operation and monitoring of the F/S systems from the ACR. The DPCS takes input from the F/S weight measuring system, stage pressure level, and outputs for the F/S weight control valve and the stage pressure control valve to achieve pressure changes in the cascade while on automatic operation. Local unit control panels are installed to provide manual override of the DPCS when required.

There are a total of 52 F/S (vertically-mounted shell and tube heat exchangers) arranged in one of three ways. There are 19 "piggy-back" units (two 10 MW vessels in parallel), 4 single 10 MW vessels, and 10 single-vessel 20 MW units. The total weight of UF_6 that can be stored in these F/Ss is equivalent to approximately 640 MW of cascade power load. A typical flow diagram for a piggy-back configuration is shown in Figure 3.3-10.

The 10 MW F/S vessel is 4 ft in diameter with an overall height of approximately 9½ ft. The tube bundle consists of finned tubes mounted vertically between fixed tube sheets. The tubes are 7 ft in length with a finned length of 6½ ft. Process gas is admitted to the center of the tube bundle through a pipe connection that penetrates the top tube sheet allowing the UF_6 to flow radially outward. Liquid coolant is admitted to the vessel through a pipe connection located on the bottom dished head. The liquid coolant flows upward through the tubes where it is vaporized, and the vapors are removed through an off-center

pipe nozzle at the top of the vessel. A vent line connection located just below the top tube sheet is provided to remove non-condensables. A double-ply expansion joint is installed in the shell to compensate for differential thermal expansion. The vessel is supported on three dual bridge load cells, which are used to measure and control UF_6 inventory within the F/S. The amount of UF_6 in a 10-MW F/S is limited to 11,900 lbs of UF_6.

The 20 MW F/S vessel is 4¾ ft. in diameter with an overall height of 13 ft. Its tube bundle consists of tubes of the same outside diameter (OD) and construction as utilized in the 10 MW unit. The 20 MW F/S's utilize the same size RCW and coolant pumps and condenser/reboiler (C/R) as the 10 MW unit. Aside from the size of the vessel itself, the only other major difference in the 10 MW and the 20 MW installations is the range of the dual bridge load cells that have been expanded to accommodate the increased UF_6 loading. The amount of UF_6 in a 20 MW F/S vessel is limited to 22,400 lbs of UF_6.

The F/S vessels are rated at 150 psig maximum allowable working pressure (MAWP) and have rupture discs rated at 25 psid which vent to the cascade "A" line.

The Freezer/Sublimer UF_6 High Pressure Relief System is important to safety as described in Section 3.15. This system provides pressure relief to prevent overpressurizing the F/S UF_6 Primary System thus minimizing the potential for a release of UF_6 from an overpressure failure. This system applies to the freezer/sublimers in C-331, C-333, C-335, and C-337.

3.3.4.6.1 Design Considerations

Each F/S system is designed to safely remove and freeze UF_6 from the cascade process gas stream, maintain the UF_6 within the F/S vessel in the solid state, and return the UF_6 to the cascade as a gas.

The safety concerns of a F/S operation are the prevention of nuclear criticality and the containment of toxic materials (HF and UF_6). See Section 5.2 Appendix A for more detail on the criticality related safety functions of the F/S systems.

Toxic material containment is provided through the F/S vessel design and its isolation valves. The existing buffer system is utilized on system valves and expansion joints to assist in containment of toxic material. The F/S vessel and UF_6 piping are fabricated from UF_6 resistant metal to provide corrosion resistance.

The cell floor loadings resulting from the installation of 20 MW F/S at approximately the same location as the 10 MW units were great enough to warrant the addition of a structural steel transfer beam beneath the reinforced concrete floor haunch adjacent to the vessel. This transfer beam provides reserve capacity for the loads generated by the F/S at its high-high weight trip (see Section 3.3.4.6.3 for a detailed description of high-high weight trip). See Table 3.3-1 for the freezer/sublimer design conditions.

3.3.4.6.2 Description of Operation

The F/S systems can be placed in six different operational modes: freeze, sublime, cold standby, hot standby, modified hot standby, or out of service. Typical F/S component states versus modes are outlined in Table 3.3-1.

3.3.4.6.2.1 Freeze Mode

The freeze mode allows UF_6 from the "B" line to enter the F/S vessel at a controlled rate and to be stored in a solid state in a F/S vessel. The "B" line valve is a motor-operated block valve on a line connected to the "B" process line within the cell system. The weight rate valve is an air-operated control valve on the line to the vessel, which provides the control required for freeze operations. The UF_6 is frozen on the outside of the finned tubes in the F/S vessel by passing coolant through tubes within the vessel. The fins on the tubes project horizontally from the vertical tubes, such that the fins serve as trays to hold the solid UF_6. Any non-condensable gases entering with the UF_6 flow are allowed to return to the cascade cell "A" bypass through a vent valve and a vent line. If the vent valve fails to open, a rupture disc is provided as a means of pressure relief for the UF_6 system. During the freeze mode, the operation is identical to any process gas cooler where coolant vapors are condensed in an elevated condenser and returned to the F/S vessel by gravity.

3.3.4.6.2.2 Sublime Mode

In the sublime mode, UF_6 is returned to the cascade from the F/S vessel by subliming solid to gas at a controlled rate. Sublimation of the UF_6 is initiated when heat is added to the condenser/reboiler causing the coolant to vaporize. The coolant vapor condenses in the F/S vessel tubes providing the heat to sublime the UF_6. The design provides for good heat transfer between the solid UF_6 and the finned tubes. The condensed coolant liquid is pumped back to the condenser/reboiler, and the UF_6 process gas is returned to the cascade through the weight rate valve to the "A" suction line to the stage 1 compressor of the cell.

The rate at which UF_6 enters or leaves the F/S vessel is regulated by the weight control valve. The amount is determined by the production control computer also known as the DPCS computer. Three dual-bridge load cells measure the amount of UF_6 in the F/S vessel and provide data on the rate of change of the weight of UF_6 in the vessel.

3.3.4.6.2.3 Cold Standby Mode

The cold standby mode maintains any UF_6 in the F/S vessel in the frozen state and is generally the standby condition whenever the F/S system is not being used. The cold standby condition is attained by using the R-114 system as in the freeze mode and isolating the UF_6 supply and return. Heat is removed from the condenser/reboiler, which condenses the coolant. The coolant liquid flows by gravity to the F/S vessel where it removes the normal cell heat and is vaporized back to the condenser/reboiler in an essentially steady state operation. The process gas supply and return lines are isolated, stopping the flow of UF_6 to the F/S vessel. With no UF_6 flow, the coolant, RCW, and UF_6 temperatures will stabilize at the RCW control temperature. Trips to cold standby will result from a DPCS high UF_6 weight.

3.3.4.6.2.4 Hot Standby Mode

The hot standby mode of operation is attained by using the R-114 system as in the sublime mode (except that the R-114 pump is off) and isolating the process supply and return lines. Trips to hot standby are a result of weight signal fault, and mode failure (a failure of any part of the F/S required for the mode that the F/S is currently operating in that must be reset from the control console).

3.3.4.6.2.5 Modified Hot Standby Mode

The modified hot standby mode is designed to occur as the result of a high-high UF_6 weight trip. It consists of isolating the process supply lines with the return valve, vent valve, UF_6 weight control valve open and stopping the R-114 coolant pump from running. At equilibrium with the coolant pump off, heat will not be added to the F/S vessel.

3.3.4.6.2.6 Out of Service Mode

The out of service mode is attained when the R-114 is drained from the vessel.

3.3.4.6.3 Instrumentation and Controls

3.3.4.6.3.1 Freezer/Sublimer Weight Monitoring

Three dual-bridge load cells measure the total UF_6/coolant weight in a F/S vessel, providing information which the DPCS uses to control the freeze or sublime rate. These load cells provide a signal to two separate summing boxes, which in turn supply an output signal through signal conditioners to the DPCS and to the hard-wired High-High Weight Trip System.

3.3.4.6.3.2 Distributed Process Control System

The DPCS performs two major functions in relation to F/Ss. It provides semi-automatic control of the F/Ss based upon operator input, and it monitors local process variables.

The DPCS consists of process control modules (PCMs) which collect data and send control functions to the process equipment and display control modules (DCMs), which control the operator console monitors (OCMs). There are OCMs in each of the four enrichment cascade process building ACRs, C-300, and selected interfaces with other buildings and locations. The OCMs are used to provide operator input to the process equipment and display data, alarms, and messages from the process equipment.

The F/Ss can be operated on an individual basis from the OCMs. First, the operator would select the desired mode. If a freeze or sublime operation is requested, the operator can specify the amount of UF_6 in lbs along with a desired rate of UF_6 transfer or the number of MW to swing along with the length of the swing in minutes. The DPCS then controls the rate of UF_6 transfer by positioning the F/S weight control valve, and automatically transfers the F/S to the cold standby mode when the specified final net UF_6 weight is achieved.

The DPCS monitors numerous process parameters including vessel weight and pressures, RCW and coolant temperatures and pressures, and valve positions. The system generates alarms and in some cases transfers the F/S to a safe operating mode upon detection of abnormal conditions.

The F/S weight measurement circuits include a calibration panel. The F/S control cabinet includes an operation/test switch, which is used to lock out the low weight signal trip during trip tests. Interlocks are included to prevent operation of a F/S while in the test mode. Loss of AC power to a weight transmitter is indicated by a “weight signal fault” alarm and the F/S mode is forced to hot standby.

3.3.4.6.3.3 High-High Weight Trip

The potential exists for the stress rupture of the coolant tubes or the F/S vessel due to overfilling (allowing UF_6 to bridge the tube-to-tube or tube-to-shell gap) and subsequent reheating due to expansion of the solid UF_6. Studies have shown that 11,900 lbs of UF_6 in a 10 MW vessel (compared with 18,000 lbs total capacity) is the limit without experiencing some degree of bridging; 22,400 lbs (compared with 38,000 lbs total capacity) is the comparable value for a 20 MW vessel.

For a 10 MW vessel, the high-high weight trip system is calibrated and tested to actuate when either channel of the weight monitoring system indicates a maximum of 10,000 lbs total UF_6/coolant weight (a 10 MW unit holds approximately 1,000 lbs coolant). For a 20 MW vessel, a maximum of 20,000 lbs UF_6/coolant weight initiates the trip, approximately 2,200 lbs of which is coolant. When compared to the amount of UF_6 required to initiate bridging, the weights of UF_6 required to actuate the high-high weight trip system provide a margin of more than 20% between the trip setpoint and the bridging limit.

Upon activation of the high-high weight trip system, the F/S system is automatically placed in the modified hot standby mode, which was described previously and an alarm sounds in the ACR, and a trip message appears on the operator control panel. This system is hardwired and cannot be overridden by the DPCS.

The F/S High-High Weight Trip System (see Figure 3.3-11) is important to safety as described in Section 3.15. This system is hardwired and is not part of the DPCS high-high weight trip. This system plays a role both in the prevention of a UF_6 release, and in the prevention of a criticality event.

The system prevents a UF_6 release by detecting an accumulation of excessive solid UF_6 material inside the vessel, isolating the vessel from the cascade, and transferring out of the freeze mode to prevent further accumulation. Overfilling the F/S vessel could stress the tubes and the vessel walls due to thermal expansion of the solid UF_6 during a subsequent sublime mode. The system automatically closes the inlet B-line valve that is supplying UF_6 to the F/S system upon detection of a weight greater than or equal to the system set point to prevent excessive material from accumulating inside the vessel. The required support systems to support these objectives are 120 VAC, 480 VAC, 24 VDC electric power, and plant air. Two sources of 120 VAC electric power are used for the High-High Weight Trip System. One source is supplied through a stepdown transformer from 480 VAC at the associated F/S motor control center. This supply of 120 VAC power is then used to provide power to one of the two weight measurement channels ("A-weight") and to provide power to two of the three 24 VDC power supplies that are used for relay logic in the high-high weight trip circuits. These two 24 VDC power supplies and the A-weight instrumentation are located in the primary F/S instrumentation cabinet. A second power source of 120 VAC is fed from a nearby process building lighting panel (120/208 VAC) to provide power to the other of the two weight measurement channels ("B-weight") and to provide power to the third of three 24 VDC power supplies. This third 24 VDC power supply and the B-weight instrumentation are physically located in nearby instrument enclosures. The 24 VDC power that is used for the F/S mode logic is derived from these three power supplies in such a manner that precludes failure of any one power supply from disruption of continuous power to the relay logic circuits. The 480 VAC electric power is supplied from the F/S motor control center, which is an extension of the associated cell motor control center. The 120 VAC is required for the weight measurement channels to provide an instrument signal output for comparison to the limit setting in the associated alarm/trip switch.

The 480 VAC is required for the motor operated UF_6 inlet "B" valve to close. The 24 VDC power is required for control relay contacts to close, thereby allowing 480 VAC power to be supplied to the UF_6 inlet "B" valve close contactor coil. The F/S high-high weight trip system valve actuations described below are not required to place the F/S in a safe stable condition as described in SAR Section 3.15. These valves reposition to facilitate recovery to normal operation. The 480 VAC also provides power for the motor operated UF_6 return valve, which will actuate to the "Open" position. The plant air support system provides the air pressure to operate the weight control valve, the UF_6 vent valve, and the coolant bypass valve. On the recirculating cooling water (RCW) loop, the plant air support system provides the air pressure to operate the pump flow control valve, the 3-way RCW valve, and the RCW flow control valve. When the High-High Weight Trip System is actuated the plant air system opens the weight control valve and the UF_6 vent valve. This allows the UF_6 to leave the F/S vessel. The RCW 3-way valve will move to the "Open to Return" position allowing water to enter from the cascade RCW return line. If the 3-way RCW valve is not operable or available, then the RCW supply and return manual block valves may be closed to meet the operational requirements. The 120 VAC, 480 VAC, and 24 VDC are support systems, which are important to safety as described in Section 3.15.

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The system also prevents a criticality event in F/S vessels that are exposed to greater than or equal to 1.0 wt % ^{235}U by closing the UF_6 inlet B-line valve upon an excessive accumulation of UF_6 in the vessel. Excessive UF_6 could cause bridging between the F/S collection tubes, which could lead to a breach of the coolant loop. The required support systems to support these objectives are 480 VAC, 120 VAC, and 24 VDC electric power as described in the previous paragraph.

All critical components of the system are "locked in" position. The term "locked in" refers to the fact that when the trip actions occurs, critical components cannot be overridden by operator action until the undesired condition has been corrected. This prevents an operator error from aggravating the undesirable condition. The critical components are maintained by the system until the process variables are again in acceptable ranges. At such time, the system can be manually reset and reverted to a specific mode of operation.

3.3.4.6.4 Freezer/Sublimer Coolant System

The F/S R-114 High Pressure Relief System is important to safety as described in Section 3.15. This system provides pressure relief to prevent overpressurizing the UF_6 Primary System thus minimizing the potential for a release of UF_6 from an overpressure failure for C-331, C-333, C-335, and C-337.

Both the 10 and 20 MW F/S installations have a closed loop coolant system consisting of a condenser/reboiler, a coolant pump, a rupture disc relief system, associated piping and valves, and, in the case of the 20 MW and "piggyback" installations, a coolant surge tank. In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the following ensure safe operation of the F/S coolant systems:

- Because of the potential for a violent exothermic chemical reaction in the F/S system, administrative controls require the substitution of dry air for coolant in the F/S and cell coolant systems during the use of cell treatment gases.

- The coolant pressure in the F/S system is to be controlled below 150 psig while coolant is being charged to the F/S coolant system. This will prevent a coolant release to the environment as a result of blowing the rupture disc and relief valve.

- The manual block valve between the coolant condenser and the rupture disc will be sealed open any time the F/S coolant system is in the freeze or cold standby mode.

3.3.4.6.5 Freezer/Sublimer Functional Trips

Other functional trips have been incorporated into the F/S system for C-331, C-333, C-335, and C-337 and are listed below:

- The high weight trip places the F/S in the cold standby mode when the unit reaches approximately 9,000 lb of UF_6/coolant (about 1,000 lb of which is coolant) in the 10 MW vessel or approximately 18,000 lb (about 2,200 lb of which is coolant) in the 20 MW unit. When this trip is actuated an alarm sounds in the ACR and trip message appears on the operator control panel. This trip is not maintained as important to safety since the High-High Weight Trip is maintained and is considered important to safety.

3.3.4.6.6 F/S Overfilling Protection

The F/S vessels are constructed from materials that are compatible with UF_6 service. The F/S vessels are inside the heated cell housing, which have low relative humidity. Thus, external corrosion is not a significant concern. Piping and valves are similar to those in the enrichment cascade. The F/S systems are typically operated at or below atmospheric pressure, so breaches of the pressure boundary would tend to result in atmospheric air inleakage.

The F/Ss present a unique mechanism for potential UF_6 outleakage. As UF_6 freezes on the F/S tubes and horizontal fins, the potential exists for solid UF_6 to "bridge" the tube-to-tube or tube-to-vessel gap (if the vessel is grossly overfilled). By itself, this bridging effect does not pose a significant safety concern. It was postulated that if the F/S is subsequently placed in the sublime mode and heated to normal operating temperature for that mode, UF_6 temperature can increase at such a rate that the thermal

expansion of the solid UF_6 occurs more rapidly than the sublimation rate can accommodate, and F/S tube or vessel stress ruptures can eventually result. However, during the initial testing of the F/S concept, the vessels were routinely filled to capacity and subsequently sublimed with no tube failures. Because the UF_6 release would be predominantly from a solid UF_6 source, the unlikely incident would result in a slow release rate.

Several layers of protection are provided to prevent overfilling the F/S. The DPCS controls the F/S freeze rate and net weight by positioning the weight control valve. If the net weight exceeds an operator-specified target value, a high weight trip will place the F/S in the cold standby mode. Finally, there is a hard-wired high-high weight trip to modified hot standby, which is not dependent upon the DPCS system

3.3.4.7 Materials of Construction

The materials used for construction of the cascade must have good resistance to the three powerful fluorinating agents used in cascade operations (UF_6, F_2, and ClF_3). The following subsections note particular materials meeting this criteria; however, other materials may be used as specified by engineering.

3.3.4.7.1 Nickel and Its Alloys

Nickel and its alloys are used in a variety of applications in the enrichment cascade and its supporting systems. Pure nickel is used in barrier manufacture and in some valve sub-components. The corrosion rate of nickel and high-nickel content alloys is greatly reduced by a thin protective coating of nickel fluoride formed during pre-use conditioning with F_2 and ClF_3.

3.3.4.7.2 Nickel-Plated Steel

This material is the predominant material of construction used for large process piping and components (converter shells, compressor shells, “000” axial compressor rotors, large process piping and valves) intended for moderate to high temperature UF_6 service. The UF_6-exposed surfaces exhibit the corrosion resistance properties of nickel while the structural and pressure boundary requirements benefit from the economy, strength, and fabrication ease of steel.

3.3.4.7.3 Monel

The typical use for Monel is smaller process piping and valves, expansion joint bellows, and some converter sub-components. Because of the high nickel content, Monel exhibits similar corrosion protection to nickel-lined piping and components.

3.3.4.7.4 Unplated (Boiler Plate) Steel

The corrosion resistance properties of steel make it suitable for low to moderate temperature UF_6 service. Most large vessels exposed to low to moderate temperature UF_6 are steel (e.g., surge drums).

3.3.4.7.5 Copper

Copper is used extensively in the enrichment cascade and its associated subsystems primarily as instrument line and heat exchanger tube material (process gas coolers, compressor aftercoolers, coolant condensers, etc). Copper has excellent heat transfer properties and good resistance to fluorinating agents.

3.3.4.7.6 Aluminum

Aluminum is used most often for gas cooler components (tube fins), converters, transition pieces, compressor blades, "00" axial compressor rotors, and stator assemblies, and as a gasketing material. Aluminum has good resistance to fluorinating agents.

3.3.4.7.7 Bronze Alloys

Phosphor bronze is used in various bellows and Bourdon tube assemblies and aluminum bronze is used to make converter fasteners. Both have good resistance to fluorinating agents.

3.3.4.7.8 Plastics

Teflon and Kel-F (Fluoroethene) find use as valve seats, packings, and some gasketing materials. Viton and Fluorel elastomers are used in O-rings and gaskets.

3.3.4.7.9 Material Fabrication and Joining

Electric arc-welding with nickel filler metal is widely used in assembling plated components. Brazing filler metal can be used on instrument lines and in instruments. Soft solders are usually avoided, although solder is used in assembling seal bellows.

3.3.4.8 Administrative Controls

3.3.4.8.1 Enrichment Cascade Process

In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the following ensure safe operation in the enrichment cascade:

- Valve control procedures are followed to protect from inadvertent valve openings to atmosphere.
- Purging of cells is done prior to opening to atmosphere.
- Cascade auxiliary equipment (e.g. booster, surge, seal, seal exhaust, and wet-air systems) that contains UF_6 is maintained below atmospheric pressure. This does not apply to the B Booster pumps.
- The rate at which oxidants are fed back to the cascade from off stream cell treatments is controlled to minimize potential excessive concentrations of oxidants.
- Concentrations of light cascade gases are monitored during off-stream cell treatments.

3.3.4.8.2 Freezer/Sublimer Process

In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the following ensure safe operation of the freezer/sublimers:

- Valve control procedures are followed to protect from inadvertent valve openings to atmosphere.
- Purging of cells is done prior to opening the freezer/sublimers to atmosphere.

3.3.5 Auxiliary Equipment

The cascade is made up of large equipment which is used directly in the separation of uranium isotopes. This equipment must be powered, cooled, instrumented, and serviced for maintenance in order to function efficiently. Systems that perform the above are referred to as auxiliary equipment and are important to the overall operation of PGDP. The auxiliary systems, that support isotope enrichment operations, and other support equipment will be discussed in this section. The auxiliary or utility systems that support plant operations, but are not directly concerned with isotope enrichment are discussed in Section 3.9.

3.3.5.1 Purge and Evacuation Systems

During normal operation, small amounts of light molecular weight contaminants (from seal buffering systems, buffered valves, and expansion joints) or small coolant leaks enter the cascade equipment. If the inleakage becomes excessive or another malfunction occurs, the situation requires isolating the affected system and evacuating the system to repair the leaks and/or malfunction. Therefore, during operation of the cascade, there are times when equipment must be removed for repair.

Evacuation of the affected cell is accomplished through the use of one of the cell evacuation systems. These include the purge and evacuation (P&E) stations and the wet air evacuation systems. The choice of the system used depends upon the type and quality of material in the cell. Other considerations are the pressure level and the rate of evacuation required.

The wet air evacuation system is used to evacuate equipment/portions of the cascade that have been opened to atmosphere or have been in standby, prior to returning these systems to service. This evacuation removes contaminants that may interact with the process gas to form deposits or undesirable by-products within the UF_6 enrichment cascade. The wet air system may also be used to obtain a UF_6 negative or HF (hydrogen fluoride) sweeping of various cascade systems or components.

When an operating cell must be evacuated, using the P&E pumps, it is typically isolated and the UF_6 is fed back into the cascade. The cell is then valved to the low-speed P&E pumps or the dual speed P&E pumps in low-speed mode by opening the motor-operated evacuation valve and the remaining UF_6 is returned to the cascade or stored in surge drums. After it is determined through pressure readings that only trace amounts of UF_6 remain, the high-speed P&E pumps or the dual speed P&E pumps in high-speed mode are used with the discharge valved to the cascade or to the surge drums listed in Table 3.3-2. A sweeping purge of dry air is used to purge the cell to a UF_6 negative, which is defined as less than 10 ppm at atmospheric pressure.

Each cascade building has several banks of surge drums that are used for four primary functions.

- To ensure stable operation of the cascade, large volumes of "lights" (N_2, O_2, and coolant mixtures) or UF_6 may be evacuated or purged from the cascade and stored in the surge drums. The mixtures may then be returned to the cascade at the appropriate assay match point at a controlled rate or pumped to the atmosphere through chemical traps to remove any remaining UF_6.

- For cell maintenance activities, the surge drums are used in obtaining a cell negative. Various banks of the surge drums are used in reducing the pressure in the cells as much as possible. The purge gases and UF_6 from the cells are returned from the surge drums to the cascade at a later time.

- During cell treatments, the drums are used to hold the UF_6 generated by the treatment gases and other reaction product gases. These gases are returned to the cascade at controlled rates.

- To handle periodic shifts that can occur in the cascade inventory, either planned or unplanned. Planned shifts in inventory are usually performed in a controlled manner to prevent adverse cascade conditions. They may be initiated to change power levels, perform maintenance on cascade equipment, maintain cascade balance, etc. Unplanned shifts in inventory can be more severe and are usually due to equipment failure or operational anomalies.

In addition to these functions, the surge drums may be used to provide backup storage of product material should C-310 equipment become unavailable for a short period of time.

Table 3.3-2 shows the location of the surge drum banks and their volume capacity. Product material can be stored only in those surge drums covered by a Criticality Accident Alarm System. The drum pressure and room temperature are controlled to maintain UF_6 in the gaseous phase.

Each bank of surge drums is enclosed within an insulated housing. These housings are heated and maintained at an elevated temperature to prevent solidification of the process gas.

When obtaining UF_6 negatives on cells and equipment during cell maintenance activities, the surge drums are used in conjunction with the P&E stations. The P&E pumps are valved into cells and discharged to the drums during the purge and evacuation process. The P&E pump stations are also used when returning the contents of the surge drums to the cascade.

Visual indicators for monitoring the surge drum pressure are located on ACR panels in each building and in the C-300, Central Control Building. Indicators for monitoring the temperature of the surge drum rooms are located at the drum rooms.

3.3.5.2 Plant Air System

Dry compressed air is one of the utilities required at PGDP for plant operations. Pneumatic instruments, controllers, and valves are used for control of the many plant processes. Air is also used in the enrichment process for the purge and evacuation of cascade components. In addition, air is used for

plant support, production equipment operations, steam plant operations, laboratory facilities, test facilities, maintenance functions, process seals, and other miscellaneous uses. It is supplied to PGDP from the air stations through a distribution system. See Section 3.9 for a further description of the plant air system.

Dry compressed air enters the process buildings through service air headers and passes through reducing stations where the pressure is regulated to provide the proper pressure for air usage application. Air filters are installed at some instrument locations to prevent foreign materials from entering the instruments. Air line sizes are reduced to be commensurate with usage.

3.3.5.3 Plant Nitrogen System

Nitrogen can be utilized in the process buildings for purging process equipment and for process seal feed. While nitrogen is distributed throughout the plant at a nominal 50 psig, the pressure within the process buildings is reduced to correspond to the specific usage. See Section 3.9 for a further description of the plant nitrogen system.

As in the plant air system, the nitrogen system is arranged in loops to maintain service in the event that a portion of the system is out of service. The majority of the distribution system is pipe supported above the ground.

The loss of nitrogen flow to the process buildings would only constitute an operational inconvenience to the cascade, because a check valve in each of the buildings would automatically transfer instrument air to the building nitrogen header upon a loss of header pressure. This transfer could be accomplished without an interruption of gas flow to the compressor shaft seals. Therefore, normal operation of the seal system would continue with no expected loss of material containment.

3.3.5.4 Plant Steam and Condensate System

Steam is primarily utilized in the process buildings for heating building pipe enclosures to maintain the desired operating temperatures to prevent freeze-out of UF_6. The steam distribution system is designed in loops to provide uninterrupted service in the event that a section of the system is out of service. See Section 3.9 for a further description of the plant steam and condensate system.

3.3.5.5 Process Coolant System

During the compression of UF_6, a large amount of the shaft horsepower is converted to thermal energy, which results in a significant rise in process gas temperature. Since there are operating temperature limits on the barrier and other components within the gaseous diffusion process, a process gas coolant system must be provided to remove the excess heat to maintain a desirable UF_6 operating temperature. This requires the coolant system to remove most of the energy supplied to the process system.

In the gaseous diffusion process, leakage of water into the UF_6 stream could cause problems. Therefore, to eliminate this possibility, a two loop cooling process is used. One coolant loop uses a refrigerant coolant and the other uses water (which is remote from the UF_6).

Each converter has a gas cooler installed in its shell. Typically, the UF_6 stream diffuses through the barrier tubes of the converter (A-Stream) and then passes through the fins on the finned tubes of the heat exchanger. However, on A-B cooled cells the UF_6 stream flows through the cooler before entering the barrier tubes. These gas coolers facilitate the transfer of heat from the process gas through the fins and tube walls into the coolant flowing inside the cooler tubes. A simplified schematic of the heat removal system is shown in Figure 3.3-12. The process gas coolant systems vary slightly from cascade building to cascade building with the size of the process gas equipment. In general, "000" cells have a coolant loop and condenser for each half cell, while "00" and "2X" (C-310 building) cells have one loop and condenser each. Some "2X" cells have two coolant loops; the normal coolant loop for the converter and the interpump coolant loop which is external to the converter. These cells also have two separate condensers. A schematic of the cascade coolant system is shown in Figure 3.3-13. When the coolant receives the heat it vaporizes. This coolant vapor progresses to a water-cooled condenser, transferring its heat and changing back to the liquid phase. The condenser is at a higher elevation than the cooler which makes it possible to maintain a liquid head in the condenser outlet line sufficient to promote gravitational flow around the coolant loop without the assistance of mechanical pumps.

The coolant condensers are cooled by RCW. The RCW system is discussed in Section 3.3.5.5.4.

Because of the size of the equipment and the process layout, each "000" cell has two coolant systems, while "00" cells have one coolant system serving all 10 stages. Each of these systems contains about 20,000 to 25,000 lb of coolant.

During normal operation, the coolant system operates at a higher pressure than the pressure of both the UF_6 system and the RCW system. Therefore, in case of leakage, the coolant leaks into the UF_6 or the RCW, thus preventing water from leaking into the coolant system and then potentially into the process gas. To minimize corrosion, the water content of the coolant is typically maintained at a low level. The coolant is dried when necessary.

The coolant drain, recovery, and transfer system is designed to transport and recover coolant taken from out of service equipment as a liquid or vapor within the plant or from delivery tanks to a storage facility in the plant. In addition, the system serves to evacuate residual coolant from a cell coolant system prior to cutting into the system for repairs and to evacuate air in preparing for on-stream operation. One system is located in each "00" and "000" building.

3.3.5.5.1 Gas Coolers

The Paducah plant utilizes three sizes of stage base coolers: 2X, "00," and "000." The 2X coolers are constructed of integral fin tubing and are installed in the C-310 building and on some of the auxiliary pump coolers. The original "00" base coolers used in C-331 and C-335 have two different designs, but both use fins mechanically attached to tubes. The "000" base coolers used in C-333 and C-337 utilize three different designs. Two of these designs use fins mechanically attached to tubes and differ only in fin spacing and hence fin area. The third design is a compact design with integral finned tubes. Coolers are hydrostatically tested to 150% of design pressure or pneumatically tested to 110% of design pressure prior to installation. The process gas coolers are part of the UF_6 Primary System and are important to safety as described in Section 3.15.

In the original configuration, the process gas coolers were installed in the inlet end of the converter, as shown in the 2X converter drawing in Figure 3.3-6 and cooled both the "A" and "B" streams. Converters are described in Section 3.3.4.1. In the early 1960s, the conversion to "A" line cooling was made, thus only the "A" stream gases were cooled as they left the outlet end of the converter. "A" line cooling has the advantage of allowing both the barrier and the compressor to operate at temperatures at which they are most efficient. Conversion of most cells to "A" line cooling required the addition of more free area in the coolers, except in the more compact design, to reduce the pressure drop associated with cooling the "A" stream. This free area was provided by the addition of peripheral coolers to the outside diameter of the base coolers. The converter shell requires "bulging" to accept these coolers as shown in Figures 3.3-7 and 3.3-8. All cells except four "00" cells and the 2X cells in C-310 are now "A" line cooled. Many of the peripheral coolers are similar in design. One exception is a "00" extension cooler manufactured and installed during the Cascade Improvement Program (CIP). This type of cooler is a different design than previously described. The coolant passages of the core are formed by an extrusion and the fins are formed by a skiving process which creates petal-shaped fins integral with the extrusion. The extrusions are manifolded together to form inlet and outlet coolant piping.

The "00" cooler is of very similar construction to the "000" cooler. However, the size and flowpath are somewhat different. The gas flow on "00" coolers is radially inward as compared to the axial flow "000" coolers. UF_6 is the shell-side fluid.

3.3.5.5.1.1 Stage 1 Recycle Coolers

Various situations arise when cells are taken off stream and require full-power, off-stream operation. "AB"-cooled cells operate satisfactorily off-stream because the heat of compression is removed on the discharge of each compressor. However, with "A"-line cooling, in which the gas cooler cools the enriched stream flowing to the next upstream compressor, the "B" stream from the stage 1 converter is not cooled. Therefore, when an "A"-line cooled cell is taken off-stream, additional cooling is achieved by a stage 1 recycle cooler arrangement consisting of a gas cooler assembly installed in the recycle line that connects the "B"-stream from the stage 1 converter to the "A" inlet of the stage 1 compressor.

3.3.5.5.1.2 P & E and Booster Coolers

Other UF_6 process coolers in the cascade, such as the P & E coolers and the booster station coolers are similar to the UF_6 process gas coolers used in the cascade in terms of design and function. However, the UF_6 process gas coolers located in the cells of the cascade are larger than the UF_6 process gas coolers located in other areas of the cascade.

3.3.5.5.2 Condensers

The coolant condensing requirements at PGDP are handled by typical shell and U-shaped tube design condensers. The cell coolant condensers are ASME-code rated for 300 psig, except for the C-310 condensers and some of the auxiliary pump condensers, which are only rated for 200 psig. The tubes provide a passage for the RCW with the inlet and outlet on the same end of the condenser. The configuration of these condensers is basically the same except for size, number of tubes, and head configuration. To provide the desirable water velocity through the tubes, different head configurations

are used to determine the number of water flow passes through the condensers. A typical coolant condenser is shown in Figure 3.3-14.

Condenser tube fouling is not considered to be a problem when the plant is operating at high power levels and sufficiently high water velocities. However, when operating at low power levels, desired water velocities are difficult to maintain and tube fouling becomes a concern. Cleaning processes may be used to keep the water flow passages through the tubes clean. During previous cleaning programs, condenser heads have been epoxy-coated to minimize corrosion.

3.3.5.5.3 Coolant System Auxiliary Equipment

Maintenance on the coolant systems requires draining, pumping, and evacuation of the coolant. The coolant system auxiliary equipment provides these services with piping, drain tanks, liquid pumps, vapor pumps, vapor condensers, and air evacuation pumps. C-310 and C-315 do not have some of this equipment and must rely on the other buildings for these services.

3.3.5.5.3.1 Coolant Piping

The coolant distribution system, exclusive of the condenser and gas cooler, is composed of pipe from the condenser to the gas coolers and a vapor return network from the gas coolers to the condenser. Each cell/system has a coolant drain valve or valves which may be opened to allow the coolant to flow into the drain lines leading to coolant storage tanks on the first floor of the buildings. In addition, the coolant piping allows connection of the systems to the coolant system servicing equipment.

3.3.5.5.3.2 Drain Tanks

Each “00” building has one coolant drain tank, while “000” buildings have two tanks to provide a storage volume for coolant. The normal coolant pressure in these tanks depends upon ambient temperature and the amount of noncondensible gases in the tanks. Coolant inventory can be transferred from one storage system to any other storage system in each of the four process buildings, C-310, and C-315.

3.3.5.5.3.3 Liquid Transfer Pumps

Coolant is returned to the cell coolant systems by means of centrifugal pumps set in pits below the drain tanks. Since the pumps will not pump vapor, the pumps are set in the pits to provide sufficient head to the suction of the pump. The “000” and the “00” buildings have two pumps each. They are used to transfer liquid coolant between the drain tanks and the process coolant system. C-310 coolant is usually provided from building C-331, although it can be provided from other buildings as well.

3.3.5.5.3.4 Vapor Transfer Pumps

Each coolant storage and transfer system has two pumps that are used to remove coolant vapors from cell systems. These evacuation pumps are used to evacuate coolant vapor from equipment prior to opening the system to atmosphere and for transferring coolant from transport tanks to storage tanks. Coolant vapor removed from the system is condensed and returned to the storage tanks.

3.3.5.5.3.5 Vapor Condensers

These vapor condensers, which are separate from the coolant condensers described above, are used for coolant recovery purposes. This water-cooled heat exchanger condenses the coolant vapor discharged from the vapor transfer pumps to allow liquid coolant flow to the drain tank.

3.3.5.5.3.6 Coolant System Air Exhaust Pumps

These pumps are used to reduce the concentration of coolant to parts per million levels after the majority of the coolant vapor has been removed to the extent possible by the vapor transfer pumps and to evacuate wet air from the cell coolant systems. The low vacuum obtained by these pumps allows almost complete evacuation of air from these systems and therefore more efficient operation of the coolant systems.

3.3.5.5.4 Recirculating Cooling Water Systems and Cooling Towers

The primary purpose of the RCW systems is to remove heat from the coolant in the coolant condensers. In addition to this, RCW is supplied to other auxiliary equipment in the cascade area. See Section 3.9 for a further description of the recirculating cooling water system.

Each of the four process buildings has one or two cooling towers installed nearby to cool the RCW after it returns from the coolant condensers. Each cooling tower is divided into cells which operate independently of the other cells.

The cascade buildings are supplied with cooled RCW by pumps that move the water from the pump house wet wells through underground mains and vertical risers to horizontal supply headers that are located under the process building roof trusses. The control of the pumps is normally performed from the pump house. However, control of all pumps can be performed from the C-300 building. The supply headers have branches that supply water to the coolant condensers. Return lines are installed from the condensers to return headers, which are connected to the underground mains that return the heated water through risers to the top of the cooling towers. Blend pumps are available to provide cold water from the cooling tower basin to blend with the hot return RCW before it reaches the cooling towers.

To increase the updraft through each of the tower cells, fans in shrouds are mounted at the top and are driven through gear reducers by electric motors. The shrouds promote an effective updraft and also serve to contain the blades from a fan in case of a failure.

Each of the four main process buildings is serviced by double-ended loops, with lines running into the buildings at opposite ends. Each of these buildings has two supply loops and two return loops. The quantities of RCW required by the various process buildings depends primarily upon the process temperatures, the heat load required to be removed, and ambient temperatures.

The RCW is treated with a corrosion inhibitor and dispersant to minimize corrosion and scale deposition. Chemicals are added to control pH and the growth of microorganisms. External electrolytic corrosion is inhibited by a cathodic protection system.

Large quantities of water are lost through evaporation in the cooling towers. This causes the dissolved chemicals to become more concentrated. To prevent solids accumulations from exceeding desired levels, a blowdown stream is provided. To meet Environmental Protection Agency (EPA) limitations on maximum concentration of contaminants in the pipeline effluent, the blowdown stream must be chemically treated to dispose of the contaminants. In C-616, Liquid Pollution Abatement and Appurtenant Structures, the concentration of corrosion inhibitors and other pollutants is reduced in the waste water. To replace the water lost through evaporation and blowdown, a makeup water stream is required. In addition to the corrosion inhibitor treatment mentioned above, the makeup water is also given an acid treatment and a chlorination treatment.

3.3.5.5.5 Cell Coolant Instrumentation and Overpressure Control System

The coolant instrumentation in the process buildings is used to indicate the conditions existing in the coolant system, control these conditions at a predetermined value, and to sound an alarm and/or shut down the equipment when the existing conditions reach a point that may result in damage to the process equipment.

Each cell in the “00” process buildings is supplied with an independent coolant instrumentation system. In the “000” buildings, each half cell is provided with a coolant system with one set of instrumentation for the even stages and one set for the odd stages. Coolant temperature and pressure are indicated on the cell panel. The pressure indicating controller (PIC) indicates the position (percent open) of the control valve (CV) located in the cooling water supply line. Changes in stage temperature cause corresponding changes in coolant temperature and pressure. The coolant pressure causes the water control valve to open or close to maintain the appropriate coolant temperature. The coolant pressure can be controlled manually.

An alarm is received when the coolant temperature becomes too high or when the coolant pressure becomes too low. The low coolant pressure alarm has been replaced with a R-114-RCW low differential pressure alarm at Purge and Evacuation Stations. This alarm consists of an audible and visual alarm in the ACR and a visual alarm on the local cell panel. The low pressure alarm point and corresponding coolant pressure will vary depending on the pressure transmitter range. An alarm on low coolant pressure will be actuated so that any relatively low coolant pressure will be noted and corrective action may be taken. For Purge and Evacuation Stations, the low pressure switch has been replaced with two differential pressure switches that monitors the R-114 and RCW pressure directly. A low differential pressure alarm provides a warning that the RCW could leak into the coolant system and then potentially into the process gas, if these systems are breached.

If the high temperature alarm fails or if for some reason the system coolant pressure becomes extremely high, increasing the probability of rupturing the system, a high pressure trip circuit has been installed in the system to shut down the cell motors. In all process buildings this system consists of a pressure blind switch (PBS) and an associated relay tied into the system coolant vapor line. In the event that this circuit is actuated, either accidentally or by overpressure, it is necessary to manually reset the switch before the cell motors can be restarted. A block valve upstream of the PBS permits isolation of the system during maintenance. This valve is normally sealed open. The PBS may be isolated (electrically or mechanically) during operation of the system it serves with the appropriate actions and precautions The seal is inspected on a quarterly basis to ensure that the PBS is on-stream.

An R-114 Coolant Overpressure Control System is the primary protection if the PBS should fail. This system, in all process buildings, is a rupture disc system designed to relieve the system pressure prior to rupturing the coolant system. It consists of a block valve in series with one or two rupture discs manufactured from materials suitable for use with coolant and a cone diffuser to prevent roof damage in

case the discs rupture due to overpressure. Some systems in C-310 and some auxiliary systems are not equipped with a cone diffuser. The block valve is sealed open to assure the rupture discs are exposed to system pressure when required. PGDP purchases rupture discs that are manufactured in accordance with the requirements of the ASME Boiler and Pressure Vessel (B&PV) Code, Section VIII. Rupture discs are applied and installed in PGDP systems based on Section VIII requirements. The block valve seal is inspected to assure it is intact to prevent the inadvertent closing of the valve. In C-310, and some auxiliary systems, a single rupture disc is used. The R-114 Coolant Overpressure Control System is important to safety as described in Section 3.15. The pressure settings for the cell coolant PBS and rupture disc are shown below:

Cell coolant high pressure protective devices

Component	C-331, C-333, C-335, C-337	C-310
PBS	225 psia	150 psia
Rupture disc	300[a] psig	200[a] psig

a. MAWP, disc ruptures at ± 5% of the rated pressure, as allowed by code. The rated actuation pressure can be conservatively less than those values stated above. Pressure settings for auxiliary systems are also determined by the system MAWP.

3.3.5.6 5.5 wt. % UF_6/R-114 Separation System

Another cell servicing system is the 5.5 wt.% UF_6/R-114 separation system in C-335. The 5.5 wt.% UF_6/R-114 separation system is used to freeze out UF_6 from process gas that has been significantly contaminated with R-114 coolant. Such mixtures usually result from equipment failure but may also result from abnormal cascade operation. The surge drums are used to store these mixtures until they can be separated. The primary purpose of the 5.5 wt.% UF_6/R-114 separation system is to remove the coolant and return the UF_6 to the cascade. The 5.5 wt.% UF_6/R-114 separation system is located on the ground floor in building C-335.

3.3.5.6.1 Process Operation Description

In the event that a large amount of R-114 coolant has entered the cascade, the process gas containing the coolant is isolated in a portion of the cascade and manually routed to surge drums for storage. The UF_6 is recovered by processing the process gas through the 5.5 wt. % UF_6/R-114 separation system. The separation system operates by freezing out the UF_6 from the process gas. To freeze out the UF_6, the UF_6/R-114 mixture is transferred from the surge drum (via pressure differential or process gas pumps) through a refrigerated set of favorable geometry cold traps. The gas stream then passes through sodium

fluoride (NaF) traps and alumina (Al_2O_3) traps to absorb any residual UF_6. Typically, the gas stream flows through the alumina traps, although these traps can be bypassed. The trap discharge is connected to the seal exhaust/wet air pump system and to atmosphere through the existing common discharge header. Coolant may be recovered from the seal exhaust/wet air discharge prior to venting to atmosphere. The UF_6 is sublimed back to cascade after the processing of the coolant-laden gas has been completed.

Three sets of chemical traps are provided to ensure that the UF6 concentration in the gas vented to the atmosphere is reduced to levels below plant limits. The first set of traps consists of four NaF traps; only two are normally in operation at any given time. The second set of traps consists of three Al_2O_3 traps downstream of the NaF traps. Two of these traps are operated in parallel, with the third in series. The third set of traps is two Al_2O_3 traps associated with the seal exhaust/wet air station. Space recorder trending and alumina trap heat up downstream of the NaF trap may be used to indicate breakthrough of the NaF trap. The process would then be discontinued and the NaF regenerated by desorption of the UF_6 through heating. The discharge of the Al_2O_3 traps is connected to the seal exhaust/wet air pump station. The seal exhaust/wet air pump also ensures a pressure differential across the system, which provides the pressure differential for flow through the separation system.

3.3.5.6.2 Major Components

The 5.5 wt.% UF_6/R-114 separation system major components include the cold traps, NaF traps, alumina traps, and assorted piping and valves. The cold traps, NaF traps, and alumina traps are discussed in more detail in the following sub sections.

3.3.5.6.2.1 Cold Traps

The purpose of the cold traps is to allow UF_6 to be frozen out from the process gas (R-114 and air primarily) and allow the UF_6 to be returned to the cascade. The remaining process gas and remaining small amount of UF_6 is further treated to remove most of the UF_6 in the NaF and Al_2O_3 traps. The cold traps are a set of four individual cylinders, each with a diameter that is favorable for nuclear criticality safety. Each individual cold trap cylinder is externally heated and cooled.

3.3.5.6.2.2 Sodium Fluoride Traps

The sodium fluoride (NaF) traps are the first of a series of chemical traps used to scrub residual UF_6 from the process gases (primarily R-114 coolant). The four NaF traps are in two heated cabinets, two traps per cabinet. The NaF traps can also be filled with Al_2O_3 and operated as Al_2O_3 traps. When a high concentration of UF_6 occurs downstream of the traps, the traps have become saturated with UF_6 and must be regenerated. This requires removing the trap from service, desorbing the UF_6 by heating the trap while bleeding a nitrogen/fluorine mixture through the trap.

3.3.5.6.2.3 Alumina Traps

These chemical traps are used to remove residual UF_6 remaining in the process gas prior to entering the seal exhaust/wet air system and eventually direct discharge to atmosphere, or processing by a R-114 recovery process and discharge the remaining gases to the atmosphere. The Al_2O_3 in these traps must be replaced when the media is loaded

.

3.3.5.6.2.4 R-114 Recovery Process Equipment

The recovery process is an optional technique that can be connected to the discharge of the C-335 #7 seal exhaust/wet air pump to allow recovery of R-114 from the process gases exiting the UF_6/R-114 separation system. The recovery process, typically obtained through contracted vendor services, consists of equipment necessary to condense the R-114 from the gases prior to discharge to atmosphere and processing of the R-114 to the degree necessary to yield material acceptable for reuse by process equipment. The outlet of the recovery process is connected to the common discharge header of the seal exhaust/wet air system. The separation system process gases can also be vented directly to atmosphere from the seal exhaust/wet air system, bypassing the R-114 recovery process.

3.3.5.6.2.5 Cold Trap Refrigeration/Heating System

The cooling during freezing for the cold traps is supplied by an external refrigeration system. The refrigeration system uses ethylene glycol as a coolant media. The refrigeration system heat sink is RCW. External electrical heaters provide heat for subliming the UF_6 from the cold traps.

3.3.5.6.3 Instrumentation and Controls

The 5.5 wt.% UF_6/R-114 separation system instrumentation and controls include a portable UF_6 analyzer, space recorder, and general process control. These instrumentation and controls are discussed in more detail in the following sub sections.

3.3.5.6.3.1 Portable UF_6 Analyzer

A portable UF_6 analyzer on the discharge of the cold trap is used during freeze mode to indicate UF_6 concentration and proper cold trap operation. The analysis may not be continuous.

3.3.5.6.3.2 Space Recorder

A space recorder monitors the discharge of the NaF traps prior to the first set of Al_2O_3 traps. The space recorder provides continuous monitoring of the NaF trap output for UF_6 concentration. In the event the space recorder is not available, a UF_6 analyzer can be used. If the UF_6 concentration exceeds a preset value, indicating breakthrough of the NaF trap media, the NaF trap is shutdown and the trap media regenerated or replaced.

3.3.5.6.3.3 Administrative Control

In addition to the administrative controls in Chapter 4.0 and the controls covered by programs and plans, the following control ensures safe operation of the 5.5 wt.% UF_6/R-114 separation system. An administrative control is employed to ensure that F_2 is not valved into the system except during regeneration, conditioning, or passivation modes of operation.

3.3.5.7 Electrical System in Process Buildings

The process system electrical system consists of four major elements: transformers, switchgear, static capacitors, and motors. The transformers, switchgear, static capacitors, and Auxiliary Power are described in Section 3.9. The motors are described in Section 3.3.4. The UF_6 Compressor Motor Manual Trip System is discussed in Section 3.3.4.3.3.1.

3.3.5.8 Seal Exhaust/Wet Air System

The seal exhaust/wet air (SE/WA) system provides an exhaust for the seal cavities on the UF_6 compressors, P&E pumps, booster pumps, and for wet air evacuation. The seal exhaust evacuates air and/or nitrogen leaking through seals, thus preventing this inleakage from entering the process gas (UF_6) enrichment system. The wet air evacuation system is used to evacuate those equipment/portions of the cascade that have been opened to atmosphere, for maintenance, prior to returning those systems to service. This evacuation removes contaminants that may interact with the process gas to form deposits or undesirable by-products within the UF_6 enrichment cascade. The wet air system may also be used to obtain a UF_6 negative or HF (hydrogen fluoride) sweeping of various cascade systems or components. Depending upon location (e.g., C-310, C-331, C-333, C-335, and C-337), there may be either seal exhaust, wet air, or combined seal exhaust/wet air pumping stations. Realignment of available valving enables selected pumping stations the ability to provide either the seal exhaust or wet air exhaust function. However, in practice, operations personnel prefer not to realign the seal exhaust pumping stations to provide a wet air exhaust function since this realignment reduces the available seal exhaust capacity for the affected location.

The systems are made up of vacuum pumps, alumina traps, valves, wet air headers, seal exhaust headers, seal exhaust header control valves, and where required, oil overflow tanks. Oil mist eliminators are installed on the vacuum pump discharges to filter visible oil from the exhaust and return the collected oil to the pump reservoir. The alumina traps, located on the suction side of each pump, remove traces of UF_6 from the gas before entering the pump. The alumina traps prevent damage to the pumps from the process gas and serve as the final engineered barrier between the process gas and the environment. The seal exhaust headers are maintained at a constant pressure at each cell through the use of control valves on the exhaust header serving each cell. This is accomplished by using two separate lines from the main header, one serving the "A" seals and the other serving the "B" seals. The seal exhaust control valves are located in each of the seal exhaust headers and allows for each of the headers to be regulated at the desired pressure.

The vacuum pump oil supply line is physically disconnected from the building lube oil supply and the pump is filled using an individual manually controlled valve to prevent exceeding the geometrically favorable level of oil in the reservoir. An oil overflow system is incorporated to ensure the oil level (as measured from the bottom of the oil reservoir cover plate) does not exceed 4.75 in. C-333 does not have an oil overflow tank.

Operating experience over the past 30 years has shown that the seal exhaust pumps will not discharge large quantities of UF_6 before failure. The UF_6 reacts with the vacuum pump oil and greatly increases the viscosity of the oil causing the pump to shut down.

Many operating, maintenance, waste handling, and design aspects are taken into account when establishing nuclear controls and would include considerations of safe geometry, interaction, and potential UF_6 loading. The vacuum pump stations are under configuration control for nuclear criticality safety. Controls for design, maintenance, and operation of the vacuum pumps are established under the Nuclear Criticality Safety Program described in Section 5.2.

Waste oil and spent alumina are handled in accordance with waste management programs. The spent alumina is placed in containers of favorable geometry which are approved by Nuclear Criticality Safety (NCS) for operations involving fissile material.

3.3.5.9 Process Instrumentation

The control and monitoring of the vast number of stages in the cascade requires hundreds of pneumatic and electrically operated instruments. Many stages of the cascade are grouped into manageable units through the use of various instruments.

Because of the sensitivity of barrier and compressor performance to the cascade pressure level, it is desirable to maintain the operating pressures accurately. Temperature and gas composition are variables that must be maintained as well. Instrumentation at various points monitors the process system and automatically regulates the pressures and temperature to the desired levels.

Pressures in the cascade are sensed by differential pressure transmitters and compared to a reference "datum pressure."

3.3.5.9.1 Datum System

The Datum System consists of a volume of dry air, that can be fed and exhausted through pressure control instruments to maintain a preset pressure level. A low datum pressure supplies a reference pressure for measuring "A" suction pressure but is not used for control. A high datum system provides reference pressure for measuring and automatically controlling the cell high side pressures. Since the unit pressure transmitters and controllers are referenced to the same datum system, a shift in datum pressure will produce a movement of the cascade inventory within the unit. This technique can be used when inventory shifts or new operating conditions are desired. An instrument called a pressure level index (PLI) is used to control stage pressures as a group within a cell.

There are four types of datum systems: low datum (controlled at the datum station), high datum (controlled at the datum station), cell datum (controlled at the cell), and freezer/sublimer (F/S) datum (controlled locally at the F/S datum panels or utilizing the distributed process control system (DPCS)). The datum systems provide reference pressures to increase the precision in the measurement of the stage pressures for UF_6 inventory accountability and control purposes. These systems utilize static lines to maintain controlled reference pressures of dry air in the high side of the stage differential blind multiplier (DBM) transmitters and are equipped with dry air feeds, exhaust systems, controllers, and pressure blind multiplier (PBM) transmitters for maintaining the datum pressures. The datum station in each area contains controls for the high datum, spare high datum, and the low datum for each unit.

Components of the High and Low Pressure Datum Systems that are required to control the operating pressure of the cascade and provide a direct indication of the cascade systems' pressure that is used in the nuclear materials control and accountability (NMC&A) process are important to safety as described in Section 3.15 (See Figure 3.3-16).

The support systems for the High and Low Pressure datum are plant air, 480 VAC electric power, and 120 VAC electric power. The 480 VAC that supplies the datum exhaust pumps comes from the auxiliary power through a unit substation. The 480 VAC is transformed to 120 VAC and goes through a distribution panel to power datum pressure transmitters in the "00" buildings. Loss of 120 VAC results in a low air pressure signal. Also, if air pressure varies by 0.1 psia from its setpoint, a solenoid block valve is energized and closes. If air pressure decreases below a specific value or the exhaust pressure increases above 0.5 psia, an alarm will be received in the ACR and the datum is isolated. That portion of plant air, 480 VAC electric power for the datum exhaust pumps, and 120 VAC electrical power for some datum transmitters and a solenoid block valve which supports the datum systems are important to safety, as described in Section 3.15. See Section 3.9 for a description of plant air and the AC Power system.

3.3.5.9.1.1 High Datum System

High Datum Systems are found in C-331, C-333, C-335, C-337, and some cells in C-310.

This type of datum is controlled at the building datum station located near the area control room (ACR). It provides reference pressures for measuring and controlling high-side pressures. Figure 3.3-16 shows a detailed schematic of a typical datum system. The High Datum System consists of an automatic system and a manually operated system which serves as a spare in the event of the failure of the automatic system. The building seal exhaust header is connected to the datum exhaust pump manifold and may be

used in the event of datum pump failure. The outlet port of the inverting booster relay (IBR) controls the datum pressure to the surge drum (compensates for short-term fluctuations in pressure). Normally there is very little or no air entering the surge drum from the IBR since the datum system is a dead end control system. However, if the datum pressure should fall, the input to the PBM would decrease and its output to the pressure indicating controller (PIC) would decrease. As the pressure varies, the High Datum System will bring the pressure back to the control point. Once the pressure reaches the control point, the IBR would assume its normal position. The reverse action would take place should the datum pressure increase. The IBR would close down on the air feed and the exhaust system would exhaust the excess pressure from the surge drum until the pressure decreased to the control point. From the surge drum, the datum pressure is sent to the unit datum header. The datum pressure is piped through tubing to each cell in the unit. From the cell, the tubing branches off a header to each stage DBM.

In the event of the failure of the automatic part of the High Datum System, the manual system can be put into operation. The feed is supplied from instrument air and the exhaust is provided by the datum pumps. Each unit high datum header has a spare datum controller. The spare high datum controller is a manual controller used to control high datum pressure if the normal high datum fails. The building seal exhaust header is connected to the datum exhaust system as a backup exhaust path in the event of a failure of the datum exhaust pumps or a blockage in the datum exhaust system.

A pneumatic block valve in the High Datum System is part of the unit high datum isolation system. The block valve is spring loaded to close and requires air pressure to open. The valve is controlled by a three-way solenoid valve, which operates to vent the air from the pneumatic valve, allowing the valve spring to close the block valve.

The solenoid valve is caused to operate by pressure switches monitoring system parameters. When the solenoid valve is operated, alarms are activated at the datum control panel and the ACR. The loss of instrument air to the datum control instruments, datum system pressure going a set amount above or below its normal operating setpoint, or datum exhaust systems high pressures will cause the three-way solenoid to close the pneumatic block valve, isolating the unit datum systems in the area so that the datum pressures will not change.

The alarms and lock-ins are checked in accordance with plant procedures by operations personnel. Unit high datums are checked before each cascade inventory to ensure accuracy of cascade inventory.

3.3.5.9.1.2 Low Datum System

Low Datum Systems are found in C-331, C-333, C-335, C-337, and C-310.

The Low Datum System is controlled at the building datum station near or in the ACR and provides a reference pressure for measuring all stage “A” suction pressures in the unit the low datum serves. The Low Datum System header distributes the datum pressure created by the IBR to the unit. See Figure 3.3-17.

The low datum in C-310 also serves as the high datum for the high-speed cells providing a means to measure and control stage discharge pressures for these cells. Adjustments can be made with the low datum controller without having an effect on low speed cell pressures.

There are no alarms associated with the Low Datum System except in C-310. In C-310 the low datum has the same type alarms as the high datum, since it serves as the high datum for some cells.

A spare low datum is applicable to C-310, C-333, and C-337 Low Datum Systems. C-331 and C-335 do not have an installed spare low datum. The Low Datum System header distributes the datum pressure created by the IBR to the datum header. The spare low datum in C-310 is controlled by a manual controller.

With the exception of C-337 spare low datum, all exhaust goes through the same datum exhaust pumps as the High Datum System. In the C-337 spare low datum, a separate spare low datum exhaust pump is used to direct excess air pressure to the exhaust header.

Unit low datums are checked before each cascade inventory to ensure accuracy of cascade inventory.

3.3.5.9.1.3 Cell Datum System

Another type of datum system is the cell datum system which provides a reference pressure to the high side of the stage DBMs in the same manner as the high datum. It is similar to the manual part of the High Datum System. There is a cell datum system for each cell in the cascade. Cell datum systems are self-contained systems and are located at the local cell control panels. The cell datum system consists of pressure instrumentation, associated valves and piping. A typical cell datum system is shown in Figure 3.3-18. In normal operation, the cell datum block valve is closed and the unit datum system furnishes the datum pressure for the high side DBMs of each cell. In the event of trouble with the unit datum system, the cell datum can be valved into the unit datum header and a whole unit can be operated on a single cell datum system. However, the cell datum system is not as accurate as the unit datum system. Cell datum is normally used when a cell is out of the control range of the high datum, such as evacuating or charging a cell. Cell datum is also used in emergency situations such as: loss of high datum and loss of F/S datum. The individual cell datum can be placed in service by isolating the high datum header and opening the cell datum valve.

3.3.5.9.1.4 Freezer/Sublimer Datum System

Each F/S datum panel will maintain controlled reference pressures of dry air to the high side of the stage DBM transmitters for five cells within the unit. The “00” buildings have two F/S datum controllers for four units, while the “000” buildings have two F/S datum controllers for six units. In all of the “000” and some of the “00” buildings the odd and even unit datum headers can be tied together. Either datum system can be used to supply the odd and even datum headers, if the need arises. This also allows each F/S datum to control both odd and even cells. The datum pressures for the even and odd unit datum header and the alarms for the F/S datum system can be monitored in the ACR on the DPCS and at the local panel. In addition, the F/S datum system is equipped with a spare datum controller in the event the normal controller fails. Also, the F/S datum exhaust is provided by the Seal Exhaust pumps by way of the unit and building Seal Exhaust header.

3.3.5.9.2 Stage Instrumentation

The purpose of stage instrumentation is to control the flow of process gas between stages. Gas flow is maintained by holding a constant pressure on the barrier. Stages have similar instruments which function alike. The process gas is controlled at each stage by a stage control valve whose position is indicated and set by a stage controller. The controller can be operated on automatic or manual control. A typical stage pressure control is shown in Figure 3.3-19.

3.3.5.9.3 Temperature Instrumentation

Cell temperatures are regulated by controlling the coolant pressure in the coolant systems. This is based on the principle that fluids such as the coolant have specific vapor pressures associated with temperature. Therefore, a coolant pressure can be specified that will yield the desired UF_6 temperature.

Coolant pressures are monitored and controlled at the local cell panel. Alarms are actuated on the local cell panel, the ACR and on selected cells from the ADP system in the ACR ("000" and "00" only) when the coolant temperature exceeds the set limits.

The temperatures of individual stages are monitored by thermocouples installed in the gas lines and indicated at the local cell panel.

3.3.5.9.4 Analytical Equipment

The process gas stream is monitored as necessary to maintain the proper assay of material and to determine the concentration of gases such as nitrogen, coolant, fluorine, and ClF_3. Several types of analyzers are used which include mass spectrometers (refer to Section 3.3.3.2 for a description) for assay measurement (referred to as assay machines) and miscellaneous gas concentration detection equipment (referred to as line recorders); infrared and ultraviolet analyzers for fixed and portable measurement of F_2, ClF_3, UF_6, coolant, and other gases; and space recorders for measurement of UF_6 at low concentrations. Connections are provided at each cell to accommodate portable analytical instrument usage whereas most fixed application instruments can be aligned to various locations via manifolds to assist in activities such as inleakage location.

3.3.5.9.5 UF_6 Release Detection System

The Cascade UF_6 Release Detection Systems have detection and alarm functions only. They are available to monitor cascade equipment that is operated above atmospheric pressure. The UF_6 Release Detection Systems are important to safety as described in Section 3.15. Figure 3.3-20 provides a simplified block diagram of a typical cascade UF_6 Release Detection System.

The operation of the systems are described in the following paragraphs.

Multiple detectors are installed in cell housings, bypass housings, and above the "B" seals on the axial flow compressors. The detectors are typically mounted inside, near the top of the housings. The housing of interbuilding tie-lines that operate at pressures exceeding atmospheric are also equipped with release detectors. The detectors are connected to signal conditioners that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate alarm indications.

3.3.5.9.5.1 Detectors

The UF_6 detectors in the cascade operate by means of a cold cathode tube and dual ionization chambers—one chamber to detect UF_6 release reaction products in the air, and one that serves as a reference to help stabilize the detector's sensitivity for changes in ambient temperature, humidity, and pressure. In the detection chamber, ambient air in the gap between two charged electrodes is ionized by an alpha-emitting source. As the concentration of particles in the air increases to a characteristic point, the cathode tube produces an output signal. Detector sensitivity is maintained by twice each shift applying a bias voltage to the detectors, which increases the voltage at the cathode starter electrode and produces an electrical simulation of the presence of UF_6 reaction products. Records from the many tests conducted on detector sensitivity, operating at elevated temperatures, indicate that a firing of detector heads on an eight-hour interval is sufficient to maintain a sensitivity that will detect UF_6 leaks.

The UF_6 release quantity that would actuate the detectors is established as follows. On the basis of the drawing of a typical cell housing ("000"), it was calculated that the volume internal to the cell housing was approximately 116,000 ft^3 (after subtracting the volume of the cell equipment itself). Assuming a release that is perfectly mixed within the cell housing, a release of 2.14 lb of UF_6 would provide a concentration of 200 mg/m^3 which would activate all of the detectors in the cell housing within 30 seconds. It should be noted that a release in cell housings with smaller volumes than the "000" equipment housings ("00" or withdrawal area housings) would actuate all the leak detectors at smaller release quantities. Actually, the release would initially have two components: the reaction products of UF_6 and H_2O, and unreacted UF_6. The reaction of UF_6 with moisture in the cell housing air would contribute approximately 124 BTU/lb UF_6 reacted. At 50% relative humidity, there would be enough moisture in the cell housing air to react with about 1500 lb UF_6 and would generate about 200,000 BTU. The reaction would be primarily adiabatic due to the rapid reaction rate and the poor heat transfer mechanisms from the gas phase to the cell housing and cell equipment. Assuming adiabatic reaction, the temperature of the gases in the cell housing would increase initially by about 120 ºF from a normal operating temperature of about 200 ºF. If there were only 10% relative humidity, the initial temperature increase would be about 25 ºF. It should be noted that the reaction products would be considerably hotter initially because complete mixing would not occur instantaneously.

The heat of reaction would cause the reaction products to rise to the top of the cell housing and spread out along the top. Since the UF_6 leak detectors are within about 3 feet from the top of the cell housing which is approximately 19 ft in height, it would only take a fraction of the amount discussed earlier to cause the detectors to actuate. This is consistent with plant experience with the ability of the UF_6 detectors to detect very small leaks that required considerable searching and leak testing to discover. This indicates that, for the postulated accidents described in Section 4.3.2, that one operational detector in the cell housing would be more than adequate to detect the release. It also points out that a release of the magnitude described in the Section 4.3.2 would actuate every operational detector in the cell housing and probably within adjacent bypass and cell housings as the release spread through the bypass housings. The time to reach the concentration required would be within seconds of the postulated releases.

The number of detectors required to be operational to detect the releases postulated should be one per cell housing. The housing of interbuilding tie-lines that operate at pressures exceeding atmospheric should have one operational detector at each end of the tie line. However, due to the extreme non-specificity and sensitivity of the detectors and their desired operational capability of detecting very small releases, it is desirable to have more than one detector operational per cell housing since actuation of one detector is not necessarily an indication of a

UF_6 release. Therefore, the safety function of shutting down the cell would not be taken in response to a single UF_6 detector actuation alone without some investigation nor would the cell be shut down due to the response of a single detector due to actuation causes other than a UF_6 release.

Operability of the detectors is assured by periodic testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 release products is also known with regard to particle size and mass concentration. An engineering evaluation concluded that the particles generated during a UF_6 release are in the same size range as the particles generated by the test smoke. Historical laboratory analysis shows that the detectors are capable of detecting smoke concentrations lower that that generated by the test smoke.

3.3.5.9.5.2 Signal Conditioners

The signal conditioning units control system operation and energize relays that initiate alarm circuitry upon detector actuation. The signal conditioners also provide a means to manually test fire the detectors. The power supply converts 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits. Lamps on the signal conditioners indicate the firing status of individual detectors. Actuation of a detector enables the signal conditioner to actuate designated alarm circuits. The alarm relay latches in the "on" position until manually reset. The 120 VAC power is a support system which is important to safety as described in Section 3.15.

3.3.5.9.5.3 Operation

The UF_6 Release Detection Systems interface with the Automatic Data Processing (ADP) unit substation computers (see Figure 3.3-20). However, the computers cannot actively support the detection system. The ADP system provides operator interfaces at the ACRs and the C-300 Central Control Building for the detector systems. The cascade UF_6 Release Detection Systems are operated manually independent of the ADP computers.

The detectors are test fired manually, and the ADP system can be used to monitor detector status. In this case, a fixed voltage is applied manually from each local signal conditioner to test fire the detectors. Manual firing is conducted on each shift. In the event of detector actuation, the ADP alarm printer in the ACR is capable of indicating which detector actuated and whether the actuation represents a trouble condition or an alarm.

An audible alarm and general alarm light are received in the ACR cell panel when a detector is tested or alarmed. An operator must go to the local cell panel ("000" and "00" only) to determine which detector has alarmed. The operator then investigates and takes the proper action to shut down the cell or to determine the cause of alarm, if no UF_6 release is found.

3.3.5.9.5.4 Support Systems

The 120-VAC electric power supply to the UF_6 Release Detection Systems in the cascade is supplied from the plant process auxiliary power system. Power is fed to the detector systems in each cascade unit from local panels to the detector system signal conditioners located in local operating panels on the operating floor.

Nominal 125-VDC power is required for the UF_6 release alarm and annunciator circuits in the ACRs. DC power is supplied from the building DC electrical system.

The 120-VAC power and 125-VDC power are support systems that are important to safety as described in Section 3.15.

3.3.5.9.5.5 Alarm Indications

The Cascade UF_6 Release Detection Systems have the following alarm indications:

- An audible alarm and a light actuate in the ACR to indicate cell location in the event of detector actuation.
- An individual detector alarm indicator light on the front of the signal conditioner is illuminated when a detector actuates.

3.3.5.9.6 Vibration Detection

There is a compressor vibration detection/monitoring system that contains trip circuitry. The trip circuitry is typically enabled on the "00" and centrifugal compressors. This system can be set: 1) to print out a high vibration level on the ADP system, 2) to print out on the ADP and alarm in the ACR on high vibration, or 3) to print out on the ADP, alarm in the ACR, and trip the cell on high vibration. The vibration detection systems provide operational information used for the protection of the cascade equipment.

3.3.5.9.7 Surge Drum Pressure/Room Temperature Instrumentation

The surge drum pressure instrumentation and room temperature instrumentation perform a safeguard function to provide pressure and temperature readings utilized in the NMC&A (Nuclear Material Control and Accountability) inventory calculations. See Section 3.3.3.2.3 for a discussion of NMC&A inventory instrumentation. The surge drum pressure instrumentation and room temperature instrumentation are important to safety as described in Section 3.15.

Each of the "00" and "000" cascade buildings contain several banks of surge drums for use in UF_6 processing. The banks of surge drums are enclosed in insulated rooms. For operation of the surge drums, the surge drum temperature and pressure levels are maintained to keep both HF and UF_6 in the gaseous phase. To maintain the gaseous state requires accurate indications of the pressure and temperature of these drums.

For pressure indication, each bank of surge drums is connected by small tubing to a pressure transmitter or transducer usually located in the surge drum room. This transmitter sends its output signal to the Area Control Room panels and the C-300 Central Control Building. Surge drum bank pressure recorders are located in the area control room.

The drum room ambient temperature is monitored and indication is provided at each drum room.

The support systems for the Surge Drum Pressure Instrumentation are plant instrument air and 120 VAC electric power back to the first breaker. The 120 VAC is supplied to the instrumentation from the ACR terminal cabinet. Upon loss of the 120 VAC electric power, the drum instrumentation would be affected indicating the presence of a problem. The pressure could then be read by connecting instrumentation to the local valve panel. Upon loss of the plant instrument air, the pressure transmitters would drop to a 0 psig output. This would cause the Recorder to indicate less than zero. This would indicate a problem with the instrumentation. The pressure could then be read by connecting instrumentation to the local valve panel (individual drums can be valved in for a reading). These support systems are important to safety as described in Section 3.15 and are discussed in more detail in Section 3.9.

3.3.5.10 Process Lube and Hydraulic Oil Systems

Each cascade unit is provided with a lubricating system to maintain a continuous supply of oil to the compressor and motor bearings. This same system supplies oil to operate the hydraulic stage control valves in the "000" buildings. The nominal building lube oil capacities (including supply tanks, drain tanks, headers, and piping) are:

C-331, C-335	The capacity for the system is approximately 60,000 gallons.
C-333, C-337	The capacity for the system is approximately 135,000 gallons.
C-315	The capacity for the system is approximately 375 gallons.
C-310	The capacity for the system is approximately 14,000 gallons.

3.3.5.10.1 Process Lube Oil System

The process recirculating oil system is designed to maintain a continuous and adequate supply of lubricating oil at a controlled temperature and free of abrasive matter to the bearings of axial compressors, centrifugal compressors, and electric motors of the cascade process equipment. The unit lube oil systems also serve the booster pumps and motors as well as hydraulically operated stage control valves in the "000"-size equipment.

Individual units within the cascade areas are equipped with recirculating lube oil systems, which include recirculating pumps, oil strainers, supply and drain tanks, and an oil cooler. This equipment, coupled with the necessary supply, drain and vent piping, and the instrumentation for manual and automatic control, comprises the basic components of the system (see Figure 3.3-21).

Oil is pumped from the unit drain tank to the unit supply header and supply tank by means of lube oil pumps. This oil is filtered through a lube oil strainer and is cooled by a water-cooled heat exchanger. Oil flowing to each cell is filtered through a second oil strainer before entering the equipment bearings. One lube oil pump will supply more oil than is required for one unit of compressor and motor bearings. Surplus oil is pumped to the oil supply tank and overflows through a weir, which is located near the top of the tank. The overflow oil drains into the drain tank.

3.3.5.10.1.1 Drain Tank

Each unit in the "00" cascade buildings has a single drain tank. The "000" cascade buildings contain two drain tanks in each unit. Excess lubricating oil in the supply tank is returned to the ground floor drain tank along with the system oil drain. The drain tank provides one of the main reservoirs for the lube oil inventory in each unit and can contain the entire normal inventory of the system when a unit is shut down.

All building lube oil systems have level indication and alarms on the drain tanks. The level-indicator alarms close a set of electrical contacts that actuate a high/low-level alarm to warn personnel of a high/low-level drain tank condition.

A retaining dike around the drain tanks and pumps is capable of holding the normal quantity of oil contained in the system in the event a rupture or leak occurs in the pit area. However, in the event of an oil spill and a fire that activates the sprinkler system, the liquid capacity of the pit could be exceeded. To prevent a mixture of oil and water from spilling out over the dike area, a liquid sump pump has been installed at each lube oil pit, which discharges to the storm sewer, although a portable line can be connected to it to reroute the discharge elsewhere. This pump can be started manually from the local control panel at the pit or will start automatically when liquid level in the pit becomes excessive and/or upon actuation of a sprinkler system over the lube oil pit.

3.3.5.10.1.2 Recirculating Pumps

One of the recirculating pumps is operating continually to supply lube oil to the unit supply header and the supply tank.

The normal power supply to the lube and hydraulic oil pumps in C-333 and C-337 is fed from the 480-volt auxiliary power system. In C-333 and C-337, the system contains permanent ties from two different substations plus an automatic tie-breaker system that will furnish power from either substation. In C-331 and C-335, a manual disconnect can be closed to furnish auxiliary power from a different pair of substations. The C-310 building has both a manual disconnect and an automatic tie-breaker that will furnish power from another substation. Each of these substations receive power from a separate feeder so that one feeder can be out and normal power is still available to the lube oil pumps.

The supply line motor-operated valve is also electrically interlocked to prevent the recirculating pumps from operating when the valve is closed. Another electrical interlock prevents the valve from being closed when either pump is running.

3.3.5.10.1.3 Recycle Line

The lube oil system maintains a proper supply tank level by using a recycle line. All of the unit lube oil systems are equipped with a manual recycle valve for coarse adjustments and all buildings, excluding C-315 have an automatic recycle adjustment used for fine control. In process buildings that have automatic lube oil recycle control, the level controller opens the control valve to allow more lube oil to recirculate through the pumps. In both instances, the manual recycle valve must be set in proper position for the automatic recycle valve to function properly.

To correct a high lube oil level condition in the supply tank for C-315 which does not have automatic recycle, operations personnel manually adjust the lube oil recycle control valves. Only one lube oil pump is operating under a high lube oil level condition. The recycle system, both manual and automatic, bypasses enough lube oil to the suction of the pumps to maintain the lube oil at the operating level. If for some reason an automatic recycle control system fails and the supply tank lube oil level increases beyond the operating level, an alarm would be received and the manual recycle valves must be adjusted to return the supply tank level to normal.

3.3.5.10.1.4 Strainers

After the oil is discharged from the recirculating pumps, it passes through an oil strainer for the removal of foreign material that can damage bearing surfaces. Operations personnel switch a strainer if the differential pressure across the strainer exceeds normal. The normal pressure drop across the strainer varies from unit to unit. Operations personnel check each strainer for plugging. During each shift, the differential pressure across the filter and the oil temperature are checked and logged.

The pressure gauge or gauges checking differential pressure across the unit strainer give only a local indication of strainer conditions. Operations personnel are made aware of an immediate plugging condition by visual and audible alarms in the ACR. The alarm is activated by a pressure switch located in the lube oil header on the inlet to the unit lube oil strainer.

3.3.5.10.1.5 Lube Oil Cooler

The lubricating oil leaves the strainer to pass through a shell and tube heat exchanger which removes heat from the oil before it is pumped to the equipment bearings on the cell floor. Cooling water from the RCW system flows through the tubes of the heat exchanger while the oil enters on the shell side.

The lube oil temperature is maintained by regulating the flow of RCW from the RCW supply header through the exchanger.

Operations personnel can read the RCW pressure that is present in the lube oil coolant system by means of a pressure gauge. The normal water pressure in the exchanger tubing is maintained lower than the lube oil pressure, for all systems except C-315.

A temporary lube oil cooler may be installed in a lube oil system to facilitate maintenance on the permanent cooler without shutdown of the system and associated cells. Some systems are equipped with valves for connection of temporary supply and return lines. When a temporary lube oil cooler is in use, manual valve throttling may be required for control of the cooling water flow rate and lube oil pressure.

Temporary lube oil cooler installations are arranged to ensure leakage from the temporary oil cooler and associated oil piping is contained and routed to the concrete retaining dike. The dike is sized to contain the normal volume of oil in the system and may not contain the additional oil due to the temporary cooler and piping. Also, some oil storage volume inside the dike could be lost due to the volume occupied by temporary equipment. The potential excess volume of oil is small relative to the overall system capacity and operation of the liquid sump pump located inside the diked area will ensure the dike does not overflow in the event of a major leak.

3.3.5.10.1.6 Supply and Drain Headers

The unit supply header provides a means for the lube oil to be distributed throughout the unit after leaving the exchanger. The feed line from the supply tank connects to the unit supply header, which progresses through the unit supplying lubricating oil to the stage compressors and motor bearings.

The cell header connects to the unit supply header. The cell (“00” buildings) or half-cell (“000” buildings) supply header contains a duplex strainer similar to the unit strainer, except smaller. In the “00” buildings the cell strainers are located on the cell floor, while the “000” buildings have the half-cell strainers located on the operating floor.

The drain lines coming from the compressor contain a sight flow indicator and a flame arresting vent. The cell drain header connects with the unit drain header which then drains into the drain tank.

The unit supply header has two vent lines to the roof, one at each end of the unit. To reduce the chance of oil being pumped onto the roof, the unit vent lines are extended above the supply tank vent line. This ensures that any excess oil will flow from the supply tank vent line through a drain line to a point inside the diked lube oil pit.

The booster stations can receive an oil supply from one of two unit supply headers and return to the respective unit drain header.

3.3.5.10.1.7 Supply Tank

Excess oil pumped to the supply header is carried to the supply tank located on the roof of the "000" buildings and just below the roof in the "00" buildings. The supply tank is maintained such that oil passes through the overflow pipe to the drain tank on the operating floor. Each cascade unit contains one lube oil supply tank. The main function of the supply tank is to furnish sufficient oil for bearing lubrication in the event of a lubricating oil pump failure. If both supply pumps fail to operate, the process bearings will receive sufficient lubrication by gravity feed flow from the elevated supply tank for approximately 15 min. During this time, if the oil is not restored, the equipment which needs lubrication must be shut down.

The process buildings' elevated supply tanks have connections for a vent line, a weir overflow line, and an oil supply line. The vent line serves to vent the top of the supply tank to atmosphere while the weir overflow line returns excess oil from the elevated supply tank to the drain tank below. During normal operation, the unit lube oil pump supplies lubricating oil to the elevated supply tank, as well as the bearings, but in the case of a pump failure the lubricant is furnished by the unit supply tank to the unit supply header. The supply tank normally operates approximately 95% full, which allows for some oil flow through the overflow weir.

Pressure switches control the lube oil level and alarm system. These switches actuate alarms in the ACR on a low or high level of lube oil in the supply tank. The low level switch automatically starts the standby lube oil pump.

3.3.5.10.1.8 Auxiliary Systems

Auxiliary systems that are supplied oil from the lube oil systems in C-310, C-310-A, C-315, C-331, C-333, C-335, and C-337 include "A" and "B" booster station pumps and motors, purge and evacuation system pumps and motors, centrifugal and high-speed pumps and motors, and purge and waste system pumps and motors.

The majority of these systems have instrumentation for alarming low lube oil pressure to the equipment bearings for shutdown of this equipment if the pressure continues to drop. The alarms for low lube oil pressure and system trip were installed to prevent bearing overheating.

When the lube oil pressure decreases to the setpoint, the pressure switch actuates alarms in the ACR. These alarms remain actuated until the problem is resolved. If the lube oil pressure decreases further, the PBS will actuate the pump and/or compressor systems' motor trip relay and de-energize the pump motor. Coinciding with the motor trip action is the energizing of the systems' solenoid-operated pneumatic valve.

Upon energizing the solenoid valve, the pneumatic-operated block valve is closed, shutting off the flow of lube oil to equipment bearings. The lube oil pressure must be restored to normal before Operations personnel can restart the shut down equipment. This is accomplished through a permissive control switch which is located on the local panel of the system. This switch must be depressed to allow

the lube oil solenoid valve to be de-energized. De-energizing the solenoid valve allows the air-operated block valve to be opened, supplying lube oil to the motor and compressor bearings. The low pressure trip alarms automatically reset when the lube oil pressure exceeds switch set pressure.

3.3.5.10.2 Hydraulic Oil System

The hydraulic oil system provides a continuous source of hydraulic pressure as the driving force for the operation of the process control valves in the "000" buildings. The "B" boosters also utilize hydraulic control valves.

The hydraulic oil systems within each "000" cascade unit utilize components of the lube oil system, including the lube oil itself, in such a manner that duplicated equipment is unnecessary. Lube oil drain lines and drain tanks serve both the lube and hydraulic systems within an individual unit. Additional components that make up the hydraulic system are the hydraulic oil pumps, oil filters, and the hydraulic oil supply lines. The hydraulic pumps take their suction from the unit lube oil drain tank and in turn discharge through a duplex filter to a common unit supply header. The common unit header supplies hydraulic oil to the cells through individual half cell systems. Each half cell system supplies four cascade stage control valves and is instrumented with a pressure indication on the downstream side of the half cell block valve. The hydraulic oil is returned to the drain tank from the control valves through the normal oil drain headers.

3.3.5.10.2.1 Hydraulic Oil Pump

Each "000" unit contains two pumps, one in operation and one which starts automatically on a loss of hydraulic oil pressure or through manually operated controls in the ACR or local to the pump. These pumps supply oil at sufficient hydraulic pressure to operate the stage control valves as necessary. The pumps take their suction from the drain tank through the lube oil pump suction header.

3.3.5.10.2.2 Filters

The hydraulic oil systems contain filters at two points within the system. A duplex oil filter, located on the pump discharge line, removes foreign material which may cause a malfunction of the hydraulic control valve operator. Separate oil filters are also located on the individual cell housings to serve each stage control valve.

3.3.5.10.2.3 Hydraulic Oil Lines

Essentially identical hydraulic oil supply systems serve the individual units of the "000" buildings. A typical system contains a common oil supply header which extends the length of the unit below the cell floor. From the supply header, individual half cell supply lines drop to within a few feet of the operating floor where the half-cell block valve is located along with a pressure indicator (PI) on the cell side. Individual filters are located on the outside of the cell housing near each stage control valve, and block valves are provided at each filter for the isolation of the filter and control valves.

The unit supply header may be vented near the extreme ends of the unit through vent valves located on the cell floor. These valves are normally closed. The hydraulic oil returns to the unit drain tank through the lubricating oil return lines.

3.3.5.10.2.4 Hydraulic Oil System Instrumentation

Hydraulic oil supply pressure is indicated at two locations within the building. The first PI is located on the main supply header on the cell side of the main hydraulic oil strainer at each lube oil pit. This PI alerts Operations personnel when the strainer is becoming clogged with debris or on any abnormal reading. A second PI is located near the half-cell strainer located on the operating floor.

The pressure switch which actuates when the hydraulic oil pressure fluctuates to a preset condition, is connected to actuate both an alarm and automatically start the standby hydraulic oil pump on low pressure. When the unit strainer begins to plug, the strainer is switched and the plugged side is cleaned. If the plugging in the strainer is undetected and the hydraulic oil pressure to the pressure switch drops, the ACR receives a low pressure alarm and the standby hydraulic oil pump is started. The second pump will assist in transferring enough oil to the stage control valves until the strainer is switched. The standby pump must be manually shut down when the system is returned to normal operation. If, for any reason, hydraulic oil is cut off from the control valves, the valve operators are designed to lock the valves in their present position until oil pressure is restored.

The alarms for the hydraulic oil system are located in each ACR. The alarm panels are supplied from 125VDC, with battery backup systems supplying power to the alarms in case of a power outage.

3.3.5.11 Process Ventilation System

The process building ventilation systems must satisfy the following basic criteria on a year-round basis:

- They must maintain an environment wherein the process equipment can continuously operate at scheduled loads throughout a specified period of time (economic life).

- The buildings' interior environments must be maintained at conditions which will permit operational and maintenance activity to be conducted with acceptable work practices without endangering the health and/or safety of the personnel performing the work due to industrial safety concerns.

- They must distribute the process heat within the building to avoid UF_6 and water freezing problems.

The ventilation systems are generally designed to maintain an average maximum 20ºF temperature rise from the outside of the building to the walking level on the cell floor, when the outside temperature is 95ºF. Exterior filter room dampers are covered as needed to regulate interior building temperatures.

Figure 3.3-22 illustrates the typical air circulation through a process building. The following sections will describe the components of the process ventilation system in the “00” and “000” process buildings. Sections 3.3.5.11.8 and 3.3.5.11.9 describe the ventilation systems in the C-310, C-310-A, and C-315 buildings respectively.

3.3.5.11.1 Supply Air

Supply air is air that is supplied to the cell floor. The supply fans located on the ground floor provide the motive force for the movement of air from the ground floor to the cell floor. The supply fans take a suction from the general area around the fan on the ground floor and discharge it to a header that typically runs the length of a unit. The air to the general area of the ground floor passes through filter rooms located around the perimeter of the building ground floor. There are risers off the supply headers that generally deliver the air to the cell floor. There are several headers in each building, each is independent of the others. The supply fans have a discharge damper that will shut when the fan is secured.

3.3.5.11.2 Exhaust Air

Exhaust air is air that is removed from the cell or ground floor. There are two primary methods for removing air from the cell floor, through the roof exhaust dampers or by the exhaust fans. Additionally, there is a ground floor exhaust flow path in C-331, C-333, and C-335 only, through the high level exhaust system. C-337 does not have the high level exhaust system.

3.3.5.11.2.1 Roof Exhaust

Exhaust air through the roof is accomplished by the differential pressure between the cell floor and the outside, and by natural convection. The cell floor is typically kept at a higher pressure than the outside, thereby promoting exhaust air flow. The heat from the process also tends to support this flow path.

3.3.5.11.2.2 Exhaust Fan Flow

The primary method for removing heat from the process motors is by the exhaust fans. The air from the cell floor is pulled past the motors into an exhaust duct branch located in the motor base. Each branch ties to an exhaust header which is similar to the supply header. The exhaust header typically runs the length of the building and is independent of the other exhaust headers. There are a number of exhaust fans, on either end of the exhaust header, which can overload if the discharge is restricted. Therefore, fan motor current is periodically reviewed for abnormal indications. The fan discharge can be directed to either the outside, via the exhaust fan discharge damper, at the roof level or back to the filter rooms, via the recirculating damper, depending on thermostatic control. When the fan is secured, the exhaust discharge and recirculating dampers will shut.

3.3.5.11.2.3 High Level Exhaust System

Along the top of the exhaust headers in C-331, C-333, and C-335, there are manually operated dampers that, when opened, will exhaust air from just below the cell floor. Operation of these dampers optimizes the performance of the building ventilation system.

3.3.5.11.3 Air Control

Air control is the control of the direction of exhaust air and the source of supply air for the building. The majority of building supply air comes from the filter rooms through air filters. The source of air to the filter rooms is dependant on the temperature in the building and is controlled by a pneumatic thermostatic control system. When the building temperature drops below the thermostatic setting, the building supply and exhaust fans discharge dampers will shut and the recirculating dampers will open, effectively recirculating the warm cell floor air back to the ground floor. When the building temperature rises above the thermostatic setting, the building supply and exhaust fans discharge dampers will open and the recirculating dampers will shut, effectively discharging the warm cell floor air to the outside.

3.3.5.11.4 Secondary Exhaust Systems

The “00” and “000” process buildings contain some secondary air flows in addition to the primary air flows described previously. These secondary air flows, while not considered essential to the health and safety of personnel, are regarded as significant to the reliable, uninterrupted operation of the process instrumentation and electrical equipment.

The secondary air flows consist of transformer exhaust systems and instrument cubicle exhaust systems and are described in the following two sections. The secondary air flows also includes air that flows from the heat exchanger exhaust fans in the unit bypass housings to the surge drum rooms (“000” buildings only).

3.3.5.11.4.1 Transformer Exhaust System

Most transformers use an induced draft exhaust system consisting of fans which pull air through vents in the substations and, in some cases, fans exhaust it into the motor exhaust duct which can discharge the air outside the building or recirculate it back inside the building. Some transformers, and in particular non-uprated transformers, use a forced air configuration where fans push the air through the transformer.

3.3.5.11.4.2 Instrument Cubicle Exhaust System

A relatively small amount of air also circulates from the interior of the cell enclosures to the ground floor via the instrument line ducts which contain a blower. The ducts carry air from the interior of the cell enclosures to the ground floor, then expel it at the cell instrumentation cubicles. The air flow helps to prevent freeze-out of UF_6 in instrument tubing.

3.3.5.11.5 Special Exhaust Systems

Each battery room is equipped with an exhaust system to facilitate the removal of battery fumes through a roof vent. These fans employ a pressure differential switch which actuates an alarm in the ACR in case of loss of flow.

The coolant pits are equipped with exhaust systems to facilitate the removal of any asphyxiant which may be generated as a part of normal or abnormal operations.

3.3.5.11.6 Miscellaneous Systems

Air conditioning facilities are provided for the ACR, associated rooms and offices, and other miscellaneous areas in order to maintain temperature and humidity levels determined by equipment operation and/or personnel considerations. Maintenance shops and offices also are equipped with air conditioning units.

Steam heating is provided for the building pipe enclosures to maintain the desired operating temperatures in these locations. Remote bulb thermostats transmit impulses to air relays which regulate the air loading on the steam control valves in order to achieve the set temperature.

3.3.5.11.7 Emergency Operations

In the case of a UF_6 release or the existence of any situation detrimental to the health and safety of employees, it may be desirable to purge contaminated air from a process building. This is accomplished by positioning the manual selection switch(es) to emergency purge in each ventilation zone. This causes the duct exhaust and outside air dampers to fully open and causes the recirculating dampers to close, thus providing the maximum air change. During cold weather conditions, the process building inlet louvers are typically covered to help maintain interior temperature. This reduces the effectiveness of the Emergency Purge feature.

In the event of a UF_6 release, it will be determined if ventilation fans will be operated to clear the building or be turned off to slow the release from the building.

3.3.5.11.8 C-310 and C-310-A Building Ventilation System

The product withdrawal facility is located in buildings C-310-A and C-310. The C-310-A building contains the condensers and accumulators. The C-310 building contains the UF_6 cylinder drain stations along with the Normetex pumps. C-310 also houses the purge cascade; the process cells for this system are located on the second floor of the building.

3.3.5.11.8.1 Supply Air

Supply air is air that is supplied to the cell floor. The supply fans located on the ground floor provide the motive force for the movement of air from the ground floor to the cell floor. The supply fans take a suction from the general area around the fan on the ground floor and discharge it to a header that typically runs the length of the building. The air to the general area of the ground floor passes through filter rooms located around the perimeter of the building ground floor. There are risers off the supply headers that generally deliver the air to the cell floor. The supply fans have a discharge damper that will shut when the fan is secured.

3.3.5.11.8.2 Exhaust Air

Exhaust air is air that is removed from the cell floor. There are two primary methods for removing air from the cell floor, through the roof exhaust dampers or recirculating to the ground floor. The exhaust flow rate is dependent upon the differential pressure between the cell floor and the adjacent space. The flow path from the cell floor to the ground floor is through a fixed opening in the cell floor.

3.3.5.11.8.3 Air Control

Air control is the control of the direction of exhaust air and the source of supply air for the building. The majority of building supply air comes from the filter rooms through air filters. The source of air to the filter rooms is dependant on the temperature in the building and is controlled by a pneumatic thermostatic control system or is controlled manually. When the building temperature drops below the thermostatic setting, the building supply and roof exhaust dampers will shut, effectively recirculating the warm cell floor air back to the ground floor. When the building temperature rises above the thermostatic setting, the building supply and roof exhaust dampers will open, allowing the warm cell floor air to move outside. Exterior filter room dampers are covered as needed to regulate interior building temperatures.

The C-310-A ground floor area is heated by steam and outside air intake. Air is exhausted through exhausters through the outside wall. The second floor area is heated by steam. Emergency exhausters are located in the roof.

The product withdrawal stations in C-310 are equipped with exhaust hoods, an exhaust fan, and a high efficiency particulate absorption (HEPA) type filter. The air exhausted through these hoods is discharged to the atmosphere at roof level. The exhaust fan and the building ventilation fans are capable of being shut off manually from a remote location.

3.3.5.11.9 C-315 Building Ventilation System

The tails withdrawal facility is located in the three-story portion of C-315. Outside air is drawn into the building, filtered, warmed when necessary, distributed through the building, and either exhausted through roof vents or partially recirculated by components of the building ventilation system.

The function of the ventilation system in the surge tank rooms is to purge the rooms of a contaminated atmosphere in the event of a release. In this case, air is drawn in through outside dampers mounted in the walls just below the ceiling of the room. The air is then exhausted by an exhaust fan through roof vents by means of ductwork leading from the vents to air intakes near the floor.

The function of the ventilation system for the tails cylinder filling and sampling stations is primarily one of heat removal. In case of an emergency condition, each station has its own individual hood and a common exhaust fan which operates continuously. The air exhausted through these hoods is discharged to the atmosphere at roof level. For cold temperature operation, a supply fan draws air into the building through the outside dampers. It is filtered, steam-heated, and discharged into a manifold duct which carries the air to the room outlet grilles. When the outside temperature is high, the air is exhausted through exhaust dampers mounted in the outside wall. During intermediate seasons a portion of the air may be recirculated and the remainder exhausted.

The tails withdrawal stations are equipped with exhaust hoods, an exhaust fan, and a HEPA-type filter. The supply and exhaust fans are capable of being shut off manually from a remote location.

3.3.5.12 Fire Protection System

The Fire Protection System consists of automatic sprinkler systems in each of the six process buildings, C-310, C-315, C-331, C-333, C-335, and C-337. The sprinkler systems provide interior

protection of the process buildings. These systems, which are wet-pipe type, are the same as found throughout industry and consist of water-filled piping with standard sprinkler heads installed in the pipes. The alarm valve within each system and all replacement components as required by NFPA 13, "Installation of Sprinkler Systems," are Underwriters Laboratories listed and/or Factory Mutual approved. The temperature ratings of the sprinkler heads vary according to the maximum expected temperature of the area in which the heads are installed. The ratings range from 160ºF to 286ºF in the process buildings. The highest rated heads are installed at the ceiling level on the cell floor in the C-331, C-333, C-335, and C-337 buildings.

There are wet-pipe systems installed throughout the six process buildings except for inside cell housings and surge drum rooms. The size of most buildings necessitates that more than one system be used in each building. The vast majority of systems are installed in areas not subject to freezing. However, those in areas subject to freezing (e.g., filter rooms) have an antifreeze solution maintained in the piping from the riser to the sprinkler heads.

Water is supplied to the plant buildings' fire suppression systems either by the High Pressure Fire Water System (HPFWS) or the Sanitary and Fire Water System (SFWS). The HPFWS is a grid system and supplies the sprinkler systems in the C-310, C-315, C-331, C-333, C-335, and C-337 process buildings, the C-310-A Product Withdrawal Building, the C-360, Toll Transfer and Sampling Building, the C-620 Air Compressor Room, the C-631-03 Pump House (Firewater), and the RCW blend pump houses. It also supplies the water spray systems in the RCW cooling towers. The HPFWS and the wet-pipe Sprinkler Systems in the six process buildings are important to safety as described in Section 3.15. Further descriptions of the HPFWS are located in Section 3.9. The SFWS is also a grid system and supplies fire suppression systems in other plant buildings. The SFWS is discussed in Section 3.9. The suppression systems supplied by both the HPFWS and SFWS have water flow sensing devices that are continuously monitored by the site fire alarm system.

The Fire Protection Program is described in Section 5.4.

3.3.5.13 Special Gas Treatment

When new equipment is installed or the cascade has been opened to atmosphere, a treatment comprised of a mixture of F_2 and N_2 or a mixture of F_2, N_2 and ClF_3 may be used to condition previously untreated surfaces as well as remove moisture before exposing the equipment to UF_6. Deposits of UO_2F_2 and other compounds may also be removed from equipment by exposure to these gases.

F_2 and ClF_3 gases react violently with organic and oxidizable materials and with most metals at elevated temperatures. Procedural controls are exercised over the introduction of these gases into the cascade to minimize the risk of an explosive reaction within the cascade.

3.3.6 Purge Cascade

3.3.6.1 System Description

The top cells in the PGDP cascade are called the purge cascade. The purge cascade is located in the C-310, Purge and Product Building with a portion of the product withdrawal equipment located in the C-310-A, Product Withdrawal Building (see Section 3.3.2 for a description of these buildings). The ventilation system is described in Section 3.3.5. The UF_6 process system up to the point of withdrawal will be discussed herein.

The purge cascade performs three functions essential to the operation of the diffusion cascade. These functions are: the removal of light molecular weight gases from the cascade; the removal of intermediate molecular weight gases, which may be present in the product stream; and the withdrawal of product from the cascade. The product withdrawal process and its important to safety systems are described in Section 3.4.

The day-to-day operation of the enrichment cascade results in the introduction of a variety of low molecular weight gases, called "lights," into the process stream. These lights are forced up the cascade (toward the product withdrawal point) by the diffusion process, which separates gases on the basis of differing molecular weights. The principal lights forced to the top of the cascade are nitrogen (N_2) and oxygen (O_2).

Lights are introduced into the cascade in many ways, including inleakage from seals or buffered components. Lights are also introduced periodically from cell servicing efforts (cell treatment, evacuation, etc.) and from feed cylinders which may contain a variety of contaminants. Finally, it is possible for lights to be introduced to the cascade in an uncontrolled manner, due primarily to equipment failure (i.e., process gas cooler failure, seal failure, expansion joint failure, or other failures).

Lights containing only traces of UF_6 will normally be withdrawn from the cascade at the top cell in the purge cascade, which is normally cell 2. From the top cell the lights pass to the tops booster station and then to the purge flow control system. A portion of the lights is recycled to maintain the lights front while the remainder is passed through one or both of two banks of alumina traps then on to the evacuation jet and exhausted to the atmosphere by venting through a stack outside the C-310 building. The vent stack contains various sampling systems to track stack emissions of fluorides and selected radionuclides.

Intermediate molecular weight gases, including fluorine (F_2), chlorine trifluoride (ClF_3), cascade coolant (chlorofluorocarbons), and various fluorine compounds such as technetium, molybdenum and arsenic also diffuse to the top of the cascade because they are lighter than UF_6. Safe and reliable operation of the gaseous diffusion complex demands efficient control of these intermediate molecular weight components.

The intermediate molecular weight gases may enter the cascade as a result of cell treatments. Small quantities of coolant are always present due to inleakage from the many coolers used in the cascade. Existing procedural controls limit the concentration of selected gases to preclude the possibility of an explosive hazard. If these intermediate gases are not effectively removed from the system, the administrative controls that must be exercised become restrictive to normal enrichment cascade operation.

The intermediate molecular weight gases can be removed from the UF_6 product by entrainment in the condensed product UF_6 with subsequent extraction at the burp station after the UF_6 has solidified in product cylinders.

The intermediate gases in the enrichment cascade migrate to the top of the process system and are trapped or "pocket" near the product withdrawal point in the C-310 purge cascade. The F_2 can be vented out the top vent. An additional side purge is available to supplement normal cascade upflows should they be too low. This side purge enables dilution of some contaminants, principally F_2 that might otherwise

pocket in C-310 under low purge conditions. This purge can also act to add stability to the control system by increasing the purge load.

ClF_3 can be vented to some degree depending upon the purge rate and the number of high-speed cells on stream. The ClF_3 and coolant usually require a different procedure for their removal. After withdrawal, a "burping" operation is used which relies upon dissolution of the ClF_3 and coolant in liquid UF_6 (see Section 3.4 for this operation).

Below the product withdrawal point and a few cells above it, the purge cascade provides the same isotopic enrichment function as other enrichment cascade equipment. Above the product withdrawal point, the function is to separate light and intermediate molecular gases from the residual UF_6 and vent them via the tops purge stack to atmosphere. Both functions use equipment similar to that in the enrichment cascade to effect separation (isotopic separation below the product withdrawal point and light and intermediate gas separation from the heavier UF_6 above the product withdrawal point) using gaseous diffusion. Some differences, particularly with respect to compressor types and equipment size, are necessary due to the nature of the process gas (which consists primarily of UF_6 below the product withdrawal point and light and intermediate gases above the product withdrawal point) and the low interstage flows in the purge cascade.

In certain concentrations, mixtures of $F_{2,}$ $ClF_{3.,}$ and coolant can react explosively provided an ignition source exists. These concentrations are only achievable above the product withdrawal point where the concentrations of UF_6 are significantly reduced. This exothermic reaction, referred to as a treatment gas reaction ($F_{2,}$ ClF_3 are used in cell treatment), is analyzed in the hazard analysis.

The ten cells in the purge cascade are normally operated as a separate cascade tied into the top of the C-335 Process Building. Nitrogen or lights separation from the residual UF_6 is accomplished primarily in the top four cells; 2, 4, 6, and 8, while cells 1, 3, 5, and 7 are used primarily for isotopic separation under normal operations. Cell 9 and cell 10 are considered intermediate cells, which provide for a transition as the UF_6 concentration rapidly drops. These cells (as well as cell 7 if needed) have enhanced high side pressure control to deal with the steep pressure gradients in these stages.

The "A" or "B" process lines connecting the purge cascade with the C-335 cascade may require booster capacity, depending on the pressure levels existing in the purge cascade and at the top of C-335 cascade. The "B" booster station is a flexible pumping station, designed to either boost the "B" stream from the purge cascade back to C-335, or the "A" stream from C-335 to C-310.

The stage high-side pressure gradient and cell temperatures are maintained at the desired levels by cell instruments located on the ground floor level. The operation of selected building systems can be monitored from the C-310 Area Control Room (ACR). The purge flow control system, product withdrawal system control, as well as numerous analytical instruments are also located in the ACR. Selected alarms can also be monitored in the Central Control Facility (CCF) and the C-331 ACR.

3.3.6.2 Equipment

The important to safety UF_6 Primary System within C-310 is the UF_6 containment barrier in the enrichment cascades. The system is required to provide integrity for the cascades and supporting processes that handle $UF_{6.}$ From the entry point into the building to the withdrawal point, the process gas

piping 2 inches or above, valves, expansion joints, seal assemblies, process gas coolers, and equipment containing UF_6 comprise the boundary. The UF_6 Primary System for the purge cascade is similar to that of the other enrichment cascades as discussed in Section 3.3.4. Any differences are primarily in equipment size and quantity as discussed in the sections below.

3.3.6.2.1 Converters

The smallest converters in the cascade are located in the purge cascade section. The C-310 converters are designated as a Size 2X; this designation has no significance other than that of categorizing the converters according to size (see Section 3.3.4).

The cells in C-310 are comprised of 6 inline stages, each with a converter and two centrifugal compressors. The 60 converters are arranged side by side, with 30 converters along each wall of the building from north to south.

The gas cooler is built into the inlet end of the converter. Therefore, a combined stream is cooled in each stage.

3.3.6.2.2 Coolant System

The coolant system in the purge cascade cells and the booster stations serve to remove the heat of compression from the process gas and control its temperature at a specified value. This closed loop system removes heat from process gas using gas coolers in the converter shell and transfers the heat to water-cooled condensers. Operation of the coolant system in the purge cascade is similar to the coolant systems in the other enrichment cascades except for size and capacity (refer to Section 3.3.5).

Coolant pressure is sensed by a pressure transmitter connected to the coolant vapor line and is indicated on the local control panel pressure indicating controllers (PICs). These PICs also indicate the position of the RCW control valve located in the cooling water supply line. The PIC output positions the RCW control valve based upon detected coolant pressure (which is indicative of coolant temperature). A visual alarm is provided for low coolant pressure/high coolant temperature at the local control panel, and a visual and audible alarm in the ACR. The low coolant pressure alarm has been replaced with a R-114-RCW low differential pressure alarm at the Purge Cascade High Speed Cells.

The cell coolant, “A” suction, and “B” outlet temperatures are monitored on a temperature indicator at the local cell panel. A temperature blind switch closes on high coolant temperature and activates a high coolant temperature alarm at the local cell panel and in the ACR.

The purge cascade cells contain a Coolant Overpressure Control System that is important to safety as described in Section 3.15. This system is a rupture disc system designed to relieve the system pressure prior to rupturing the coolant system. This system is described in detail in Section 3.3.5.

3.3.6.2.3 Stage Control Valve

Each stage of a purge cascade cell is provided with a control valve in the “B” stream discharge line. The valve is adjusted to maintain a near constant high-side pressure in the converter. The valves are pneumatically loaded and operated. They are positioned by a pneumatic signal from a pressure-indicating controller (PIC). There is a PIC for each stage of the cell located on the local control panel to monitor the

process gas pressure and provide the input signal. The PIC is normally placed on automatic to maintain the proper pressure for cascade gradient purposes.

The stage PICs use the output of a cell pressure level indicator (PLI) controller on the local control panel to control the position of the stage control valves. Together, the PLI and PICs are used to fine tune the cascade for optimum performance.

3.3.6.2.4 Stage Compressors

The variable operating conditions in the purge cascade make it desirable to utilize a versatile stage pump. Since these compressors must pump gaseous mixtures from nearly pure UF_6 in cell 1 to nearly pure lights in cell 2, centrifugal pumps are desirable because they will pump almost any gaseous mixture if suitably sized and operated at sufficient speed.

Assuming all purge cascade cells are on-stream, the normal intercell flow sequence is 1-3-5-7-9-10-8-6-4-2. Product withdrawal is normally from cell 7/stage 1, but can be from any of the odd-numbered cells. Cells 1, 3, 5, 7, 9 and 10 use low speed compressors (commonly called low-speed cells) and, being below or just above the product withdrawal point, handle UF_6-laden streams. These cells accomplish primarily isotopic enrichment. The high speed compressors in cells 2, 4, 6, and 8, being above the product withdrawal point, are designed to pump a gaseous mixture containing up to 100% light molecular weight contaminants and primarily accomplish light gas separation.

In the purge cascade, there are two compressors per stage. As an example of how they are used, the cell 1/stage 1 “A” compressor withdraws the enriched UF_6 “A”-stream from the cell 1/stage 1 converter and discharges (through an aftercooler on high-speed cells) to the suction of the cell 1/stage 2 “B” compressor. The cell 1/stage 2 “B” compressor also draws suction on the cell 1/stage 3 “B”-stream, and discharges the combined flow to the cell 1/stage 2 converter. This pattern is repeated throughout the purge cascade. Normally, it is only necessary to run three of the four high-speed cells for adequate UF_6 separation from the purge gas stream. Running with only one or two cells is possible with the disadvantage that the tops alumina traps will experience increased loading.

All the stage compressors in the purge cascade are centrifugal compressors. The specific impeller sizes and configuration use vary depending on the location of the compressor. Six compressors are located along each side of a cell with three of the compressors designated as “A” compressors and three designated as “B” compressors.

A centrifugal pump is subject to surging under abnormal system conditions and can experience severe heat buildup and, if allowed to continue for an extended length of time, can experience damage to pump impellers, seals, bearings, and connections. If an impeller contacts the casing, rubbing will cause heat buildups, vibration, and possibly a UF_6/hot metal reaction if allowed to continue.

Vibration detection systems have been added to the purge cascade centrifugal pumps to aid in the detection of mechanical failures.

Dry air and nitrogen buffers are supplied to the shaft seals of compressors in the purge cascade to prevent both inleakage of moisture and air into the UF_6 systems and outleakage of UF_6 from compressors.

Instruments on the local cell panel monitor and control both the seal feed flow and pressure. A flood control switch is used to flood the seals with nitrogen prior to a cell being brought on or off line.

Most of the buffer flow is discharged to the atmosphere via the seal exhaust system through chemical traps that absorb the residual UF_6 if present The seal exhaust system is made up of vacuum pumps, alumina traps, seal exhaust headers, and seal exhaust header control valves at each cell. Alumina traps, located in parallel on the suction of each pump, remove UF_6 which may be in the suction line due to seal leakage or from evacuating a cascade cell. The alumina traps minimize damage to the pumps from the process gas. The seal exhaust gases are pulled though the alumina traps and discharged to a vent stack by one or more vacuum pumps.

3.3.6.2.5 Motors

The motors used to drive the stage compressors are similar to those in the other enrichment cascades (refer to Section 3.3.4). Low speed motors are used in the cells that primarily perform isotopic enrichment, while high speed motors are used in the cells that accomplish light and intermediate gas separation.

3.3.6.2.6 Speed Increasers

Speed increasers are used in the high-speed purge cascade cells and the tops booster stations to increase the rpm of the compressors relative to the motor speed and thereby maintain the desired interstage flow based on the average molecular weight of the gas being processed.

3.3.6.2.7 Piping and Valves

UF_6 enters the C-310 building through the “A” normal bypass header. The cell bypass valves in this header are motor-operated. In addition, an “A” auxiliary bypass header parallels the “A” normal header through the building. Block valves on this line are manually operated. The.“B” normal bypass header passes through the building and has motor-operated block valves. The “B” auxiliary bypass header has manually operated cell bypass valves.

The evacuation line is a general-purpose header for passing any gaseous mixture into or out of a cell. Crossover lines are provided from each cell into this header. With the aid of the purge and evacuation station in the C-331 or C-335 building, inventory can be removed from any cell in the purge cascade and returned to an adjacent cell by utilizing the auxiliary feed line or the auxiliary cell bypass line. Inventory can be removed from any cell through the evacuation line and transferred to the C-331 or C-335 surge system. The evacuation line is also used for evacuating the system and equipment installations in the building. A vent line also connects the condensers and pumps in the product withdrawal system to the evacuation line. The standby Normetex product withdrawal pump may also be used as a vacuum pump to pull down C-310 cells or headers as necessary.

There are four feed header lines, which extend the full length of the building. The auxiliary feed line is generally used for returning gas to a cell. Cross-over lines allow various means of supplying evacuation, purge, and special gas treatment to any cell in the purge cascade.

The tops withdrawal line is used to supply light gases to the tops booster and purge system. By tying this line to the 6B pump discharge on cells 2, 4, 6, or 8 or the stage 6 "B" stream on cells 2 or 4, it is possible to remove lights.

3.3.6.2.8 Expansion Joints

Expansion joints are located throughout the purge cascade. Expansion joints are required to allow for pipe misalignment and thermal expansion. Some of the joints contain an internal sleeve to minimize flow induced vibration of the bellows. Expansion joints are located on the compressor discharge and B-stream flow lines of each stage, as well as other locations where necessary. On certain expansion joints, an external containment device is used to provide a means of actuating an alarm if a bellows failure occurs. This cover also prevents the escape of process gas if the inner bellows should fail.

3.3.6.2.9 Booster Stations

The purpose of the tops purge system is to remove light contaminants from the top of the cascade. The tops flow through the tops booster station is divided into a recycle stream and a purge stream by the tops purge flow control instrumentation. The two high speed tops booster pumps normally operate in series.

Tops booster stations are used to raise the vent gas stream pressure from the last purge cell (generally cell 2) to the tops purge (air ejector) system and to maintain an approximate 95% lights (typically less than 1 % UF_6) concentration near the middle of the purge cascade (at the suction of the first on-stream high-speed cell). Because the volume of the booster compressor is greater than needed, a pump recycle is provided to give additional suction volume for the booster compressor to operate at the designed compression ratio. Recycle flow control instrumentation monitors the approximate stage location of the UF_6/lights gas "front," and controls the recycle flow of a portion of the booster discharge back to a pre-selected location (normally the middle of cell 10). The purge flow control system sets the total purge flow (exhaust gas and recycle) at the booster discharge. The interaction of these two controllers effectively maintains the light gas inventory of the high-speed cells reasonably stable so that the front remains in the same place except for minor transients. Operator manual control may also be used during significant transient periods. The purge flow control system normally discharges to either or both of two banks of alumina traps to remove any remaining UF_6 in the purge stream (see Figure 3.3-23).

Air jet exhausters are used to take the lights discharge from the top booster station alumina traps and exhaust these gases to the atmosphere. The jets are operated with plant air, which flows through one or more of three jets, as required by the operating mode of the purge cascade. The plant air forced through the jet combines with light gases and is vented through a stack adjacent to C-310 which is monitored. An alternate vent stack is available should an outage of the normal vent stack be necessary. The light gases entering the jets are diluted with the plant air passing through the jets. The amount of dilution is dependent upon the rate of lights flowing through the jets. Tops purge gases are also recycled to cells 8, 9, or 10 in order to control the UF_6/lights separation front. In the event of a loss of the TOPS booster station or associated systems such as the alumina traps or vent stack, cross-over piping permits limited capacity purging to the cascade surge drums or to the atmosphere via one or more wet-air pumps.

The "B" booster station is a flexible pumping station designed to increase the pressure to provide control of the flow of the "A" or "B" stream between the purge and product building and C-335. Two

low-speed compressors are available for this purpose. A single inter-pump cooler serves the on-stream booster.

3.3.6.2.10 C-310 Alumina Traps for Tops Booster Station

The tops booster alumina trapping system traps residual UF_6 from the light molecular weight gases that are removed from the top of the cascade exhaust system. After passing through the alumina traps, the gases are vented to the atmosphere through evacuation jets and the vent stack.

The tops booster alumina trapping system consists of two trap banks with 13 traps in each bank. Normally one set of 13 alumina traps is in use, while the other set is maintained as a standby/spare, although both sets can be used in a series or parallel arrangement if necessary.

3.3.6.2.11 Gas Phase Technetium Trap Station

Technetium (^{99}Tc) traps are located in heated housings on the ground floor. The traps are used to remove technetium from the UF_6 stream in the purge cascade. A small portion of the purge cascade cell flow is diverted to the traps and then returned. The trapping system contains three banks, with each bank having two traps in parallel. One or more banks of traps may be used simultaneously. Each trap contains approximately 140 pounds of sintered MgF_2 pellets approximately 1/8-inch in diameter. As gaseous UF_6 flows through the trap, technetium compounds absorb on the surfaces of the MgF_2 pellets. Each trap vessel has a volume of approximately 4.4 cubic feet. The cylindrical traps are a nominal 10-inch diameter, constructed of monel, with heads bolted to each end for a total height of approximately 96 inches. The traps contain a screen near the bottom of the vessel to retain the trap media. Gaseous UF_6 flows in the bottom of the traps and out of the top of the traps. The traps may be connected to cell 5, cell 7, or cell 9 and use the “B” compressor discharge to “A” compressor suction differential pressure to provide the flow through the traps.

3.3.6.3 Instrumentation

Instrumentation and controls for the purge cascade are located for the most part at local stations in the building. The operation of the building and auxiliary systems can be monitored from the building control room. Critical operation alarms can be monitored in the C-331, Process Building ACR and the C-300, Central Control Building CCF. Instrumentation not previously discussed is described below.

3.3.6.3.1 Cell Remote Manual Shutdown System

The Cell Remote Manual Shutdown System is important to safety as described in Section 3.15. The Cell Remote Manual Shutdown System provides capability for tripping the cell compressor motors from the C-310 local control panel and the CCF. This is accomplished by tripping the associated stage feeder motor circuit breakers. The DC Power Distribution System supplies 250VDC power required to energize the trip coil of the motor circuit breakers. These systems are described in Section 3.3.4. The inter-building booster compressor motors can also be shutdown from the C-310 local control panel and the CCF, but they are not required to accomplish the safety function.

3.3.6.3.2 Motor Load Indicators

Motor load indicators (ammeters) for each purge cascade cell are located in the C-310 ACR and in the CCF in C-300. These ammeters can be used to provide early indication of compressor abnormalities. There are also motor load indicator lights in the ACR that illuminate whenever any one or all compressor motors in a cell experience an overload or underload. An alarm also sounds, and the affected motor load light illuminates.

3.3.6.3.3 "Cell Dump" Control System

Each cell is equipped with a "cell dump" feature to prevent overpressure of a cell while off-stream. This instrumentation consists of a pressure switch connected electrically to the cell motor-operated inlet and outlet block valves. If the cell pressure reaches a predetermined setting of the pressure switch the cell block valves open to put the cell on-stream and reduce the cell pressure to that of the purge cascade. When the pressure switch operates, an alarm is sounded in the C-310 ACR and the operator takes corrective action to close the block valves, bleed the pressure from the cell, and prevent subsequent

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overpressure. When a cell is opened for maintenance, the cell block valves are de-energized to prevent accidental operation of the "cell dump" feature.

3.3.6.3.4 Datum Systems

The Datum Systems provide reference pressures for UF_6 inventory accountability and control purposes. Datum Systems utilize static lines to maintain controlled reference pressures of dry air in the high side of the stage pressure transmitters. There are three types of C-310 cascade datum systems: Low Pressure Datum, High Pressure Datum, and cell pressure datum.

The Low Pressure Datum System provides reference pressures for measuring stage "A" suction pressures. The Low Pressure Datum also serves the High Pressure Datum for cells 2, 4, 6, and 8 providing a means to measure and control stage discharge pressures.

The High Pressure Datum System provides reference pressures for measuring and controlling stage high side pressures in cells 1, 3, 5, and 7.

The cell pressure datum system is self-contained and acts as a backup for the High Pressure Datum System. In addition, the cell pressure datum system in cell 9 and 10 constitutes the sole datum source for the high side pressure measurement.

Both of the Low and High Pressure Datum Systems are important to safety as described in Section 3.15. Support systems include plant air to the datum station and 480VAC power for the datum exhaust pumps. These Datum Systems are described in detail in Section 3.3.5.

3.3.6.3.5 Acoustic Gas Analyzer

An acoustic gas analyzer (AGA) is used to control the lights concentration at the sample point in the C-310 cascade in an effort to maintain the position of the process gas front at the desired location. The AGA operates by taking a continuous sample of process gas and producing an output signal that varies with the average molecular weight of the gas.

The output of the AGA recorder actuates the flow control valve on the "tops recycle" line in order to maintain a constant lights concentration at the control point. An increase in lights at the control point will close the control valve, while a decrease in lights will open the control valve.

3.3.6.3.6 Line Recorders

Line recorders in C-310 are mass spectrometers which are used to monitor and record the concentration of lights (contaminant gases) flowing in the process gas stream. Process gas flows through a sample loop which is connected across a process compressor through a header system. The header system allows the line recorder to be connected to any one of a limited number of cells. One line recorder monitors the low speed cells. The second line recorder is modified to monitor F_2 as well as several other noncritical contaminants for the high speed cells.

3.3.6.3.7 Infrared Analyzers

C-310 makes use of infrared analyzers (IRAs) for gas concentration monitoring of UF_6, ClF_3, and coolant. These IRAs can be valved to predetermined points in the C-310 process gas system. The capability also exists to connect portable analytical instrumentation to the process gas system so as to analyze for the gas of interest.

3.3.6.3.8 Space Recorder

The space recorder monitors the concentration of uranium in the purge stream to the vent stack and alarms when a predetermined set point is exceeded. Samples from various points going to or on the vent stack can be routed to an ion chamber in the manifold cabinet. The manifold cabinet also contains a pressure indicator, pressure indicating controller (PIC), and a flow meter. The PIC is used to control the flow to the ion chamber. Both the space recorder and manifold cabinets are located in the C-310 ACR.

The electronics associated with the ion chamber develop and provide the radiation detection signal to the chart recorder. The chart recorder displays amount of uranium present. When the uranium concentration exceeds the set point, the chart recorder closes a set of contacts initiating an alarm in the ACR.

Local instrument air is provided to the pressure transmitter, PIC, and control valve. 120VAC electrical power is provided to the flow meter and to the electronics. 125VDC power is provided from the ACR through the chart recorder set of contacts to initiate the alarm.

3.3.6.3.9 Potassium Hydroxide (KOH) Bubblers

As part of the air emission monitoring, continuous sampling is provided on the vent stack by KOH bubblers. The system consists of three caustic KOH solution scrubbers, flowmeters, valving and a vacuum pump. Gases from the vent stack are pumped through the scrubbers where the KOH solution removes contaminants from the gas. The solution is periodically tested for quantity of uranium and other radioactive elements.

3.3.6.4 Administrative Controls

In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the following ensure safe operation of the purge cascade.

UF_6

1. Valve control procedures to protect from inadvertent valve openings to atmosphere.

2. Purging of cells prior to opening to atmosphere.

3. Crane operators are provided with PPE for protection should a release occur.

4. Cranes are parked in a standby location (i.e., not over operating equipment) when not in use.

5. Visual crane inspections are made daily prior to first use for the purpose of detecting obvious defects.

6. ACR operating personnel are informed of crane movements over operating cells and equipment.

7. Cascade auxiliary equipment (e.g. booster, surge, seal, seal exhaust, and wet-air systems) that contain UF_6 are maintained below atmospheric pressure.

Light Cascade Gases (CLF_3, F_2, Coolant, O_2, N_2)

1. Control rates at which off-stream cell treatment gases are fed back to the cascade and to monitor purge cascade information.

2. Valve control procedures to protect from inadvertent valve openings to atmosphere.

3. Purging of cells prior to opening to atmosphere.

4. Monitor concentrations during off-stream cell treatments.

5. Remove coolant prior to performing an off-stream cell treatment.

3.3.7 Control Facilities

Control facilities at PGDP consist of local control panels for each cell in the enrichment cascade, an Area Control Room (ACR) for each process building, and a plant Central Control Facility (CCF) located in the C-300, Central Control Building. The ACR instrumentation permits control room operators to monitor the operation of process equipment with the ability to control and/or shut down some equipment. The CCF instrumentation monitors the process buildings' status and also permits operators to control the operation of some equipment, but only under abnormal situations when the task cannot be accomplished from the ACR. In addition, communication and activity during an emergency are coordinated from the CCF.

3.3.7.1 Local Cell Panels

Each cell in the enrichment cascade has a local operating area on the ground floor which can consist of a cell operating panel, motor breaker panel, valve control center, buffer control panel, and a freezer/sublimer (F/S) panel for those cells containing F/Ss (C-315, Surge And Waste Building is not considered a cascade building and has no cell local control panels). The cell panels are essentially the same in all buildings except for the arrangement of instrumentation on the panels.

Items monitored and/or controlled from the local operating area where applicable are:

- Stage pressure measurement and control

- Temperature measurement

- Coolant pressure measurement and control
- Seal instrumentation
- Datum
- "A"-line suction pressure indicator
- Buffer system
- Recycle valve control (Not in C-310, Purge And Product Building)
- Cell pressure measurement and control (PLI/PIC)
- Block valve control
- Air circuit breaker and motor breaker controls
- Instrument cubicle low temperature alarm
- UF_6 Release Detection System/loss of power alarm

Alarms associated with the local operating area can include:

- Low- and high-seal pressure differentials
- Coolant high-temperature, low-pressure (The low coolant pressure alarm has been replaced with a R-114-RCW low differential pressure alarm at the Purge and Evacuation Stations and Purge Cascade High Speed Cells.)
- Duct and cubicle low-temperature
- Buffer flow alarms
- Block valve buffer alarms (selected cells only)
- Seal feed low-pressure
- Atmospheric seal high-differential
- High- or low-buffer pressure alarms

3.3.7.1.1 Stage Pressure Control/Monitoring

This system gives an indication of stage pressure to indicate abnormal process conditions. The system provides the input signal to the stage control valve in order to control upstream process gas pressure. There is a PIC for each stage of the cell to monitor the process gas pressure and provide the input signal.

3.3.7.1.2 Temperature Measurement

The cell coolant, "A"-suction, and "B" outlet temperatures are monitored on a temperature indicator at each cell panel. A temperature blind switch closes on high coolant temperature and activates high coolant temperature alarms in the ACR and at the cell panel.

3.3.7.1.3 Coolant Pressure Measurement and Control

Coolant pressure is sensed by a pressure transmitter connected to the coolant vapor line and is indicated on local cell panel PICs. These PICs also indicate RCW control valve position. The PIC output positions the RCW control valve based upon detected coolant pressure (which is indicative of coolant temperature). A visual alarm is provided for low coolant pressure/high coolant temperature.

3.3.7.1.4 Seal Instrumentation and Controls

Seal gas in axial compressor cells is supplied by a seal feed system, which is usually divided into independent systems, for the "A"-seals and the "B"-seals. Centrifugal compressors have one seal system. Each seal feed system must maintain the seal feed pressure above the seal exhaust pressure. Instruments are provided on the panel to monitor and control both the seal feed flow and pressure. The seal exhaust system must maintain pressure above the process gas pressure. Control of the seal exhaust pressure is provided by a PIC for each system.

A flood control switch is used to flood the seals with nitrogen prior to a cell being brought on or off line.

3.3.7.1.5 Datum

The Datum System provides a reference pressure to process differential pressure transmitters. The local cell panel contains a cell datum pressure indicator that can be switched (via valving) to monitor high or cell datum pressures.

The pressure indicator forms part of the boundary for the important to safety High Pressure Datum System as described in Sections 3.3.5 and 3.15.

3.3.7.1.6 "A"-Line Suction Pressure Indicator

The "A"-suction pressure is monitored by a pressure indicator to provide information used in diagnosing the causes of process upsets.

The indicator forms part of the boundary for the important to safety Low Pressure Datum System as described in Sections 3.3.5 and 3.15.

3.3.7.1.7 Buffer System

Where needed, there are two buffer systems in the cascade. One system supplies the compressor flanges, blowout preventers, control valves, and buffered expansion joints, and the other supplies only the cascade buffered block valves.

Instrumentation is provided to monitor buffer flow and pressure. An alarm is provided in the ACR on high buffer flow (indicating buffered component leakage) or abnormal buffer pressure. To determine the location of the alarm, the local cell cubicle and buffer cabinet is checked.

3.3.7.1.8 Recycle Valve Control

When the difference between "A"-suction and high-side pressures exceeds the compression ratio tolerance, a pressure blind switch (PBS) opens the recycle valve automatically to bring the compression ratio within tolerance and avoid compressor surging.

A pressure indicator is provided to monitor this differential pressure. A recycle PBS control is provided to manually operate the recycle valve.

3.3.7.1.9 Cell Pressure Control

Cell pressure is controlled through use of the PLI and PIC controllers.

The purpose of the PLI is to aid in controlling cascade inventory, operation of cascade equipment, and normal and abnormal inventory shifts to protect cascade equipment. The PLIs are located on the ACR cell panels (located on the local cell panel in C-310).

PICs located on the local cell panels (one for each stage of the cell), use the output signal of the cell PLI to control the position of the stage control valves in order to establish cell pressures at or near the PLI setpoint. Together, the PLI and PICs are used to fine-tune the cascade for optimum performance. This control system can be overridden for manual control of stage control valve position. PLIs and PICs are used in conjunction with the surge drums and the F/S systems to control cascade disturbances due to inventory shifts.

3.3.7.1.10 Block Valve Control

Block valves are controlled from a valve control center (VCC) located beside each local cell panel. The VCC houses a main electrical breaker and individual valve breakers for the motor-operated valves associated with that cell. The control panel of the VCC has a mimic (single line representation) of the cell and bypass piping. Valve position-indicating lights and pistol-grip controls (close-stop-open) for each individual valve are located directly on the mimic. Switches are provided to accomplish multi-valve operations, including stopping traveling valves, taking a cell off-stream, and initiating a cascade split.

3.3.7.1.11 Air Circuit Breaker and Motor Breaker Controls

In the C-333, Process Building and the C-337 Process Building ("000" buildings), a primary control switch at the local cell panel is used to close the switchyard air circuit breaker (ACB) to start four of the

stage motors. A second control switch (permissive) allows closure of the motor circuit breakers and starting of the other four stage motors. The primary control switch can be used to stop all eight stage motors. An ACR control switch is also available to open the ACB to trip the stage motors.

In the C-331, Process Building and the C-335, Process Building ("00" buildings), the switchyard ACB typically remains closed, and stage motors are started by closing the motor breakers using control switches at the local cell panel. A primary control switch starts five stage motors by closing the motor circuit breaker "A". Closure of a second control switch (permissive) allows starting of the other five stage motors. The primary control switch can be used to stop all ten stage motors. An ACR motor stop button is also available to open the motor breakers and trip the stage motors.

In C-310, closure of a primary control switch starts six stage motors by closing the motor circuit breaker. Closure of a second control switch (permissive) allows starting of the other six stage motors. The primary control switch can be used to stop all 12 stage motors. The primary control switch forms part of the boundary of the important to safety Cell Remote Manual Shutdown System as described in Sections 3.3.4 and 3.15.

Cells are always started at the local panel, but can be shut down from the local panel, ACR (except C-310), emergency shutdown switches on the cell floor, or CCF.

3.3.7.1.12 Instrument Cubicle Low Temperature Alarm

Instrument lines containing gas from various positions in the cascade cell go from the cell floor to the local cell panel on the operating floor. The instrument cubicle is heated to prevent UF_6 freeze-out in these instrument lines. Since instrument line freeze-out could cause inaccurate cell status indications, there is a low temperature alarm installed to alert operating personnel of a low instrument cubicle temperature condition. Non-uprated cells, which operate at lower pressures less susceptible to freeze-out, do not typically have this alarm.

3.3.7.1.13 UF_6 Release Detection Alarm System

A UF_6 Release Detection System (or process gas leak detection-PGLD) is used to detect a UF_6 release in areas with equipment that operates above atmospheric pressure. Detectors are installed inside cell housings, cell bypass housings, unit bypass housings, interbuilding tie-line housings, and in interbuilding booster stations.

The system annunciates alarms at the unit/cell level in the ACR and at the individual detector head level at the local cell panel ("000" and "00" buildings only) upon detection of UF_6 outleakage. Further description is given in Section 3.3.5.

3.3.7.2 Area Control Room

Each process building (C-310, C-315, C-331, C-333, C-335, and C-337) has an ACR located on the ground floor. The purpose of each ACR is to permit operators to monitor process equipment, make changes in operation, and take corrective action to mitigate abnormal operating conditions. All operating cells except C-310 cells can be shut down and isolated from the building's ACR. The C-310 cells must be shut down at the local panels.

3.3.7.2.1 ACR Cell Panel

Each building cell has a cell panel located in the ACR. This permits an ACR operator to monitor cell motor loads, transformer and circuit breaker status, and receive indication of departures from normal cell operation. In addition, the ACR operator can shut down any operating cell (except C-310 cells) by pressing the motor stop switch on the cell's ACR panel. The C-315 building contains no cells but has a main control panel to monitor low and high-speed compressor motors, Normetex pumps, and Hortonsphere surge volume. The C-315 ACR operator has the ability to shutdown any operating process pumps.

3.3.7.2.1.1 Indicators

Indicators available to the operator and their functions are as follows:

- General alarm – energizes in event of an out of tolerance condition for seals and (where required) buffer systems and instrument and cubicle low temperature. For the C-315 ACR general alarm functions, see Section 3.3.7.2.5.

- Cell coolant alarm – energizes in event of low coolant pressure and/or high coolant temperature. (The low coolant pressure alarm has been replaced with a R-114-RCW low differential pressure alarm at the Purge and Evacuation Stations and Purge Cascade High Speed Cells). An alarm horn also sounds. C-315 coolant indicator energizes only for low speed compressors.

- Motor load alarm indicator (light) - illuminates whenever any one or all compressor motors experiences an overload or an underload (alarm also sounds and the affected motor load light also illuminates).

- Motor load indicators (ammeters) – display the amount of current to each stage and interbuilding booster compressor motor. There is an ammeter for each stage of a cell and interbuilding booster compressor motor. The C-315 high-speed compressor motors have ammeters in the C-315 and C-331 ACRs. The C-310 ACR has only a total cell motor load ammeter.

  The motor load indicators for the C-315 tails withdrawal compressor motors and the "00" and "000" building enrichment compressor motors are important to safety as described in Sections 3.3.4 and 3.15.

- Surge Drum indicator – Monitors the pressure of the surge drums in the building. The two hortonspheres are monitored in the C-315 ACR.

Note: The remaining indicators are not applicable to C-315.

- Transformer general alarm indicator - energizes and provides an audible alarm in the event of low air flow through the transformer (induced draft air flow transformers only), transformer high temperature, and loss of transformer fans (fanlights would also de-energize).

- Transformer fan "ON" indicator - remains energized as long as the fans are operating.

- Switchyard ACB position indicators - show if the ACBs are open or closed The indicator shows if an ACB has tripped from some location other than the local panel (e.g., motor goes to ground). In this case both the open and trip indicators would be energized and the operator would be alerted to a potential abnormal condition.

- Cell alarm circuit power indicator - energized as long as this circuit has power and can operate.

- Cell high-pressure alarm (C-310) – alarms on cell overpressure while off-stream.

Note: The remaining indicators are not applicable to C-310.

- Stage motor load indicator (light) - illuminates to indicate which particular motor(s) is experiencing undercurrent or overcurrent.

- Cell evacuation valve indicators - illuminate if the evacuation valve is open or closed. If the valve is between the extreme positions, both lights are on.

- Cell valve indicators – Each group of block valves, bypass valves, and recycle valves have an open and closed light. If the valves are between their extreme positions, both lights are energized.

3.3.7.2.1.2 Controls

(Note: none of the controls described below exist in the C-310 and C-315 ACR except for the alarm silence feature and the motor stop switch for the C-315 high-speed compressor motors. Control functions are performed at the local cell level for C-310).

Controls on the cell panel available to the ACR operator perform the following functions:

- Motor stop switch - used to accomplish motor shutdown for all cell stages and the C-315 high speed compressor motors (the C-315 high speed motors can also be shutdown from the C-331 ACR). This switch provides for immediate cell shutdown capability from the ACR.

  This switch forms part of the boundary for the important to safety Cell Remote Manual Shutdown System for the enrichment compressor motors in the “00” and “000” buildings and the compressor motor manual trip system for the high speed withdrawal compressor motors in C-315. These systems are described in Sections 3.3.4 and 3.15.

- Cell evacuation valve - permit the ACR operator to open or close this valve and is used primarily to evacuate the cells. The top switch allows operator to select operation of the valve, open or close. The bottom switch is used to stop the action initiated by the upper switch.

- Cell ON switch - opens cell block valves and closes bypass (BP) valves. Operates six valves – open for two “A” valves (inlet and outlet) and two “B” valves (inlet and outlet) and close for two “A” and “B” BP valves. The switch will also will cause recycle valve to close, if open.

- Master valve stop switch - stops the operation of all valves in operation at their present position.

- Cell OFF BP open switch - used primarily in emergencies to take a cell off-stream. Valve action is reverse to that of the "cell on" operation including the recycle valve.

- BP "B" valve OPEN switches - allow the normally closed BP "B" valve of an on-stream cell to be opened from the ACR under excessive high-pressure excursions.

- Recycle "OPEN" switch - causes the recycle valve to open. The valve will operate only while the switch is being pressed.

- Alarm silence switch – silences the audible alarm. For the "000" and "00" buildings, an additional master override switch silences the motor load audible alarm, while leaving other alarms active.

- PLI (knob) allows the ACR operator to increase or decrease the cell pressure by opening or closing the stage control valves providing fine-tuning of the load on each cell from the ACR. The PLI for C-310 is located on the local cell panel.

3.3.7.2.2 ACR Unit Utilities Panel ("000" and "00" Buildings)

Each "000" and "00" process building has a unit utilities panel serving each unit. These panels are sectionalized with groupings of controls/monitors to allow ACR operators to monitor or control auxiliary power substation loads, lube oil system, hydraulic oil system (in "000" only), and the auxiliary power transformers. An alarm annunciator is available for troubleshooting.

The groupings of indicators and controllers and their functions available at the ACR unit utilities panel include:

- Auxiliary substation ammeters (four) permit ACR operators to monitor the load being placed on a particular substation.

- Alarm annunciator panel provides annunciation for up to 24 alarms. The basic systems monitored by all process buildings include: Lube Oil, Hydraulic Oil ("000"only), Datum, Auxiliary Transformer Overheat, Auxiliary Transformer Ground Fault, and DC Power Failure for Load Alarms. Other miscellaneous alarms on the panel vary among buildings.

  The Datum alarm is part of the boundary for the important to safety High-Pressure Datum System as described in Sections 3.3.5 and 3.15.

- The lube oil (LO) system control/monitoring section contains:

  LO supply tank supply valve switch - permit the ACR operator to open, stop, or close the valve. However, there exists an interlock which prevents the valve from being closed while the LO pump(s) is still in operation.

  LO supply tank supply valve position indicator - denotes valve is open or closed. Both indicators are on for a position between these extremes.

LO supply tank drain valve switch - permits the ACR operator to open, stop, or close the LO supply tank drain valve. The LO supply tank drain valve position indicators show the valve's status open, or closed position. Both lights are on when the valve is between the extremes.

LO pump trip relays reset switch - allows ACR operators to restart a LO pump that has been shut down by C-300.

LO pump run/off monitors - indicate the particular pump is running or is off.

LO pump start/stop switches - allow each LO pump, if hand/auto switch is in "hand" mode, to be started. The pumps can be stopped at any time.

Alarm circuit potential indicator - energized as long as current flows in the circuit and the alarm is functional.

LO pumps hand/auto selector switch- are provided for each pump. When the selector switch is in the hand position, the pump can only be started by the ACR operator or an operator at the LO pit. When the selector switch is in the auto position, the pump will start automatically when the LO supply tank falls to a preset limit on the supply tank level indicator.

Lube oil supply tank level indicator and low/high level alarm - allows the operator to visually determine the tank's level. When the level reaches a preset limit, an audible and visual (on annunciator panel) alarm occurs and the spare LO pump is energized on low level if the hand/auto selector switch is in the auto position. When the LO level returns to normal, the alarm resets and the pump can be manually shut down.

Lube area drain pump power-on indicator - This light energizes when the LO sump pump has power available for starting.

- The hydraulic oil system control/monitoring section ("000" only) contains:

  Hydraulic stage control valve oil pumps start/stop pistol-grip switches - allow normal starting or stopping of the hydraulic oil pumps if the associated hand/auto selector switch is in the "hand" position.

  Hydraulic stage control valve oil pumps run/off indicators - energize to indicate if the hydraulic oil pumps are operating. There is one pair of indicators for each pump.

  Hydraulic oil pumps hand/auto selector switch - determines if pump operation is automatic or manual. In the "auto" mode the standby pump will automatically start in the event of a drop of hydraulic oil pressure.

- UF_6 Release Detection System:

  Annunciator alarms and light illuminates to indicate cell or B-booster location upon detection of a UF_6 release or loss of 200-VDC power to the detectors. A printout of the detector that alarmed is also obtained.

These alarms form part of the boundary of the important to safety UF_6 Release Detection System for the "00" and "000" buildings as describe in Sections 3.3.5 and 3.15.

- The auxiliary power transformer section contains a graphic layout of the unit auxiliary substations along with the electrical feeders supplying the substations. The transformer secondary breaker positions are indicated by position lights displaying whether the breakers are open or closed. Finally, a run light is provided for the transformer cooling fans to permit the ACR operator to monitor the fan operation.

3.3.7.2.3 Utilities Panel ("000" and "00" Buildings)

There are indicators and alarms on each plant utility system. Each ACR is equipped with such a panel. Both audible and visual alarms are available. The indicators and alarms are as follows:

1. RCW header low pressure
2. Plant air low pressure
3. Plant nitrogen low pressure
4. Sanitary water low pressure
5. Drying gas (DG) manifold low pressure
6. Ventilation system floor differential pressure
7. Pressure recorder for seal exhaust and area datum exhaust pressure. Alarms are actuated on high pressure.
8. Mixed Gas [nitrogen (N_2), fluorine (F_2) and chlorine trifluoride (ClF_3)] storage drum pressure recorder, with high pressure alarm (C-335 only)

The plant air low pressure and area datum exhaust pressure alarms are part of the boundary and/or support system for the important to safety Low and High Pressure Datum Systems as described in Sections 3.3.5 and 3.15.

3.3.7.2.4 Utilities Panel (C-310)

The Utilities Panel in C-310 contains controls, indicators, and alarms for the following:

1. RCW header low pressure
2. Sanitary water low pressure

3. Pressure indicator for seal exhaust and area datum exhaust pressure. Alarms are actuated on high pressure. The area datum exhaust pressure alarm forms part of the boundary for the important to safety High Pressure Datum System as described in Sections 3.3.5 and 3.15.

Other indicators/controls and their function include:

- Auxiliary substation ammeters (16) permit the ACR operator to monitor the load being placed on a particular substation.
- The lube oil (LO) system control/monitoring section is similar to the other process buildings described in Section 3.3.7.2.2.
- UF_6 Leak Detection System is similar to that described in Section 3.3.7.2.2.

3.3.7.2.5 Utilities Panel (C-315)

The Utilities Panel for C-315 contains a general alarm for the entire building and is energized for the following:

1. Motor loads - over current or under current
2. Coolant – low coolant pressure and/or high coolant temperature
3. Buffer – high buffer flow or abnormal buffer pressure
4. UF_6 Detection – loss of low voltage power to the low voltage heads

The LO system control/monitoring section contains:

1. LO supply tank emergency supply valve switch – permits the ACR operator to open, stop, or close the valve.
2. LO supply tank emergency supply valve position indicator – denotes if valve is open or closed. Both indicators are on if the valve is between the open and closed position.
3. LO supply tank drain valve switch – permits the ACR operator to open the valve (must be reset at the drain tank). The position indicators show the valve's open or closed position. Both lights are on if the valve is between the open and closed position.
4. LO pump trip relays reset button – Allows ACR operator to restart a LO pump that has been shut down by C-300.
5. LO pump run/off indicators – indicate if the particular pump is in the "run" or "off" position.
6. LO pump start/stop switches (pistol-grip switches) – allow each LO pump, if hand/auto switch is in the "hand" position, to be started.

7. LO pumps hand/auto selector switch - provided for each pump. When the selector switch is in the hand position, the pump can only be started by the ACR operator or an operator at the LO pit. When the selector switch is in the auto position, the pump will start automatically when the LO falls to a preset limit on the lube oil supply tank level indicator.

8. Lube oil supply tank level indicator and low/high level alarm - allows the operator to visually determine the tank's level. When the level reaches a preset limit, an audible and visual (on annunciator panel) alarm occurs and the spare LO pump is energized on low level if the hand/auto selector switch is in the auto position. When the LO level returns to normal, the alarm resets and the pump can be manually shut down.

There is a breaker position indicator for normal power to valve control cabinets four and six.

3.3.7.2.6 Diesel Generators

A diesel generator will automatically energize if two substations are lost. A diesel panel is provided for each diesel and monitors the main operating parameters of the diesel including voltage and current.

3.3.7.2.7 Line Recorders (Cascade Buildings)

Line recorders are used to monitor nitrogen (N_2), oxygen (O_2), and coolant on the cascade. There is one line recorder for each unit in “00” and “000”. They have switching arrangements that permit them to monitor the cells in their respective units, as well as the cells in adjacent units. This feature allows monitoring to be continued during line recorder maintenance. The C-300 CCF has a slave recorder for each unit in the cascade.

3.3.7.2.8 Valve Status Control (Cascade Buildings except C-310)

Many cascade auxiliary valves of operational significance that do not have electrical position indicators are controlled administratively by means of valve tags and valve boards. This system is used to show valve status and reduce the possibility of misvalving on the crossover manifold or feed headers.

3.3.7.2.9 Purge and Evacuation (P&E)

When a cell must be evacuated and purged, the P&E panels control and monitor this operation. Controls are available to perform the necessary functions to isolate the cell, store the UF_6 in surge drums, energize the low-speed or other required pumps, purge the cascade, and return the UF_6 to the cascade.

Status of the valves, pumps and surge drum pressures are monitored.

3.3.7.2.10 Vaporizer Panel (“000” Buildings)

Each ACR has a vaporizer panel for control and monitor of the UF_6 and steam systems at the autoclaves. Controls include feeder header alignment and autoclave isolation. Indicators provide status of various steam and UF_6 valve positions. Alarms include: low flow, high outlet

pressure, and high conductivity. Flow/pressure meter controller/recorders for each autoclave position adjust the feed rate, provide trending data, and maintain historical records.

The autoclave manual isolation switch forms part of the boundary of the important to safety Autoclave Manual Isolation System as described in Section 3.15.

3.3.7.2.11 Freezer/Sublimer Controls ("000" and "00" Buildings)

Each ACR has a computer based distributed process control system (DPCS) to provide inventory control of the UF_6 in the freezer/sublimers. Refer to Section 3.3.4 for further discussion.

3.3.7.2.12 Automatic Data Processor ("000" and "00" Buildings)

An automatic data processor (ADP) provides monitoring, alarm, and printout capability for various operating parameters such as (but not limited to):

- Low coolant pressure/high temperature
- "B" outlet pressure
- High compressor vibration
- High steam usage
- Low duct and cubicle low temperature
- Buffer flow
- UF_6 release detection
- Cell housing temperature

3.3.7.2.13 Communications.

The ACR operator has three methods of communication: radio, telephone, and a paging system (Note: C-315 has no local paging system). There are three telephone systems: a conventional telephone, a PAX telephone, and an emergency direct to C-300 phone.

3.3.7.3 Central Control Facility

The CCF is located in C-300. Its function is to monitor, coordinate, and/or control critical plant processes, power distribution, utilities, communications, plant alarm systems, and emergency operations. Building C-300 is important to safety as described in Section 3.15 since it must maintain structural integrity during evaluation basis natural phenomenon events (earthquake, high winds, and flooding).

The CCF receives backup ac power from a diesel generator located in the C-310 building, and batteries located in the basement of C-300 supply DC power for control power and backup lighting.

3.3.7.3.1 Power Control and Monitor

Control panels are arranged in a semicircular configuration with the electrical distribution system control and monitoring area in the center (power pit). The power operator continually monitors the power load for each building and the total plant load. The power operator has the ability to switch incoming power through different circuit breakers to different electrical buses in the plant or to trip out an entire electrical bus.

Power control and monitor of the 161-kV and the 14-kV high voltage systems is accomplished using the supervisory control and data acquisition (SCADA) system, which is a self contained computer system. The system contains dual computers, either of which may be used as the primary.

SCADA features include the following:

- Breaker positions in the switchyards.
- Control of selected breakers, transformer tap changers, and synchronous condenser output.
- Dynamic mapboard of the switchyard.
- Summary of bus voltage, transmission line loading, transformer loads and temperatures. synchronous condenser loads and temperatures, and reactor temperature.

Instantaneous information provided by SCADA maximizes the operator's effectiveness in dealing with normal operation, monitoring, switching, load control, and power emergencies. The SCADA system also provides total MW readings to the cascade operator in C-300 for monitoring the 161-kV and 14-kV loads.

3.3.7.3.2 Cascade Control and Monitor

Cascade information flows between the ACRs and the CCF. This information includes:

- Feed assay changes
- Feed and withdrawal rates
- Power load

The Cascade Coordinator directs adjustments in each building in order to maintain the electrical power load at contracted level.

The cascade operator can trip any cell, booster, purge and evacuation or withdrawal pump in any of the cascade buildings and C-315. These manual trip switches for the enrichment compressor motors (“000” and “00”) form part of the boundary of the important to safety Cell Remote Manual Shutdown

System as described in Sections 3.3.4 and 3.15. The manual trip switches for the C-315 high-speed withdrawal compressor motors form part of the boundary of the important to safety Compressor Motor Manual Trip System as described in Sections 3.3.4 and 3.15.

Each cascade-operating unit is graphically identified on the operating panels. Alarms and lights allow monitoring of the following:

- Cell block valve position for an entire cell
- Total amperage load for each cell. This ammeter forms part of the boundary for the important to safety motor load indicators as described in Sections 3.3.4 and 3.15.
- Purge and evacuation pumps
- Key evacuation valve indications
- Surge drum pressures in each building. This indicator forms part of the boundary for the important to safety Surge Drum Pressure System as described in Section 3.15.
- Bottom overlap pumps (not all buildings – based on alignment)
- Top overlap pumps (not all buildings – based on alignment)
- "B" boosters (not all buildings – based on alignment)
- Cascade light gas upflows through the line recorders for each building

Cascade control capability includes taking a cell off-stream and splitting the cascade at any of several locations per building.

3.3.7.3.3 Auxiliary Pumps

The cooling tower pumps are monitored by pump discharge header pressure to the buildings. Designated RCW pumps can be started or stopped from C-300.

3.3.7.3.4 UF_6 Feed Monitoring

The UF_6 feed rates are monitored and logged and the feed point changes are logged. A separate panel has been installed to depict the position (open or closed) of the feed valves in the cascade. This panel is a mimic of the cascade piping.

3.3.7.3.5 Autoclave

One panel in the CCF is dedicated to alarms in the autoclaves of the C-360, Toll Transfer and Sampling Building, C-333-A, Feed Vaporization Facility, and C-337-A, Feed Vaporization Facility.

Alarms in C-300 associated with building C-360 are:

- UF_6 release
- UF_6 detection trouble
- UF_6 release in autoclaves - high pressure / high conductivity

Alarms in C-300 associated with buildings C-333-A and C-337-A are:

- UF_6 release
- Surge drum high pressure (C-337-A Only)
- Containment

3.3.7.3.6 Lube Oil

The lube oil panel alarms in the event of low level or high level in the lube oil supply tanks for each process building. The CCF has the capability to shut down oil pumps in process buildings but cannot start pumps. The ability exists to close oil supply valves and open drain valves from each oil supply tank.

3.3.7.3.7 Fire Protection

The plant sprinkler system is monitored, and an alarm is received when any sprinkler system in the plant is activated. These panels also provides the CCF with the capability to monitor the sanitary and fire water tank level, and the C-631, RCW Pump House and Appurtenant Structures cooling tower basin level. These panels have the control capability to start and stop the C-631 and C-631-03, Pump House (Firewater) fire water pumps, and the makeup water booster pump supplying plant water from C-611-T, Booster Pump Station (Plant Water).

3.3.7.3.8 Criticality Accident Alarms/Controls

Plant criticality accident alarms are received at the radiation control panel in the CCF from the radiation detection systems located throughout PGDP. The panel provides both alarm indication and location. The condition of the CAAS is also displayed.

A trouble alarm is received for various events such as loss of power. The loss of power indication and the building horn control switch form part of the boundary for the important to safety CAAS as described in Sections 3.12.6 and 3.15.

3.3.7.3.9 Freezer/Sublimer Controls (“000” and “00”)

The CCF has a computer based distributed process control system (DPCS) to provide inventory control of the UF_6 in the freezer/sublimers. Refer to Section 3.3.4 for further discussion.

3.3.7.3.10 Seismic Alarms

A seismic switch system monitors seismic activity. The seismic switch system consists of two seismic switches in C-331 and two in C-335. The only function of these seismic switches is to provide an alarm in C-300.

3.3.7.3.11 Meteorological Data

Wind velocity is monitored in the CCF. A meteorological station is located just outside C-300 and supplies wind speed and wind direction information that is displayed at the CCF console. In addition to the C-300 meteorological station data, wind velocity data can also be obtained from the National Weather Service.

Table 3.3-1. Freezer/Sublimer Design Conditions and Modes of Operation

F/S Design Conditions

	10 MW Vessel	20 MW Vessel
Maximum vessel capacity[a] (without bridging)	11,900 lbs of UF_6	22,400 lbs of UF_6
High-high weight trip[b]	10,000 lbs[c]	20,000 lbs[c]
Maximum assay (to prevent criticality with water in coolant tubes)	3.5 wt % ^{235}U	2.35 wt % ^{235}U
Maximum vessel pressure (all components)	150 psig	150 psig
Recirculating water pressure (in condenser/reboiler)	10 to 20 psig	10 to 20 psig
UF_6 rupture disc	25 psid	25 psid

a. Safety limits
b. Limiting control setting
c. Total weight of UF_6 and coolant

Typical Component States for F/S Modes[e]

Component	Freeze	Sublime	Cold Standby	Hot Standby	Modified Hot Standby
UF_6 inlet valve	Open	Closed	Closed	Closed	Closed
Weight control valve	Open	Open	Closed	Closed	Open
Vent valve	Open	Closed	Closed	Closed	Open
UF_6 return valve	Closed	Open	Closed	Closed	Open
R-114 pump	Off	On	Off	Off	Off
R-114 bypass valve	Open	Closed	Open	Open	Open
RCW pump	On/Off	On/Off	On/Off	On/Off	On/Off
3-Way RCW valve	Open to Supply	Open to Return	Open to Supply	Open to Return[d]	Open to Return[d]

d. RCW supply and return manual block valves may be closed if 3-way RCW valve is not operable or available.
e. The listed component states during the specified F/S modes are not restrictions but typical. The Technical Safety Requirements define specific mode requirements.

Table 3.3-2. Location and Volume of Cascade Surge Drums

Location	Volume (ft^3/bank)
C-331 A, B, C, or D banks	10,000
C-331 E bank	8,000
C-331 F bank	2,000
C-333 A, B, C, D, E, F, or G banks	10,000
C-333 H bank	8,000
C-333 J bank	6,000
C-335 A bank	4,000
C-335 B bank	6,000
C-335 C, D, or E banks	10,000
C-335 F, G, H, or J banks	10,000
C-337 A, B, C, D, E, F, or G banks	10,000
C-337 H bank	8,000
C-337 J bank	6,000
C-315 Hortonsphere A or B	20,000

Table 3.3-3. Table Deleted.

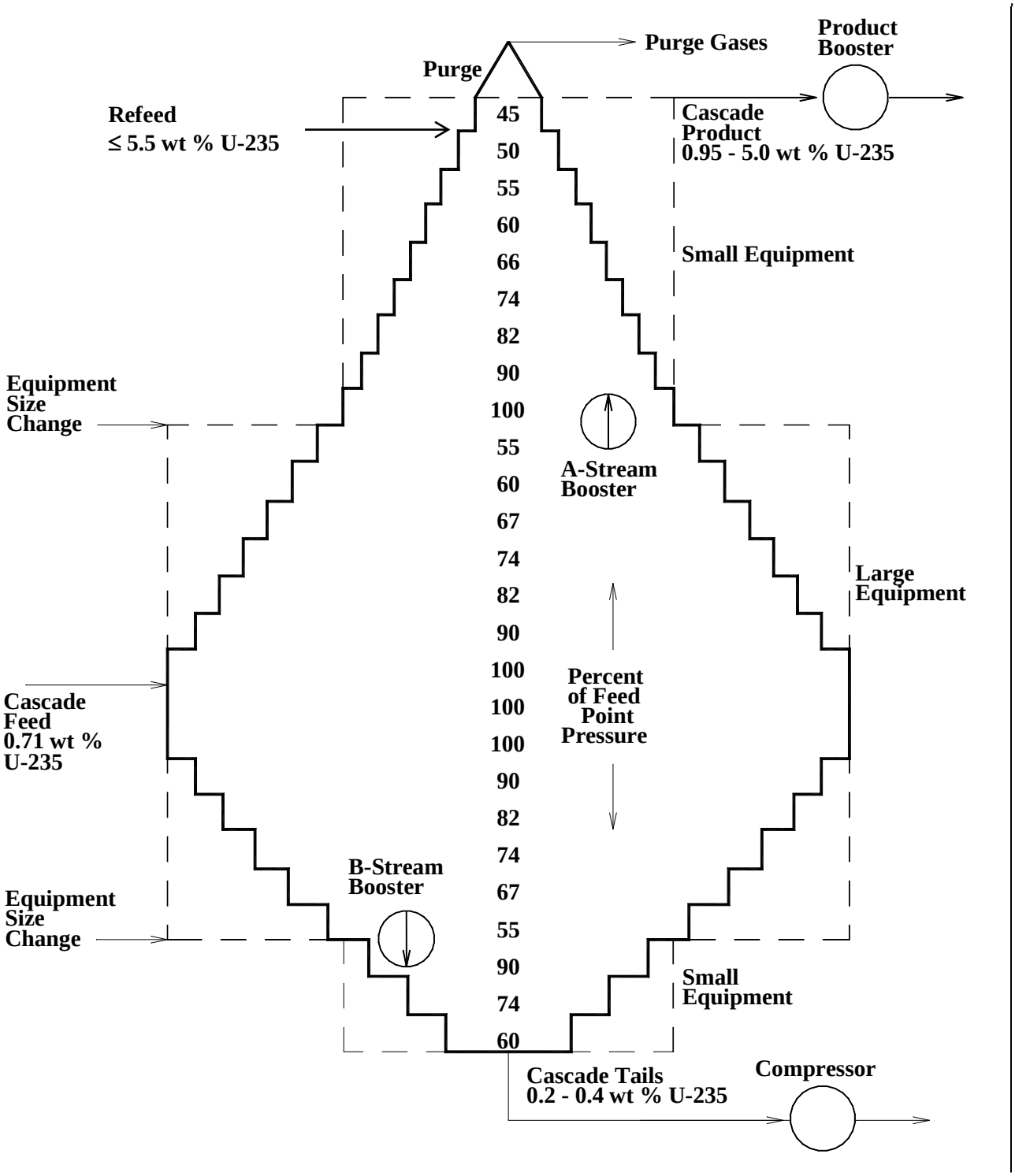


Figure 3.3-1. Schematic of a Cascade Tapered With Two Equipment Sizes

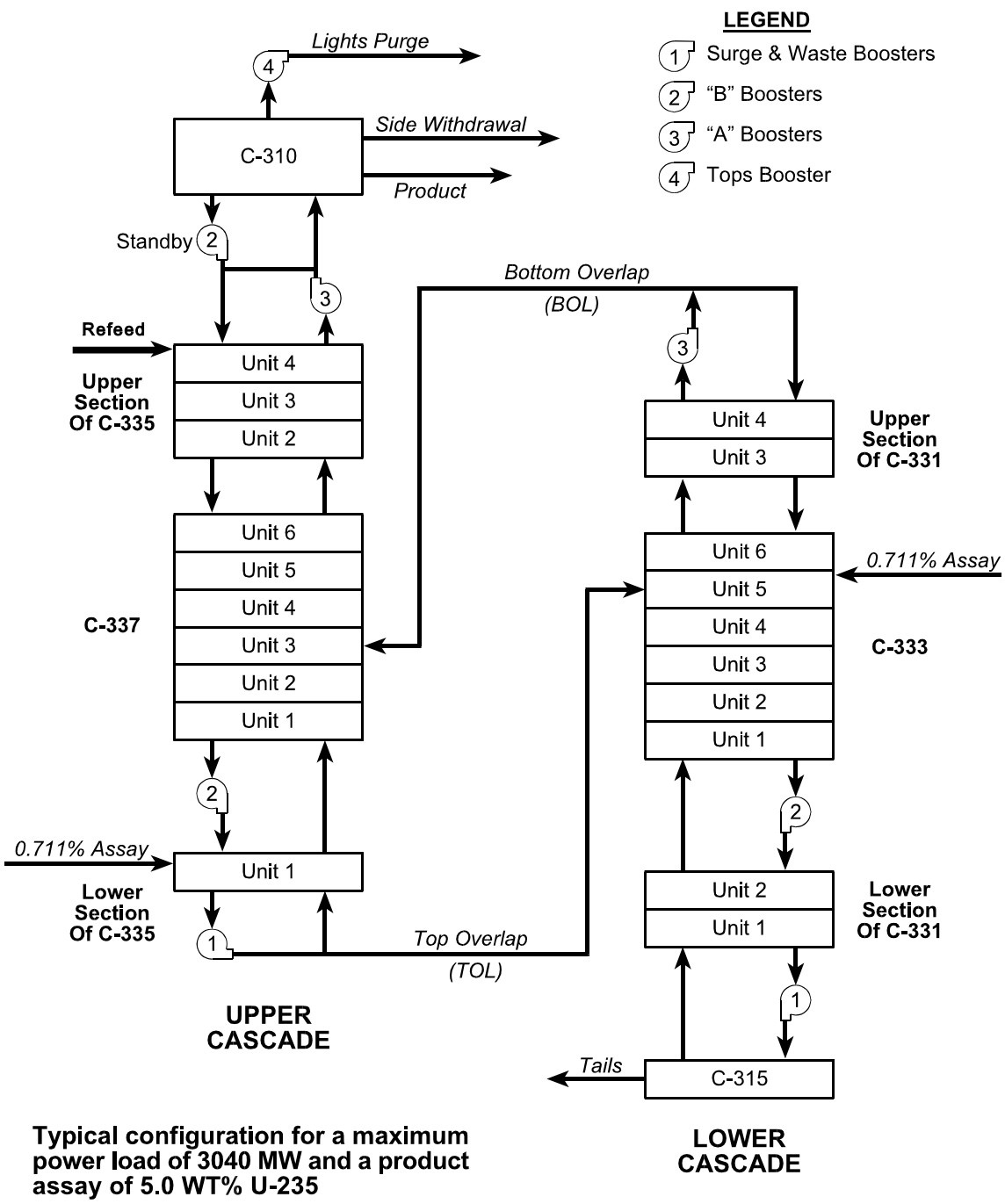


Figure 3.3-2. Locations and Major Flows of the Cascade Boosters

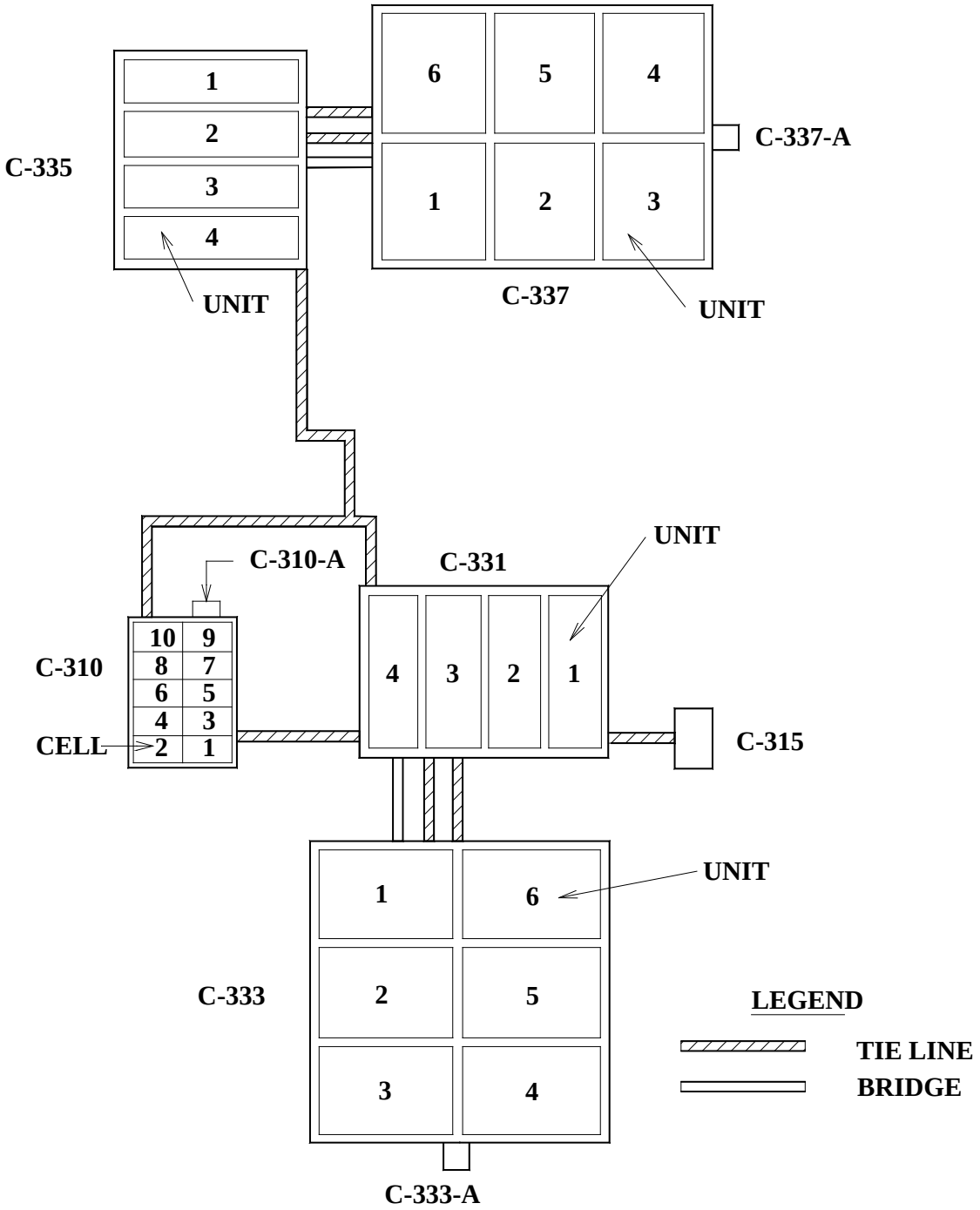


Figure 3.3-3. Plan View of Main Process Buildings

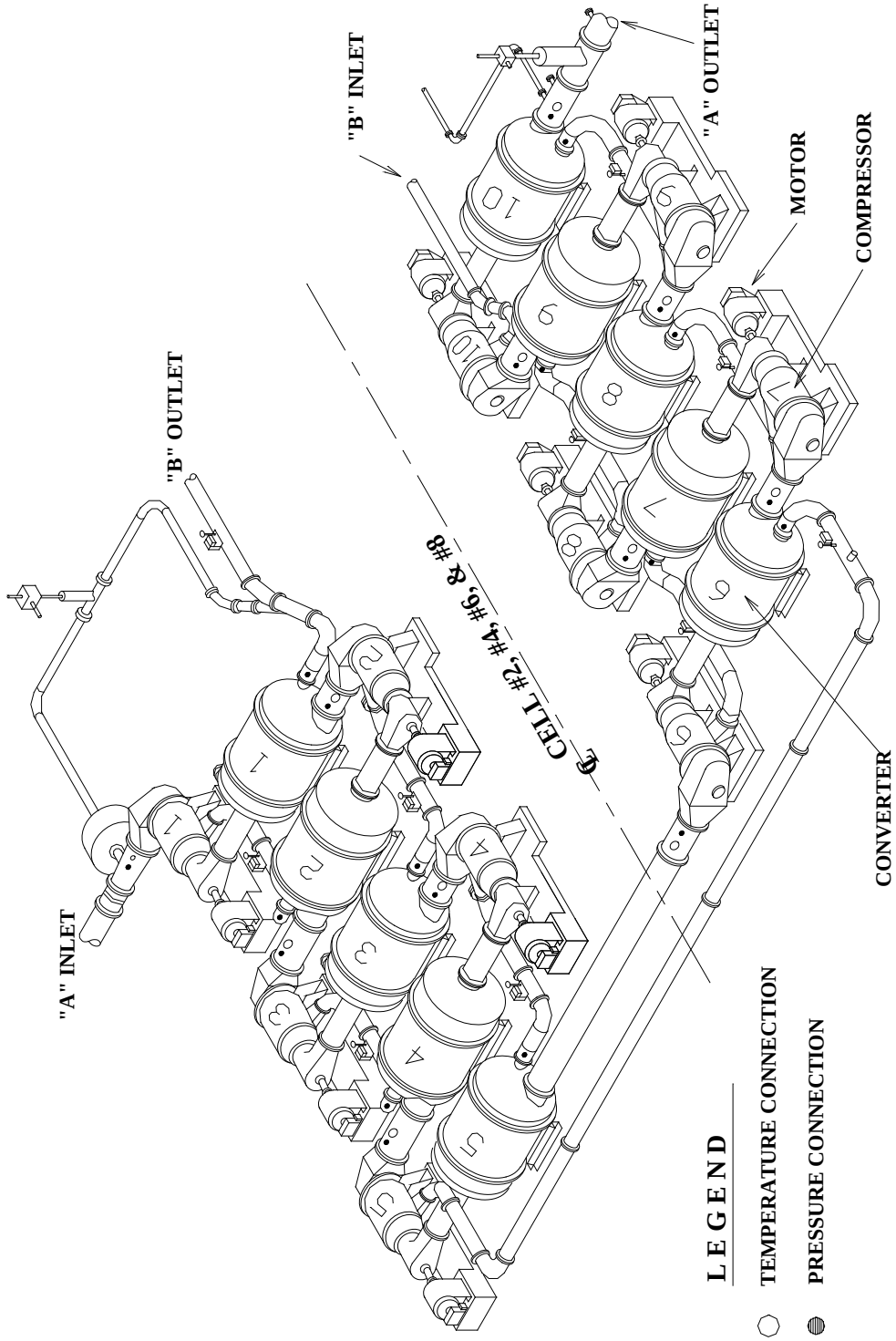


Figure 3.3-4. Typical "00" Cell

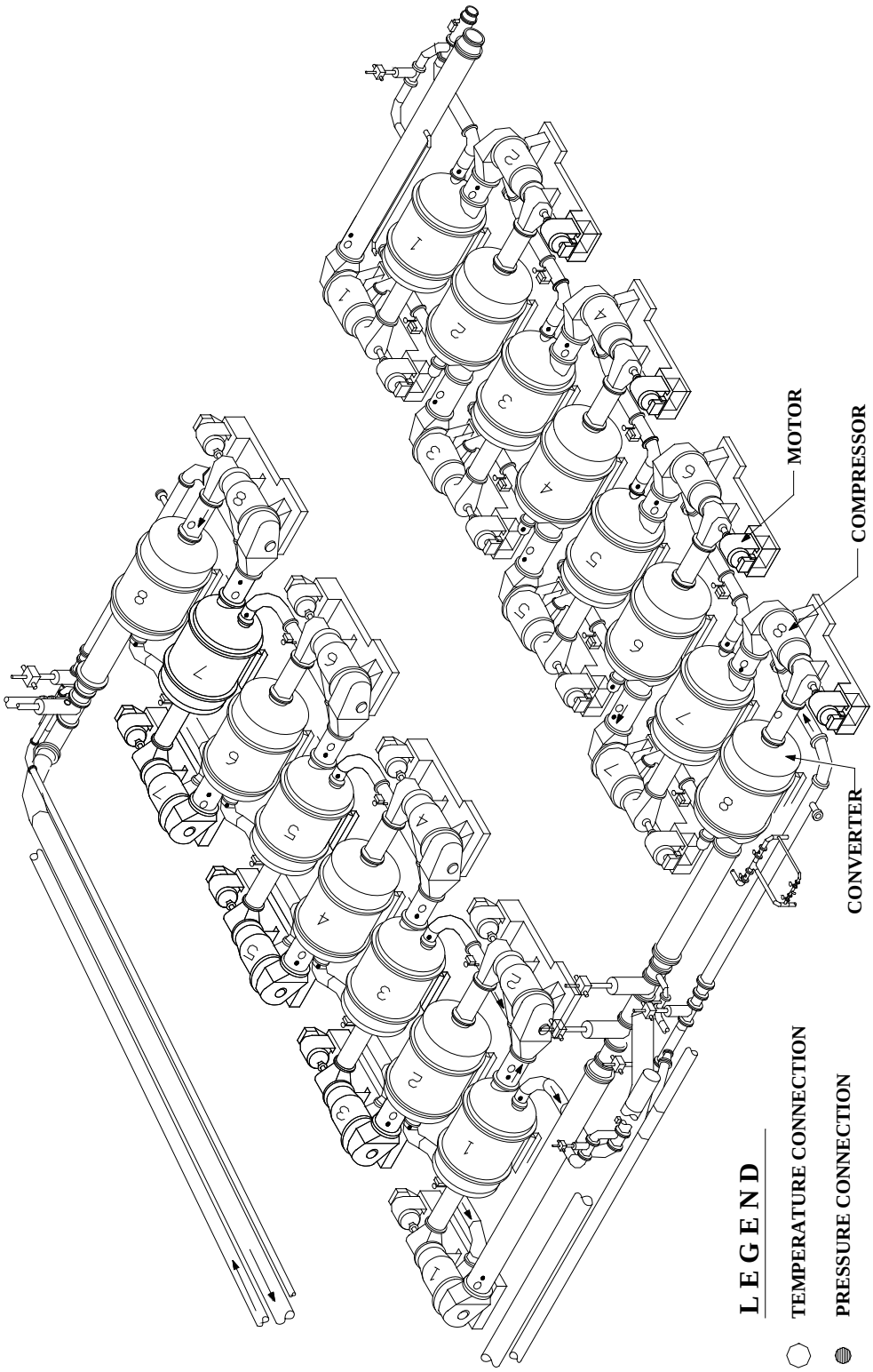


Figure 3.3-5. Typical "000" Cell (Two shown)

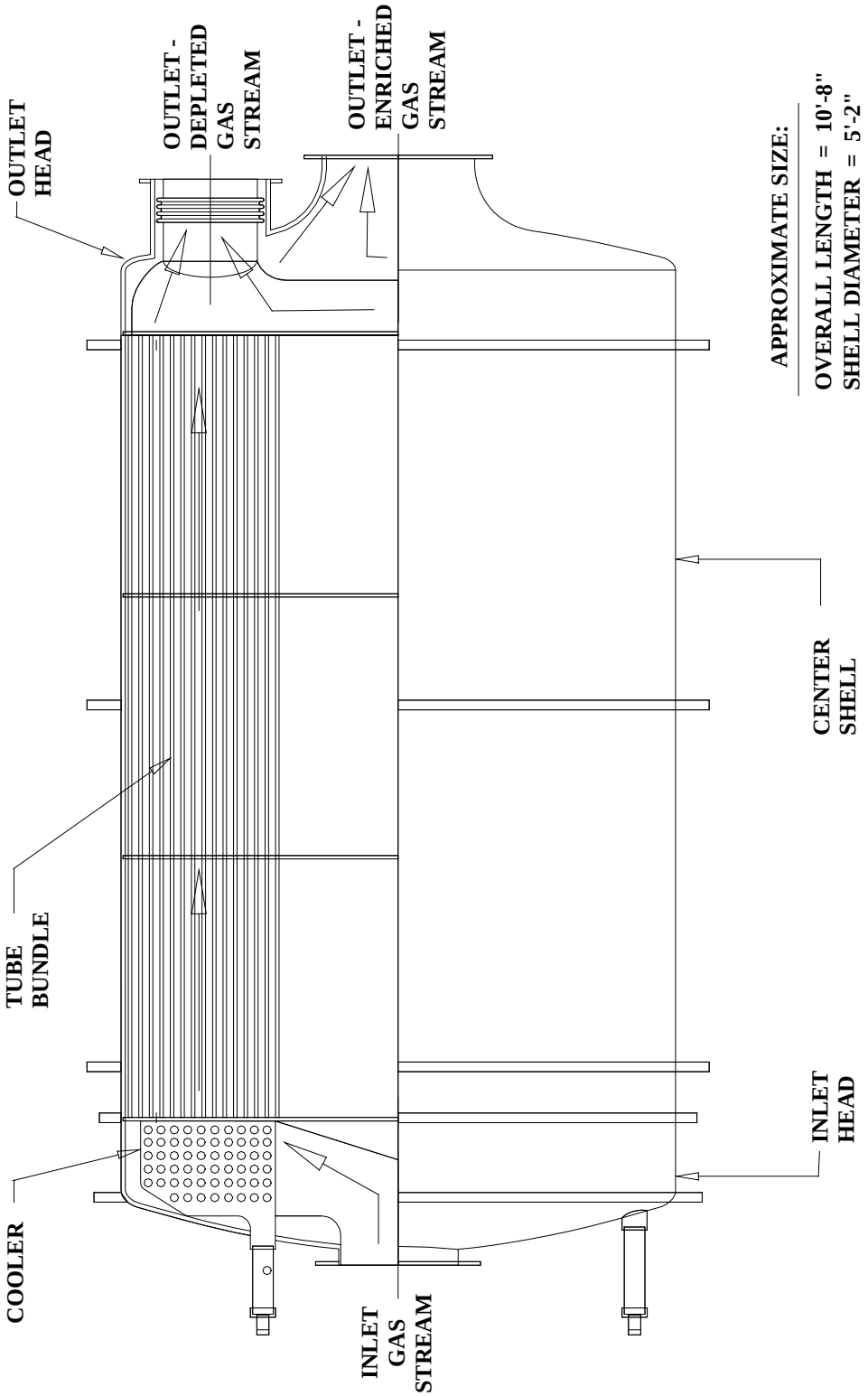


Figure 3.3-6 "2X" Converter

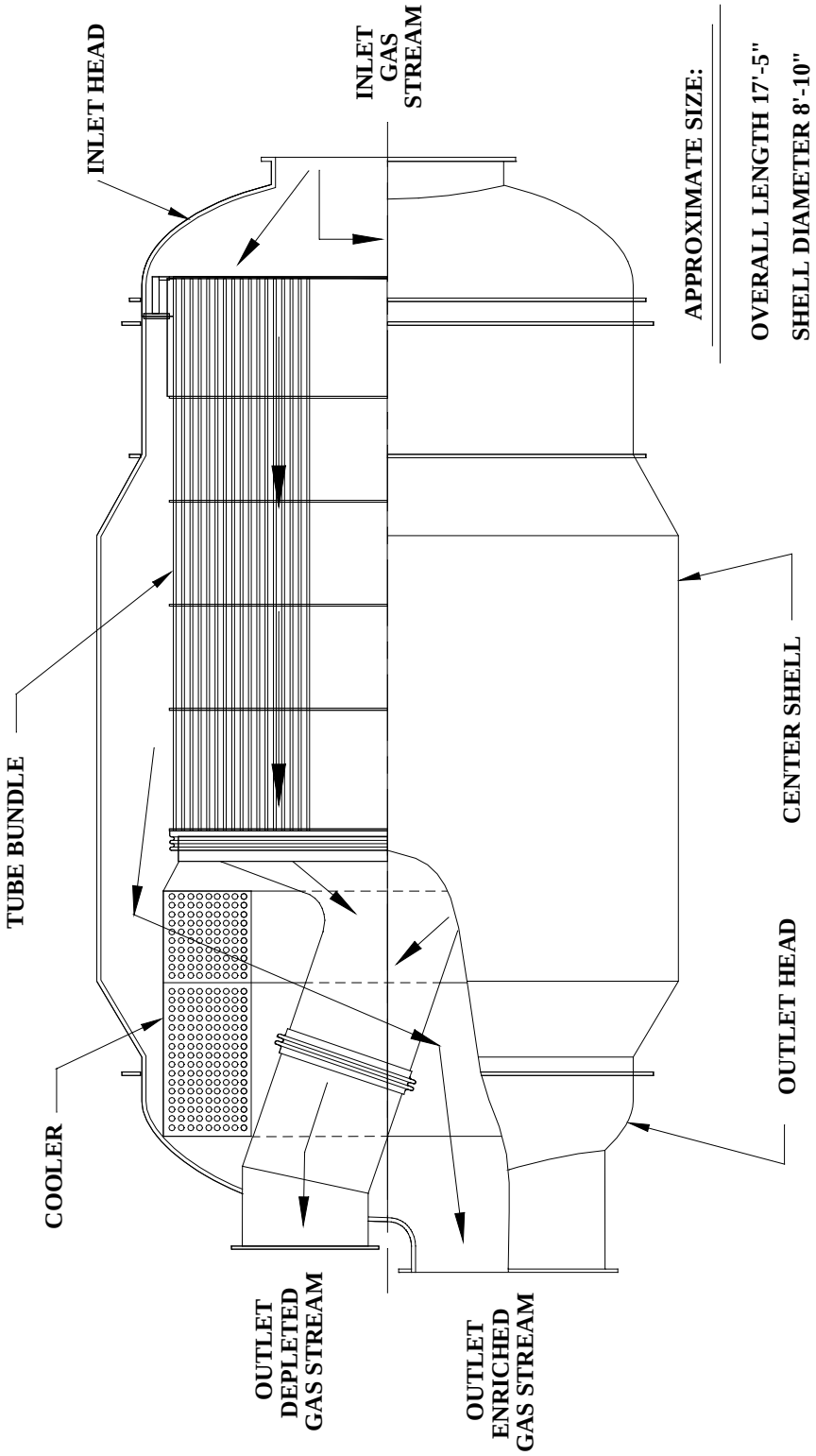


Figure 3.3-7 "00" Converter

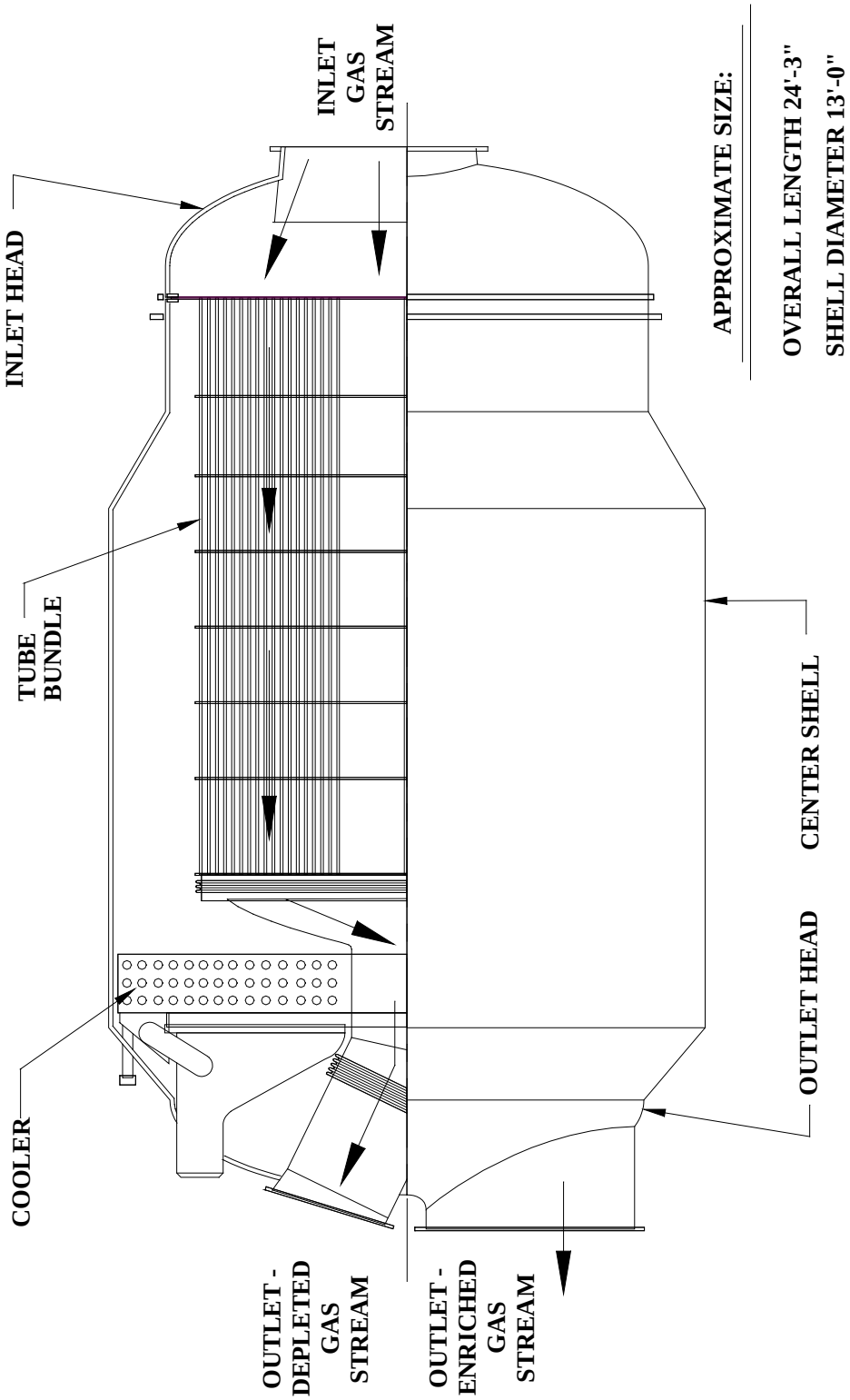


Figure 3.3-8 "000" Converter

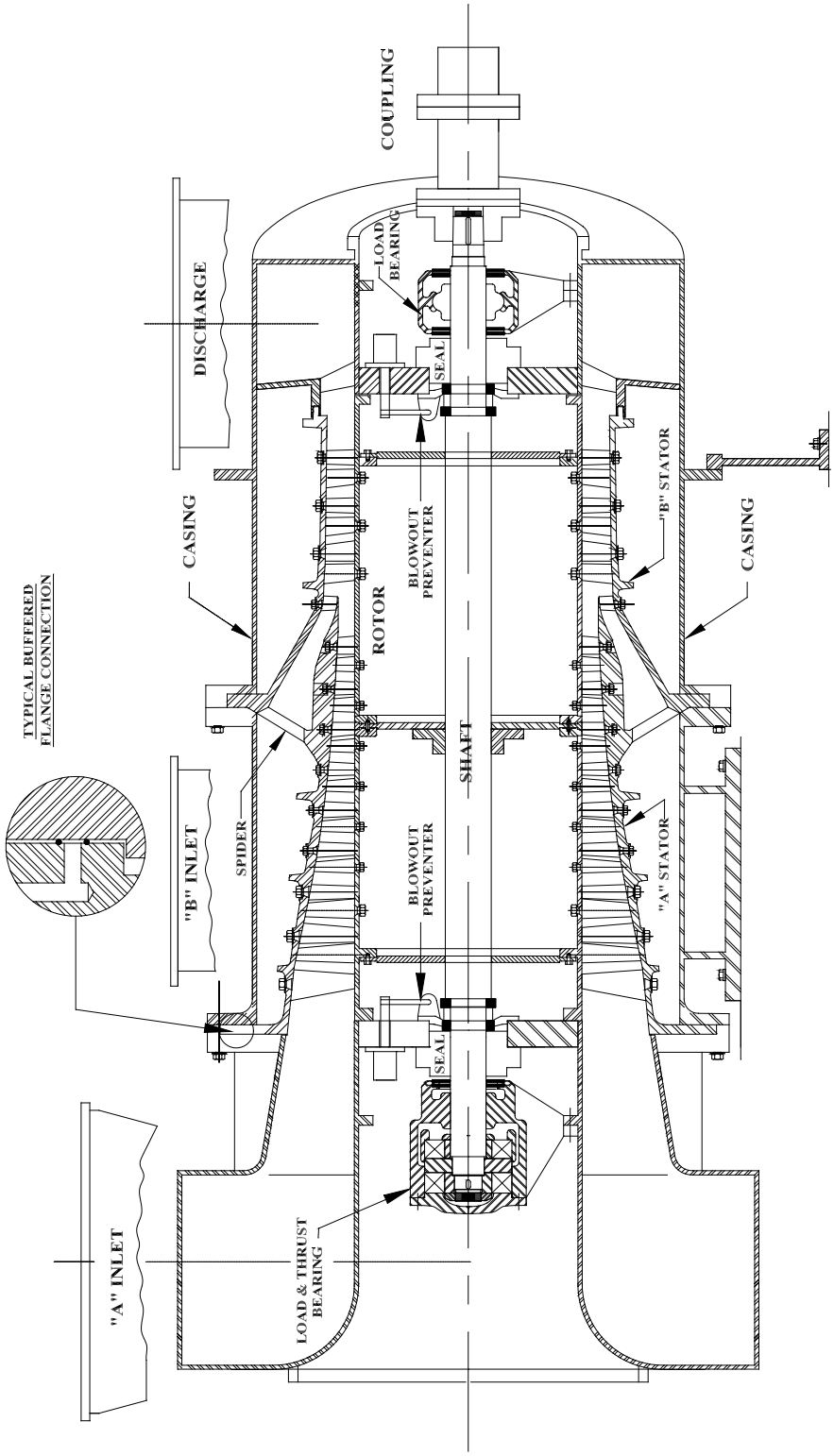


Figure 3.3-9. Axial Flow Compressor With Blowout Preventers

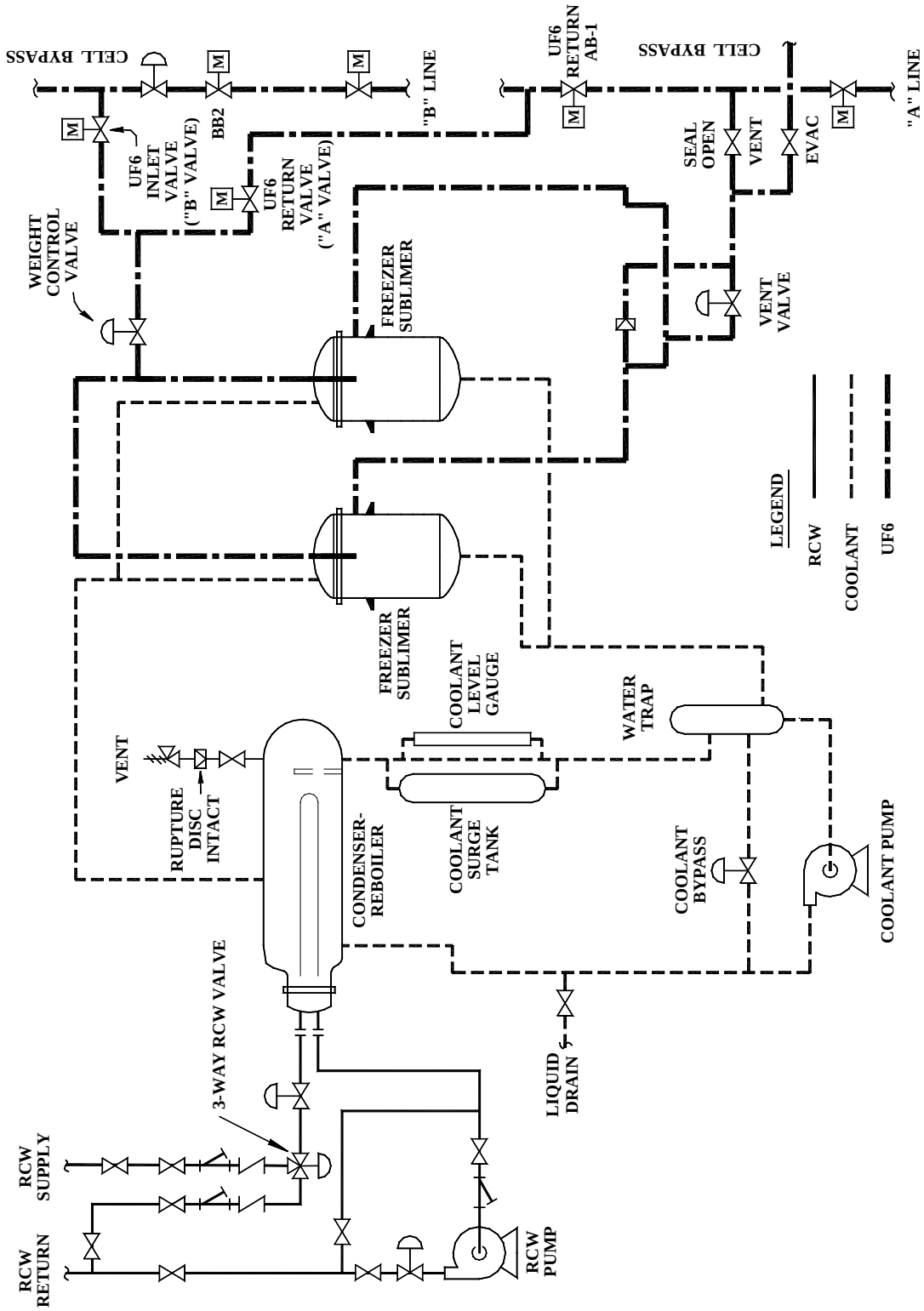


Figure 3.3-10. Typical Flow Diagram for Piggyback Freezer/Sublimer Unit

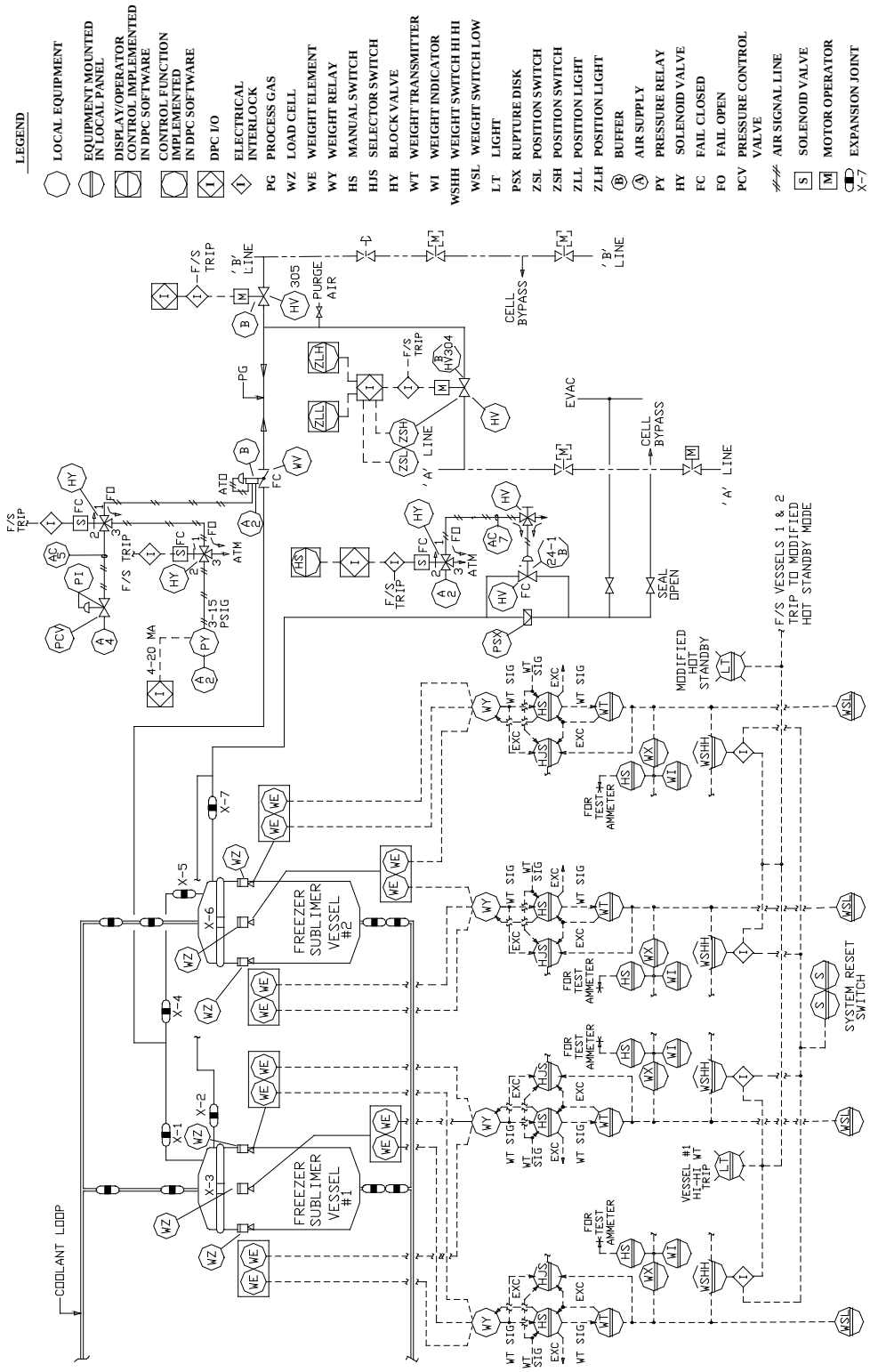


Figure 3.3-11. Freezer/Sublimer High-High Weight Trip System

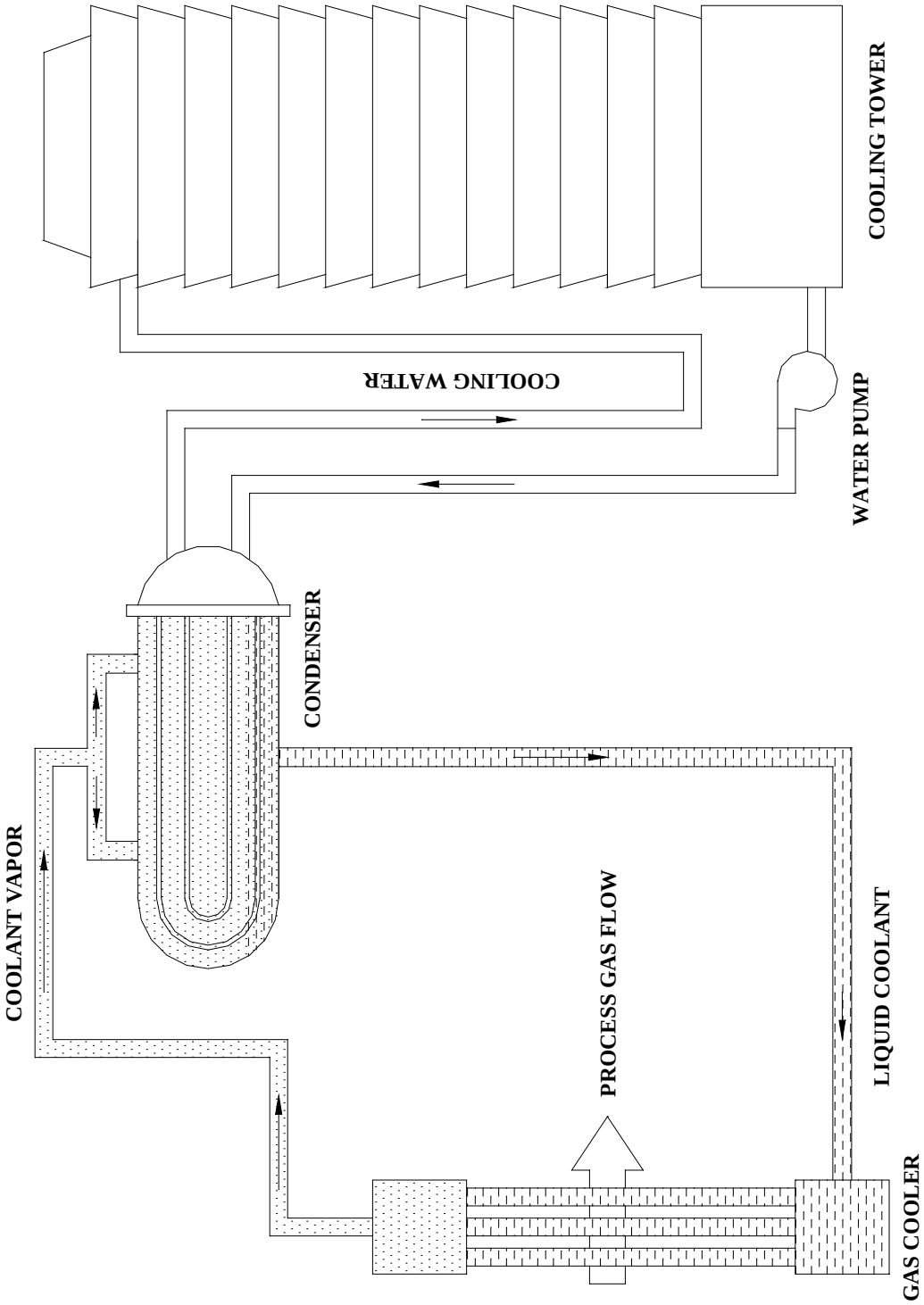


Figure 3.3-12 Schematic of Heat Removal System

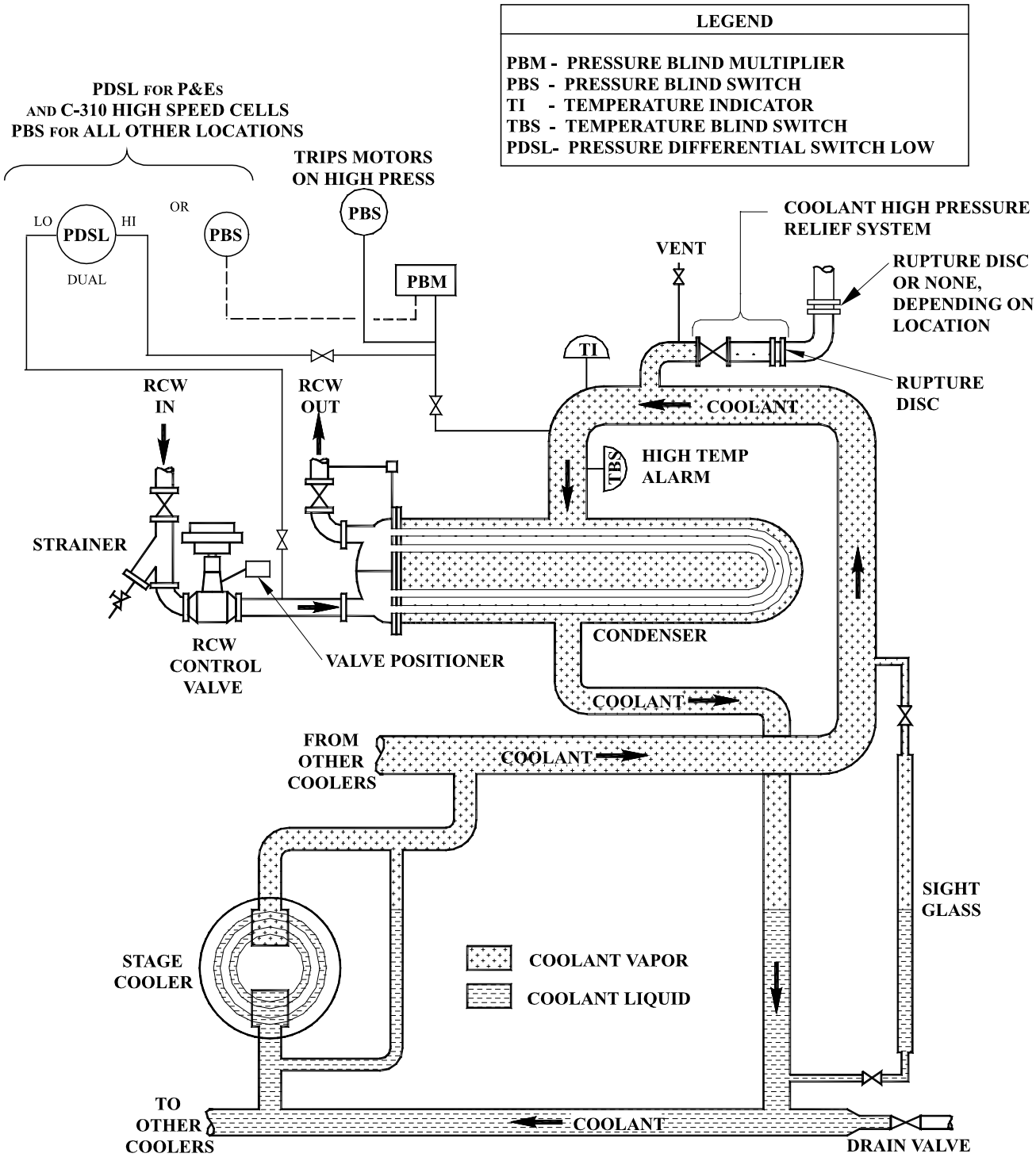


Figure 3.3-13. Simplified Schematic of the Cascade Coolant System

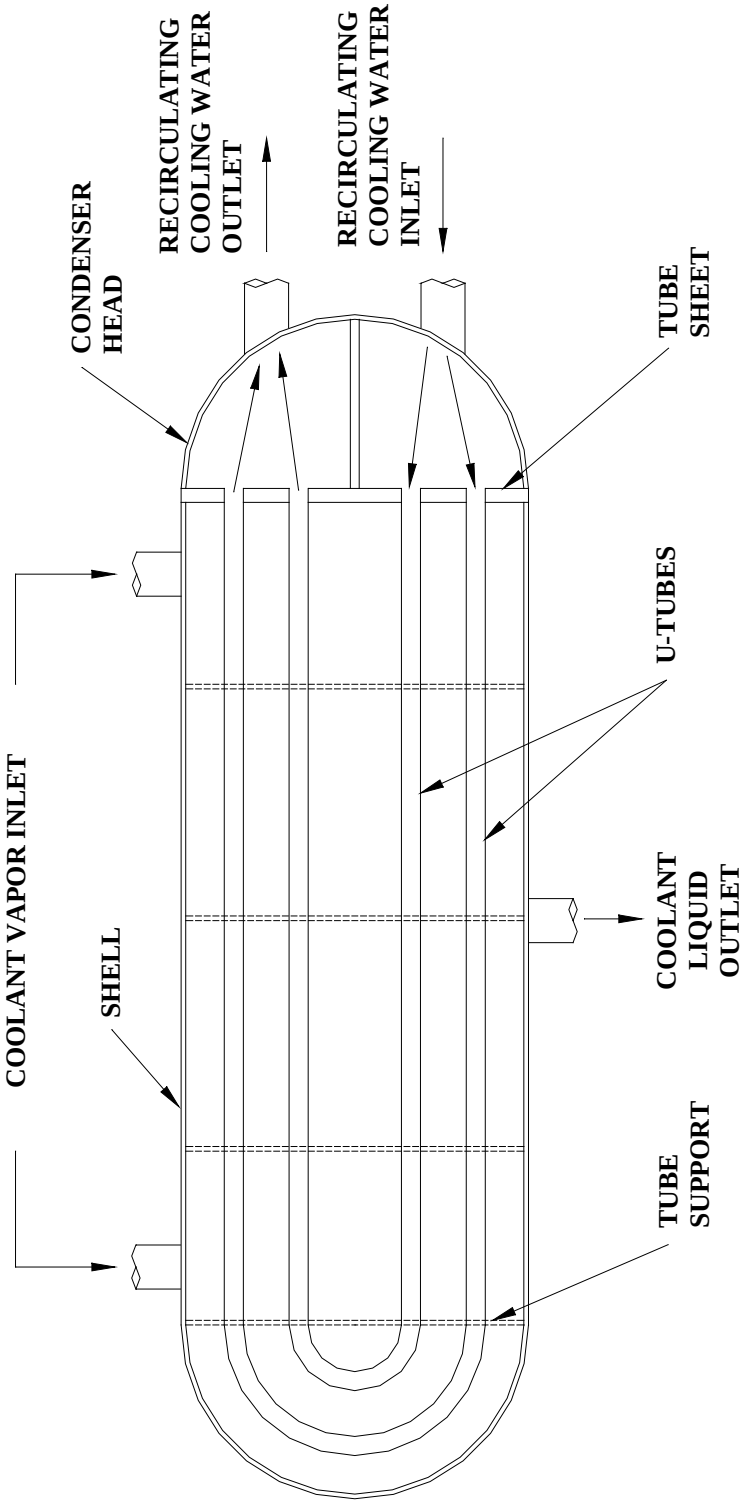


Figure 3.3-14. Typical Coolant Condenser

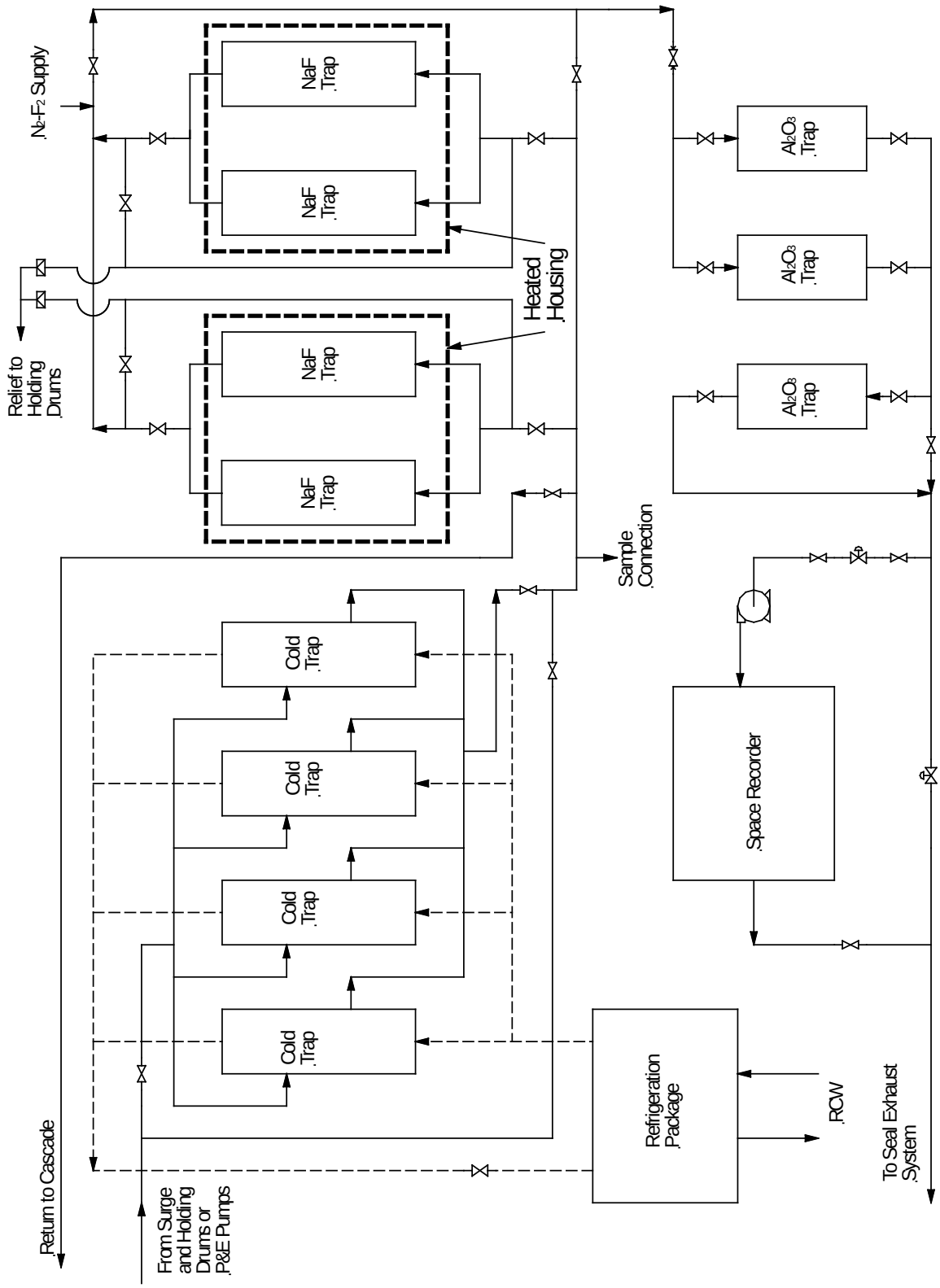
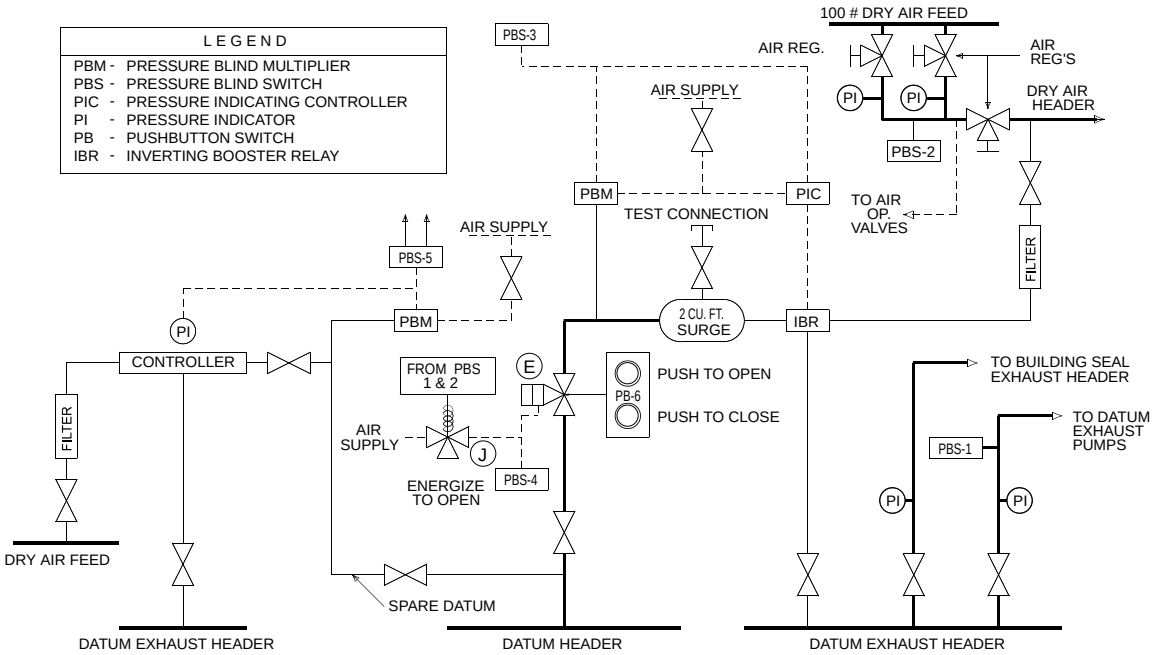


Figure 3.3-15. C-335 5.5 wt.% UF_6/R-114 Separation System.



NOTES

Valve E Air to open.

Valve J When energized, closes valve E.

PBS-1 Actuates upon high exhaust pressure, energizes valve J and closes valve E.

PBS-2 Actuates upon low air pressure, energizes valve J and closes valve E.

PBS-3 Actuates upon high or low PIC output pressure, seals in trip circuit and prevents opening valve E until PBS-1, PBS-2 and PBS-3 are deactuated.

PBS-4 Actuates upon closing of valve E and energizes alarm and light.

PBS- 5 Actuates upon high or low spare datum pressure and energizes alarms.

PBS-6 Pushbutton switch - operates valve E.

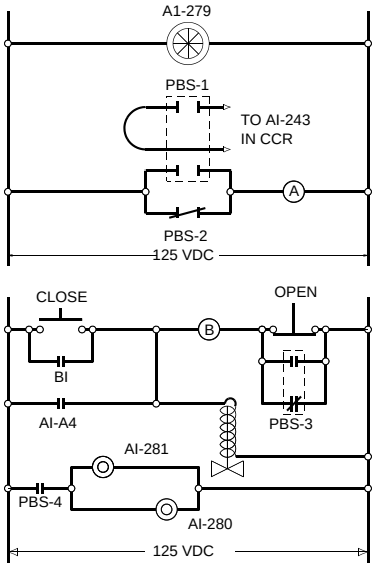


Figure 3.3-16. Typical cascade high datum or high/low datum (C-310) system.

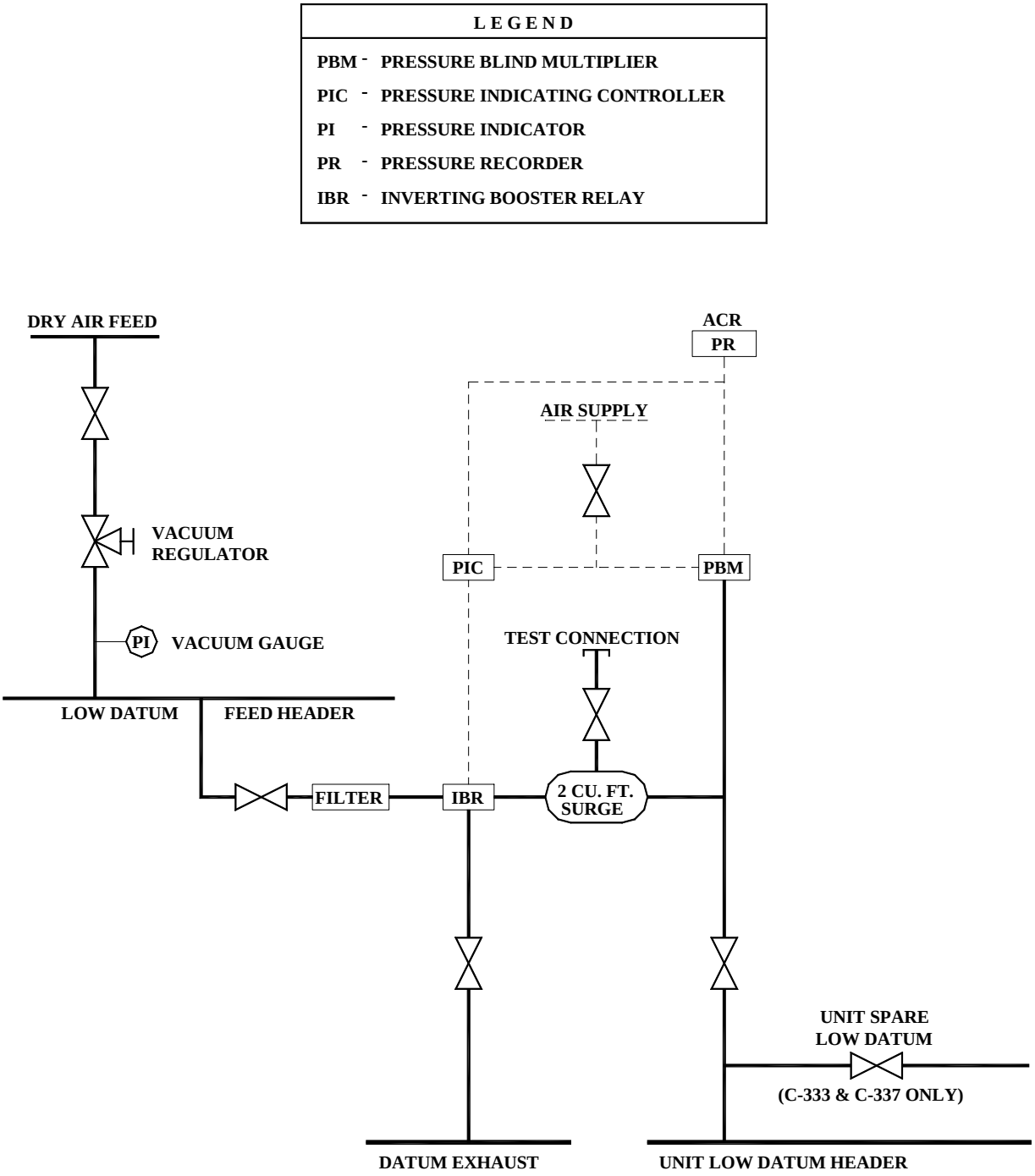


Figure 3.3-17 Typical Cascade Low Datum System

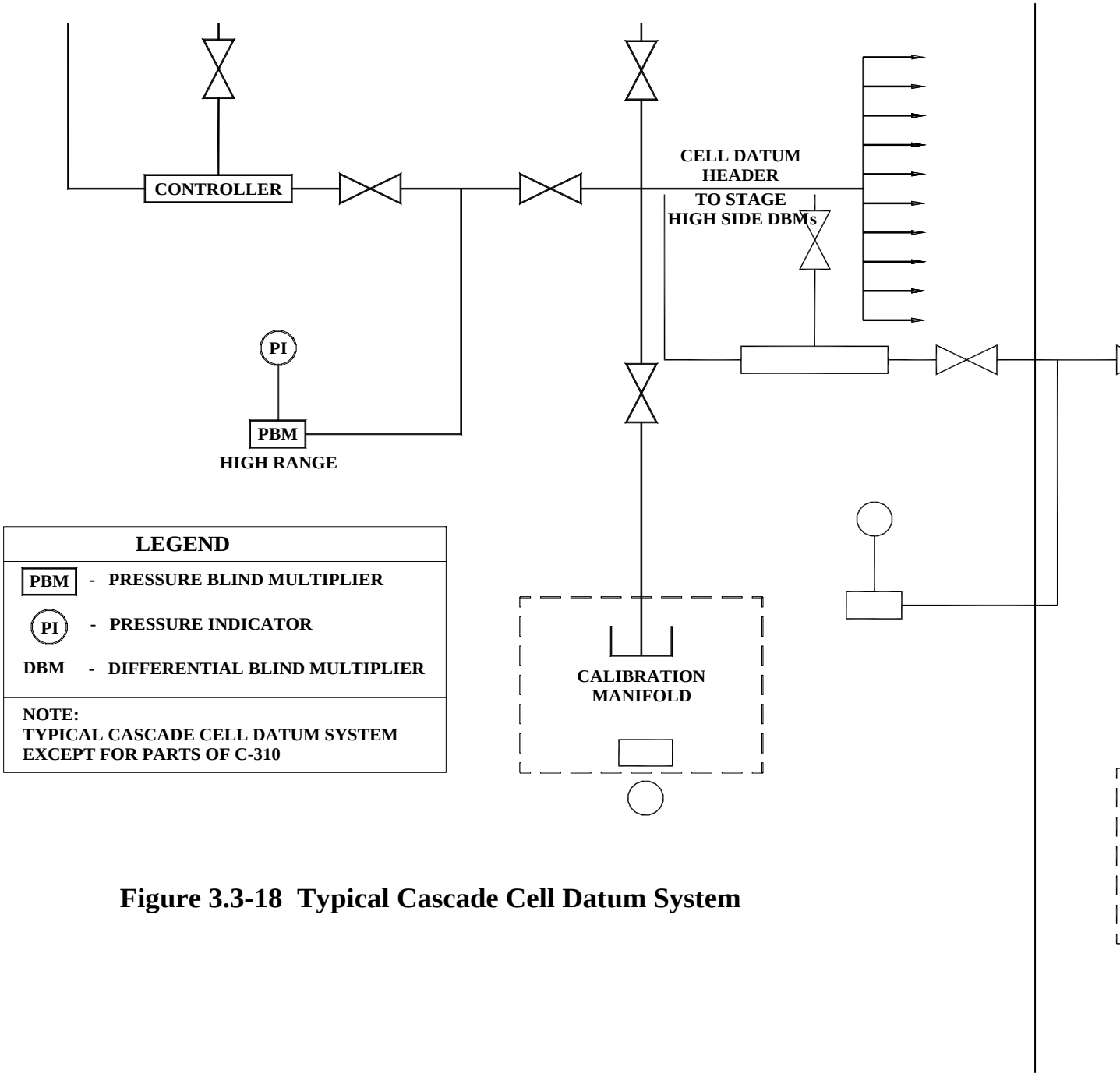


Figure 3.3-18 Typical Cascade Cell Datum System

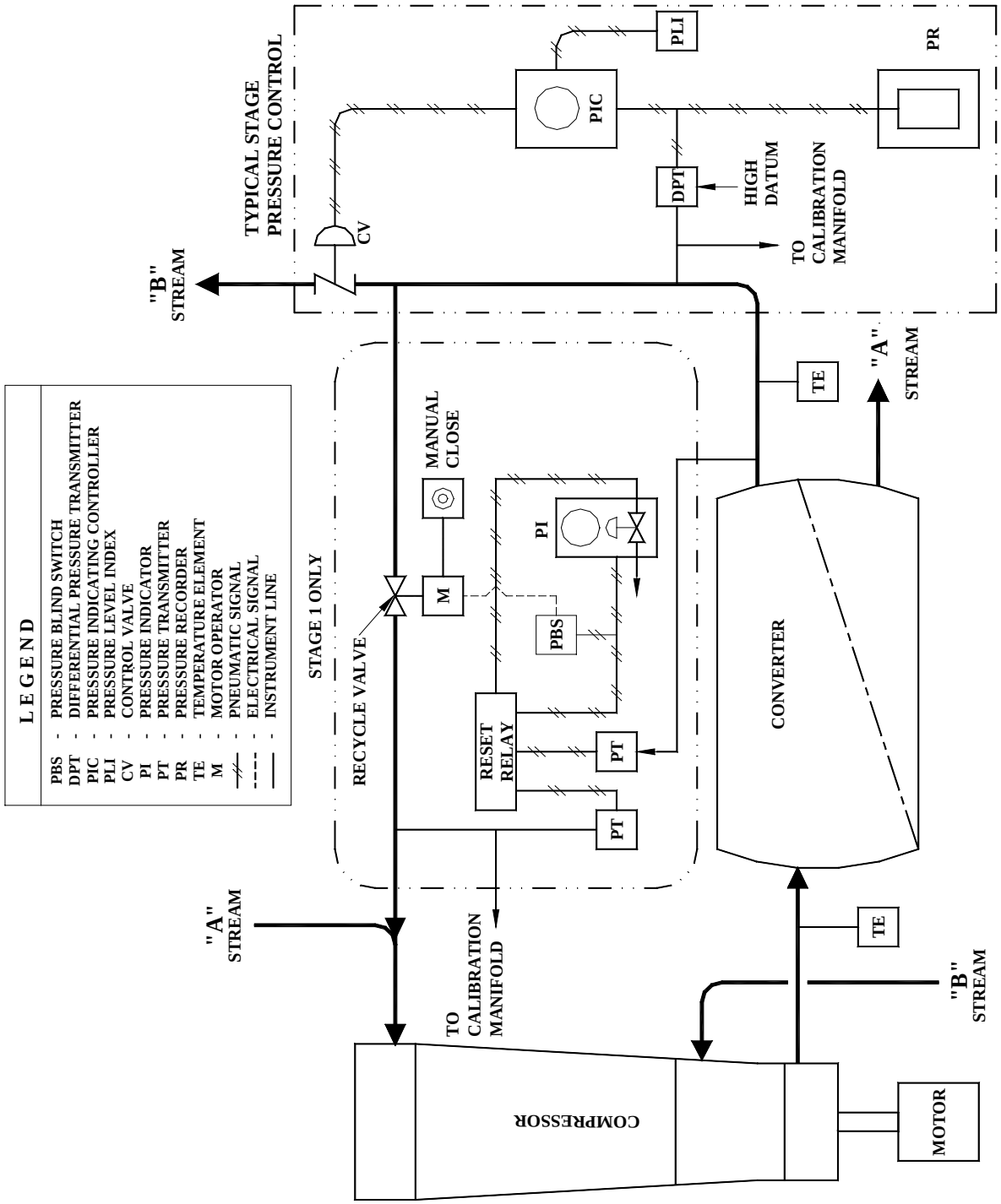


Figure 3.3-19 Stage Instrumentation

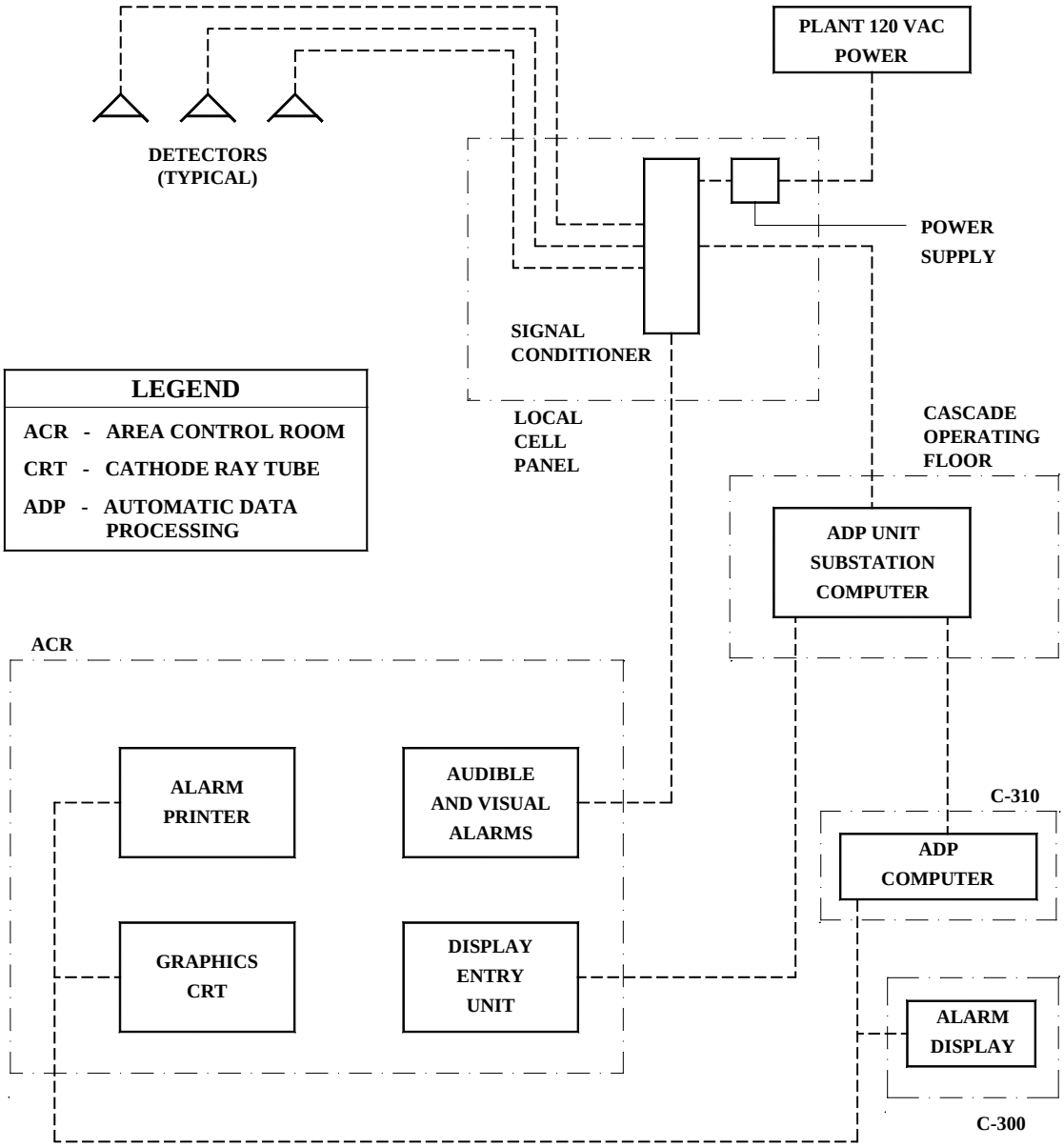


Figure 3.3-20 Simplified Block Diagram of a Typical Cascade UF_6 Release Detection System

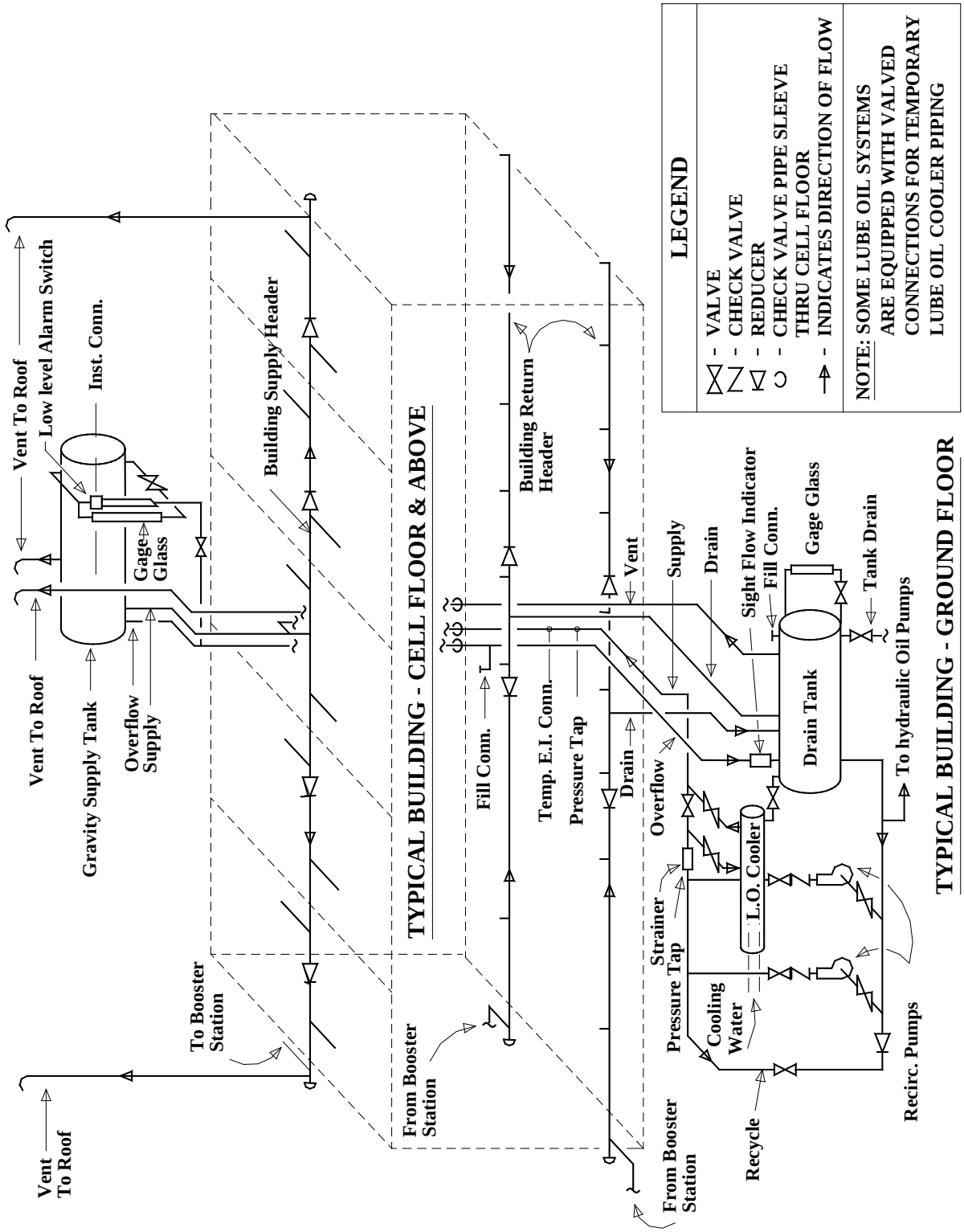


Figure 3.3-21 Lube Oil System Flow Diagram

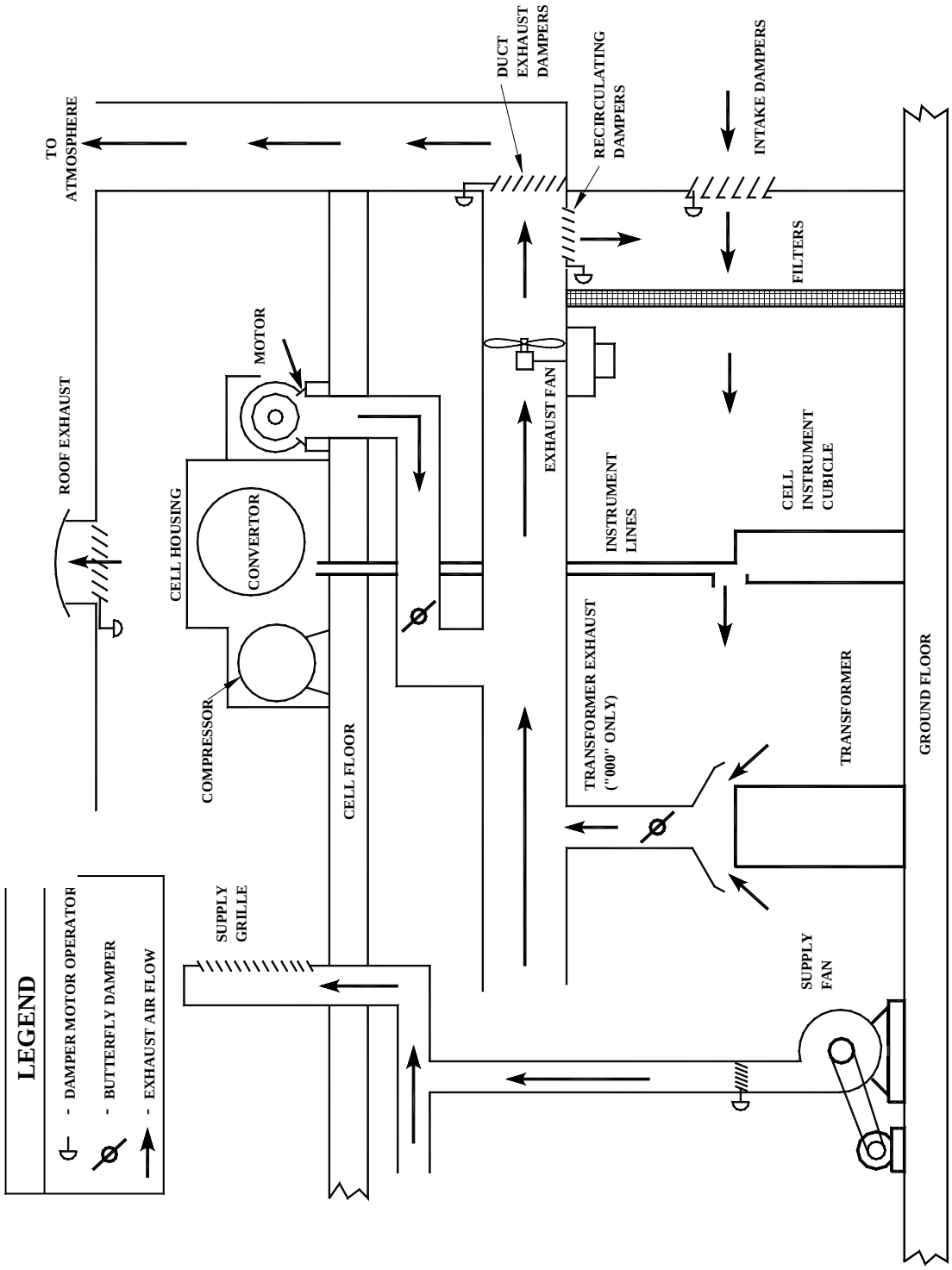


Figure 3.3-22 Typical Process Building Ventilation System

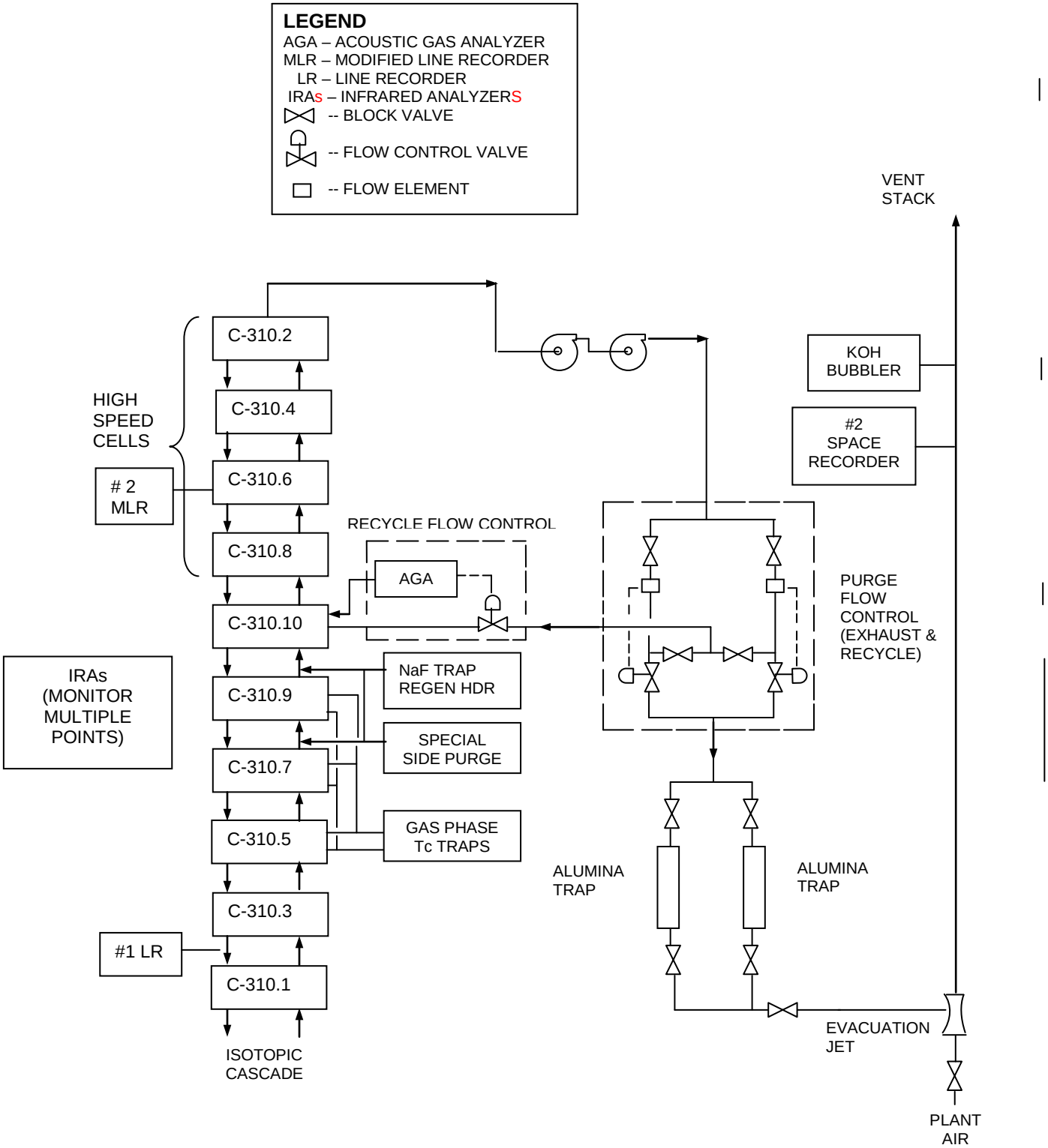


Figure 3.3-23. Typical Purge Cascade and Purge Systems Arrangement

3.4 UF_6 PRODUCT WITHDRAWAL FACILITY

The product withdrawal systems for PGDP are housed in the C-310, Purge and Product Building and the C-310-A, Product Withdrawal Building, which is attached to and located immediately north of C-310. The Product Withdrawal Facility Structure is important to safety and is discussed in Section 3.3. The facilities in these buildings provide for two separate withdrawal loops. These two loops can be cross-connected to withdraw a single assay or separated for dual assay operation. When a second assay is withdrawn, the lower assay is referred to as Side Withdrawal. Either system using any combination of the three Normetex pumps can be used to withdraw material of any assay up to 5.5 wt % ^{235}U to obtain 5.0 wt % ^{235}U in the product cylinder. When the Tails Withdrawal Facility is unavailable, tails withdrawal may be performed at C-310. Figure 3.4-1 depicts the process UF_6 flow in the product withdrawal facility. The side product withdrawal system may also be used to temporarily store liquid UF_6 in the accumulator before filling multiple product cylinders.

Normetex pumps in C-310 compress the UF_6 from the cascade. The liquefaction and accumulation is performed in C-310-A. The cylinder filling, sampling, and burping operations are conducted in C-310. Each facility has local operating controls. The area control room (ACR) in C-310 provides additional instrumentation for monitoring the withdrawal process. Fine control of the assay level of the product being withdrawn is accomplished by monitoring the withdrawal stream with mass spectrometers and/or by analyzing UF_6 gas stream samples periodically collected during cylinder filling operations.

UF_6 from the cascade is compressed, cooled to condense it, and the liquefied UF_6 flows by gravity into cylinders. Each cylinder being filled is mounted on a scale that monitors the cylinder weight. The filled cylinder is disconnected and moved outside the building for cooling and solidification of the UF_6 product. Non-condensable gases remaining in the cylinder are removed by connecting the cylinder to the "burp" station at C-310 or at the product withdrawal station. Gases evacuated from the cylinder are either (1) routed back to the cascade or (2) passed through sodium fluoride traps to remove almost all UF_6 before discharging the remaining gases to the atmosphere through the C-310 stack.

Not all the gaseous material supplied to the condenser is liquefied. A portion of the UF_6 flow and that part of the non-condensable gases not entrapped in the liquid UF_6 are returned to the cascade via the condenser vent. These gases are normally returned near the stage of the cascade from which they are withdrawn. However, they may be returned to other portions of the cascade or vented to surge drums in one of the other process buildings.

The following sections discuss components or systems associated with the product withdrawal system. Included are structures, systems, and components (SSCs) important to safety which are discussed in more detail.

3.4.1 UF_6 Withdrawal Primary System

The UF_6 Withdrawal Primary System (i.e., valves, equipment containing UF_6, and piping) is considered the primary means of confinement for UF_6 and includes both a UF_6 gas system and a UF_6 liquid system. The gaseous UF_6 system provides a confinement boundary for UF_6. The liquid UF_6 system provides a pressure boundary and a transfer of UF_6 in the liquid state. The system is important to safety as described in Section 3.15.

Condensers, accumulators, manifolds, sampling stations, and associated piping and valves are enclosed in heated housings and/or are heated independently. They are maintained at a temperature necessary to prevent UF_6 solidification. The components of the UF_6 Withdrawal Primary System are discussed in the following sections.

3.4.1.1 Normetex Pumps

The product withdrawal Normetex pumps are low-speed positive-displacement pumps used to compress the process gas (PG) without the use of dynamic seals between the PG and atmosphere. Three Normetex pumps are installed on the C-310 cell floor.

The Normetex pump uses a fixed and a moving spiral vane. The moving vane has an eccentric motion causing "pockets" between the vanes to open and close to compress the gas and move it from the inlet to the discharge of the pump. This design permits compression of UF_6 without the use of dynamic seals between the process and atmosphere. There are two motors associated with the Normetex pump that are used to drive the spiral vane. These motors are referred to as the vacuum pump motors.

The UF_6 enters the pump through fine mesh inlet gas filters designed to prevent any foreign material entry that might increase the wear of the vanes. A suction control valve regulates the amount of flow through the pump by controlling the suction pressure. The pump discharge is then routed to one or more of the three UF_6 condensers. A buffered expansion joint is installed between the pump and the discharge block valve on the outlet line.

The pump is lubricated and cooled by oil. An oil heater and oil cooler are used as necessary to maintain the desired oil temperature. The upper oil temperature limit prevents expansion of the vanes to prevent rubbing, while the lower oil temperature prevents formation of solid or liquid UF_6. A heat exchanger equipped recycle line, between the discharge and suction lines, aids to maintain lower pump operating temperatures when product withdrawal rates are low.

The product withdrawal facilities are equipped with a high discharge pressure shutdown system (HDPSS). This system minimizes the likelihood of a breach in the UF_6 Primary System due to a blockage in the discharge line. Each of the Normetex pumps in C-310 have their own HPDSS. In event of high discharge pressure, the vacuum pump is shutdown.

The product withdrawal facility Normetex pumps are equipped with a high oil temperature trip. In the event of high oil temperature in the Normetex pump oil supply system, the oil pump and vacuum pump motors are shut down and the Normetex pump is isolated from the discharge header.

The product withdrawal facility east and west Normetex pumps are equipped with a high inlet pressure shutdown system. In the event of PG high inlet pressure in the Normetex pump suction lines, the vacuum pump is shutdown and is isolated from the discharge header.

The Normetex pump motors and oil pump drive motor are provided with overload protection. When the pumping mechanism of the Normetex pump becomes clogged the pump motors are isolated from the power source. This action trips the vacuum pump motors and further damage to the system is prevented. The oil pump motors also trip on motor overload.

A simplified flow diagram for the product withdrawal facility showing the location of the Normetex pumps in the process flow is provided as Figure 3.4-1.

The Normetex pump has safety systems designed to mitigate a UF_6 release or a criticality due to failures in the systems. Figure 3.4-2 shows a typical Normetex Pump and its safety systems. These safety systems are discussed below and in Section 3.4.2.1.1.1.

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3.4.1.1.3 C-310 Normetex Pumps High Oil Pressure Trip

The product withdrawal facility Normetex pumps are equipped with a high oil pressure trip. The Normetex Pumps High Oil Pressure Trip mitigates the risks of having a criticality due to UF_6 and oil mixing from a failure in the oil/UF_6 barrier. In the event of high oil pressure in the Normetex pump oil supply system, the oil pump and vacuum pump motors are shut down and the Normetex pump is isolated from the discharge header. This system is important to safety as described in Section 3.15.

If high oil pressure is detected, then the oil pump motor and the vacuum pump motors are shut down. The high oil pressure switch serves to shut down the oil pump on a high oil backpressure condition normally indicative of a clogged filter. Also closed is the air-operated suction control valve on the Normetex pump.

The Normetex Pumps High Oil Pressure Trip includes an air-operated block valve on the PG discharge line that supports compression isolation. This discharge block valve is a diaphragm-actuated valve that requires air to open (via pressure regulators), a spring to close, and is considered fail-safe. The air-control solenoid (the discharge block valve has two solenoid valves, which provide assurance that, the valve will close and isolate the compression loop during the Normetex pump shutdown sequence) is deenergized during activation of the isolation system. Air is then vented from the discharge block valve and it fails closed. Loss of the plant air supply will result in the discharge block valve transferring to the closed (safe) position.

The plant air system also provides the motive power for the suction CV. This valve requires air to remain open. The operation of the suction control valve during the safety system activation is significant but is not credited for isolation of the Normetex pump.

The control logic for the C-310 east, west, and side withdrawal Normetex pumps requires 48 VAC power to operate and initiate pump shutdown. The transformers that supply 48 VAC power to the pump control relay circuits require 480 VAC power to operate. The Normetex pump motors and the transformers are fed from the same power source. Loss of 480 VAC or

48 VAC power will cause loss of power to the Normetex pump motors, stopping the pump. Electrical power is a support system, which is important to safety as described in Section 3.15.

The alarm indication for the oil pump motor status occurs on the local control panel. The alarm indication for the Normetex pump shutdown occurs in the building ACR.

3.4.1.1.4 C-310 Normetex Pumps Low Oil Flow Trip

The product withdrawal facility Normetex pumps are equipped with a low oil flow trip. The Normetex Pumps Low Oil Flow Trip mitigates the risks of having a criticality due to UF_6 and oil mixing from a failure in the oil/UF_6 barrier. In the event of low oil flow in the Normetex pump oil supply system, the oil pump and vacuum pump motors are shut down and the Normetex pump is isolated from the discharge header. This system is important to safety as described in Section 3.15.

The oil flow is monitored to ensure that oil is being circulated throughout the pump. The low oil flow switch serves to trip the oil pump on a loss of oil flow indicative of a severed oil line. If low oil flow is detected, then the oil pump motor and the vacuum pump motors are shut down. A flow alarm is indicated. Also closed is the air-operated suction control valve on the Normetex pump.

The Normetex Pumps Low Oil Flow Trip includes an air-operated block valve on the PG discharge line that supports compression isolation. This discharge block valve is a diaphragm-actuated valve that requires air to open (via pressure regulators), a spring to close, and is considered fail-safe. The air-control solenoid (the discharge block valve has two solenoid valves, which provide assurance that, the valve will close and isolate the compression loop during the Normetex pump shutdown sequence) is deenergized during activation of the isolation system. Air is then vented from the discharge block valve and it fails closed. Loss of the plant air supply will result in the discharge block valve transferring to the closed (safe) position.

The plant air system also provides the motive power for the suction CV. This valve requires air to remain open. The operation of the suction control valve during the safety system activation is significant but is not credited for isolation of the Normetex pump.

The nominal 120 VAC power necessary to operate the Normetex Pumps Low Oil Flow Trip is supplied from 480 VAC at the motor control center. The control logic for the C-310 east, west, and side withdrawal Normetex pumps requires 48 VAC power to operate and initiate pump shutdown. The transformers that supply 48 VAC power to the pump control relay circuits require 480 VAC power to operate. The Normetex pump motors and the transformers are fed from the same power source. Loss of 480 VAC or 48 VAC power will cause loss of power to the Normetex pump motors, stopping the pump. Electrical power is a support system, which is important to safety as described in Section 3.15.

The alarm indication for the oil pump motor status occurs on the local control panel. The alarm indication for the Normetex pump shutdown occurs in the building ACR.

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3.4.1.1.6 Section Deleted

3.4.1.1.7 C-310 Normetex Pump Discharge Block Valve Closure on Pump Trip

The C-310 product withdrawal facility Normetex pumps are equipped with a block valve on the discharge of each pump that will close during a Normetex pump shutdown sequence (pump trip). When the Normetex pump trips, the pump motors are shut down and the Normetex pump discharge block valve closes to isolate the pump from the discharge header. The closure of the discharge block valve to isolate the pump discharge is credited as an NCS active engineered feature in section 3.15.10.4.12.

The Normetex discharge block valve is an air-operated block valve on the PG discharge line that supports compression source isolation. The discharge block valve is a diaphragm-actuated valve that requires air to open (via pressure regulators), a spring to close, and is considered fail-safe. The air-control solenoid (the discharge block has two solenoid valves, which provide assurance that, the valve will close and isolate the compression loop during the Normetex pump shutdown sequence) is deenergized during activation of the isolation system. Air is vented from the discharge block valve and it closes. Loss of plant air supply will result in the discharge block valve transferring to the closed (safe) position.

The 120 VAC power necessary to operate the Normetex pump trip systems are supplied from 480 VAC at the motor control center. The control logic for the C-310 east, west, and side withdrawal Normetex pumps requires 48 VAC power to initiate pump shutdown and closure of the discharge block valve. Loss of 480 VAC or 48 VAC power will cause loss of power to the Normetex pump motors, stopping the pump. Electrical power is a support system, which is important to safety as described in 3.15.

3.4.1.2 Piping, Valves, Expansion Joints and Accumulators

3.4.1.2.1 Piping

The piping and other elements of the compression/liquefaction process are used to transfer the UF_6 vapor or liquid into receiving cylinders. All of the piping is permanently installed passive primary containment systems.

3.4.1.2.2 Valves

Most valves in the UF_6 Primary System are critical only as a pressure boundary to control UF_6 from being released. Selected valves are relied on to close and isolate systems in the event a system failure occurs.

3.4.1.2.3 Expansion Joints

Expansion joints are located between PG piping and fixed equipment in the withdrawal Normetex pump portions of the system to allow for thermal expansion of the piping and for small differences in pipe alignment.

3.4.1.2.4 Accumulators

Accumulators are located in the liquid withdrawal line to provide staging of liquid UF_6 during withdrawal interruptions. Each withdrawal loop has its own accumulator, separated from other withdrawal loops as necessary to prevent mixing of materials of different assays between the withdrawal loops.

Two UF_6 liquid accumulators serve the product withdrawal system. The product accumulator is a nickel-lined steel tank used in the top product withdrawal system. The side accumulator is a monel tank. The accumulators are located on the second floor below the condensers. They provide surge volume by "floating" on the drain line. Equipment that "floats" is not piped into the main flow but is connected such that liquid UF_6 can freely fill or be emptied from the accumulator as the need arises. The side accumulator can also be piped into the main flow by way of a top connection so that the accumulator can be filled more efficiently before draining into the product cylinder. In addition, the accumulators can be used to receive the contents of a 48X (10 ton) product cylinder via vapor transfer from a feed autoclave. The liquid UF_6 in the accumulator is then used for filling multiple cylinders. A vent line with a control valve is provided to permit the return of non-condensables to the cascade and to control pressure. Overpressure protection is provided by a rupture disc located on each accumulator vapor vent line, exhausting back to the cascade.

3.4.1.2.5 UF_6 Cylinder Pigtails

The UF_6 cylinder pigtails, which are classified as important to safety, comprise a pigtail assembly and gaskets. The pigtail assembly is fabricated of metal tubing equipped with fittings on either end that allow the pigtail to be attached to a manifold at one end and the cylinder at the other end. After fabrication, UF_6 cylinder pigtails are heated for stress-relief. Gaskets are used between the sealing surfaces of the pigtail assembly and the cylinder and equipment to which it is connected. UF_6 cylinder pigtails that are used outside of heated enclosures have heat tape applied to the pigtail assembly in order to prevent UF_6 freezeout during its use.

A specific pigtail design is employed for each UF_6 operation. UF_6 cylinder pigtails, used at C-310 withdrawal positions 3, 4, and 5 are important to safety and are described in Section 3.15.

All UF_6 cylinder pigtails are subjected to acceptance inspection and testing prior to certification for use. Included in this testing are hydrostatic tests after fabrication. Prior to connecting a certified UF_6 pigtail, it is visually inspected for defects, and a new pigtail gasket is installed on each disconnected end fitting. Visual inspection of UF_6 cylinder pigtails in C-310 is limited due to the presence of heat tracing. All new cylinder pigtail connections are vacuum checked and leak rate tested per applicable procedure prior to admitting UF_6 to the affected connection.

3.4.1.3 Coolant and Condensing Systems

Coolant is used in the condensers at the product withdrawal facilities to lower the temperature of the UF_6. Heat is removed from the coolant by the recirculating cooling water (RCW) system. The coolant acts as a heat transfer medium, carrying heat from PG to the RCW. A heat transfer medium must be used to keep water from the PG as water reacts chemically with UF_6. During normal operations this is accomplished by maintaining the coolant pressure above the PG pressure and the RCW pressure to prevent water from entering the coolant system and then into the PG. This pressure differential prevents UF_6 and RCW from mixing should a system failure occur.

3.4.1.3.1 UF_6 Condensers

The UF_6 condensers are horizontal tanks with U-tubes, in a tube bundle, and double-tube pass UF_6 flow. UF_6 flows through a bank of tubes, shaped in a “U” design, making two passes through the condenser before exiting the vessel. UF_6 condensation takes place on the tube side with coolant circulated on the shell side. They are designed to condense the UF_6 from gas to liquid prior to withdrawal. The coolant is cooled with RCW in a coolant condenser similar to the UF_6 condensers. Gases not liquefied are returned to the cascade via the condenser vent. Overpressure protection is provided by a rupture disc located on each condenser UF_6 vapor inlet line, exhausting back to the cascade.

The product withdrawal system uses three UF_6 condensers. The UF_6 condenser has a maximum allowable working pressure (MAWP) rating of 400 psig on the shell side and 75 psig on the tube side. The shell is manufactured with steel and the “U”-type tubes in the tube bundle are manufactured from Monel to resist corrosion.

3.4.1.3.2 Coolant Overpressure Control System

The product withdrawal facility coolant condensers are equipped with coolant overpressure protection. In the event of an overpressure condition in the coolant, the system is utilized to lower the coolant system pressure, protecting the UF_6 Primary System. This system is important to safety as described in Section 3.15. Figure 3.4-1 shows the Coolant Overpressure Control System.

The Coolant Overpressure Control System is designed to relieve coolant pressure when the pressure reaches a maximum safe design limit. The system activates prior to rupturing the coolant system, thus protecting the UF_6 Primary System piping and equipment. Each coolant condenser is provided with a rupture disk that is set to protect the UF_6 condenser by preventing coolant pressures from exceeding 110% of the MAWP. The rupture discs can be isolated from the system by closing a manual block valve.

3.4.1.4 Sample System

The sampling system is connected to the liquid withdrawal line between the cylinder pigtail isolation valve and the double block valves. The sampling system provides the capability of capturing a sample of the product stream before the UF_6 enters a product/customer cylinder. The system is connected to the withdrawal positions, providing the capability of sampling either of the withdrawal loops. Purging and evacuation connections provide the capability of evacuating the system for subsequent sampling operations.

The sampling system is composed of three integrated components: an electrical control panel, a glove box and a heated enclosure. The primary component of the system is the heated housing containing a sample pipette, UF_6 piping for liquid and gaseous flow paths, nitrogen piping for system purging, block valves, and a sample manifold. The sample pipette is a vessel constructed with a viewing port (sight glass) for determining the chamber internal liquid level. When the sample pipette is filled to a predetermined level, the sample pipette is then isolated and evacuated to a sample cylinder or sample tube. Sample cylinders and tubes may be re-fed to the cascade from the sampling stations by sublimation.

3.4.1.5 Materials of Construction

The components associated with the product withdrawal systems, except product cylinders, are fabricated of corrosion-resistant materials, such as nickel alloys, nickel-plated steel, copper, or aluminum. Most joints in the withdrawal systems are welded. All components exposed to PG are constructed of materials that are corrosion resistant, capable of operating in high temperature conditions, and are compatible with PG. UF_6 cylinder pigtails are used as required flexible connections. UF_6 condensers are constructed with U-tubes using all welded construction. Surfaces normally in contact with gaseous UF_6 or liquid UF_6 are constructed with approved materials. The UF_6 condensers are built to American Society for Mechanical Engineers (ASME) standards. Accumulators are constructed of material that will withstand pressures higher than will be encountered in service. The accumulators are built to ASME standards and inspected to National Board Inspection Code (NBIC).

3.4.2 Monitoring and Protection Systems

3.4.2.1 Outleakage Detection

The Withdrawal Facility High-Voltage UF_6 Release Detection Systems and the Withdrawal Facility Low-Voltage UF_6 Release Detection Systems monitor the C-310/C-310-A product withdrawal facility for UF_6 releases. These detection systems are discussed further below.

3.4.2.1.1 Withdrawal Facility High-Voltage UF_6 Release Detection Systems

The condenser, accumulator, selected piping heated housings, areas around the heated housings, buffer system, Normetex pumps, and withdrawal area (Stations 3 and 4) are monitored by the Withdrawal Facility High-Voltage UF_6 Release Detection Systems. Alarms from detector components alert withdrawal facility personnel to take appropriate action in the event of a UF_6 release. The UF_6 Release Detection System - Normetex Pump uses a high-voltage detection system to monitor for the release of UF_6 from the pumps and piping and is important to safety as described in Section 3.4.2.1.1.1. The UF_6 Release Detection System - High-Voltage (“old”) System for UF_6 Condensers, Accumulators, and Piping Heated Housings monitors for a UF_6 release and is important to safety as described in Section 3.4.2.1.1.2.

High-voltage detector heads and circuits operate in a similar manner in each system and are discussed below.

The UF_6 release detectors are connected to circuits that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate alarm indications.

The sensing element of the detector head consists of two ionization chambers in which air is made conductive by the use of an alpha emitter: 1) the sensing chamber, which is open to atmosphere and will sense the presence of 'smoke' or PG, and 2) the reference chamber, which is virtually sealed from the atmosphere and acts like a constant current source. UF_6 'smoke' released inhibits the normal ionization current developed in the detector head. The reduction in ionization current causes the activation of an alarm.

Detector actuation results in an audible alarm in the ACR and the illumination of a UF_6 detection alarm light in the ACR. An operator must investigate the signal conditioner at the local panel to

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determine which detector actuated. Individual lamps on the signal conditioners identify each alarming detector.

The 120 VAC electric power supply to the high voltage UF_6 release detection systems in the withdrawal facilities is supplied from the plant process auxiliary power system. In the withdrawal facilities, 120 VAC power is fed from local distribution panels to the signal conditioners located in the withdrawal facilities.

3.4.2.1.1.1 UF_6 Release Detection System - Normetex Pump

The product withdrawal facility is equipped with the UF_6 Release Detection System - Normetex Pump. In the event of a UF_6 release at the Normetex pump, the pump is shut down and the discharge line is isolated from the rest of the compression loop. Each of the Normetex pumps (east, west, and side withdrawal pump) in C-310 has a UF_6 Release Detection System - Normetex Pump. This system is important to safety as described in Section 3.15. Figure 3.4-2 shows a typical Normetex pump and its associated UF_6 release detection system.

The signal from each detector is fed to a signal conditioner, then to a programmable logic controller (PLC). The system has two signal conditioner/PLC channels to improve reliability since only one channel is required. Each PLC actuates the logic to trip the pump, close the discharge block valve, and provide an alarm in the ACR.

On activation of the ‘smoke’ heads the computer controlling the release detection system processes the signal. The system then trips the Normetex pump and closes the discharge block valve if any two adjacent detectors actuate. The UF_6 Release Detection System for the C-310 side withdrawal Normetex pump includes three heads inside the housing and three heads outside, which provides for three different combinations (two out of three) of fired heads at either location to be able to trip the pump. The discharge block valve is closed to decrease the system pressure. The pump cannot be restarted until the UF_6 release detection system is reset. One head actuation will initiate an alarm only.

Emergency shutdown of the Normetex pumps can be initiated from the local control panel, the C-310 ACR, or from C-300. Emergency shutdown will also close the discharge block valve. The discharge block valve can be closed remotely from the ACR in C-310. Detector heads can also be fired manually from the local detector panel or automatically by the system PLC as necessary for testing or to maintain the desired level of detector sensitivity.

The west Normetex pump has an additional detector located over the pump housing. This detector, although part of the High-Voltage UF_6 Release Detection System - Normetex Pump, activates only an alarm and is not part of the Normetex pump shutdown circuitry.

The UF_6 Release Detection System - Normetex Pump includes an air-operated block valve on the PG discharge line that supports compression isolation. This discharge block valve is a diaphragm-actuated valve that requires air to open (via pressure regulators), a spring to close, and is considered fail-safe. The air-control solenoid (the discharge block valve has two solenoid valves, which provide assurance that, the valve will close and isolate the compression loop during the Normetex pump shutdown sequence) is deenergized during activation of the isolation system. Air is then vented from the discharge block valve and it fails closed. Loss of the plant air supply will result in the discharge block valve transferring to the closed (safe) position.

The nominal 120 VAC power necessary to operate the UF_6 Release Detection System - Normetex Pump is fed from local distribution panels. Supplied 120 VAC power is then used for internal conversion to 200 VDC, which is required for detector heads to operate. The discharge block valves are air-operated and are designed to close (i.e., fail-safe) upon loss of 120 VAC power. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and the 200 VDC power are support systems, which are important to safety as described in Section 3.15.

3.4.2.1.1.2 UF_6 Release Detection System – High-Voltage ("old") System for UF_6 Condensers, Accumulators, and Piping Heated Housings

The product withdrawal facility is equipped with a UF_6 release detection system for the condenser/accumulator area consisting of high-voltage detector heads located on the second floor of C-310A at the ceiling of the condenser/accumulator area, in the condenser housing, and in the accumulator housing. Should a release be detected, an audible alarm and alarm light is received in the ACR. This system is important to safety as discussed in Section 3.15.

On activation of an alarm, the operator must determine which detector has alarmed and initiate the appropriate actions. The detector heads are tested to determine operability.

The nominal 120 VAC power necessary to operate the UF_6 Release Detection System - High-Voltage ("old") System for UF_6 Condensers, Accumulators, and Piping Heated Housings is fed from local distribution panels. Supplied 120 VAC power is then used for internal conversion to 200 VDC, which is required for detector heads to operate. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and the 200 VDC power are support systems, which are important to safety as described in Section 3.15.

3.4.2.1.2 Withdrawal Facility Low-Voltage UF_6 Release Detection Systems

The product withdrawal area in C-310 is monitored by the Withdrawal Facility Low-Voltage UF_6 Release Detection Systems. Detector system components in the withdrawal rooms are part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations and the UF_6 Release Detection System – Low-Voltage System at the Withdrawal Room Ceiling. When activated, the Low-Voltage ("new") System at the Withdrawal Stations isolates the withdrawal positions and is important to safety as discussed in Section 3.4.2.1.2.1. The UF_6 Release Detection System - Low-Voltage System at the Withdrawal Room Ceiling, important to safety as discussed in Section 3.4.2.1.2.2, isolates all withdrawal positions in the withdrawal room and initiates an alarm in the ACR. Low-voltage detector heads and circuits operate in a similar manner in each system and are discussed below.

The detectors are connected to control units that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate actions. They function by means of a solid state switching circuit and dual ionization chambers: 1) one chamber to detect UF_6 reaction products with moisture in the air, and 2) one chamber that serves as a reference to help stabilize

the detector's sensitivity for changes in ambient temperature, humidity, and pressure. In the detection chamber, ambient air in the gap between two charged electrodes is ionized by an alpha-emitting source.

As the concentration of particles in the air increases, the resistance across the detection chamber increases, which causes a voltage increase. When the voltage reaches a characteristic point, the detector produces an output signal.

The system control units consist of a power supply for converting 120 VAC plant power to 24 VDC for the detector circuit, supervisory circuits for monitoring the status of multiple detector zones, and an audible alarm signal circuit. Trouble alarms are activated on the local control panel in the event that the voltage drop across a supervised circuit changes, indicating a malfunction or discontinuity. The local control panel also contains relays to activate output devices. An output signal from a detector energizes an alarm circuit relay that latches in the "on" position until manually reset.

3.4.2.1.2.1 UF_6 Release Detection System - Low-Voltage ("new") System at the Withdrawal Stations

The product withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions consisting of a low-voltage detector located above each withdrawal drain position (at Stations 3 and 4). At Station 5, a pair of low-voltage detectors are located above the withdrawal drain position. In the event of a pigtail failure or a liquid sampling station failure, the system is utilized to isolate the withdrawal position, including its sampling station, to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.15. Figure 3.4-3 shows a typical UF_6 Release Detection System - Low-Voltage ("new") System at the Withdrawal Stations.

Activation of a low-voltage detector above any drain position pigtail will initiate isolation of that withdrawal position causing the following actions to occur: (1) close the two liquid drain block valves located between the accumulators and the withdrawal pigtail; (2) close the withdrawal cylinder valve; (3) initiate alarms in the withdrawal area and in the ACR; and (4) open the evacuation block valves to evacuate the manifold area. Actions 3 and 4 are not important to safety but are accomplished as part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations activation.

If the automatic UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations fails to activate due to a failure in the system, liquid drain block valves can be closed with controls located outside the withdrawal room, in the ACR, or in C-300. The pushbutton located immediately outside the withdrawal area, and the controls in C-300, close the liquid drain block valves and cylinder valve at all withdrawal positions. Controls for each position in the ACR close the liquid drain block valves and cylinder valve at that position. The ACR also has the capability to close only the liquid drain block valves at all positions.

The UF_6 line isolation valves associated with the UF_6 Release Detection System - Low-Voltage ("new") System at the Withdrawal Stations include air-operated liquid drain block valves (spring actuated/fail closed), cylinder valve (with an air-operated/motor driven closure assembly), and miscellaneous valves associated with the building air/nitrogen systems that support withdrawal isolation. The liquid drain block valves are diaphragm-actuated valves that require air to open and springs to close and are fail-safe. The air-control solenoid for the cylinder valve closure assembly is deenergized during activation of the isolation system. Air is then supplied to the cylinder valve closure motor, which closes the cylinder valve, isolating the UF_6 cylinder from the withdrawal position. A backup nitrogen system for Withdrawal Stations 3 and 4 and a backup air supply system for Withdrawal Station 5, provided for the cylinder valve closure assembly, activates upon failure of the plant air system. The evacuation block valves are not part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations safety boundary but they provide some mitigation to minimize the

consequences of a failure in the withdrawal pigtail or the liquid sampling station. The air-operated valves associated with the evacuation line open, allowing UF_6 to be evacuated from the pigtail and the sampling station to the evacuation header during automatic activation of the isolation system.

The 120 VAC power to operate the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations is fed from local distribution panels. Supplied 120 VAC power is then used to develop the 24 VDC power supply for the UF_6 release detection circuit. A separate 120 VAC power circuit feeds the solenoid valves that actuate the liquid drain block valves, the cylinder valve closure assembly, and the evacuation block valves. The liquid drain block valves and the evacuation block valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power. The cylinder valve is designed to close (by activation of the nitrogen backup system) upon loss of electrical power. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and 24 VDC power are support systems, which are important to safety as described in Section 3.15.

The plant air system provides the motive power for the cylinder valve closure assembly. Loss of plant air causes the block valves to fail in the closed position, isolating the withdrawal position from its liquid source. The cylinder valve closure assembly is also provided with a nitrogen backup system. On loss of plant air or low plant air pressure, a pressure switch on the air supply line actuates to open a solenoid valve making nitrogen available through the air supply line. The nitrogen is supplied from a portable tank in sufficient quantity and pressure to completely close the cylinder valve within 30 seconds after release detection. The nitrogen supply is isolated from the plant air system by a check valve that prevents loss of nitrogen pressure. On loss of power the system also shifts to the nitrogen supply system for motive power to the cylinder valve. The cylinder valve, on loss of both air and nitrogen, will fail in the current position. Loss of power or indication of a UF_6 release is required to initiate closure of the cylinder valve via this system.

The cylinder valve closer for Withdrawal Station No. 5 is air operated with an air accumulator providing backup air supply. The pressure in the air accumulator is maintained at the pressure of the plant air system and on a loss of plant air, check valves on the air accumulator limit the loss of air pressure in the accumulator. The cylinder valve can be closed by the backup air from the accumulator in 30 seconds. Operability of both check valves is verified during quarterly testing. Another indicator of proper check valve performance is closing a cylinder valve using the backup air from the accumulator (also part of the quarterly test). If the cylinder valve will close within the required 30 seconds using backup air then both check valves are properly operating.

3.4.2.1.2.2 UF_6 Release Detection System – Low-Voltage System at the Withdrawal Room Ceiling

The product withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions. In the event of a pigtail failure, the system is utilized to isolate all the withdrawal positions to minimize the amount of UF_6 released. This system is important to safety as described in

Section 3.15. Figure 3.4-4 shows a typical UF_6 Release Detection System - Low-Voltage System at the Withdrawal Room Ceiling.

Activation of any of the low-voltage ceiling detector heads will result in closure of the liquid drain block valves at all the withdrawal stations to isolate the drain header and alarm in the C-310 ACR. In addition, pushbuttons are located outside the withdrawal room in the C-310 ACR and in C-300 which, when activated, close the liquid drain block valves at all withdrawal positions. Only the alarm is credited with providing a safety function.

The 120 VAC power to operate the UF_6 Release Detection System – Low-Voltage System at the Withdrawal Room Ceiling is fed from local distribution panels. Supplied 120 VAC power is then used to develop the 24 VDC power supply for the UF_6 release detection circuit. A separate 120 VAC power circuit feeds the solenoid valves that actuate the liquid drain block valves. The liquid drain block valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform

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their safety function. The 120 VAC and 24 VDC power are support systems, which are important to safety as described in Section 3.15.

3.4.2.2 Instrumentation

Standard cascade instrumentation is used on the product withdrawal. A very small amount of UF_6 is normally diverted from the product withdrawal line as a continuous sampling operation. This sample becomes the official sample on which the assay of the contents of the filled cylinder is based. When the sampler is not available, alternate sampling is used to determine the official cylinder assay.

Mass spectrometers are used to monitor the suction of the Normetex pumps and are important to safety as discussed in Section 3.15. The mass spectrometer automatically traps, analyzes the sample, and records the assay. The C-310 utilizes two mass spectrometers (one for normal operations and one for backup purposes) to monitor product assay limits. The mass spectrometers are addressed in more detail in Section 3.3.3.2.2.

A radiation warning system, Criticality Accident Alarm System (CAAS), continually monitors the product withdrawal facility for nuclear excursions. The CAAS is important to safety, as discussed in Section 3.15, and is discussed further in Section 3.12.6.

3.4.2.3 Scales and Scale Carts

Each empty cylinder is placed on a scale cart equipped with cradles to accommodate the cylinder being moved to a scale and positioned for filling. The scale carts are air-operated and brake on loss of air. The scale carts are important to safety as discussed in Section 3.15. The scale cart air supply is equipped with a key-operated interlock switch which blocks the air supply to the scale cart without the interlock key. Administrative controls require the air supply interlock key ring to be placed on the pigtail when the pigtail is connected to a cylinder to prevent cylinder movement during filling. Additionally, even with key in the lock, a system consisting of a pressure sensor on the drain line prevents scale cart motion unless the pigtail is close to atmospheric pressure. The Cylinder Scale Cart Movement Prevention System is important to safety as discussed in Section 3.15.

The product withdrawal scales perform operational and accountability functions. The operational function is a convenience to fill cylinders to a target weight. At a predetermined weight, an alarm sounds and a valve in the associated UF_6 drain line automatically closes. Filling the cylinder to its specified fill limit is completed using local controls. The accountability function provides the NMC&A weight for the filled cylinder. The NMC&A weight is used to verify cylinders are not filled above established fill limits. The accountability function is checked with a test cylinder prior to placing a cylinder in the withdrawal process, or at a specified surveillance frequency. The scales are important to safety as discussed in Section 3.15.

The scale pit has an alarm to notify the operator and other personnel in the area if a water level is detected in the scale pit. Scales and scale carts are discussed further in Section 3.7.

3.4.3 Operation

3.4.3.1 Cylinder Filling Stations

There are three cylinder filling stations or withdrawal positions in normal use in C-310. Each has a cylinder cradle arrangement mounted on a cart, which is moved into position on a scale at the filling station. A removable pipe or "pigtail" connects the filling station to the cylinder valve. Withdrawal UF_6 cylinder pigtails are exposed to ambient conditions and are thus susceptible to freeze-out (UF_6 solidifying in the pigtail due to a temperature decrease). For this reason, withdrawal UF_6 cylinder pigtails are wrapped with electrical heat tracing covered with insulating tape to reduce the likelihood of freeze-out. Each cylinder filling station has an exhaust hood connected to a common exhaust duct, high-efficiency particulate air (HEPA) filter, and fan, which is then exhausted to atmosphere. This mitigates minor releases that might arise from withdrawal operations. If the system is inoperable, portable vacuum cleaners with HEPA filters are used to mitigate the effects of small releases. UF_6 detectors are located above each fill station and are discussed in Sections 3.4.2.1.1 and 3.4.2.1.2.

Prior to connection, the pigtail is visually inspected for defects and a new pigtail gasket is installed. When an empty cylinder is installed for filling, the pigtail connection is attached to the cylinder valve and the UF_6 fill line is vacuum checked and then pressure checked with N_2 or air to test for leaks. Filling is started by opening the valve in the UF_6 drain line to allow flow from the condenser and accumulator. When a cylinder has been filled with liquid UF_6, the drain line valve is closed, the cylinder valve is closed using the cylinder valve closer motor, and the pigtail line is evacuated to remove the majority of the residual UF_6. Before the pigtail is disconnected from the filled cylinder, it is pressurized or "purged" using N_2 or dry air and is then evacuated to a low pressure. This purge and evacuation cycle is repeated several times (based on the purge and evacuation pressures) to remove most of the residual UF_6.

While the liquid UF_6 is being drained from a condenser or accumulator into the cylinder, the weight of the material withdrawn can be read from the operational scale to determine when the weight is approaching the cylinder target weight. The cylinder target weight is set at or below the cylinder fill limit. If the target weight or the cylinder fill limit should be exceeded, the excess material may be removed by valving the cylinder to the evacuation header at the withdrawal position.

3.4.3.2 Burping Station

After the liquid UF_6 product in the cylinder has solidified and cooled to ambient temperature (i.e., completed its prescribed cool-down period), the cylinder is normally moved to the burping station. The cylinder is then connected via a pigtail to a manifold, which contains two exhaust lines. One is for cylinder pigtail purge gases, which are exhausted to the cascade, and the other is routed to a trapping system. Coolant or other non-condensable gases that might remain in the cooled cylinder are mostly removed through the trapping system. The pressure in the cylinder is reduced as necessary to remove these non-condensable gases. The gases evacuated from the cylinder are passed through sodium fluoride (NaF) traps to absorb UF_6 that might be pulled from the cylinder. The exhaust from these traps is then

released to the atmosphere. The UF_6 is desorbed from the NaF traps by heating the traps and passing a sweeping purge through the traps. When the NaF traps are unavailable or multiple cylinders must be burped, the non-condensable gases may be evacuated to the cascade. The cylinders are pressure checked before shipping.

3.4.3.3 Sampling Station

A sample of the UF_6 product stream can be taken at any time the facility is capable of withdrawing product. There is one sample station for position~~s~~ #3 and #4 and one sampling station for position #5. Only one withdrawal station will be valved to a sample station at a time for positions #3 and #4. During sampling, the inlet valve to the pipette in the sample cabinet is opened and the pipette is allowed to fill to a visible level on the viewing-level window. An evacuation valve is opened and the entire sampling system is flushed with liquid UF_6 to an evacuation source to ensure all UF_6 is removed from the pipette and sampling manifold. This flushing process may be repeated several times to thoroughly flush the sample lines. All system valves are closed, then the pipette inlet valve is opened to fill the pipette with liquid UF_6 until the liquid level reaches an appropriate level in the sample chamber. After closing the inlet valve, the sample is transferred to a sample cylinder or sample tube. The operation may be repeated to obtain duplicate samples. When all sampling has been completed, the sampling pipette and sampling piping are purged and evacuated of UF_6. Sample cylinders and tubes may be re-fed to the cascade from the sampling stations by sublimation. The containers are connected to the sample cabinet manifold and the evacuation is completed by aligning the manifold to a UF_6 evacuation source.

3.4.4 Liquid Cylinder Handling

The movement of cylinders containing liquid UF_6 in C-310 is minimized to reduce the potential of damage to the cylinder. This could result in a loss of containment and the release of UF_6.

The cylinder handling equipment in the product withdrawal facility includes scales, scale carts, and cranes. The movement of liquid filled cylinders is restricted to removal from the filling station to the cool-down yard. After being filled, cylinders are moved to the cool-down yard, where they remain for the required cool-down period per administrative controls. Limited movement of cylinders may be conducted within the cool-down yard before completion of the cool-down period if the precautions for handling liquid filled cylinders are followed (i.e., moving cylinders as low to the ground as practical, using the overhead crane for cylinder movements, etc.).

Upon completion of the cool-down period, cylinders are handled as described in Section 3.7. The UF_6 cylinders are important to safety as discussed in Section 3.15 and are discussed further in Section 3.7. Liquid UF_6 cylinder handling equipment is important to safety as discussed in Section 3.15.

3.4.4.1 Cranes

Two overhead bridge cranes transport empty or solid cylinders from the storage area to the scale carts, liquid filled or solid UF_6 cylinders from the scale carts to the storage area, and solid UF_6 cylinders to and from the burping station. The scale carts transport the empty cylinders to the withdrawal station and the filled cylinders from the withdrawal stations. Both bridge cranes for this facility operate on the same crane rail system and should not be loaded at the same time. Administrative controls are used to ensure both cranes are not used at the same time.

Liquid cylinder movement from the scale cart to the cylinder cool-down area shall be minimized. The height the liquid cylinder is lifted above the work area and/or ground is limited by administrative controls to the lowest practicable height to facilitate movement.

Mobile cylinder handlers can also be used for solid and empty UF_6 cylinder movements. Cranes are important to safety as discussed in Section 3.15. Cranes, lifting fixtures, and rigging are discussed further in Section 3.7.

3.4.4.2 Short-Term Storage

The facility contains a cylinder yard for the short-term storage of empty cylinders and cylinders containing liquid and solid UF_6. The yard is equipped with saddles for cylinder storage.

The yard is used for cylinder cool-down; the liquid UF_6 must assume a solid state prior to moving the cylinder to the burping operation or longer-term storage yards. Storage yards are discussed in Section 3.7.

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3.4.5 Administrative Controls

In addition to the Administrative Controls in Chapter 4 and those controls covered by programs and plans, the following facility-specific Administrative Controls ensure safe operation of the product withdrawal facility. Additional general Administrative Controls for cylinders are listed in Section 3.7.6.

1. The remote cylinder valve operator shall not be used except by the automatic control system to minimize the potential for pigtail damage during this mode of operation.

   (Note: The mode discussed above is Mode 1, Cylinder Preparation or Removal.)

2. Valve control procedures shall be in place to protect from inadvertent valve openings to atmosphere.

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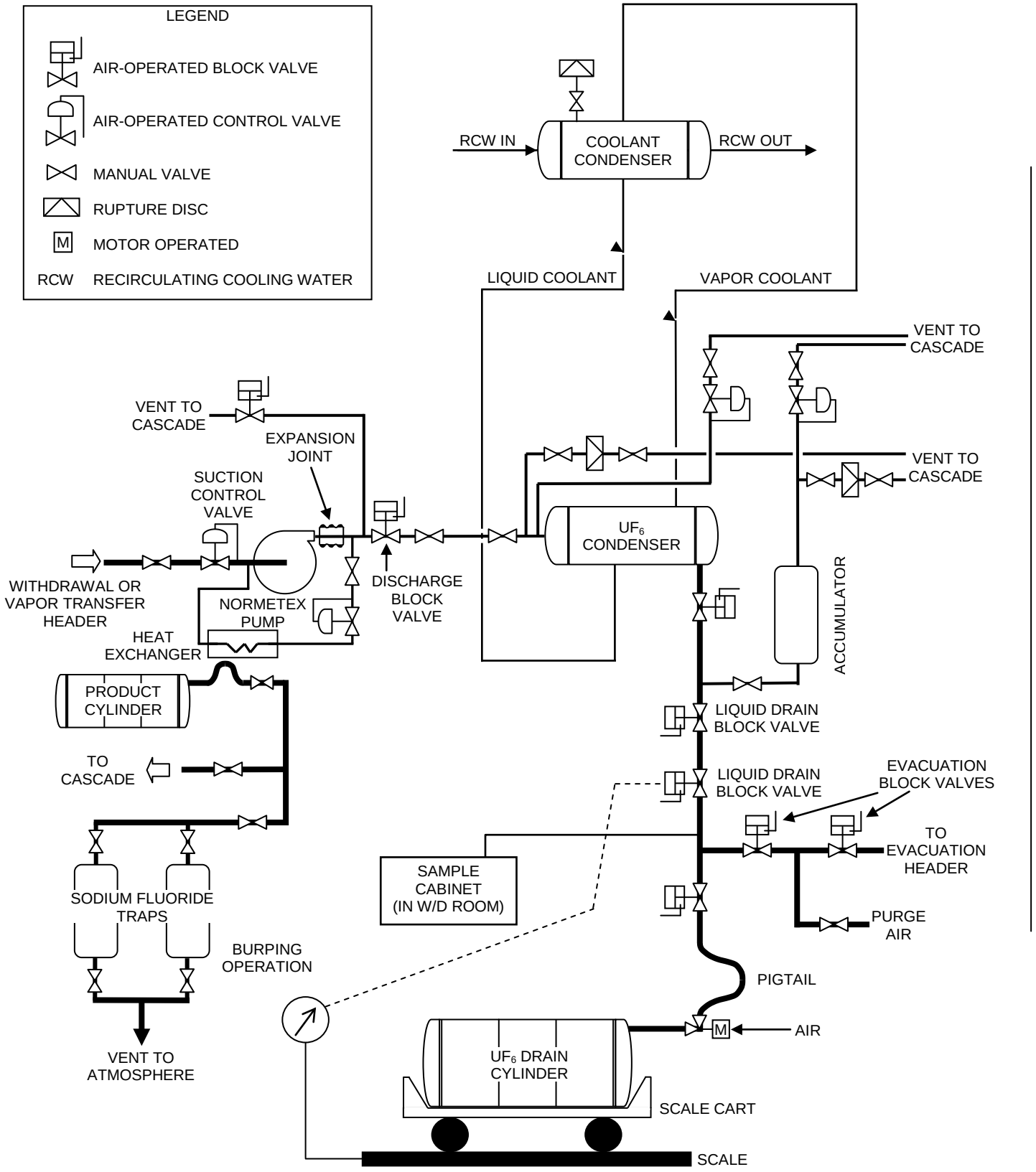

Figure 3.4-1. Typical Product or Side Withdrawal Flow Diagram

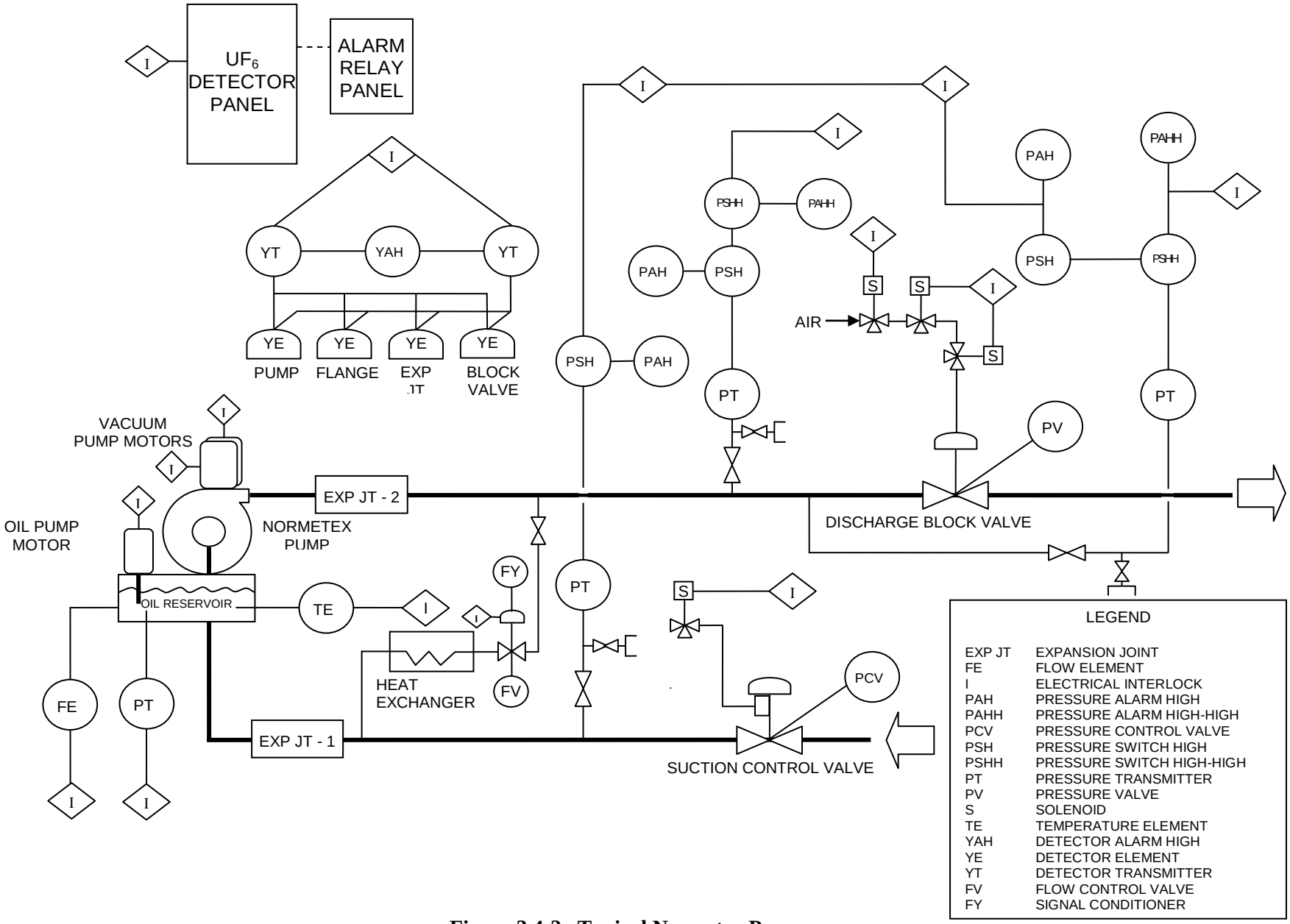

Figure 3.4-2. Typical Normetex Pump

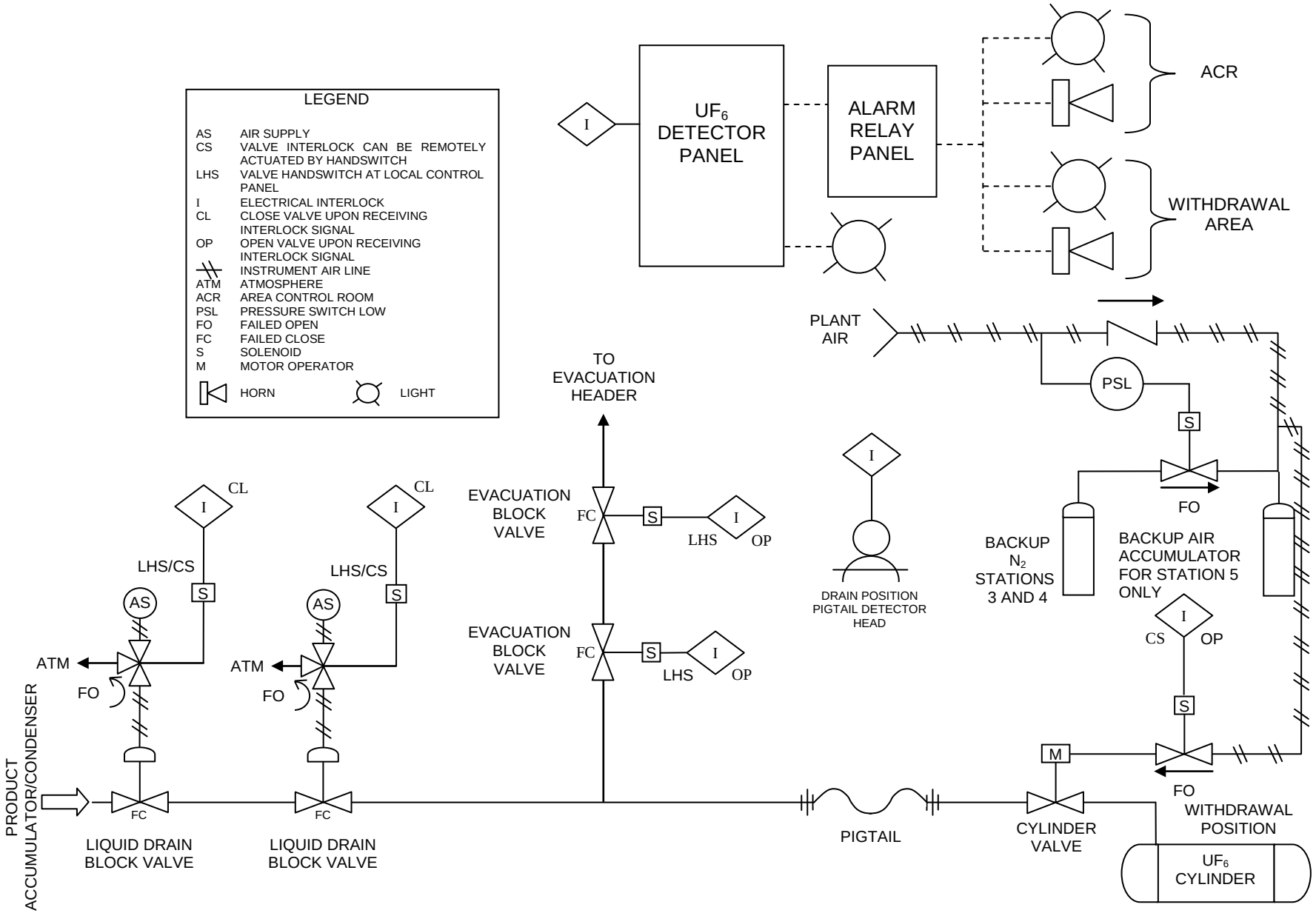

Figure 3.4-3. Typical Low-Voltage System at the Product Withdrawal Stations

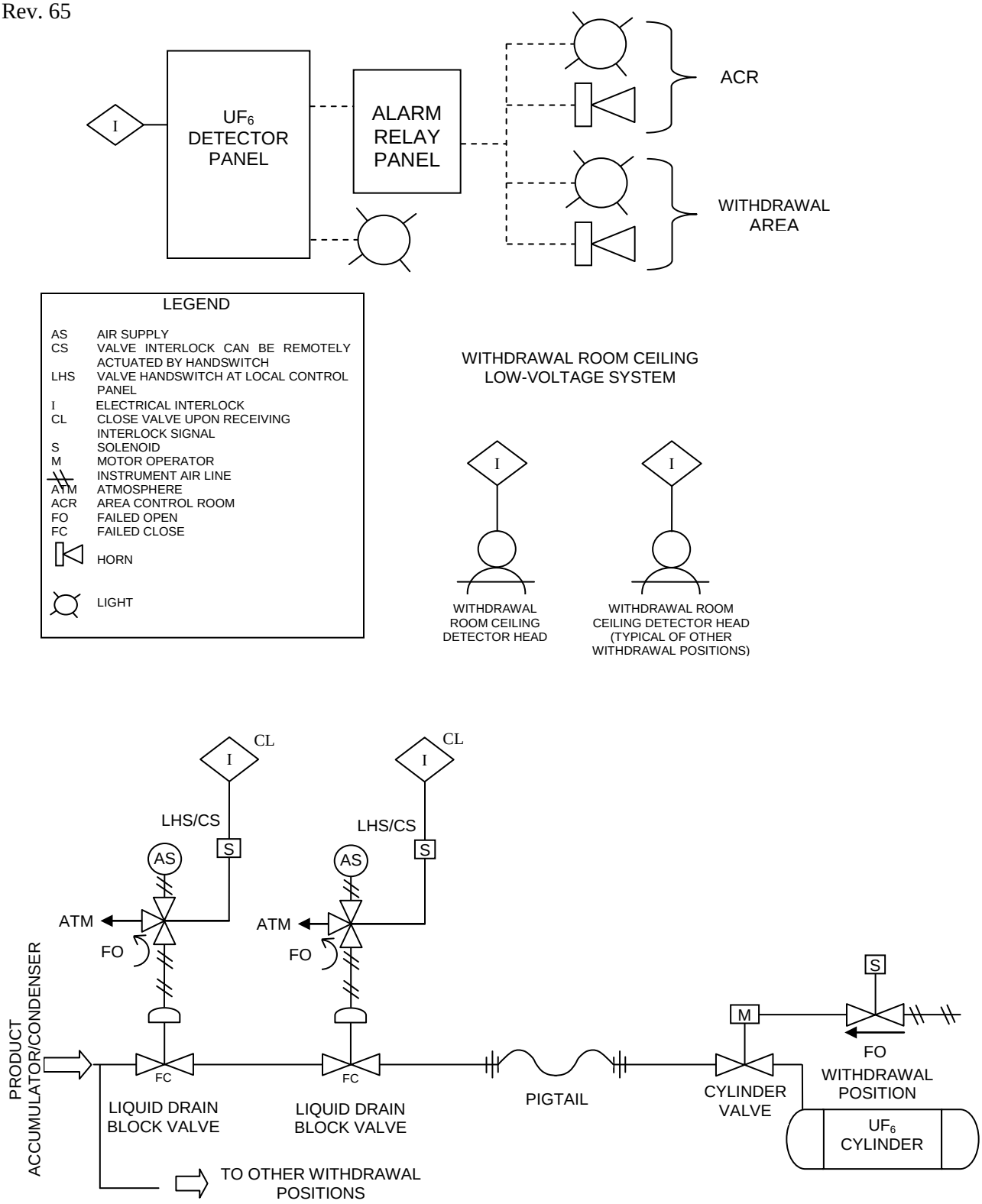

Figure 3.4-4. Typical Low-Voltage System at the Product Withdrawal Ceiling

3.5 UF_6 TAILS WITHDRAWAL FACILITY

Withdrawal of UF_6 tails, normally 0.2% to 0.47% ^{235}U, from the enrichment cascade is accomplished with a compression and liquefaction system. The tails withdrawal facility is housed in the C-315 Surge and Waste Building. A temporary storage yard for tails cylinders is served by semi-gantry cranes. The Tail Withdrawal Facility Structure is important to safety and is discussed in Section 3.3.

The two primary purposes of C-315 are to provide a cascade surge volume consisting of two Hortonspheres (normally, one on-stream and one off-stream) and to compress and condense the tails UF_6 to permit withdrawal through the withdrawal system (see Figure 3.5-1). The surge volume of the Hortonspheres helps control cascade inventory fluctuations.

These two functions are accomplished by routing the "B"-stream from the bottom of the cascade in the C-331 Process Building (via one or both of two low-speed compressors if necessary) to the on-stream Hortonsphere as well as using the suction of the Normetex pumps or high-speed compressors. At lower withdrawal rates, a low-speed compressor may not be required. One or more of the three Normetex pumps operate in parallel and discharge to the UF_6 condensing system. Two high-speed compressors in C-315 that are maintained in standby can be used in lieu of the Normetex pumps. The flow through the Normetex pumps is normally controlled by each pumps suction control valve. The process gas is returned from the on-stream Hortonsphere via control valves to the bottom of the cascade in C-331 as the "A"-stream. Since the on-stream Hortonsphere floats on the discharge of the low-speed compressors, it provides a surge volume for changes in tails withdrawal as well as flows to and from the cascade. When the high-speed compressors are used, the Hortonspheres do not float on the low-speed compressor discharge but are still on line. Compressor shaft seals are equipped with special sealing and buffering systems to prevent leakage.

The UF_6 from either the Normetex pumps or high-speed compressors is piped to a condenser, where the gas is cooled to form UF_6 liquid. The liquid UF_6 flows by gravity into a tails storage cylinder at one of the four cylinder filling positions. Accumulators are located in the liquid withdrawal line to provide staging of liquid UF_6 during withdrawal interruptions. The accumulators float on the discharge of the UF_6 condenser. During filling, the cylinders rest on scale carts positioned over scales at each station. The scales provide a weight readout and an adjustable audible alarm to alert the operator when that fill limit has almost been reached. Before filling a cylinder, an accountability weight is established so that, in the event of an overfill, evacuation of the excess UF_6 can be performed with the cylinder in the drain position. After a cylinder has been filled with tails material, it is carefully transported outside by the use of the air-operated scale cart. It is then lifted by a crane and carefully transported to the temporary storage area for tails cylinders where it remains until its contents have cooled and solidified (five-day cooldown period for 10- or 14-ton cylinders).

An additional function of C-315 supports transfer of UF_6 directly from a vaporizer in a feed facility to the withdrawl equipment in C-315. Assays of material transferred by this method must be less than 1.0 wt.% ^{235}U. This type of transfer operation is typically performed to move material from one type cylinder to another type cylinder.

The following sections discuss components or systems associated with the tails withdrawal system. Included are structures, systems, and components (SSCs) important to safety which are discussed in more detail.

3.5.1 UF_6 Withdrawal Primary System

The UF_6 Withdrawal Primary System (i.e., valves, equipment containing UF_6, and piping) is considered the primary means of confinement for UF_6 and includes both a UF_6 gas system and a UF_6 liquid system. The gaseous UF_6 system provides a confinement boundary for UF_6. The liquid UF_6 system provides a pressure boundary and a transfer of UF_6 in the liquid state. The system is important to safety as described in Section 3.15.

Compressors, aftercoolers, condensers, accumulators, manifolds, and associated piping and valves are enclosed in heated housings and/or are heated independently. They are maintained at a temperature necessary to prevent UF_6 solidification. The components of the UF_6 Withdrawal Primary System are discussed in the following sections.

3.5.1.1 Normetex Pumps

Normetex pumps are used to compress the gaseous UF_6 withdrawal stream for liquefaction. Three Normetex pumps are installed on the second floor of C-315. The Normetex pumps are operated with one or more running in parallel, taking a suction from the header supplied by the low-speed compressors or from the B stream from C-331 and discharging to one or more UF_6 condensers, which are also operated in parallel. Additionally, the No. 3 Normetex pump has alternate suction and discharge valves that enable compression from a separate source. This could allow withdrawal at a second assay value. However, a second assay is not normally withdrawn in C-315. This alternate piping allows the pump to be used as an evacuation pump for operations such as evacuating the off-stream Hortonsphere.

The Normetex pump uses a fixed and a moving spiral vane. The moving vane has an eccentric motion causing “pockets” between the vanes to open and close to compress the gas and move it from the inlet to the discharge of the pump. This design permits compression of UF_6 without the use of dynamic seals between the process and atmosphere. There are two motors associated with the Normetex pump that are used to drive the spiral vane. These motors are referred to as the vacuum pump motors.

The UF_6 enters the pump through fine mesh inlet gas filters designed to prevent any foreign material entry that might increase the wear of the vanes. A suction control valve regulates the amount of flow through the pump by controlling the suction pressure. The pump discharge is then routed to one or more of the three UF_6 condensers. A buffered expansion joint is installed between the pump and the discharge block valve on the outlet line.

The pump is lubricated and cooled by oil. An oil heater and oil cooler are used as necessary to maintain the desired oil temperature. The upper oil temperature limit prevents expansion of the vanes to prevent rubbing, while the lower oil temperature prevents formation of solid or liquid UF_6.

A simplified flow diagram for the tails withdrawal facility showing the location of the Normetex pumps in the process flow is provided as Figure 3.5-1. Figure 3.5-2 shows a typical Normetex pump and its UF_6 Detection system. This safety system is discussed in Section 3.5.2.1.1.1.

3.5.1.2 Low and High Speed Compressors

There are two low-speed and two high-speed centrifugal compressors in C-315. The low-speed centrifugal units are operated by electric motors and discharge through a process gas (PG) aftercooler to a common header for the on-line Hortonsphere and the suction of the Normetex pumps or the high-speed compressors. The high-speed centrifugal units are operated by electric motors through speed increasers. An administrative control is in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. During high-speed operations, the discharge from the high-speed compressors is sent to the condensers and/or to the Hortonspheres. The low-speed compressors use a common recycle line, recycle valve, and the necessary instrumentation to recycle UF_6 when the need arises. They also are interconnected by piping and valves to provide the needed versatility should it become necessary to remove an individual compressor from service. Similarly, the high-speed compressors have common systems and are piped for versatility. These compressors and drive motors are lubricated by a recirculating lube oil system. This lube oil system is comprised of duplicate pumps that transfer the oil from the drain tank to the elevated gravity supply tank. The compressor motors are equipped with sensors to trip the motors if the current through the motors is excessive.

3.5.1.2.1 Motor Load Indicators

Motor Load Indicators are used in the tails withdrawal facility to monitor the high-speed compressor motors during withdrawal station operations. In the event of a motor overload, the indicators are used to inform the operator so that appropriate actions can be taken. This system is important to safety as described in Section 3.15.

The Motor Load Indicators are used in normal operations to monitor the power levels of withdrawal motors. Each compressor motor has its own ammeter in the C-315 and C-331 Area Control Room (ACR) which indicates large changes in the motor loads or surging of the compressors or compressor motors. The ampere loading on the motors that drive the compressors can be indication of pending problems or failures. In addition, load alarms indicate nominal increases and decreases in amp load for operational purposes; however, these alarms are not required by the Motor Load Indicators to meet their safety function.

3.5.1.2.2 Compressor Motor Manual Trip System

The tails withdrawal facility is equipped with a manual compressor motor trip. The Compressor Motor Manual Trip System provides the capability to rapidly deenergize the withdrawal high-speed centrifugal compressor motors in C-315. In the event of a withdrawal system failure, the manual trip system is utilized to aid in the prevention and mitigation of releases during cascade operations by: (1) maintaining primary system temperature/pressure below allowable values, (2) eliminating heat and/or friction, and (3) minimizing the amount of UF_6 released in postulated accidents. This system is important to safety as described in Section 3.15.

Compressor Motor Manual Trip provides the capability to remotely trip compressors as required to reduce the primary system pressure. The trip circuit consists of one switch for each compressor. When initiated, a trip coil in the switchgear will trip the associated circuit breaker to the compressor, thus removing power. Compressor motor trip can be activated from either the C-315 ACR or the C-331 ACR

(high-speed compressors only). Primary control of the C-315 high-speed compressors resides in the C-331 ACR.

The trip circuit is powered by 125 VDC control power. The DC power is used to energize the trip coil of the motor circuit breaker. The energized coil initiates a breaker trip, disconnecting motive power to the withdrawal motors. The Compressor Motor Manual Trip System interfaces with the DC Power System in order to shut down the compressors on demand as described in Section 3.9. The 125 VDC power is a support system, which is important to safety as described in Section 3.15.

Manual trip can be accomplished from the C-300, although this capability is not used except during emergency situations.

3.5.1.3 Piping, Valves, Expansion Joints and Accumulators

3.5.1.3.1 Piping

The piping and other elements of the compression/liquefaction process are used to transfer the UF_6 vapor or liquid into receiving cylinders. All of the piping is permanently installed passive primary containment systems.

3.5.1.3.2 Valves

Most valves in the UF_6 Primary System are critical only as a pressure boundary to control UF_6 from being released. Selected valves are relied on to close and isolate systems in the event a system failure occurs.

3.5.1.3.3 Expansion Joints

Expansion joints are located between PG piping and fixed equipment in the withdrawal compressor portions of the system and on some long pipe runs to allow for thermal expansion of the piping and for small differences in pipe alignment.

3.5.1.3.4 Accumulators

Two nickel-lined steel accumulators are located downstream from the condensers in the tails withdrawal system. They are fed by gravity flow of liquid tails material from the condensers into the accumulators and into the tails storage cylinders. Each accumulator can be used for short-term storage of the liquefied tails material while a cylinder is valved off, being changed, or for other withdrawal interruptions. Normally, only a small amount of UF_6 is contained in the accumulators, which merely float on the line ready for immediate use if required (during cylinder changes, etc.). Pressure in each accumulator is maintained by venting the vessel through the same vent control valve as on the corresponding condenser. Overpressure protection is provided by a rupture disc located on each accumulator UF_6 vapor vent line, exhausting to the hortonspheres.

3.5.1.3.5 Surge Tanks

Surge tanks include the vent surge drum and Hortonspheres. The vent surge drum operates under a vacuum and collects gases that have not condensed in the UF_6 condenser or from the accumulator or are generated during withdrawal station venting or purge line operations. Hortonspheres are used only in the C-315 to help control cascade fluctuations and to handle surges within tails withdrawal. The off-stream Hortonsphere is used as a local evacuation source.

3.5.1.3.6 UF_6 Cylinder Pigtails

The UF_6 cylinder pigtails comprise a pigtail assembly and gaskets. The pigtail assembly is fabricated of metal tubing equipped with fittings on either end that allow the pigtail to be attached to a manifold at one end and the cylinder at the other end. After fabrication, UF_6 cylinder pigtails are heated for stress-relief. Gaskets are used between the sealing surfaces of the pigtail assembly and the cylinder and equipment to which it is connected. UF_6 cylinder pigtails that are used outside of heated enclosures have heat tape applied to the pigtail assembly in order to prevent UF_6 freezeout during its use.

A specific pigtail design is employed for each UF_6 operation. UF_6 cylinder pigtails that are used at C-315 are important to safety as described in Section 3.15.

All UF_6 cylinder pigtails are subjected to acceptance inspection and testing prior to certification for use. Included in this testing are hydrostatic tests after fabrication. Prior to connecting a certified UF_6 pigtail, it is visually inspected for defects, and a new pigtail gasket is installed on each disconnected end fitting. Visual inspection of UF_6 cylinder pigtails in C-315 is limited due to the presence of heat tracing. All new cylinder pigtail connections are vacuum checked and leak rate tested per applicable procedure prior to admitting UF_6 to the affected connection.

3.5.1.4 Coolant and Condensing Systems

Coolant is used in the condensers and aftercoolers at the tails withdrawal facility to lower the temperature of the UF_6. Heat is removed from the coolant by the recirculating cooling water (RCW) system. The coolant acts as a heat transfer medium, carrying heat from PG to the RCW. A heat transfer medium must be used to keep water from the PG as water reacts chemically with UF_6. During normal operations this is accomplished by maintaining the coolant pressure above the PG pressure and the RCW pressure to prevent water from entering the coolant system and then into the PG. The pressure differential prevents UF_6 and RCW from mixing should a system failure occur.

The following sections discuss components of the coolant and condensing system as well as the safety system necessary to control overpressure in the coolant.

3.5.1.4.1 UF_6 Aftercoolers

An aftercooler, associated with and located just downstream from each low-speed compressor, is used to cool the compressed gas stream from the low-speed compressor to avoid overheating the second-stage compressor. The UF_6 aftercoolers consist of finned tubes mounted inside a metal shell. Coolant is circulated on the tube side of the aftercooler. The aftercoolers are designed to remove the heat

of compression by using a closed loop type coolant system. The coolant for the aftercoolers is supplied from the coolant systems for the condensers in C-315. This system is similar to that for the cascade. Liquid coolant boils in the UF_6 aftercooler and the coolant vapor is piped to a water-cooled heat exchanger where it condenses and flows by gravity back to the aftercooler.

3.5.1.4.2 UF_6 Condensers

Three UF_6 condensers in the tails withdrawal facility are used as required for the withdrawal rate. During routine operation, one or two (in parallel) condensers may be operated while the third is on standby. At high withdrawal rates, all three condensers may be used. These condensers are used to condense the compressed UF_6, prior to withdrawal, by cooling. The UF_6 condensers are horizontal tanks with monel U-tubes, in a tube bundle, and double-tube pass UF_6 flow. UF_6 flows through a bank of tubes, shaped in a "U" design, making two passes through the condenser before exiting the vessel. UF_6 condensation takes place on the tube side with coolant circulated on the shell side. The UF_6 condenser has a maximum allowable working pressure (MAWP) rating of 400 psig on the shell side and 50 psig on the tube side. There is a separate coolant system for each condenser. The coolant systems also are used to supply cooling for the aftercoolers for the low-speed compressors. A vent control valve for each condenser helps maintain the proper condensing pressure by venting gases that have not condensed to the Hortonsphere, the "A"-line suction, or a vent surge drum. This vent surge drum is held at a vacuum by either valving it to the off-stream Hortonsphere or back to the cascade A-line in C-331. Overpressure protection is provided by a rupture disc located on each condenser UF_6 vapor inlet line, exhausting to the hortonspheres.

3.5.1.4.3 Coolant Overpressure Control System

The tails withdrawal facilities are equipped with coolant overpressure protection. In the event of an overpressure condition in the coolant, the system is utilized to lower the coolant system pressure, protecting the UF_6 primary system. This system is important to safety as described in Section 3.15. Figure 3.5-1 shows the Coolant Overpressure Control System.

The Coolant Overpressure Control System is designed to relieve coolant pressure when the pressure reaches a maximum safe design limit. The system activates prior to rupturing the coolant system, thus protecting the UF_6 Primary System piping and equipment. Each coolant condenser is provided with a rupture disk that is set to protect the UF_6 condenser by preventing pressures from exceeding 110% of the MAWP. Since in C-315 the two compression-loop aftercoolers are extensions of the two condensers, the condenser rupture discs also protect the aftercoolers. The rupture discs can be isolated from the system by closing a manual block valve.

3.5.1.5 Materials of Construction

The components associated with the tails withdrawal systems, except tails cylinders, are fabricated of corrosion-resistant materials, such as nickel alloys, nickel-plated steel, copper, or aluminum. Most joints in the withdrawal systems are welded. All components exposed to PG are constructed of materials that are corrosion resistant, capable of operating in high temperature conditions, and are compatible with PG. UF_6 cylinder pigtails are used as required flexible connections. UF_6 condensers are constructed with U-tubes using all welded construction.

Surfaces normally in contact with gaseous UF_6 or liquid UF_6, are constructed with approved materials. The UF_6 condensers are built to American Society of Mechanical Engineers (ASME) standards. Accumulators are constructed of material that will withstand pressures higher than will be encountered in service. The accumulators are built to ASME standards and inspected to National Board Inspection Code (NBIC). Surge Drums are constructed of material meeting ASME standards for pressure vessels and of material compatible with UF_6.

3.5.2 Monitoring and Protection Systems

3.5.2.1 Outleakage Detection

The Withdrawal Facility High-Voltage UF_6 Release Detection Systems and the Withdrawal Facility Low-Voltage UF_6 Release Detection Systems monitor the C-315 tails withdrawal facility for UF_6 releases. These detection systems are discussed further below.

3.5.2.1.1 Withdrawal Facility High-Voltage UF_6 Release Detection Systems

The condenser, accumulator, selected piping heated housings, areas around the heated housings, surge tanks, high-speed pumps, Normetex pumps, and withdrawal areas are monitored by the Withdrawal Facility High-Voltage UF_6 Release Detection Systems. Alarms from detector components alert withdrawal facility personnel to take appropriate action in the event of a UF_6 release. The UF_6 Release Detection System - Normetex Pump uses a high-voltage detection system to monitor for the release of UF_6 from the pumps and piping and is important to safety as described in Section 3.5.2.1.1.1. The UF_6 Release Detection System – High-Voltage ("old") System for UF_6 Condensers, Accumulators, and Heated Housings monitors for a UF_6 release and is important to safety as described in Section 3.5.2.1.1.2. High-voltage detector heads and circuits operate in a similar manner in each system and are discussed below.

The UF_6 release detectors are connected to circuits that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate alarm indications.

The sensing element of the detector head consists of two ionization chambers in which air is made conductive by the use of an alpha emitter: 1) the sensing chamber, which is open to atmosphere and will sense the presence of 'smoke' or PG, and 2) the reference chamber, which is virtually sealed from the atmosphere and acts like a constant current source. UF_6 'smoke' released inhibits the normal ionization current developed in the detector head. The reduction in ionization current causes the activation of an alarm.

Detector actuation results in an audible alarm in the ACR and the illumination of a UF_6 detection alarm light in the ACR. An operator must investigate the signal conditioner at the local panel to determine which detector actuated. Individual lamps on the signal conditioners identify each alarming detector.

The 120 VAC electric power supply to the high voltage UF_6 release detection systems in the withdrawal facilities is supplied from the C-315 480V substation. In the withdrawal facilities, 120 VAC power is fed from local distribution panels to the signal conditioners located in the ACR.

3.5.2.1.1.1 UF_6 Release Detection System - Normetex Pump

The tails withdrawal facility is equipped with the UF_6 Release Detection System - Normetex Pump. In the event of a UF_6 release at the Normetex Pump, the pump is shut down and the discharge line is isolated from the rest of the compression loop. Each of the Normetex pumps (three pumps) in C-315 has a UF_6 Release Detection System - Normetex Pump. This system is important to safety as described in Section 3.15. Figure 3.5-2 shows a typical Normetex pump and its associated UF_6 Release Detection System.

The signal from each detector is fed to discrete input logic cards on two local processing units (LPUs). Discreet output logic cards on each LPU provide an output signal. The detector heads are wired to a signal conditioner card used to monitor the firing of the heads.

Emergency shutdown of the Normetex pumps can be initiated from the local control panel, the C-331 ACR, the C-315 ACR, or from the C-300. Emergency shutdown will also close the discharge block valve. The discharge block valve can be closed remotely from the ACR in the C-315. Detector heads can also be fired manually using the LPU or automatically by the system LPU as necessary for testing or to maintain the desired level of detector sensitivity.

On activation of the ‘smoke’ heads the computer controlling the release detection system processes the signal. The system then trips the Normetex pump and closes the discharge block valve if any two adjacent detectors actuate. The discharge valve is closed to decrease the system pressure. The pump cannot be restarted until the UF_6 Release Detection System is reset. One head actuation will initiate an alarm only. The Normetex pump suction valve also shuts, however no credit is taken in the accident analysis for this function.

The UF_6 Release Detection System - Normetex Pump includes an air-operated block valve on the PG discharge line that supports compression isolation. This discharge block valve is a diaphragm-actuated valve that requires air to open (via pressure regulators), a spring to close, and is considered fail-safe. The air-control solenoid (the discharge block valve has two solenoid valves, which provide assurance that, the valve will close and isolate the compression loop during the Normetex pump shutdown sequence) is deenergized during activation of the isolation system. Air is then vented from the discharge block valve and it fails closed. Loss of the plant air supply will result in the discharge block valve transferring to the closed (safe) position.

The nominal 120 VAC power necessary to operate the UF_6 Release Detection System - Normetex Pump is fed from local distribution panels. Supplied 120 VAC power is then used for internal conversion to 200 VDC, which is required for detector heads to operate. The discharge block valves are air operated and are designed to close (i.e., fail-safe) upon loss of 120 VAC power. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and 200 VDC power are support systems, which are important to safety as described in Section 3.15.

3.5.2.1.1.2 UF_6 Release Detection System – High-Voltage ("old") System for UF_6 Condensers, Accumulators, and Piping Heated Housings

The tails withdrawal facility is equipped with a UF_6 Release Detection System for the condenser/accumulator area consisting of high-voltage detector heads located at the ceiling in the condenser area, in the waste condenser housing, ceiling of the 2nd floor, in heated housings, accumulator housing and the vent surge drum housing. Should a release be detected, an audible alarm and alarm light is received in the ACR. This system is important to safety as discussed in Section 3.15.

On activation of an alarm, the operator must determine which detector has alarmed and initiate the appropriate actions. The detector heads are tested to determine detector operability.

The nominal 120 VAC power necessary to operate the UF_6 Release Detection System - High-Voltage ("old") System for UF_6 Condensers, Accumulators, and Piping Heated Housings is fed from local distribution panels. Supplied 120 VAC power is then used for internal conversion to 200 VDC, which is required for detector heads to operate. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and 200 VDC power are support systems, which are important to safety as described in Section 3.15.

3.5.2.1.2 Withdrawal Facility Low-Voltage UF_6 Release Detection Systems

The tails withdrawal facility is monitored by the Withdrawal Facility Low-Voltage UF_6 Release Detection Systems. Detector system components in the withdrawal room are part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations and The UF_6 Release Detection System - Low-Voltage System at the Withdrawal Room Ceiling. When activated, the Low-Voltage ("new") System at the Withdrawal Stations isolates the withdrawal station and is important to safety as discussed in Section 3.5.2.1.2.1. The Low-Voltage System at the Withdrawal Room Ceiling, important to safety as discussed in Section 3.5.2.1.2.2, will only close the liquid drain block valves for all withdrawal positions in the withdrawal room and initiates an alarm in the ACR. The UF_6 Release Detection System – High-Speed Centrifugal Pumps is also part of the Withdrawal Facility Low-Voltage UF_6 Release Detection System. It activates alarms upon detection of a UF_6 release and is important to safety as discussed in Section 3.5.2.1.2.3. Low-voltage detector heads and circuits operate in a similar manner in each system and are discussed below.

The detectors are connected to control units that monitor detector status, provide a means to test the detectors, and process output signals from the detectors to produce the appropriate actions. The detectors function by means of a solid state switching circuit and dual ionization chambers: 1) one chamber to detect UF_6 reaction products with moisture in the air, and 2) one chamber that serves as a reference to help stabilize the detector's sensitivity for changes in ambient temperature, humidity, and pressure. In the detection chamber, ambient air in the gap between two charged electrodes is ionized by an alpha-emitting source. As the concentration of particles in the air increases, the resistance across the detection chamber increases, which causes a voltage increase. When the voltage reaches a characteristic point, the detector produces an output signal.

The system control units consist of a power supply for converting 120 VAC plant power to 24 VDC for the detector circuit, supervisory circuits for monitoring the status of multiple detector zones, and an audible alarm signal circuit. Trouble alarms are activated on the control panel in the event that the voltage drop across a supervised circuit changes, indicating a malfunction or discontinuity. The control panel also contains relays to activate output devices. An output signal from a detector energizes an alarm circuit relay that latches in the "on" position until manually reset.

3.5.2.1.2.1 UF_6 Release Detection System - Low-Voltage ("new") System at the Withdrawal Stations

The tails withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions and consists of a low-voltage detector located above each withdrawal drain position. In the event of a pigtail failure, the system is utilized to isolate the withdrawal position to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.15. Figure 3.5-3 shows a typical UF_6 Release Detection System - Low-Voltage ("new") System at the Withdrawal Stations.

Activation of a low-voltage detector above any drain position pigtail will initiate isolation of that withdrawal position causing the following actions to occur: (1) close the two liquid drain block valves located between the accumulators and the withdrawal pigtail; (2) close the withdrawal cylinder valve; (3) initiate alarms in the withdrawal area and in the ACR; and (4) open the evacuation block valves to evacuate the manifold area. Actions 3 and 4 are not important to safety but are accomplished as part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations activation.

If the automatic UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations fails to activate due to a failure in the system, liquid drain block valves can be closed with controls located outside the withdrawal room, in the ACR, or in the C-300. The pushbutton located immediately outside the withdrawal area, and the controls in C-300, closes the liquid drain block valves and cylinder valve at all withdrawal positions. Controls for each position in the ACR close the liquid drain block valves and cylinder valve at that position. The ACR also has the capability to close only the liquid drain block valves at all positions.

The UF_6 line isolation valves associated with the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations include air-operated liquid drain block valves (spring actuated/fail closed), cylinder valve (with an air-operated/motor driven closure assembly), and miscellaneous valves associated with the building air/nitrogen systems that support withdrawal isolation. The liquid drain block valves are diaphragm-actuated valves that require air to open and springs to close and are fail-safe. The air-control solenoid for the cylinder valve closure assembly is deenergized during activation of the isolation system. Air is then supplied to the cylinder valve closure motor, which closes the cylinder valve, isolating the UF_6 cylinder from the withdrawal position. A backup nitrogen system, provided for the cylinder valve closure assembly, activates upon failure of the plant air system. The evacuation block valves are not part of the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations safety boundary but they provide some mitigation to minimize the consequences of a failure in the withdrawal pigtail. The air-operated valves associated with the evacuation line open, allowing UF_6 to be evacuated from the pigtail to the evacuation header during automatic activation of the isolation system.

The 120 VAC power to operate the UF_6 Release Detection System – Low-Voltage ("new") System at the Withdrawal Stations is fed from local distribution panels. Supplied 120 VAC power is then used to develop the 24 VDC power supply for the UF_6 release detection circuit. A separate 120 VAC power circuit feeds the solenoid valves that actuate the liquid drain block valves, the cylinder valve closure assembly, and the evacuation block valves. The liquid drain block valves and the evacuation block valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power. The cylinder valve is designed to close (by activation of the nitrogen backup system) upon loss of electrical power. The 120 VAC and 24 VDC power are support systems, which are important to safety as described in Section 3.15.

The plant air system provides the motive power for the cylinder valve closure assembly. Loss of plant air causes the block valves to fail in the closed position, isolating the withdrawal position from its liquid source. The cylinder valve closure assembly is also provided with a nitrogen backup system. On loss of plant air or low plant air pressure, a pressure switch on the air supply line actuates to open a solenoid valve making nitrogen available through the air supply line. The nitrogen is supplied from a portable tank in sufficient quantity and pressure to completely close the cylinder valve within 30 seconds after release detection. The nitrogen supply is isolated from the plant air system by a check valve that prevents loss of nitrogen pressure. On loss of power the system also shifts to the nitrogen supply system for motive power to the cylinder valve. The cylinder valve, on loss of both air and nitrogen, will fail in the current position. Loss of power or indication of a UF_6 release is required to initiate closure of the cylinder valve via this system.

3.5.2.1.2.2 UF_6 Release Detection System – Low-Voltage System at the Withdrawal Room Ceiling

The tails withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions. In the event of a pigtail failure, the system is utilized to isolate all the withdrawal positions to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.15. Figure 3.5-4 shows a typical UF_6 Release Detection System - Low-Voltage System at the Withdrawal Room Ceiling.

Activation of any of the low-voltage ceiling detector heads will result in closure of the liquid drain block valves at all the withdrawal positions to isolate the drain header and alarm in the C-315 ACR. In addition, pushbuttons are located outside the withdrawal room in the C-315 ACR and in the C-300 which, when activated, close the liquid drain block valves at all withdrawal positions. Only the alarm is credited with providing a safety function.

The nominal 120 VAC power to operate the UF_6 Release Detection System – Low-Voltage System at the Withdrawal Room Ceiling is fed from local distribution panels. Supplied 120 VAC power is then used to develop the 24 VDC power supply for the UF_6 release detection circuit. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC and 24 VDC power are support systems, which are important to safety as described in Section 3.15.

3.5.2.1.2.3 UF_6 Release Detection System – High-Speed Centrifugal Pumps

The tails withdrawal facility is equipped with a UF_6 release detection system for the high-speed centrifugal pumps. Should a release be detected an alarm will be actuated in the ACR. This system is important to safety as described in Section 3.15.

The detector heads are located over the high-speed centrifugal pumps on the 2nd floor of C-315. System alarms alert withdrawal facility personnel to take appropriate action in the event of a UF_6 release in the compressor area. Actuation of the detectors monitoring the high-speed compressors in C-315 initiates a visual alarm in the C-315 ACR, the C-315 general facility audible alarm, and audible and visual alarms in C-331 ACR.

The 120 VAC power to operate the UF_6 Release Detection System – High-Speed Centrifugal Pumps is fed from local distribution panels. Should the low-voltage detectors fail to operate, the system relies on the high-voltage detector heads as a backup until the low-voltage heads are returned to service. The nominal 120 VAC power necessary to operate the detector heads for the high-speed centrifugal pumps is fed from local distribution panels. Supplied 120 VAC power is then used for internal conversion to 24 VDC for the low voltage detector head and 200 VDC for the high voltage detector heads, which is required for detector heads to operate. The 120 VAC power system provides the power source for the detector circuits and is, therefore, required for the detector systems to perform their safety function. The 120 VAC, 200 VDC, and 24 VDC are support systems, which are important to safety as described in Section 3.15.

3.5.2.2 Instrumentation

UF_6 gas with the desired assay, as determined by a mass spectrometer in C-331 or through lab samples, is withdrawn from the cascade in C-331 and enters C-315.

The on-stream Hortonsphere provides a surge volume for tails withdrawal. The upflow is returned to the cascade in C-331 as the “A” stream of the bottom stage. High-pressure in the Hortonsphere will sound an alarm in the ACR.

The condenser pressure is controlled by the condenser vent valve. The desired flow to the condensers is automatically controlled by the condenser inlet control valve during total centrifugal operation and by the Normetex pump suction control valve during Normetex operation.

A sample of the UF_6 from the “B” stream inlet to C-315 is taken and becomes the official sample for that particular tails cylinder. When the sampler is not available, alternate sampling is used to determine the official cylinder assay.

The pneumatically and electronically operated instruments in the tails withdrawal system are similar to standard cascade instruments. Safety-related control and block valves require air to operate and a loss of instrument air would result in the safe operation of these valves. Selected alarms sound locally and in the ACR in both C-315 and C-331.

3.5.2.3 Scales and Scale Carts

Each empty cylinder is placed on a scale cart equipped with cradles to accommodate the cylinder being moved to a scale and positioned for filling. The scale carts are air-operated and brake on loss of air. The scale carts are important to safety as discussed in Section 3.15. The scale cart air supply is equipped with a key-operated interlock switch which blocks the air supply to the scale cart without the interlock key. Administrative controls require the air supply interlock key ring to be placed on the pigtail when the pigtail is connected to a cylinder to prevent movement during filling. Additionally, even with the key in the lock, a system consisting of a pressure sensor on the drain line prevents Scale Cart motion unless the pigtail is close to atmospheric pressure. The Cylinder Scale Cart Movement Prevention System is important to safety as discussed in Section 3.15.

The tails withdrawal scales perform operational and accountability functions. The operational function is a convenience to fill cylinders to a target weight. At a predetermined weight, an alarm sounds and a valve in the associated UF_6 drain line automatically closes. Filling the cylinder to its specified fill limit is completed using local controls. The accountability function provides the NMC&A weight for the filled cylinder. The NMC&A weight is used to verify cylinders are not filled above established fill limits. The accountability function is checked with a test cylinder prior to placing a cylinder in the withdrawal process, or at a specified surveillance frequency. The scales are important to safety as discussed in Section 3.15.

Scales and scale carts are discussed in Section 3.7.

3.5.3 Operation

3.5.3.1 Cylinder Filling Stations

There are four cylinder filling stations or withdrawal positions in normal use in the tails withdrawal system. Each has a cylinder cradle arrangement mounted on a cart, which is moved into position on a scale at the filling station. A removable pipe or “pigtail” connects the filling station to the cylinder valve. Withdrawal UF_6 cylinder pigtails are exposed to ambient conditions and are thus susceptible to freeze-out (UF_6 solidifying in the pigtail due to a temperature decrease). For this reason, withdrawal UF_6 cylinder pigtails are wrapped with electrical heat tracing covered with insulating tape to reduce the likelihood of freeze-out. Each cylinder filling station has an exhaust hood connected to a common exhaust duct high-efficiency particulate air (HEPA) filter and fan, which is then exhausted to atmosphere. This mitigates the accumulation of any residual gases that might arise from withdrawal operations. If the system is inoperable, portable vacuum cleaners with HEPA filters are used to mitigate the effects of a small release. UF_6 detectors are located above each fill station and are discussed in Sections 3.5.2.1.1 and 3.5.2.1.2.

Prior to connection, the pigtail is visually inspected for defects and a new pigtail gasket is installed. When an empty cylinder is installed for filling, the pigtail connection is attached to the cylinder valve and

the UF_6 fill line is vacuum checked and pressure checked with air to test for leaks. Filling is started by opening the valve in the UF_6 drain line to allow flow from the condenser and accumulator. When a cylinder has been filled with liquid UF_6, the drain line valve is closed, the cylinder valve is closed using the cylinder valve closer motor, and the pigtail line is evacuated to remove the majority of the residual UF_6. Before the pigtail is disconnected from the filled cylinder, it is pressurized or "purged" using dry air and then evacuated to a low pressure. This purge and evacuation cycle is repeated several times (based on the purge and evacuation pressures) to remove most of the residual UF_6.

While the liquid UF_6 is being drained from a condenser or accumulator into the cylinder, the weight of the material withdrawn can be read from the operational scale to determine when the weight is approaching the cylinder target weight. The cylinder target weight is set at or below the cylinder fill limit. If the target weight or the cylinder fill limit should be exceeded, the excess material may be removed by valving the cylinder to the evacuation header at the withdrawal position.

3.5.4 Liquid Cylinder Handling

The movement of cylinders containing liquid UF_6 in the tails withdrawal facility is minimized to reduce the potential of damage to the cylinder resulting in a loss of containment and a release of UF_6.

The cylinder handling equipment in the tails withdrawal facility includes scales, scale carts, and cranes. The movement of liquid filled cylinders is restricted to removal from the filling station to the cool-down yard. Liquid UF_6 cylinders remain in the cool-down yard for the required cool-down period per administrative controls. Limited movement of cylinders may be conducted within the cool-down yard before completion of the cool-down period if the precautions for handling liquid filled cylinders are followed (e.g., moving cylinders as low to the ground as practical, using equipment approved for liquid cylinder movements, etc.).

Upon completion of the cool-down period, cylinders are handled as described in Section 3.7. The UF_6 cylinders are important to safety as described in Section 3.15. Liquid UF_6 cylinder handling equipment is important to safety as discussed in Section 3.15.

3.5.4.1 Cranes

Semi-gantry cranes transport empty cylinders from the storage area to the scale carts for the withdrawal operation, liquid filled UF_6 cylinders from the scale carts to the storage areas, and solid UF_6 cylinders to transport. The semi-gantry cranes for this facility operate on the same crane rail system and should not be loaded at the same time. Administrative controls are used to ensure both cranes are not used at the same time.

Liquid cylinder movement from the scale cart to the cylinder cool-down area shall be minimized and the height the liquid cylinder is lifted above the work area and/or ground is limited by administrative controls to the lowest practical height to facilitate movement.

Cylinder haulers can also be utilized to load empty and solid UF_6 cylinders onto the scale carts. Cranes, lifting fixtures, and rigging are discussed in Section 3.7. Cranes are important to safety as discussed in Section 3.15.

3.5.4.2 Short-Term Storage

The facility contains a cylinder yard for the short-term storage of empty cylinders and cylinders containing liquid and solid UF_6. The yard is equipped to accommodate cylinder storage. The yard is used for cylinder cool-down; the liquid UF_6 must assume a solid state. Liquid cylinders are moved from scale carts to the cool-down area by a semi-gantry crane. Ten and 14 ton cylinders are allowed to cool for five days to solidify before they are moved to a long term storage yard. Storage yards are discussed in Section 3.7.

3.5.5 Administrative Controls

In addition to the Administrative Controls in Chapter 4 and those controls covered by programs and plans, the following facility-specific Administrative Controls ensure safe operation of the tails withdrawal facility. Additional general Administrative Controls for cylinders are listed in Section 3.7.6.

1. The remote cylinder valve operator shall not be used except by the automatic control system to minimize the potential for pigtail damage during this mode of operation.

   (Note: The mode discussed above is Mode 1, Cylinder Preparation or Removal.)

2. Valve control procedures shall be in place to protect from inadvertent valve openings to atmosphere.

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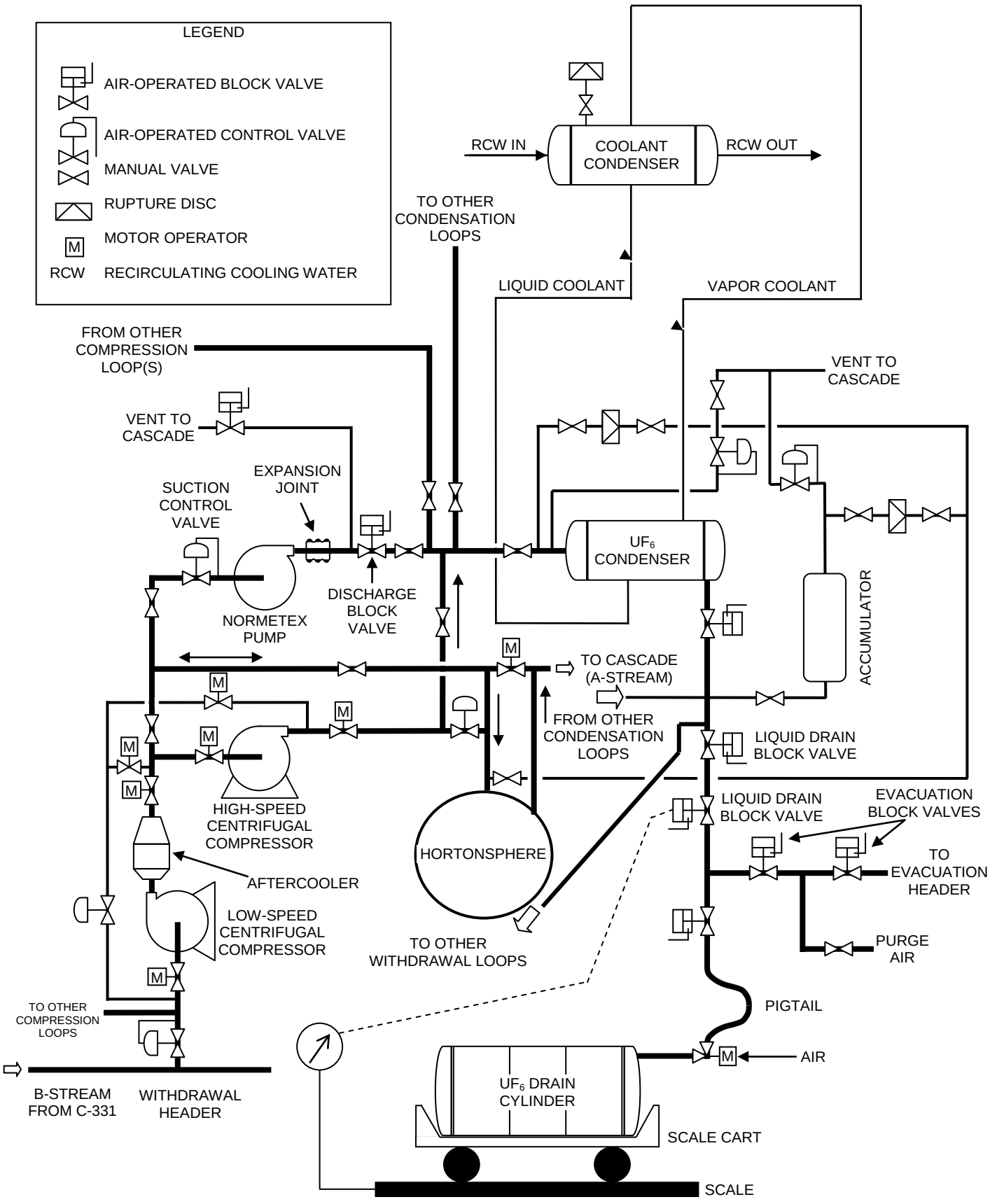

Figure 3.5-1. Typical Tails Withdrawal Flow Diagram

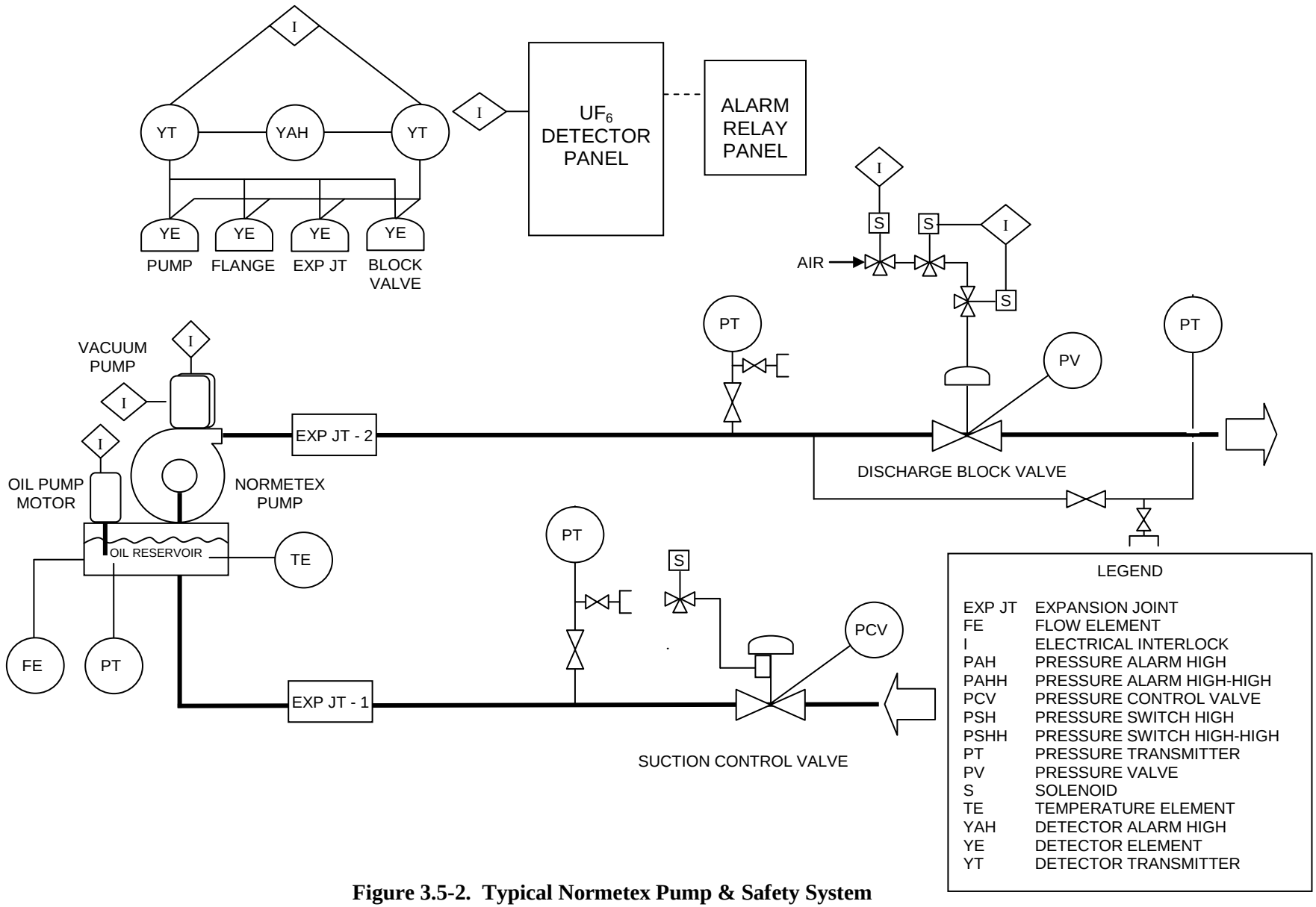

Figure 3.5-2. Typical Normetex Pump & Safety System

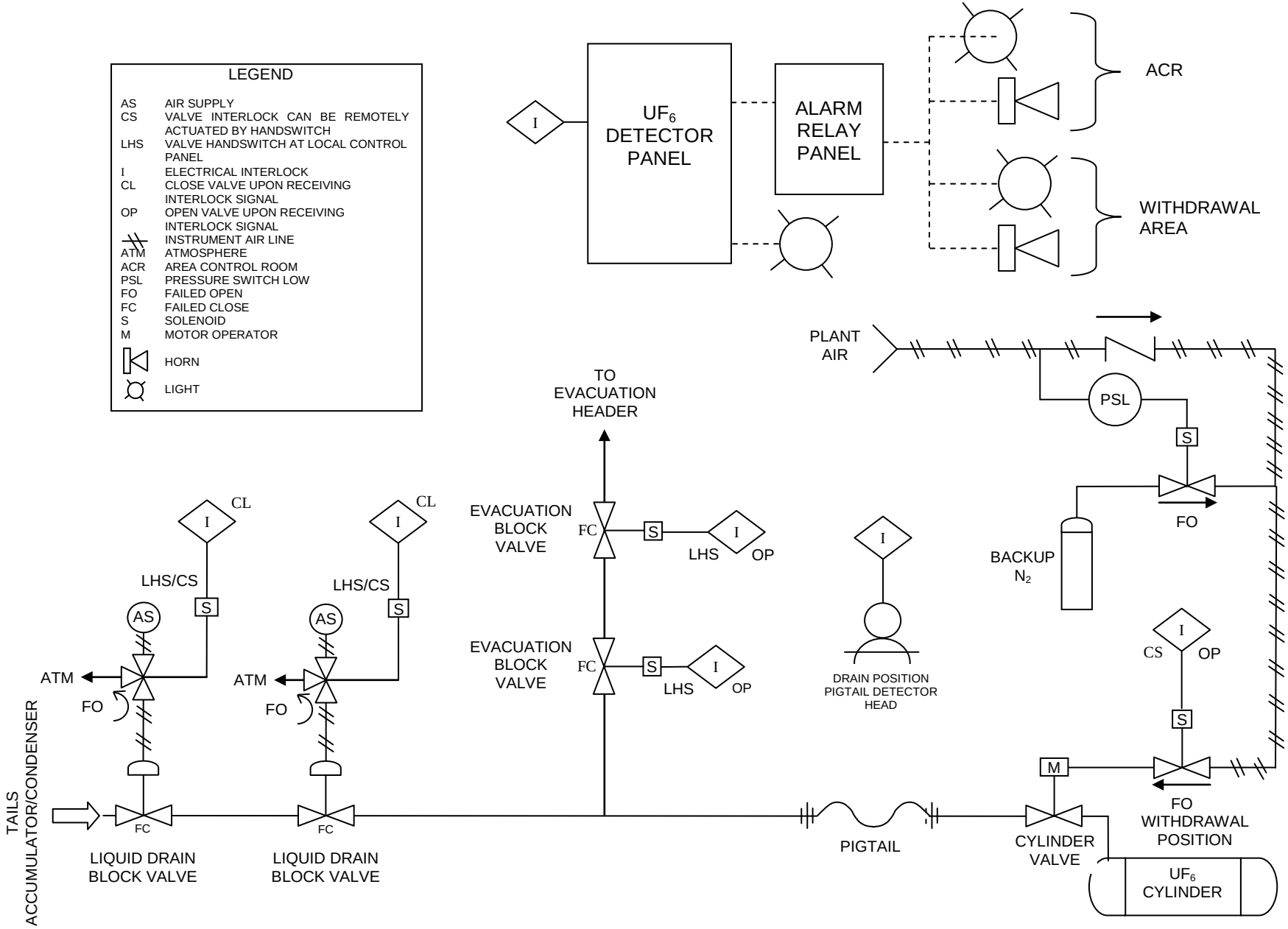

Figure 3.5-3. Typical Low-Voltage System at the Tails Withdrawal Stations

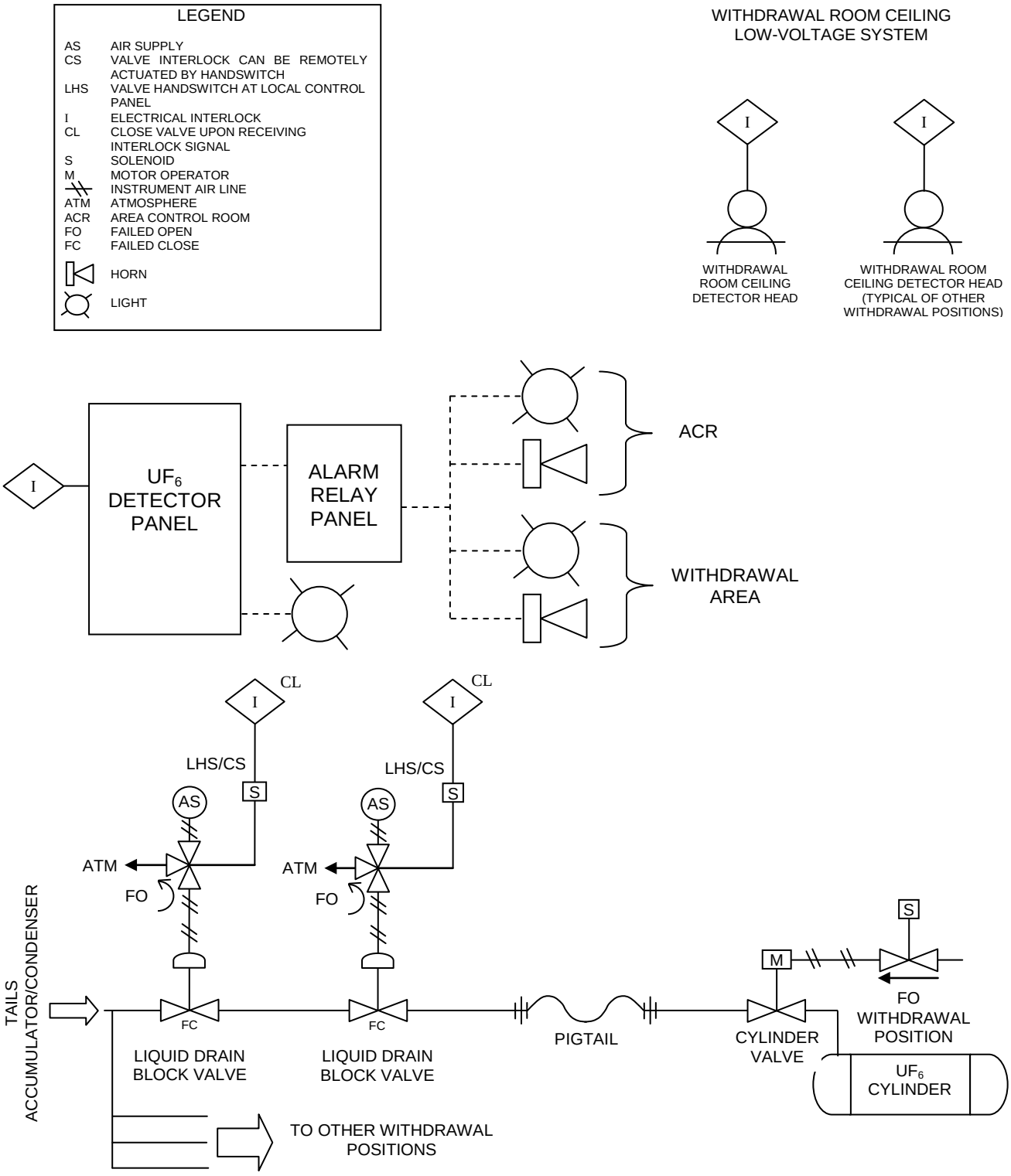

Figure 3.5-4. Typical Low-Voltage System at the Tails Withdrawal Ceiling

3.6 TOLL TRANSFER AND SAMPLING BUILDING

The C-360 Toll Transfer and Sampling Building provides systems for receiving, sampling, transferring, and shipping cylinders containing UF_6. This facility provides all operations necessary for the fulfillment of enrichment service contracts with private industry.

3.6.1 Description

Material is not introduced into the enrichment cascade unless assurance is obtained that it meets feed composition and weight specifications. UF_6 cylinders are weighed upon receipt, either at C-360 or on another operable accountability scale that has been calibrated to an adequate range and tolerance for the item being weighed. When required by the Fundamental Nuclear Materials Control Plan, UF_6 cylinders are liquid sampled at C-360.

The types of activities that take place in C-360 are described below.

3.6.1.1 Preheating

Prior to heating, an external inspection is performed on each cylinder to detect any physical damage that may be present. If serious damage is detected, the cylinder is not heated until corrective actions have been taken and verified by a certified inspector.

A cold pressure check is made on each cylinder containing solidified UF_6 prior to heating. The pressure within the cylinder is an indication of the purity of the UF_6 in the cylinder. Since UF_6 that meets feed grade specifications is at a pressure less than atmospheric at ambient temperature, higher pressure readings indicate the presence of noncondensible gases such as air or volatile contaminants that could cause overpressure of the cylinder when heated. If the cylinder pressure is greater than 10 psia, the customer is requested to provide instructions to either return the cylinder or remove the noncondensibles by cold burping the cylinder at PGDP. A cylinder containing liquid UF_6 that has been processed through the transfer or sampling operations (e.g., through the technetium traps) can be immediately loaded into an autoclave for additional transfer or sampling operations.

The cylinder is positioned in one of the four containment-type autoclaves in C-360 with the cylinder valve at the 12 o'clock position. The cylinder is connected to a manifold by means of a UF_6 cylinder pigtail fabricated from copper tubing which has passed a hydrostatic test to 400 psig. UF_6 cylinder pigtails and the tests conducted on them are described in Section 3.6.5. The cylinder valve and pigtail are checked for clarity. If clarity is not established, the cylinder will not be heated and is removed from the autoclave. After testing of all UF_6 cylinder pigtail connections has been completed, the UF_6 cylinder valve is opened, the emergency cylinder valve closer is attached, the autoclave shell is closed, and a hydraulically operated rotating ring seals the movable shell of the autoclave to the fixed head.

3.6.1.2 Heating

A steam control valve admits steam into the autoclave, and a thermovent valve bleeds atmospheric air from the shell. Autoclave temperature is controlled by utilizing a cascade control scheme within a feedback loop controller. Information from the autoclave pressure and temperature instruments is used

to maintain a constant temperature. Under normal conditions with the cylinder at a temperature of 235ºF (the temperature of saturated steam at 8 psig), the pressure of the UF_6 within the cylinder is about 82 psia.

The valve on a cylinder to be heated is opened to a system that contains a low pressure alarm system, a high pressure alarm, and rupture discs that under high pressure conditions relieve to the high-pressure relief drums. If the system pressure fails to reach a set pressure within a specified time frame, the low pressure alarm is actuated to indicate a plugged or closed cylinder valve, pigtail, or header, and closes the autoclave steam inlet valves. Excessive system pressures, which could result from impurities or hydraulic surges, would actuate the high pressure alarm.

The autoclave control scheme calls for an autoclave temperature of 220ºF with a maximum pressure of 5 psig. Thermal inertia causes condensate to form on the inside autoclave surfaces and on the outside cylinder surfaces. During normal operation, the autoclave drain valves are open to provide a condensate drain path when steam is being applied to the autoclave environment, preventing accumulation of condensate in the drain. The autoclave water inventory control system limits the amount of water present inside the autoclave during normal operation to ensure initial conditions assumed in the accident analysis are preserved.

3.6.1.3 Sampling

When the heating cycle is completed, the cylinder valve is closed and steam is evacuated from the autoclave to near atmospheric pressure by jetting the autoclave through a steam venturi. The UF_6 cylinder pigtail is purged and evacuated, the autoclave is opened, the pigtail is disconnected and the cylinder is rotated to the 3 or 9 o'clock position to permit liquid sampling. The pigtail is reconnected and pressure tested and the cylinder valve is opened before closing the autoclave shell. The steam block valve may be opened to maintain temperature during sampling.

During sampling, the inlet valve to the pipette in the sample cabinet is opened and the pipette is allowed to fill to a visible level on the viewing-level window. The pipette sample evacuation valve is opened and the entire sampling system is flushed with liquid UF_6 to the evacuation drums. The evacuation valve is closed and the pipette is valved to an evacuation source and evacuated to ensure all UF_6 is removed from the pipette and sampling manifold. All system valves are closed and the pipette inlet valve is opened to fill the pipette with liquid UF_6 until the liquid level reaches an appropriate level in the sample chamber. After closing the inlet valve, the sample is transferred to a sample container and the operation may be repeated to obtain duplicate samples. Following sampling, the UF_6 cylinder pigtail is purged and removed from the UF_6 cylinder. The UF_6 cylinder is then rotated to return the cylinder valve to the 12 o'clock position.

The crane lifts the cylinder from the autoclave. The cylinder is then placed on a scale cart and weighed. After weighing, the cylinder is moved to a hot storage area to cool for a minimum of three days for a 12B or 2½-ton cylinder or five days for a 10 or 14-ton cylinder. The cylinder can be moved from C-360 after the cooling period.

The C-360 sampling manifold and associated equipment may be treated with HF/nitrogen gas mixtures to remove contaminates. To support this process, 5-liter cylinders are filled with a known HF/nitrogen mixture that that is independently verified to be free of liquid. The gas mixture is introduced into the C-360 manifold and allowed to reside inside the equipment for a specified period of time. After the treatment, the gas mixture is evacuated to a low pressure source (e.g., surge/relief drums).

3.6.1.4 Transfer

For transfer of material, the parent cylinder (cylinder within the autoclave) is heated in the same manner as described for sampling. After heating, the steam is shut off, the cylinder valve is closed, and steam is evacuated from the autoclave to near atmospheric pressure by jetting the autoclave through a steam venturi. After purging and evacuating the UF_6 cylinder pigtail, the autoclave is opened, the pigtail is disconnected, and the cylinder is rotated to position the valve in the 6 o'clock position. The transfer pigtail, which is larger than the heating/sampling pigtail, is connected to the cylinder and the transfer line which leads to a transfer station manifold located on the lower level. Only one autoclave is valved to the transfer line at a time. Two transfer line isolation valves on each of the other autoclaves are administratively controlled in the closed position. An approved cylinder (“receiving” or “daughter” cylinder) is attached to the transfer station manifold by another UF_6 cylinder pigtail. The cold pressure is verified to be less than 5 psia prior to filling. The cylinder is positioned on a cart that rests on a scale at the transfer station. After filling, the daughter cylinder valve and transfer manifold block valve(s) are closed, and the pigtail is purged and disconnected. If the daughter cylinder is not completely filled by the parent another parent cylinder may be used to complete filling of the daughter cylinder if required. After the parent cylinder valve is reopened, the autoclave is closed and steam flow is resumed to maintain pressure in the gas volume of the cylinder. A flow of liquid UF_6 from the parent cylinder to the receiving cylinder is established by opening the drain manifold valve and the receiving cylinder valve. The daughter cylinder valve closer motor is used to close the cylinder valve. If a special desired assay is requested by the customer two or more parents are used to blend assays to achieve the desired assay. In this case an empty or partially filled cylinder is loaded on the transfer scale cart and cold pressure is verified. Only one parent is valved to the daughter cylinder at a time. Once complete this parent cylinder is valved out and another parent is valved to the cylinder to complete the blending. The UF_6 release detection system will be available during transfer and whenever liquid UF_6 is present in either the pigtail or manifold.

Transfer can be made from only one autoclave at a time. During liquid transfer from an autoclave, two transfer line isolation valves on each of the remaining autoclaves are closed. If necessary, liquid UF_6 may be transferred through traps containing magnesium fluoride (MgF_2) located in the autoclave head or through those in the basement transfer room to reduce the technetium contamination.

Based on the fill limit for the type of cylinder being used, the manifold valve at the transfer station closes automatically at a predetermined setting on the scale, which is below the final cylinder fill limit to prevent overfilling. An operator can then change the scale setting or use the jog button to fill the cylinder

to the proper weight. Cylinders inadvertently filled beyond the desired weight are evacuated to the building evacuation drums until the desired weight is reached. After block valves are closed, the UF_6 cylinder pigtail is purged and disconnected. The transfer process may involve multiple daughter cylinders being filled from one parent cylinder.

The receiving cylinder is either moved to an autoclave for additional transfer or sampling operations or it is moved to a storage area. A cylinder containing liquid UF_6 that has been processed through the transfer or sampling operations (e.g., through the technetium traps) can be immediately loaded into an autoclave for additional transfer or sampling operations. Prior to filling, this cylinder must pass cold pressure check, indicating less than or equal to 5 psia (34.5 kPa). Prior to heating, this receiving cylinder is inspected for obvious damage that could threaten its ability to withstand a normal heating cycle. The weight of this receiving cylinder is verified prior to heating to ensure that it has adequate ullage.

Receiving cylinders moved to the storage area are allowed to cool a minimum of three days for a 12B or 2½-ton cylinder or five days for a 10 or 14-ton cylinder to ensure solidification of the UF_6. Limited movement of cylinders may be conducted within the cooldown yard before completion of the cooldown period if the precautions for handling liquid-filled cylinders are followed (i.e., moving cylinders as low to the ground as practical, using the overhead crane for cylinder movement, etc.).

Cylinders containing greater than 1 wt % ^{235}U are shipped in a protective container to prevent shipping damage in accordance with DOT regulations.

3.6.1.5 Evacuation of Small UF_6 Containers

Periodically, small UF_6 containers (i.e. 1S and 2S cylinders) are required to be emptied for reuse. This can be completed by two different methods.

One method includes evacuating the containers from sample cabinets that are located in the C-360 Laboratory. The containers are connected to the sample cabinet manifold and the evacuation is completed by aligning the manifold to a UF_6 evacuation source. Evacuation of the containers is completed by sublimation, which takes several hours due to the operation being performed at room temperature.

The other method includes evacuating the containers from autoclaves located in the C-360 Facility. The containers are connected to a portable manifold inside any of the C-360 autoclaves. The portable manifold is then connected to the autoclave UF_6 manifold by a pigtail. The connections are leak checked to ensure no leaks. The autoclave UF_6 manifold is aligned to a UF_6 evacuation source. Steam is applied to the closed autoclave to quicken the small container evacuation time.

Similar to the larger cylinders that are heated inside autoclaves, the small UF_6 containers are visually inspected for damage prior to being heated to prevent leaks. Due to the small quantities of UF_6 that the small containers are capable of having, the cold pressure check of the cylinders, and valve clarity operations are not performed prior to heating.

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3.6.2 Building

The C-360 Toll Transfer and Sampling Building is divided into a high-bay work area and a low-bay service area. The high-bay work area houses four autoclaves with the associated piping, power, and instrumentation systems. The basement of the low-bay service area houses the transfer station and scales, abandoned cold trapping system, evacuation drums, and associated piping. The laboratory area, located in the low-bay service area north of the high-bay work area on the same level, contains four sampling stations, laboratory bench, and control panels to monitor and control building operations. The low-bay service area also includes the supervisor's office.

An annunciator panel is provided in the laboratory area and in the supervisor's office to provide alarms for critical parameters of building operation. The building also contains a rail siding on the south side, which utilizes the work area as an interior loading dock with space for cylinder staging.

The east side of the building has motor operated crane doors that will allow the movement of overhead cranes in and out of the building as required. Motor operated roll-up doors are provided at truck entrances, rail entrance, and entrances to maintenance areas.

The building is constructed of structural steel with build-up roof, non-metallic and metal siding and has concrete floor slabs and foundations. Seismic design consideration is in accordance with Energy Research and Development Administration (ERDA) Criteria Appendix 6301 and Uniform Building Code (UBC) Zone 3.

Ventilation for the general work area in C-360 is provided by supply and exhaust fans. Louvers provided in the building siding aid ventilation. Each autoclave is connected to a small exhaust system that provides local ventilation for potential releases of UF_6 that may occur when making or breaking UF_6 cylinder pigtail connections. Operation of the exhaust system is actuated by a manually operated switch. The exhaust is passed through a high efficiency particulate air (HEPA) filter for removal of any uranium particles prior to venting to the atmosphere. There is also an exhaust system over the transfer station. The effluent from this system is also passed through high efficiency particulate filters prior to release to the atmosphere.

The C-360 building is equipped with a building containment system, which, upon activation, initiates the following: closure of all motor-operated exterior doors, the stopping of all supply and exhaust fans, closure of the west wall vent dampers, and de-energizing the elevator pit sump pump. Activation of the building containment system is discussed in Section 3.6.7.6.

The C-360 structure is important to safety as described in Section 3.15.

3.6.3 Autoclaves

C-360 has four containment-type autoclaves used to heat cylinders for sampling and transferring UF_6. Each autoclave is a steam-heated pressure vessel with an MAWP of 150 psig and with the

necessary instrumentation for the sensing and containment of UF_6 releases that might occur when a cylinder containing UF_6 is being heated, sampled, or transferred. These units are approximately 23 ft long with an internal diameter of 8 ft and are mounted with their long axis horizontal. A section of the autoclave (head) is mounted permanently, while the remaining section (shell) is moved with a hydraulic ram on a track system. This movement is required to permit introduction and removal of the UF_6 cylinders. The moveable shell of each autoclave is secured to the fixed head with a hydraulically operated locking ring, which is sealed with a gasket. An interlock prevents opening the autoclave shell if pressure in the autoclave exceeds atmospheric pressure by a set amount. A typical autoclave and its associated piping and valves are shown in Figures 3.6-1 and 3.6-2. The autoclaves have been evaluated and shown to meet the evaluation basis earthquake performance criteria. The autoclaves are designed satisfy the requirements of Section VIII, Division 1, of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The autoclaves are containment-type autoclaves with a maximum allowable working pressure (MAWP) of 150 psig at 250ºF that were hydrostatically tested at 150% of the MAWP by the manufacturer. Autoclaves are designed to minimize standing water inventory to contain the products of a "worst case" UF_6 release.

In the open position, each autoclave opening is sufficiently long to allow a cylinder to be placed on the horizontal support chain inside the autoclave. The overhead crane is used to position the cylinder. The support chain is power-driven to permit the cylinders to be rotated for sampling and transfer operations. When the autoclave is in the open position, a tilting mechanism can be used to elevate the plug-end of the cylinder approximately 18 in. to enhance liquid transfer from the cylinder inside the autoclave to the receiving cylinder positioned at the withdrawal station. An air buffer flow to the actuator motor and cylinder roll motor is maintained to keep steam out of the electrical circuits and aid in cooling the motors and circuits. By monitoring the UF_6 manifold pressure, a roll interlock system prevents rotation of the cylinder when the UF_6 cylinder pigtail is pressurized.

The containment-type autoclave is the primary protection system against gross releases of UF_6 to the environment. Service lines that penetrate the autoclave head include piping that is isolated by two, automatically operated, in-series isolation valves or by normally shut passive devices (rupture discs, relief valves, manual valves, etc.) to prevent the escape of reaction products in the event of a UF_6 release inside the autoclave. The service lines that penetrate the head include the steam supply line, the UF_6 sample and transfer lines, condensate drain line, buffer air supply and vent lines, the autoclave relief line, autoclave temperature thermocouple probes, and electrical connection to the roll and tilt motor. The autoclave relief line, which connects to the rupture disc and relief valve, also has branches for the steam condensate sample line, the thermovent line and the vacuum breaker. A cylinder valve closer shaft containing packing and flanges to prevent leakage also penetrate the stationary head. Figure 3.6-1 provides a simplified schematic of a C-360 autoclave and the associated piping.

Each autoclave is designed to withstand the reaction pressure developed by the exothermic reaction of UF_6 with the steam vapor and the condensate present. Because the quantity of an accidental release of UF_6 from a cylinder inside an autoclave cannot be controlled, the maximum pressure generated by the reaction can best be controlled by limiting the amount of water present for a given volume or by providing an additional volume for expansion. By limiting the amount of water present for a given volume, a maximum reaction pressure can be determined in an autoclave of a given volume.

The C-360 sample-transfer autoclaves are designed for a 150 psig maximum allowable working pressure at 250ºF. Two condensate level probes are mounted at the same elevation in the condensate drain at the top of the drain line, slightly below the autoclave shell. An accumulation of condensate in the drain line reaching the actuation level of these probes automatically shuts the steam isolation valves and the thermovent line block valve to prevent the addition of more water.

As a protection against overpressure, each autoclave is provided with a rupture disc in series with a pressure relief valve set at 150 psig. In the event of a UF_6 release in which a failure of the condensate level system had allowed the autoclave to accumulate an excessive water inventory, the resulting overpressure would be relieved to the atmosphere by a vent line above the C-360 roof. The autoclave would then contain all reaction products remaining at a pressure below the set point of the relief valve.

In the event of a UF_6 release, reaction products of UF_6 and water are detected by two separate conductivity cells that monitor samples of the autoclave atmosphere. The conductivity cells are intended to detect small releases of UF_6 that do not generate a significant pressure rise within the autoclave. The cells are extremely sensitive to the HF component of the UF_6 reaction with water and detect concentrations of only a few parts per million. When triggered, these cells initiate an autoclave containment signal that closes the steam supply line, thermovent line, UF_6 line, condensate drain line, and buffer air line isolation valves. Tests of conductivity cells by controlled release of HF into a similar autoclave have shown the response time to be in the order of 30 to 60 seconds.

During a hypothetical large release, in which the pressure could rise rapidly, the use of a pressure switch provides more rapid isolation than that obtained from a conductivity cell. The C-360 autoclaves are provided with two separate pressure switches that place the autoclave in the containment mode when the internal pressure reaches 15 psig. Conductivity cells are used to detect small releases that might not result in pressures high enough to trip the pressure switch.

In addition to the important to safety systems described in Section 3.6.7, the following systems are present to support operational control of the autoclaves:

3.6.3.1 Conductivity Monitoring

Each autoclave is provided with two separate conductivity cells that monitor the atmosphere within the autoclave. These conductivity cells detect the presence of small concentrations of HF. These small concentrations would result from a small release of UF_6 that would not produce an appreciable autoclave pressure increase. Steam is withdrawn from the autoclave through a single small diameter line and passed through separate condensers corresponding to the separate conductivity cells. Each conductivity cell measures the electrical conductivity of the condensate. The HF formed by a UF_6 leakage into the autoclave results in high conductivity. If either cell detects conductivity above the setpoint, the system initiates containment shutdown and activates alarms at the autoclave operation panel, in the laboratory area, in the supervisor’s office and in the C-300, Central Control Facility. The autoclave penetrations and their associated containment isolation valves activated by this system are the same as those associated with the Autoclave High Pressure Isolation System and are described in Section 3.6.7.3.

3.6.3.2 Low Cylinder Pressure System

The low cylinder pressure system is designed to minimize the potential for heating a cylinder when unobstructed flow of UF_6 through the UF_6 cylinder pigtail and UF_6 manifold is not assured. Conditions under which this could occur include the cylinder valve being closed or the pigtail not being connected. The system consists of a pressure element connected to a pressure switch that signals the steam supply block valves and the thermovent line block valve to close if the cylinder pressure (i.e., UF_6 manifold pressure) does not increase to a specified minimum value within a specified time following initiation of the heating cycle. Activation of the system actuates alarms at the autoclave control panel and in the laboratory area. The components of this system are the timer, pressure element, pressure transmitter, pressure switch, steam supply isolation valves, thermovent line block valve, and associated relays, solenoids, and switches.

3.6.3.3 Cylinder Pressure Relief System

The cylinder pressure relief system relieves pressures in excess of 100 psig from the UF6 cylinder to the cylinder relief tanks, and closes the steam supply isolation valves and the thermovent line block valve. The components are the rupture discs on the sample manifold, pressure transducer, pressure transmitter, pressure switches, and steam supply isolation valves, thermovent line block valve, and associated relays, solenoids and switches.

During normal operation, the line between the rupture discs is maintained at approximately atmospheric pressure and the low and high pressure switches are closed. If the pressure sensing instrumentation detects pressure below the setpoint of the low pressure switch, or above the setpoint for the high pressure switch, the corresponding switch opens. If either the low or the high pressure switch opens, steam shutdown is initiated (closing the steam supply isolation valves and the thermovent line block valve), and alarms are actuated at the autoclave control panel and in the laboratory area.

3.6.3.4 Autoclave Opening Prevention System

The autoclave opening prevention system consists of two pressure sensing channels and is used to prevent the opening of an autoclave unless the internal autoclave pressure is close to atmospheric pressure. System components are the pressure elements, pressure transmitters, pressure switches, and associated relays and switches that operate off of the two internal pressure taps for each autoclave. When the autoclave pressure is less than the setpoint for the pressure switches, the switches are closed and the circuit to the hydraulic system is completed, allowing normal hydraulic control function. If either pressure sensing channel senses pressure above the setpoint, the pressure switch opens, which interrupts the circuit to the hydraulic control system preventing opening of the locking ring.

3.6.3.5 Section Deleted

3.6.4 Surge Drums

3.6.4.1 Evacuation Drums

Four surge drums are provided to facilitate the purge and evacuation requirements for the sample and transfer facility. These surge drums are arranged in banks of two drums each for this purpose. Manifolding and appropriate valving allow either set of drums to be used for evacuation of separate assays or to maintain evacuation capability in one bank while the other bank is valved to the C-337 process building for evacuation of the contents to the cascade. Following evacuation, this bank of drums is held in standby until needed.

The pressure of each evacuation drum is maintained less than or equal to 13.7 psia. If drum pressure is greater than 13.7 psia, the drum is isolated in accordance with NCSA requirements to maintain moderation control. Under normal operating conditions, this prevents the drums from reaching atmospheric pressure even though the surge tanks have a maximum allowable working pressure of 200 psig. The surge drums are heated with steam tracing to maintain any UF_6 in the gaseous phase.

3.6.4.2 Cylinder Relief Tanks

When a UF_6 cylinder is placed in an autoclave for heating, a pigtail is attached to the cylinder valve (12 o'clock position) and a manifold equipped with 100-psig-rated rupture discs. The rupture discs connect to two cylinder relief tanks rated at 150 psig at 250ºF. At least one of the relief tanks will remain valved to the four autoclave rupture disc lines at all times when an autoclave is in operation. Evacuation of material from the tanks is accomplished by valving to the evacuation line to the C-337 cascade. Each tank is equipped with pressure sensing instrumentation and an alarm is sounded in the laboratory and on the supervisor's office annunciator panel in the event the tank pressure should reach the setpoint alarm value. The pressure of each relief tank is maintained less than or equal to 13.7 psia. If tank pressure is greater than 13.7 psia, the tank is isolated in accordance with NCSA requirements to maintain moderation control.

3.6.4.3 Burping Station

One 30B cylinder Burping Station is located in the high bay area of the C-360 facility. After the UF_6 product in the 30B cylinder has completed its required cooldown period, the cylinder may be moved to the burping station to lower its internal pressure below applicable shipping limits. At the Burping Station, the cylinder containing solid UF_6 is connected via a pigtail to the evacuation system. Through appropriate valving the non-condensable gases in the cylinder can be evacuated to either bank of evacuation drums or directly to the cascade evacuation system via a tie line. After burping is complete, the cylinder is reweighed on an accountability scale and a cold pressure check is performed prior to shipment.

3.6.5 UF_6 Primary System

The UF_6 Primary System includes (1) UF_6 transfer and sample piping outside the second autoclave containment isolation valve, (2) UF_6 piping and equipment inside the autoclave, and (3) UF_6 cylinder pigtails for both parent and daughter cylinders. The following are descriptions of systems and components identified as important to safety in Section 3.15.

3.6.5.1 Piping

Autoclaves are connected to the UF_6 transfer and sample stations by piping. Where needed, the UF_6 piping is enclosed in heated housings or steam-traced to prevent freeze-out of UF_6. UF_6 transfer and sample piping, equipped with rupture discs rated at the lowest MAWP of the cylinders heated, relieve to cylinder relief tanks to prevent cylinder overpressure.

All autoclave piping (out to the outside containment valve) is installed according to national standards and engineering piping specifications with a pressure rating sufficient for its intended service. Piping downstream of the containment valves also is installed with pressure rating equivalent to its intended service.

3.6.5.2 Valves

UF_6 valves installed in C-360 are designed and tested to engineering specifications and have a bellows stem seal or a packing gland stem seal. Pneumatically operated valves have air to open-spring to close-type actuators. The actuators on containment isolation valves are required to fail to the closed position. Actuators are equipped with limit switches that indicate the open or closed position of the valve on a local panel. Valve bodies are of steel or Monel construction, corresponding to pipe size material specifications.

Containment isolation valves are suitable for UF_6 gas or liquid service and have temperature ranges appropriate for C-360 operations and pressure ratings that meet or exceed the MAWP for the C-360 autoclaves. Valves located downstream from these valves are installed with a pressure rating sufficient for its intended service (see Figure 3.6-1).

3.6.5.3 UF_6 Cylinder Pigtails

The UF_6 cylinder pigtails that are classified as important to safety comprise a UF_6 cylinder pigtail assembly and gaskets. A pigtail assembly is fabricated of metal tubing equipped with fittings on either end that allow the pigtail to be attached to a manifold at one end and the cylinder at the other end. After fabrication, pigtails are stress-relieved. Gaskets are used between the sealing surfaces of the pigtail assembly and the cylinder and equipment to which it is connected.

UF_6 cylinder pigtails that are classified as important to safety are used in the C-360 facility. Refer to Section 3.15 for a discussion of the safety classification and boundary definition of UF_6 cylinder pigtails.

All UF_6 cylinder pigtails are subjected to acceptance inspection and testing prior to certification for use. UF_6 cylinder pigtails are given a post-fabrication visual inspection to ensure that quality and design requirements are met. UF_6 cylinder pigtails are subjected to a hydrostatic test after fabrication and prior to certification for use. UF_6 cylinder pigtails that have been certified for use are provided with a metal certification tag with an identification number. There are no certification retest requirements stated because plant experience has demonstrated that the UF_6 cylinder pigtails will fail the pre-operational positive pressure leak rate test and vacuum check due to thread wear or will fail visual inspection long before there is any structural weakness in the pigtail. The only normal maintenance performed on certified UF_6 cylinder pigtails is replacing the gaskets prior to making a new connection. Prior to connecting a certified UF_6 cylinder pigtail, it is visually inspected for defects, and a new pigtail gasket is installed on each disconnected end fitting. The pigtail is then attached to the cylinder valve and the UF_6 manifold. All newly made UF_6 cylinder pigtail connections are vacuum checked and leak rate tested per applicable procedure prior to admitting UF_6 to the affected connection.

3.6.6 Technetium Traps

Technetium (^{99}Tc) traps are located in the head of each autoclave and in a heated housing in the basement transfer room. The traps are used to remove technetium from the UF_6 stream during the transfer operation. The basement transfer room trapping system contains two banks, with each bank having four traps in series. A maximum of one bank of the basement transfer room traps may be in service at any one time. When a basement transfer room trap bank is not being used during transfer operations, the bank is evacuated of UF_6 and is isolated from the transfer operations by at least two manual valves on both the inlet and outlet of the trap bank. The autoclave trapping system consists of one bank of three traps in parallel. The trap bank is placed inside the autoclave head and is connected to the transfer manifold. Each trap contains at least 33 pounds of sintered MgF_2 pellets approximately 1/8-inch in diameter. As liquid UF_6 flows through the trap, technetium compounds absorb on the surfaces of the MgF_2 pellets. Once the MgF_2 trap media loses operational efficiency due to ^{99}Tc loading, the entire bank of traps is cut out and replaced with a fresh bank. Each trap vessel is approximately one cubic foot in volume. The cylindrical traps are a nominal 10-inch diameter, constructed of monel, with heads welded to each end for a total height of approximately 24 inches. The traps contain a screen near the top and bottom of the vessel to retain the trap media. UF_6 flows in the top of the traps and out of the bottom of the traps. Both the autoclave and the basement transfer room trap bank systems are connected to the existing transfer line and can be bypassed if trapping is not required.

3.6.7 Autoclave Important to Safety Systems

The following are descriptions of autoclave systems and components identified as important to safety in Section 3.15. Other important to safety systems and components are discussed separately in Sections 3.6.5 and 3.6.9.

3.6.7.1 Autoclave Water Inventory Control System

The Autoclave Water Inventory Control System activates to stop the input of steam and sound appropriate alarms if the condensate approaches a specified actuation level in the condensate drain line. The accident analysis assumes that the amount of water available to react with UF_6 is limited to the amount of water that is normally present inside the autoclave during heating operations. The system maintains the initial condition assumed by the accident analysis by closing the steam supply isolation valves and the thermovent line block valve if a high water level is detected.

The maximum pressure generated in an autoclave from an accidental UF_6 release and subsequent reaction with the available water is best controlled by limiting the water in the autoclave shell. In the event of a release of UF_6 inside an autoclave, HF gas would be produced by the reaction of UF_6 with water. The amount of HF produced would be directly proportional to the amount of water available to react with the UF_6. To prevent excessive accumulation of condensate inside the autoclave, two water level probes are installed at the top of the condensate drain line, slightly below the autoclave shell. Each level probe consists of a level sensing element that drives an associated level switch. These switches are closed when the water level is normal. When a high level is detected, these switches open and a signal is sent to relay logic, which controls the solenoids for the containment valves. If either probe detects a high water level, the steam supply isolation valves and the thermovent line block valve close to limit the total water in the autoclave.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the laboratory area.

3.6.7.2 Autoclave Steam Pressure Control System

The Autoclave Steam Pressure Control System is used while heating a cylinder to stop the steam flow to the autoclave prior to reaching temperatures which could result in reaching the MAWP of the cylinder.

The autoclave shell head is penetrated by a single pressure tap line equipped with pressure sensing instrumentation. Steam shutdown can be initiated by either of two separate pressure switches sensing internal autoclave setpoint pressure, thereby opening a control circuit. The control circuit output de-energizes the solenoid valves that operate the actuators for the steam isolation valves and the thermovent line block valve, thereby causing these valves to close.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the laboratory area.

3.6.7.3 Autoclave High Pressure Isolation System

The purpose of the Autoclave High Pressure Isolation System is to limit the release of UF_6 and reaction products from the autoclave vessel following a release of UF_6 inside the autoclave. The Autoclave High Pressure Isolation System causes the autoclave to go into the containment mode and activate alarms if the internal pressure of the autoclave reaches the setpoint for the system. In addition, the system disables the hydraulic system required to open the autoclave shell preventing the autoclave from opening until the alarm condition has been cleared.

The autoclave shell head is penetrated by a single pressure tap line equipped with pressure sensing instrumentation. Containment isolation can be initiated by either of two separate pressure switches sensing internal autoclave setpoint pressure, thereby opening a control circuit. The control circuit output de-energizes the solenoid valves that operate the actuators for the steam isolation valves and the thermovent line block valve, thereby causing these valves to close. Automatic containment valves actuated by this system are present on the following shell head penetrations:

- UF_6 sample and transfer lines with branches for the evacuation header, the relief drums, and purge air,
- Steam supply and steam exhaust,
- Condensate drain,
- Buffer air inlet and outlet lines,
- Thermovent line, and
- Steam sample line.

No support systems are required. The system is fail safe in that all automatic containment valves fail to the closed position on the loss of electrical power or the plant air system.

Activation of this system produces audible and visual alarms at the autoclave local control panel, in the laboratory area and in C-300.

3.6.7.4 Autoclave Primary Containment System

The Autoclave Primary Containment System includes the autoclave vessel and all penetrations out to and including the required isolation valves. The autoclave penetrations and associated isolation valves are described in the preceding discussion of the Autoclave High Pressure Isolation System. In addition, the autoclave instrument lines and the autoclave pressure relief line up to and including the rupture disc are included in the system.

The rupture disc performs a passive safety function as a component of the Autoclave Primary Containment System.

Penetrations to the autoclave are protected by one of the following methods: (1) two automatic isolation valves, (2) one automatic isolation valve and one normally closed manual valve, (3) the Autoclave Pressure Relief System configuration, or (4) a closed piping system outside the autoclave (e.g., instrument lines and instruments) whose components are rated for the same pressure as the autoclave.

3.6.7.5 Autoclave Pressure Relief System

Each autoclave is equipped with an Autoclave Pressure Relief System to prevent the internal pressure from exceeding 110% of the maximum allowable working pressure (MAWP) as determined by Section VIII of the ASME Pressure Vessel Code. This system consists of a relief valve and a rupture disc, each rated at the MAWP for the autoclave on which they are installed. The rupture disc prevents constant exposure of the relief valve to steam that is present during normal operation. Such constant exposure could cause undesirable corrosion and scaling of the relief valve, which, in turn, could cause the valve to weep or otherwise fail to perform its design function. Pressure instrumentation is located between the rupture disc and relief valve to monitor the pressure in this trapped space to detect increased pressure which may result in the system not protecting the autoclave vessel at the proper relief pressure.

Pressure above the rating of the relief valve would be vented to the atmosphere through a vent line above the roof. The relief valve closes when the autoclave pressure drops below the MAWP to limit the amount of any release. Reaction products would not be released through the relief valve at pressures below the set point of the valve. This relief system could only be caused to function if there were an excessive amount of water (See Section 3.6.7.1) in the autoclave at the time of a UF_6 release within the autoclave.

3.6.7.6 UF_6 Release Detection Systems

Two UF_6 Release Detection Systems are used in C-360. A High Voltage Detector System monitors areas associated with autoclave operation, including the laboratory area, and the basement of the low bay service area. A Low Voltage Detector System monitors the autoclave heated housings. The detector systems are arranged in 8 coverage zones, with the High Voltage System covering Zones 1-4 and the Low Voltage System covering Zones 5-8.

3.6.7.6.1 High Voltage UF_6 Release Detection System

This system consists of four detector zones, all of which have alarm and containment functions. As discussed in Section 4.3.2.2.4 (Evacuation of the UF_6 Handling and Storage Facilities-External Event), mitigation of the consequences of a release in Zone 1 or 4 depends upon the detector system's containment functions, as well as its alarm functions.

Zone 1 monitors the laboratory area. Detector actuation initiates closure of the UF_6 liquid sample line isolation valves and the UF_6 transfer line isolation valves (see Figure 3.6-1). This isolates all sample cabinets from their corresponding autoclave. Detector actuation also activates the building evacuation alarm, and alarms at the laboratory panel, the supervisor's office, the CCF in C-300, and the C-337 ACR.

Zone 2 monitors the locking rings of autoclaves 1 and 2. Similarly, Zone 3 monitors the locking rings of autoclaves 3 and 4. Detector actuation in Zone 2 or 3 initiates the building evacuation alarm, as well as alarms at the laboratory panel, the supervisor's office, the CCF in C-300, and the C-337 ACR. Detector actuation also initiates closure of selected UF_6 transfer line isolation valves, the transfer line block valve, and the receiving cylinder valve (see Figure 3.6-1). The Zone 2 and 3 detectors also activate the building containment system, trip the elevator pit sump pump, and trip the exhaust fan for the HEPA ventilation system for the autoclaves and transfer station.

Zone 4 detector heads in the basement area are located above the receiving cylinder pigtail, abandoned cold trapping system, the relief tanks, surge drums and at the ceiling in the transfer room. Detector actuation initiates closure of the UF_6 sample line and transfer line isolation valves on all autoclaves, the transfer line block valve, and the receiving cylinder valve. Detector actuation also activates the building containment system, trips the elevator pit sump pump, trips the exhaust fan for the HEPA ventilation system, and activates the building evacuation alarm, as well as alarms at the local panel, C-360 supervisor's office, and in the C-300.

A brief time delay is designed into the building containment system between actuation of a detector and the closure of the overhead doors. The time delay allows the crane or scale cart to get out of the path of the closing doors.

The cylinder valve closer is air operated with a nitrogen backup. If air pressure at the valve drops below the setpoint, the nitrogen automatically provides the motive force to close the valve. The air supply and the nitrogen backup are each designed to close the cylinder valve within the time required to support the accident analysis.

The system control units consist of a power supply for converting 120 VAC to nominal 200 VDC for the supervised detector circuit and contacts for alarm circuits, trouble signals, and other control circuits. The control unit enclosures also contain system status lamps, control switches, and test switches. The control units are designed for multiple protection zones, each zone representing a separate detector circuit. Trouble alarms are activated in the event that current flow through a supervised circuit is interrupted. When a detector fires, the alarm circuitry in the control unit "latches" in the "on" position. The circuit must be manually reset to clear an alarm or trouble condition.

The detectors are wired in parallel to the control unit, and the zone circuits are continuously supervised. A loss of power to a detector zone circuit would result in a trouble alarm at the control panel. Malfunction of a detector, such as a short, would produce a trouble signal at the control panel.

3.6.7.6.2 Low Voltage UF_6 Release Detection System

This system consists of four detector zones, Zones 5-8, which cover the heated housing of each autoclave. Detectors in these zones provide operators with rapid notification of a release in the covered areas.

The system uses commercially-available fire detection system components. The detectors are ionization-type detectors that operate at 24 VDC. The detectors are connected to the control unit in the laboratory that monitors detector status and processes detector output signals to produce the appropriate alarm and containment actions. The control unit, which is designed to monitor multiple protection zones, contains power, alarm, and trouble indicator lamps. In addition, each zone module in the control unit is equipped with a zone alarm lamp. When a detector fires, the alarm circuitry in the control unit “latches” in the “on” position. The circuit must be manually reset to clear an alarm or trouble condition.

The detectors are wired to the control unit, and the circuits are continuously supervised. A loss of power to a detector zone circuit would result in a trouble alarm at the control panel. Malfunction of a detector, such as a short, would produce a trouble signal at the control panel.

When any of the detectors in Zones 5-8 are actuated, audible and visual alarms are activated at the laboratory panel, in the C-360 supervisor's office, in the CCF in C-300, and in the C-337 ACR. The building evacuation alarm is also activated.

3.6.7.7 High Cylinder Pressure System

The High Cylinder Pressure System detects cylinder pressure and isolates the steam supply before allowable cylinder pressures are exceeded. The system consists of a pressure transmitter connected to the UF_6 line in the manifold housing, a pressure converter, and a high pressure switch. The high pressure switch signals the steam isolation block valves and the thermovent line block valve to close if the cylinder pressure reaches the high cylinder pressure setpoint.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the laboratory area.

3.6.7.8 Cylinder Roll Interlock System

The Cylinder Roll Interlock System prevents the rolling of a cylinder while the UF_6 cylinder pigtail is pressurized with UF_6. If a cylinder is rolled while a UF_6 cylinder pigtail is attached, the pigtail assembly could rupture or could be damaged, resulting in a release of UF_6. This system is intended to supplement administrative controls that prohibit rolling a cylinder while the UF_6 cylinder pigtail is connected.

The components of the Cylinder Roll Interlock System consists of a pressure element, pressure transmitter, trip devices, a pigtail selector switch, limit switches and associated electrical circuitry and interlocks. The cylinder rolling feature of the autoclave is enabled only when the UF_6 manifold pressure is within an adjustable band near atmospheric pressure, the autoclave platform limit switches are closed, and the key interlock is in the correct position. The key interlock selector switch is provided to differentiate between the pressure switches that support sampling operations and the switches that support transfer operations. The operator ensures that this interlock is enabled, when a pigtail is connected, by verifying the loss of the Cylinder Roll permissive light at the local autoclave control panel. Loss of this permissive opens the circuit to the drive motor that rolls the cylinder. There are no alarms associated with this system.

The nominal 120 VAC power necessary to operate the Cylinder Roll Interlock System is supplied from a local 120 VAC power distribution panel located in the C-360 building. Loss of power to the Cylinder Roll Interlock System will result in loss of the Cylinder Roll Permissive, which disables the roll drive motor.

3.6.8 Transfer Station Enclosure

The greatest potential for a liquid UF_6 release in the basement area occurs at the transfer station. In the event of this low probability accident involving the gross failure of the UF_6 primary system, the closest path of egress from the transfer station is by the stairways east and north of the transfer station.

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An enclosure around the transfer station confines releases to a smaller area, thus making it safer for emergency evacuation of personnel. A release will still exit the area due to the open elevator shaft along the east side of the room. A double door to the north has automatic door closers held in the open position. Activation of the UF_6 release detection system at the drain position will release the doors.

3.6.9 Cylinder Handling

The movement of cylinders containing liquid UF_6 in C-360 is limited to reduce the potential of damage to the cylinder resulting in a loss of containment and a release of UF_6.

The cylinder handling equipment in C-360 includes scales, scale carts, hydraulic lifts, and cranes. Cylinders are empty or contain UF_6 in a liquid or solid state. The movement of liquid-filled cylinders is restricted to loading autoclaves (e.g., after technetium trapping operations), removal from the sampling and transfer operations, weighing, and movement to the cool-down areas. Liquid UF_6 cylinders remain in the cool-down area for the required cool-down period per administrative controls. Limited movement of cylinders may be conducted within the cool-down areas before completion of the cool-down period if the precautions for handling liquid-filled cylinders are followed (e.g., moving cylinders as low to the ground and autoclave floor level as practical, using the overhead crane for cylinder movements, etc.).

Solid and empty 12B and 30B cylinders are handled and staged at the C-360 annex building. Non-safety bridge crane(s) and forklifts are used to move cylinders in this facility.

3.6.9.1 Scales, Scale Carts and Hydraulic Lifts

Scales, scale carts, and hydraulic lifts are discussed in Section 3.7.

3.6.9.2 Cranes

Bridge cranes transport empty and solid UF_6 cylinders from the storage area to the scale carts and to the autoclaves from the scale carts. They move liquid filled UF_6 cylinders from the autoclaves to the scale carts and to the cool-down area. They also load and unload trucks and railcars. Mobile cylinder handlers can also be used for solid and empty UF_6 cylinder movement.

Cranes, lifting fixtures, and rigging are discussed in Section 3.7.

3.6.9.3 Short-Term Storage

The facility contains a cylinder yard for the short-term storage of empty cylinders and cylinders containing liquid and solid UF_6. The yard is equipped with saddles/racks for cylinder storage. The yard is used for a cool-down for the liquid UF_6 cylinders to a solid state. In addition, cylinders may be stored in the C-360 high bay area on saddles or in the open autoclave in which they were heated.

Storage yards are discussed in Section 3.7.

3.6.10 Administrative Controls

In addition to the Administrative Controls in Chapter 4 and those controls covered by programs and plans, the following facility-specific Administrative Controls ensure safe operation of the UF_6 Toll Transfer and Sampling Building. Additional general Administrative Controls for cylinders are listed in Section 3.7.6.

1. Valve covers are placed on cylinders containing liquid UF_6 prior to movement out of the autoclave or from the transfer station.

2. The weight of UF_6 cylinders that have been liquefied and material that has been removed/added shall be verified prior to leaving the facility. This supports operations at other on-site facilities.

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Upon detection of a plugged line or loss of heating to a particular area, the following administrative controls are in place to prevent applying excessive heat:

1. A line clarity check shall be performed to determine if clarity exists prior to reapplying or increasing any heat to the affected area.

2. If existing heat > 140° F is still available to the area, the heat source is not increased until line clarity is confirmed. If existing heat < 140° F is available in the affected area, a gradual increase in temperature up to 140° F may be applied to sublime the material in the plugged line.

3. Administrative controls ensure that temperature is monitored on a regular basis during the process of clearing the plugged area.

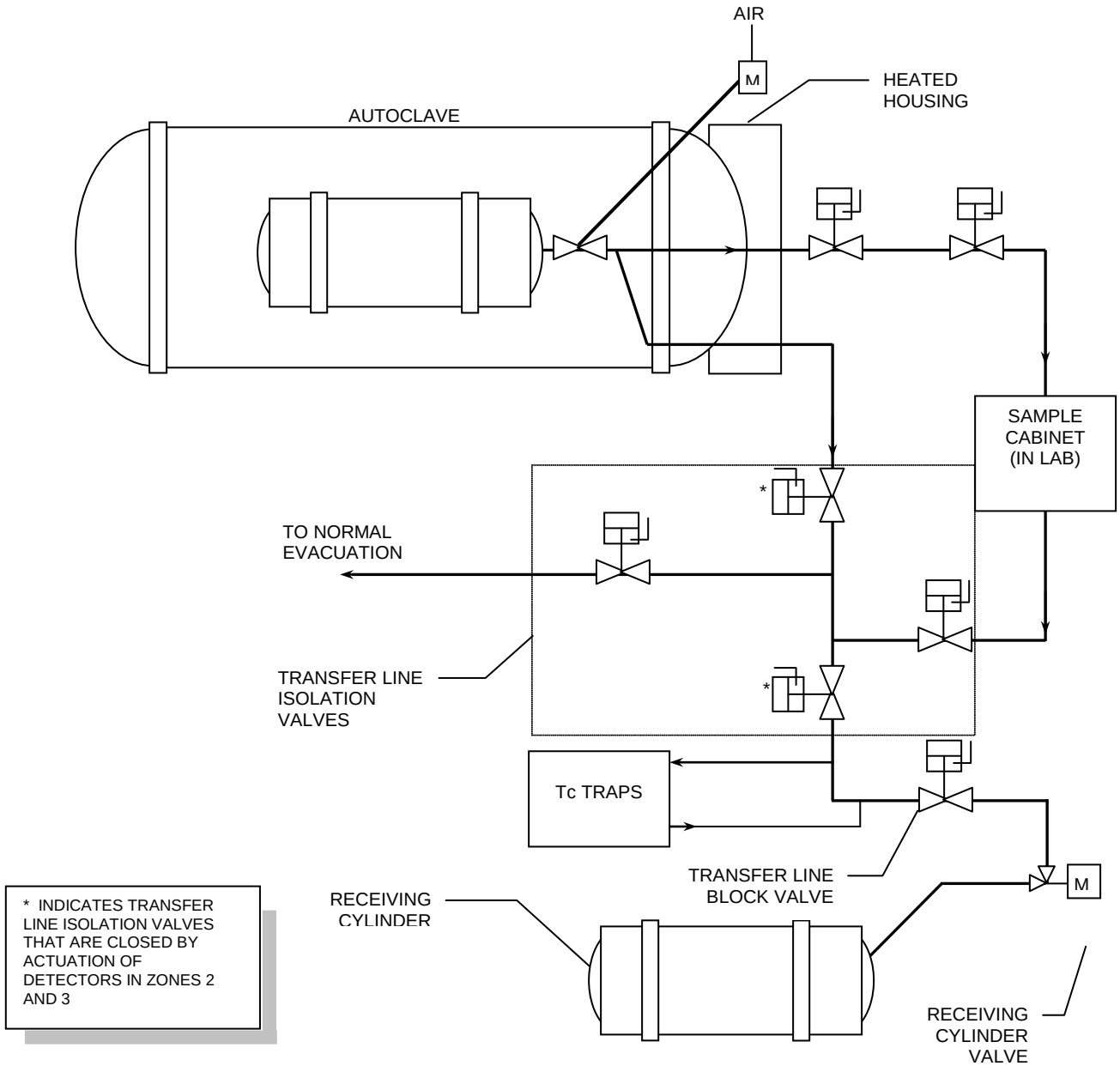

Figure 3.6-1. Simplified Diagram Showing Toll Transfer Facility Valves That Operate Upon Actuation of the UF_6 Detectors

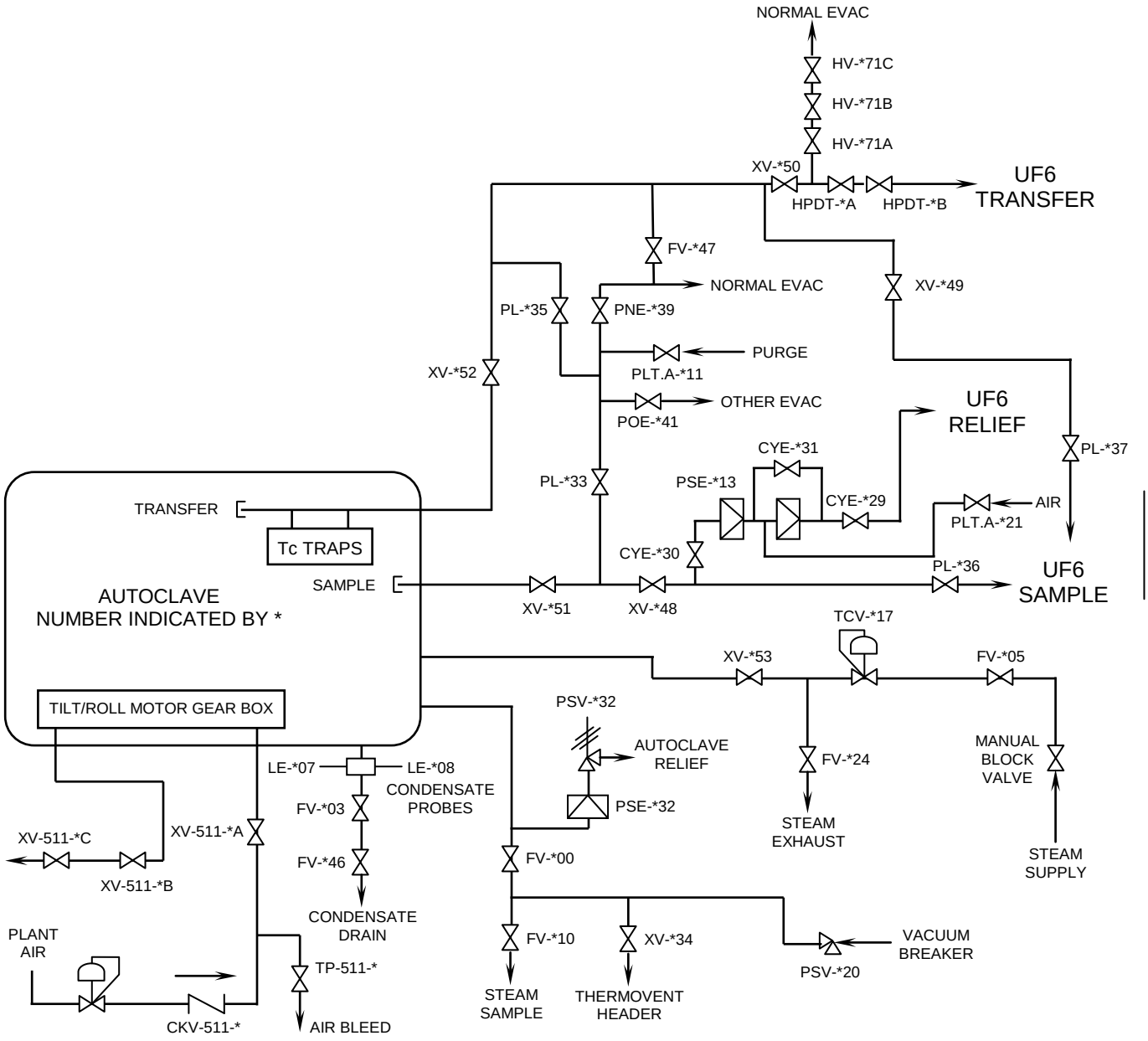

Figure 3.6-2. Simplified Schematic of the C-360 Autoclave and Associated Piping and Valves.

3.7 UF_6 CYLINDERS, STORAGE YARDS, AND HANDLING EQUIPMENT

UF_6 is received, collected, handled, transported, and stored in cylinders when it is not in the gaseous diffusion enrichment process. This section covers the following facilities:

1. C-333-A, Feed Vaporization Facility

2. C-337-A, Feed Vaporization Facility

3. C-310, Purge and Product Building

4. C-315, Surge and Waste Building

5. C-360 and C-360-A, Toll Transfer and Sampling Facility

6. UF_6 Cylinder Yards and C-745-R1 Cylinder Changeout Building

Cylinders are used for various operations on-site (e.g., tails storage) and off-site (e.g., ship product off-site). Specialized handling equipment (e.g., cranes, cylinder haulers, overpacks, etc.) is used to handle and transport cylinders.

3.7.1 UF_6 Cylinders

UF_6 is packaged, stored, and transported in containers referred to as "cylinders" or "UF_6 cylinders." The cylinders are also used for movement or handling during processing and manufacturing operations outside of the enrichment process stream. The UF_6 cylinders are important to safety as described in Section 3.15. The safety function of the UF_6 cylinder is to provide primary containment to prevent the release of UF_6 to the atmosphere. The 500 pound and less size cylinders are important to safety but do not have the capacity to contain sufficient material to result in significant health effects off-site.

The cylinders are American Society of Mechanical Engineering (ASME) Section VIII code vessels specially designed and manufactured for use in handling UF_6 in a solid, liquid, or gas phase outside the gaseous diffusion enrichment process. There are many cylinder types that can be used based on assay and handling/storage requirements of the enriched UF_6 material in the cylinder. The commonly used UF6 cylinders are shown in Table 3.7-1. All cylinders have a specially designed valve for filling or withdrawing UF6 from the cylinder. This valve and cylinder plug are part of the important to safety cylinder boundary. Valve protectors are used on the cylinder valves as required and are also part of the cylinder boundary. The terms, heavy wall and thin wall, are used to distinguish between the 48" cylinder wall thickness based on a design pressure of 200 psig and 100 psig respectively. The 30B (2½ ton) and 48X (10 ton heavy wall) cylinders are approved for shipment of enriched UF_6 at ≤ 5.0 wt % ^{235}U and ≤ 4.5 wt % ^{235}U, respectively. The thin wall cylinders are used for storage of UF_6 at < 1.0 wt % ^{235}U.

The packaging and transport of UF_6 is subject to regulation by government agencies having jurisdiction over packaging and transport. Cylinders used to transport UF_6 material on public transportation routes must be approved by the US Department of Transportation (DOT). The US nuclear

industry (government and private) through the American National Standards Institute (ANSI) issued ANSI N14.1 in 1971, "Packaging of Uranium Hexaflouride for Transport." The following should be noted relative to how the ANSI standard applies to cylinders manufactured prior to the issue of the standard, the use of existing pre-ANSI manufactured cylinders, and cylinders manufactured to different revisions of the ANSI standard:

1. Cylinders currently in service and not in accordance with ANSI N14.1 are acceptable for continued use, provided they are inspected, tested, and maintained so as to comply with the intent of the standard and are used within their original design limitations.

2. ANSI N14.1 does not take precedence over applicable Nuclear Regulatory Commission (NRC), DOE, DOT, or other governmental regulations.

Cylinders containing UF_6 come from both out-of-plant sources and in-plant sources. The cylinders may contain UF_6 in a liquid or solid state. Cylinders are used in various UF_6 feed vaporization, withdrawal, toll transfer and sampling, and storage facilities. A cylinder containing solid UF_6 can be transported along any plant-site street with approved cylinder handling devices.

Out-of-plant sources of cylinders containing UF_6 arrive by railcar or truck. They are normally received at C-360, but may also be received in C-400, C-333-A, C-337-A or C-745-V. The types of UF_6 received and their processing modes are:

1. Cylinders of normal (natural) assay (nominal 0.7 % ^{235}U) material are received, weighed, and statistically sampled. Then the cylinders are moved to a storage yard to await feeding into the enrichment process at C-333-A or C-337-A. After the UF_6 is fed into the enrichment process, the empty cylinder containing a small amount of UF_6 (heel) is moved back to the storage yard for a cooling period to allow decay of radioactive daughter products. If the cylinder is customer-owned, it is then normally returned to C-360 for shipment back to the customer.

2. Cylinders of depleted material received from another enrichment facility are inspected, weighed, statistically sampled (only required for cylinders containing greater than 500 grams ^{335}U), and stored for eventual feeding at C-333A or C-337A.

3. Cylinders of enriched material are received, inspected, weighed and stored for future blending, refeed, and/or order filling. Samples of the material are analyzed.

4. Heeled cylinders (normal, depleted, or enriched) containing less than 500 grams ^{235}U are received using shipper's weights. Cylinders within their certification period re-enter their respective production cycles or are stored for later use. Cylinders outside their respective certification period are washed and re-certified prior to re-use. Cylinder re-certifications are accomplished at the plant or at a suitable vendor.

In-plant sources of cylinders containing UF_6 may be enriched product, tails, or normal material as follows:

1. Enriched product material is withdrawn at C-310 into cylinders and cooled down for shipment off-site or for refeed.

2. Tails material produced by the plant is withdrawn into cylinders at C-315, cooled, and moved to the long term storage yards.

3. Normal material may be used in the vaporizers to provide feed to the plant.

UF_6 enriched to $ 1.0 wt. % ^{235}U is stored in heavy wall (30B, 48X, and 48Y) cylinders. Cylinder integrity is important for nuclear safety. These cylinders are visually inspected every 4-years to identify any degradation of the integrity of the cylinder wall, valve, or plug. Cylinders, which do not meet the inspection criteria, are handled commensurate with the observed damage.

If a breached cylinder containing UF_6 enriched to $ 1.0 wt. % ^{235}U is discovered during handling or inspection, the plant shift superintendent will be notified immediately so that appropriate action can be initiated. The cylinder will be covered within 2 hours to prevent the entry of precipitation or water of any source, and repairs will be effected in accordance with directions from nuclear criticality safety. Water will not be sprayed on a cylinder, which has been breached; however, CO_2 may be sprayed on the area of the breach to allow for patching. Personnel involved in the handling or repair of breached cylinders will be equipped with personal alarming dosimeters while working in close proximity to the affected cylinder (if the cylinder is not in an area with CAAS coverage).

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Only qualified personnel perform cylinder maintenance and repairs. Because these are Code vessels, any repairs will be performed by qualified personnel holding a current "R" stamp. Only qualified personnel perform inspection of repairs before the cylinder is placed back into service. The cylinder is inspected as required by the ANSI N14.1 standard for UF_6 cylinders and the ASME Section VIII standard covering unfired pressure vessels (see Figure 3.7-1).

The cylinder cleaning and decontamination process shall meet the requirements of ANSI N14.1 (includes on-site and off-site cylinders). When cylinders are cleaned for periodic recertification per ANSI N14.1, the tare weight of the cylinder is re-established and stamped on the cylinder nameplate or a supplemental nameplate in the close proximity to the cylinder nameplate. All UF_6 cylinders that are to be filled shall have a hydrostatic test pressure date stamp that is less than five years old.

As part of the periodic inspection, the empty cylinders are pressurized with air to at least 100 psig and the penetrations soap tested. Cylinders that fail the soap test are rejected until repaired. After leak testing, the empty cylinder is evacuated and placed into storage until needed. After cylinder valve or plug replacement, the cylinders are leak tested using pressurized air. Qualified personnel repair cylinders that fail testing.

All cylinders to be filled are weighed prior to filling. The empty cylinders must be free of impurities that could contaminate or react with UF_6. Cylinders with heels (the remaining quantity of material after routine evacuation) in excess of 40 pounds require special instructions.

If it can be determined with confidence that the material inside the cylinder is UF_6 or other material compatible with UF_6 (e.g., UO_2F_2), then the cylinder is considered acceptable for filling. If, on the other hand, the cylinder's contents cannot be determined with confidence, then the cylinder is rejected until the condition is resolved.

3.7.2 UF_6 Cylinder Storage Yards

The UF_6 cylinder storage facilities include both interim (short term) storage and long term storage yards. Long term storage yards leased by USEC are identified in Table 3.7-2. Interim storage yards are provided at C-310, C-315, C-333-A, C-337-A, and C-360 to serve as a staging area for cylinders scheduled for feeding, for empty feed and withdrawal cylinders, and as a cool-down area for cylinders which have been filled with tails or product. Liquid UF_6 cylinders may also be cooled in the C-360 high bay area or in the open autoclave in which they were heated. There is also a cylinder staging area at C-400 and C-360-A for empty and solid UF_6 cylinders.

The interim and long-term storage yards have aisles to allow access for inspection of the cylinders and valves. Because of their weight, the cylinders require the use of large specialized handling equipment and a firm foundation (concrete and/or aggregate layer) for both transport and storage. Yard lighting provides illumination of the areas. Storm drainage is provided in the areas to minimize exposure of cylinders to standing pools of water. Storage yard C-745-R is equipped with a pre-engineered, one-story metal building to facilitate cylinder handling operations during inclement weather.

Liquid cylinders are not stacked. Solid feed cylinders < 1.0 wt % ^{235}U or empty cylinders may be stacked. Tails cylinders that are in long-term storage may be stacked. The cylinders are placed on supports (treated wood, concrete, etc) to prevent rolling and allow stacking. The saddles also help in rust prevention by keeping the cylinders off the ground.

UF_6 enriched to $ 1.0 wt. % ^{235}U is stored in heavy wall (30B, 48X, and 48Y) cylinders. Cylinders containing greater than the heel mass limit at an enrichment of $ 1.0 wt. % ^{235}U are placed in saddles such that they are not in contact with one another and are not stacked. Cylinders containing an enrichment of $ 1.0 wt. % ^{235}U are stored in a manner which allows for the required inspections to be performed.

Administrative controls for UF_6 storage not covered in Chapter 4.0 or in other programs and plans are listed in Section 3.7.6.

3.7.3 UF_6 Cylinder Handling Equipment

Cylinder handling equipment includes many specialized devices because of the weight of full UF_6 cylinders. The devices are used to handle, lift, protect, receive, weigh and ship cylinders with liquid or solid UF_6 from both in-plant and out-of-plant sources. Administrative controls minimize the potential for any accidents during cylinder handling operations. The types of handling equipment are:

1. Truck Trailers: Heavy-duty, truck trailers are used to receive and ship cylinders. Low-bed truck trailers are used to transport cylinders over intraplant roadways and in the cylinder storage yards. Only empty cylinders or cylinders containing solid UF_6 are placed on and transported by truck trailers.

2. Railcars: Railcars are used to receive and ship cylinders. Only empty cylinders or cylinders containing solid UF_6 are placed on and transported by railcars.

3. Protective Package: Protective packages (referred to as “overpacks”) are used to protect cylinders containing greater than 1.0 w% ^{235}U from damage due to fire or accident when cylinders are transported between diffusion plants and to customers by truck or railcars. Only cylinders containing solid UF_6 are placed in overpacks. Heel quantities may be transported in bare cylinders. The acceptable amount of heel in a cylinder is defined in ANSI N14.1.

4. Scale Cart: Scale carts (referred to as “scale cart, air cart, transfer cart, or transfer car) are used to move cylinders to and from scales in C-310, C-315, C-333-A, C-337-A, and C-360. The carts move the cylinders from the scale areas to access areas to allow the UF_6 cylinder handling cranes and other cylinder handling devices to transfer the cylinders. The UF_6 in these cylinders may be in a liquid state or solid state.

5. UF6 Cylinder Cranes: Cranes are used in various plant facilities to move cylinders. They may be bridge, mobile, or semi-gantry cranes. C-310 and C-360 Cylinder Handling Cranes are bridge type and may lift empty, solid, or liquid cylinders. C-333-A and C-337-A Cylinder Handling Cranes are bridge type and may lift empty or solid cylinders. C-315 Cylinder Handling Cranes are semi-gantry type and may lift empty, solid, or liquid cylinders. Mobile Cylinder Handling Cranes, the C-400 semi-gantry crane, and the C-360-A bridge crane(s) which are non-safety, may only lift cylinders that are solid or empty.

6. Cylinder Movers: Cylinder movers (also referred to as “cylinder haulers”) are used to transport cylinders between plant facilities and the cylinder storage yards. The UF_6 in these cylinders must be in a solid state.

7. Elevator: The Elevator moves cylinders up or down between operation levels in C-360. The cylinders may be empty or have UF_6 in a liquid or solid state depending on the function to be performed.

8. Levelator: The levelator only lowers cylinders from the operating level of C-360 to the ground level. The cylinders may be empty or have UF_6 in a solid or liquid state.

9. Scales: Scales are used to weigh cylinders. The cylinders may be empty or contain UF_6 in a liquid or solid state.

10. Forklifts: Forklifts with a boom are used to lift and stack and load or unload empty or solid UF_6 filled 12B and 30B cylinders. Forklifts move empty 10- or 14-ton cylinders into and out of the cylinder washing operation.

3.7.3.1 Liquid UF_6 Cylinder Handling Equipment

Cylinder handling equipment involved with handling liquid UF_6 cylinders is important to safety as described in Section 3.15. This equipment includes the C-360 levelator, the C-360 elevator and the scale carts. The other cylinder handling equipment that only moves empty or solid cylinders are classified as non-safety and will not be discussed further in this section. Only qualified personnel perform equipment maintenance, repairs, and the required inspections. The equipment is inspected as required by applicable codes listed in Chapter 1, Appendix A. Administrative controls for handling and moving liquid filled UF_6 cylinders that are not covered in Chapter 4.0 or in other programs and plans are listed in Section 3.7.6.

3.7.3.1.1 Levelator

The C-360 levelator is a platform hydraulic elevator lift with a rated capacity of 20 tons minimum. The safety function of the levelator is that it shall not fail in a manner to allow uncontrolled dropping causing structural integrity damage (failure of pressure boundary) to a cylinder resulting in a release of UF_6 to the atmosphere. It lowers a scale cart from the autoclave floor level to the building ground level. The levelator has rail stops/chocks to prevent the rolling of the scale cart off the end of the levelator. The levelator is equipped with an interlock switch between it and the scale cart air supply to prevent scale cart movement if the levelator is not in its fully raised position.

The levelator is equipped with a raise/lower switch, an emergency stop button, an emergency alarm bell, and safety controls specified in relevant standards identified in Chapter 1, Appendix A. The following maintenance and testing requirements are performed to ensure the levelator is functioning properly:

1. Inspection and testing to meet ANSI A17.1 requirements as specified in Chapter 1, Appendix A.

2. Visual inspection of rail stops to ensure they are not bent or cracked.

3. Functional testing to ensure the interlock switch between the levelator and operating floor scale cart air supply prevents scale cart movement unless the levelator is in the “up” position.

3.7.3.1.2 Elevator

The C-360 elevator is an enclosed car hydraulic elevator lift with openings in the front and rear. It has a rated capacity of 20 tons minimum. The safety function of the elevator is that it shall not fail in a manner to allow uncontrolled dropping causing structural integrity damage (failure of pressure boundary) to a cylinder resulting in a release of UF_6 to the atmosphere. It is designed to move (raise and lower) a scale cart with a cylinder between the autoclave floor level and the basement level for filling at the transfer scale position.

The elevator is equipped with a key operated Call/Send switch in the car marked to correspond with the respective landings served, a Call/Send button at each opening, an emergency stop button in the car, an emergency alarm bell. It has the safety controls required by ANSI A17.1 as specified in Chapter 1, Appendix A. The elevator also meets these inspection and testing requirements.

3.7.3.1.3 Scale Carts

Scale carts move cylinders to and from the scales and crane loading/unloading areas. They are air driven work platforms equipped with cradles/saddles/racks to accommodate the UF_6 cylinder. The scale cart stops (brakes) upon loss of air. There are two types of scale carts in use in the plant. Both scale cart designs have a rated capacity of 20 tons minimum. They are constructed of steel (carbon or stainless) with flanged forged steel wheels, driven by an air motor, provided with a movement prevention system, and operated on a rail track system. The high profile scale carts used at the C-360 building are equipped with safety legs under each corner of the platform to prevent the platform from falling in excess of two inches. The low-profile scale carts used at C-333A & C-337A, C-310, and C-315 and will not allow a fall in excess of two inches; therefore, there is no need to rely on safety legs.

The scale carts are inspected bienially for structural damage degradation, cracks, distorted members, and loose fasteners.

3.7.3.1.3.1 Scale Cart Movement Prevention System

The Scale Cart Movement Prevention System is important to safety as described in Section 3.15. This system prevents scale cart movement while a pigtail is connected to a UF_6 drain line manifold. The Scale Cart Movement Prevention System has two interlocks to prevent the scale cart from moving. The scale cart air supply is equipped with a key-operated interlock switch which blocks the air supply to the scale cart without the interlock key. Administrative controls require the air supply interlock key ring to be placed on the pigtail when the pigtail is connected to a cylinder to prevent movement during filling. Additionally, even with the key in the lock, a system consisting of a pressure sensor on the drain line prevents scale cart motion unless the pigtail is close to atmospheric pressure. The Scale Cart Movement Prevention System is used in all facility operations where a pigtail is connected to a UF_6 drain line manifold.

3.7.3.2 UF_6 Cylinder Handling Cranes

The UF_6 cylinder handling cranes are important to safety as described in Section 3.15. This equipment includes the overhead cranes and lifting devices (e.g., rigging) used for moving liquid UF_6 cylinders at C-360, C-310, and C-315, and the cylinder handling cranes in C-333-A and C-337-A (See Table 3.7-3). The C-333-A and C-337-A cylinder handling cranes are restricted to moving empty or solid cylinders, however, they are important to safety because they move heavy loads over autoclaves containing liquid cylinders.

The required safety function is to not fail in a manner that causes UF_6 Primary System failure (i.e., dropped cylinder) during normal operation, an evacuation of facility event, or natural phenomena events. The cranes are designed for the loads they will handle during normal operation of these facilities. Inspections of the cables, brakes, lifting fixtures, and other critical items per ANSI B30.2 are required to help ensure the cranes operate correctly. In addition, the cranes are designed so that when the controls are released (e.g., evacuation of facility event), only small movements occur due to momentum after the crane drive mechanism stops and brakes are applied (the small movements are associated with the activation of the mechanical braking mechanisms). Important to safety features of each crane are given in Section 3.15. The major crane components and their functions are:

1. Crane Structure and Structural Supports – Steel fabrication forming the legs which support the rails.

2. Bridge – The main support structure between leg/rails provides the means of traveling with loads.

3. Trolley – A cart-like device supporting the hoist mechanism and provides the ability to transverse the width of the bridge (side to side of the bridge).

4. Hoist – The device to lift and lower the load by winding and unwinding the wire rope attached to the drum. The hoist consists of the drum, hoist motor, gearbox and shafts, hoist brakes (holding and emergency), limit switch, polar device/rotator (if equipped), and wire rope.

5. Reeving – All pulleys, sheaves, guides, blocks, and tackle to guide or reverse the wire rope direction to achieve force multiplication of the hoist.

6. Cable – The wire rope used to lift and lower the load.

7. Lifting Fixture – Assembly used for lifting cylinders and other loads.

8. Hook – The device that connects the cable to the lifting fixture.

9. Rails – Structural rail track members to support the wheels of the bridge, bridge legs, and trolley wheels used to guide the direction of movement.

10. Mechanical Rail Stops – Steel plates attached to the rails to prevent the trolley or bridge from running off the end of the rails.

11. Load Block – The assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting cable.

12. Gantry Leg – The structural member that supports a bridge girder or end tie (end truck). Gantry legs are commonly used when the crane rails are at different elevations (for example, the C-315 cylinder yard).

13. Emergency Stop Button– Device when activated (manually) immediately interrupts power to all crane functions and controls.

14. Operation Controls – Device to control direction, motion, and speed of the bridge, trolley, hoist and polar device (if equipped). The three basic types of operator control methods are cab, pendant, or radio controls.

Engineered and administrative controls may also be used with UF_6 cylinder handling cranes to reduce the risk of the cranes dropping a liquid cylinder, or similar weight load, on operating process equipment.

The C-310 and C-315 facilities each have two cranes on common rails. They are used to move empty, solid, or liquid-filled cylinders, as needed, to and from the scale cart or storage area. Each facility's cranes can service the entire runway except that portion blocked by the other crane. At each facility, administrative controls are used to ensure that the two cranes are not loaded at the same time.

At C-360 there are two cranes on common rails. These rails are rated for 40 tons so both cranes can be loaded and/or operated at the same time. They are used to move empty, solid, or liquid filled cylinders as needed to and from the scale carts, the storage area and the autoclaves.

The lifting fixtures, or rigging, used for UF_6 cylinder handling consists of special slings and fixtures that have been designed, type-accepted (uniquely identified), and certified for the specific handling tasks at the various facilities. Examples of the fixtures are:

1. The lift fixture for loading and unloading UF_6 cylinders into and from the autoclaves without the use of freestyle or impromptu rigging practices.

2. The sling assembly used for loading 2½ ton cylinders into shipping overpacks.

3. A specialized sling assembly used to lift a loaded 2½ ton overpack from the floor onto a flatbed semi-trailer.

Lifting fixtures are tested and inspected by qualified inspectors. Prior to first use each shift, qualified users perform inspections for kinks, knots, cracked or bent hooks, and other obvious damage. A unique identification number and load-test date identify the slings or fixtures used to handle UF_6 cylinders. The wire rope portion of the sling legs is replaced as follows:

1. Liquid UF_6 Cylinder Handling installations - every two years.
   This includes C-310, C-315, and C-360).

2. Solid UF_6 Cylinder Handling installations - every 3 years.

3.7.4 UF_6 Cylinder Weighing System (Scales)

The Cylinder Weighing System is important to safety as described in Section 3.15.

The scales weigh UF_6 cylinders in various applications in the enrichment process. There are scales at C-360, C-333-A, C-337-A, C-310, and C-315 to provide a means to determine the amount of UF_6 in the cylinders.

The withdrawal or cylinder filling scales perform operational and accountability functions. The operational function is a convenience to fill cylinders to a target weight. At a predetermined weight, an alarm sounds and a valve in the associated UF_6 drain line automatically closes. Filling the cylinder to its specified fill limit is completed using local controls. The accountability function provides the NMC&A weight for the filled cylinder. The NMC&A weight is used to verify cylinders are not filled above established fill limits. The accountability function is checked with a test cylinder prior to placing a cylinder in the withdrawal process, or at a specified surveillance frequency. The scales are important to safety as discussed in Section 3.15.

The 40,000 pound capacity scales in C-333-A, C-337-A, and the C-360 high bay area do not perform an operational function. The accountability function provides the NMC&A weight for cylinders. The scales are important to safety as discussed in Section 3.15.

The floor-mounted 8,000 lb accountability scale, located in C-360, for weighing 30B cylinders containing solid UF_6 includes a load introduction device (LID) for lowering/raising cylinders on the scale platform. A portable crane load cell with a 10,000 lb capacity that measures in 1 lb increments can be used as a backup to this accountability scale.

For accountability purposes, there are portable NMC&A scales with 2,000 pound range or less in C-331, C-333, and C-335. For shipping/receiving 12B cylinders, there are NMC&A scales with 1000 pound range in C-360 and C-360A.

3.7.5 UF_6 Cylinder Shipment

UF_6 cylinders are moved between plants and to customers by truck or rail car. Before shipping, cylinders containing > 1.0 wt. % ^{235}U are placed in protective packages called "overpacks." These packages protect the cylinders from damage due to fire or accident. Heel quantities may be transported in bare cylinders. The acceptable amount of heel in a cylinder is defined in ANSI N14.1.

3.7.6 Administrative Controls

Cylinder Storage

1. Refueling operations of cylinder handling equipment (forklifts, etc.) conducted in the yards are reviewed and approved.

2. Cylinders determined to be potentially damaged or defective cylinders shall be placed in a designated location for appropriate surveillance, and lifting restrictions applied in accordance with the maintenance program.

3. Cylinders containing UF_6 $ 1 wt % ^{235}U are inspected every 4-years for abnormal corrosion products on the cylinder valve, cylinder plug, or cylinder wall.

4. Cylinders containing UF_6 $ 1 wt % ^{235}U are inspected within one week of movement.

5. Cylinders containing UF_6 $ 1 wt % ^{235}U are spaced such that the inspection can detect any degradation of the integrity of the cylinder wall, valve, or plug.

6. Cylinders containing UF_6 $ 1 wt % ^{235}U are inspected for damage following occurrence of an evaluation basis earthquake at the site.

7. Cylinders, which are discovered not to meet the inspection criteria, are handled commensurate with the observed damage.

   If a breached cylinder containing UF_6 enriched to $ 1.0 wt. % ^{235}U is discovered during handling or inspection, the plant shift superintendent will be notified immediately so that appropriate action can be initiated. The cylinder will be covered within 2 hours to prevent the entry of precipitation or water from any source, and repairs will be effected in accordance with directions from nuclear criticality safety. Water will not be sprayed on a cylinder, which has been breached; however, CO_2 may be sprayed on the area of the breach to allow for patching. Personnel involved in the handling or repair of breached cylinders will be equipped with personal alarming dosimeters while working in close proximity to the affected cylinder (if the cylinder is not in an area with CAAS coverage).

Cylinder Handling (Liquid UF_6)

1. Moving the cylinder as low to the ground as practical.

2. Installation of cylinder valve protector prior to movement of liquid-filled cylinders (exceptions include minimal movement on scale carts to facilitate valve protector installation and/or cylinder weighing).

3. Placing the cylinder valve at the 12 o'clock or upright position (also ensured by lifting lug and lifting fixture design for 10- and 14-ton cylinders, administratively for 2.5-ton cylinders and lifting fixture/rack design for 12B cylinders).

4. Cylinders determined to be potentially damaged or defective cylinders shall be placed in a designated location for appropriate surveillance, and lifting restrictions applied in accordance with the maintenance program.

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Table 3.7-1. UF_6 Cylinders

Cylinder Size	Model No.	Cylinder Nos. or Type	Min. Volume (ft^3)
2-1/2 ton	30A	Concave Hd.	25.65[a]
10-ton thick (P)	48A	1-1,000	108.9[a]
10-ton thick (P)	48X	All	108.9[b]
10-ton thick (P)	48A	3,001-3,365	108.9[a]
10-ton thin (T)	48B(T)	5,001-9,230	107.2[a]
14-ton thick (OH)	48F	9,501-9,530	140.0[a]
14-ton thick (OHI)	48F	9,601-9,660	140.0[a]
14-ton thick (Y)	48Y	All	142.7[b]
14-ton thin (O)	48O	10,000-16,601	135[a]
14-ton thin (OM)	48OM	16,602- 18,801 and 100,001-111,820	135[a]
14-ton thin (OM)	48OM	111,821-121,925	139.0[b]
14-ton thin (G)	48G	121,926-149,999 and 160,000 and up	139.0[b]
14-ton thin (Skirted)	48HX	150,001-151,000	140.0[b]
14-ton thin (Skirted)	48H	151,001- 154,144	140.0[b]
14-ton thin wall	48OM Allied	AC-1-AC-400	140.0[a]
2-1/2-ton convex head	30B	All	26.00[b]
2-kg	2S	All	0.026
1-1b	1S	All	0.0053
460-1b	12A	All	2.38
460-lb	12B	All	2.38

a. These volumes are approximate, based on drawing dimensions. Minimum dimensions based on field measurements are used for actual volume calculations if a cylinder is to be heated in accordance with specific TSR limiting conditions.

b. These volumes are certified by the vendor.

Table 3.7-2. USEC Leased UF_6 Cylinder Storage Yards

Yard Designation	Type of Cylinders Stored[a]	Design Capacity[b]
C-745-A	10-ton and 14-ton	4,191
C-745-B	10-ton and 14-ton	8,800
C-745-E	2.5-ton, 10-ton, and 14-ton	1,970
C-745-H	10-ton and 14-ton	750
C-745-Q	14-ton	5,275
C-745-R	10-ton and 14-ton	4,145
C-745-U	10-ton and 14 ton	3,408
C-745-V	14 ton	3,826

a. Major type of cylinders stored in each yard. Several different types may be found.
b. Number of cylinders in the design basis. Actual number may vary.
c. C-745-U yard is only used to store cylinders that do not contain special nuclear material of low strategic significance.

Table 3.7-3. Cranes for Handling UF_6 Cylinders

Location	No	Type	Special Features	Capacity	Primary Use
C-310	2	Bridge	Polar trolley with double block	20 tons	Lifting and moving liquid, solid, or empty UF_6 cylinders
C-315	2	Semi-gantry	Polar trolley with double block	20 tons	Lifting and moving liquid, solid, or empty UF_6 cylinders
C-360	2	Bridge	Polar trolley with double block	20 tons	Lifting and moving liquid, solid, or empty UF_6 cylinders
C-333-A East	1	Bridge	Non-polar trolley and single block	20 tons	Lifting and moving solid or empty UF_6 cylinders only
C-333-A West	1	Bridge	Polar trolley with double block	20 tons	Lifting and moving solid or empty UF_6 cylinders only
C-337-A South	1	Bridge	Polar trolley with double block	20 tons	Lifting and moving solid or empty UF6 cylinders only
C-337-A North	1	Bridge	Non-polar trolley and Single block	20 tons	Lifting and moving solid or empty UF_6 cylinders only

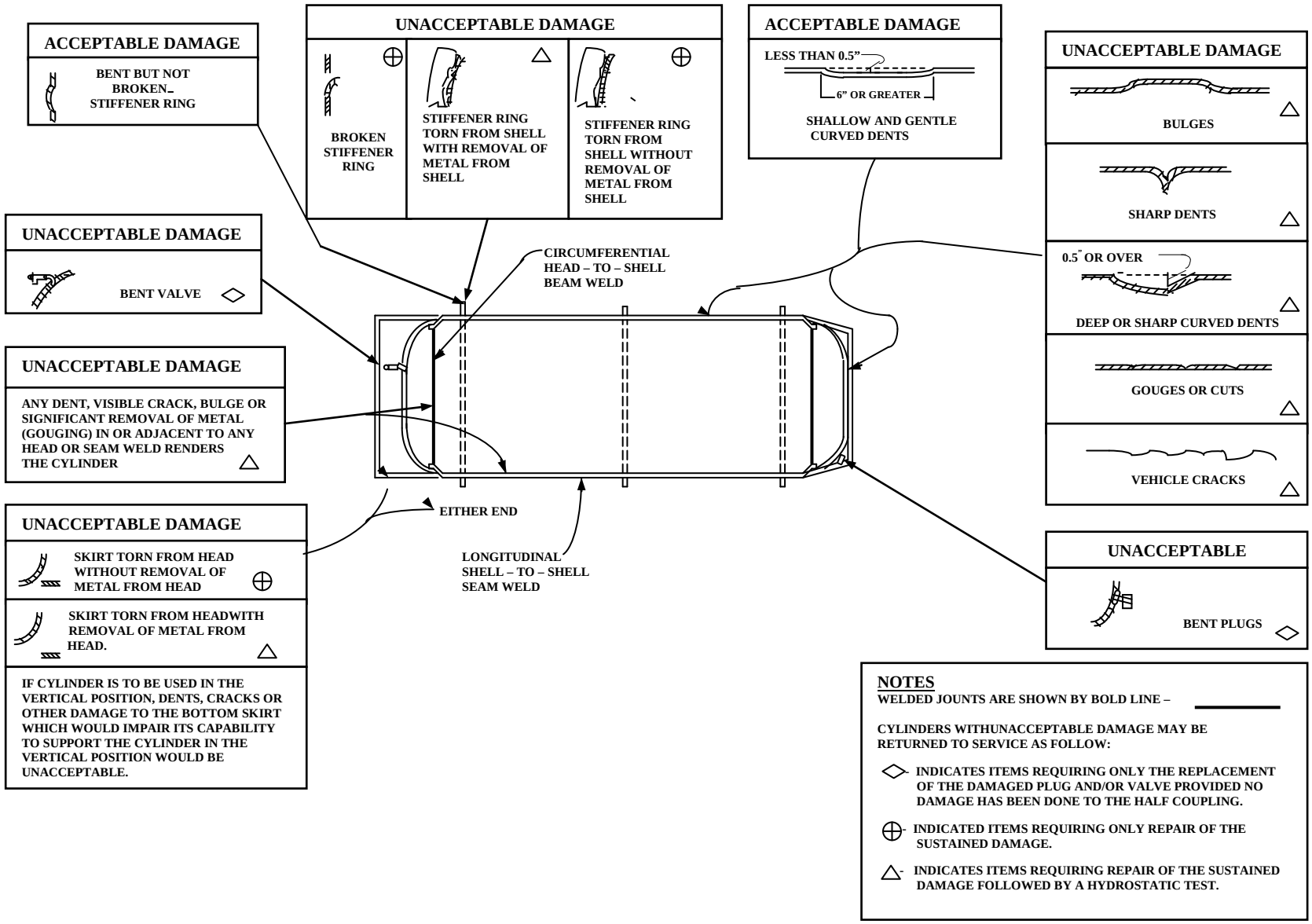

Figure 3.7-1. UF_6 Cylinder Inspection

3.8 CHEMICAL FACILITIES

Chemical facilities at PGDP are highly diversified. The C-400, Cleaning Building and Appurtenant Structures houses decontamination systems, uranium precipitation systems, chemical cleaning tanks, process equipment disassembly areas, and protective equipment processing systems. Other chemical facilities, including processes for F_2, ClF_3, H_2SO_4, and HNO_3 are located within the fenced portion of the plant. Addressed below are the chemical facilities at PGDP with their corresponding functional operations.

3.8.1 Decontamination

Decontamination systems are located in C-400 and C-409, Stabilization Building. The floor drains have been sealed or have engineered controls in place to help prevent a criticality from occurring in the drain systems and associated sumps in the event that fissile solutions are spilled onto the floor. The facilities, systems, and equipment that exist for decontamination and their respective functions are given below.

Chapter 5.2, Appendix A, Section 3.0 discusses the various controls and barriers utilized to prevent inadvertent criticality. Both C-400 and C-409 contain a CAAS. This system is important to safety as described in Sections 3.12 and 3.15.

3.8.1.1 C-400 Building

3.8.1.1.1 Receiving Booth

The receiving booth is used for storage of contaminated and decontaminated seals from the process areas. The receiving booth consists of a sheet metal housing, and a shipping container. Access to the sheet metal housing is through sliding doors on two sides and access to the shipping container is through double doors in one end.

3.8.1.1.2 Seal Disassembly and Cleaning

Failed process compressor seals that are removed from the cascade require disassembly prior to decontamination. The seals are disassembled utilizing a radio frequency generator to heat the solder allowing for removal from the bellows, housing, and other parts. As the solder is melted, compressed air is used to blow the melted solder from the parts. Ventilation is provided to remove the fumes during disassembly. Cleaning methods can include the use of aqueous solutions and the use of the small dry honer. After disassembly and cleaning the reusable parts are sent to the C-720 seal shop to be rebuilt and the remaining parts are discarded as waste. Criticality Safety aspects are discussed in Section 5.2, Appendix A, Section 6.5.

3.8.1.1.3 Cylinder Cleaning and Testing Facility

Clean UF_6 cylinders are required since UF_6 reacts vigorously with most organic materials, such as hydrocarbon oils, even in small quantities. Cylinder cleanliness is also required to maintain purity of the contained UF_6, a factor important to both the enrichment plants and the fuel fabrication plants. Cylinder cleanliness is maintained by purchasing new cylinders from approved suppliers with adequate cleanliness

control programs in place during manufacture and by controlling the purity of material withdrawn into the cylinder during use.

After the feeding and heeling process described in Section 3.2, a small quantity of material remains in the cylinder (i.e. the heel). In order to avoid UF_6 reaction with water during periodic hydrostatic testing of the cylinders, cylinders must be cleaned to remove this heel. Therefore, cleaning and testing equipment is provided for removing residual nonvolatile materials from used cylinders prior to hydrostatic testing.

UF_6 cylinders are important to safety as described in Sections 3.7 and 3.15.

Residual nonvolatile material and uranium decay products are removed to the maximum extent practical from used cylinders prior to repair and/or hydrostatic testing. Cylinders are cleaned by placing them on a positioning fixture and spraying the interior surfaces. The cylinder is then rinsed and transferred to the hydrostatic testing area for pressure testing. The hydro-water is removed and the cylinder is moved to the drying stand, where it is dried and purged with air.

Used cylinders to be cleaned are stored for at least three months after being emptied to allow radioactivity to decrease to an acceptable level. The heels contained in used cylinders generally have relatively high levels of radiation, and the solutions generated by cylinder cleaning can be expected to have high levels of activity. Thermoluminescence dosimeters (TLDs) are used to confirm that personnel exposure to radiation is kept within the allowable limits.

The adequacy of each cylinder cleaning operation is confirmed by visual inspection of the interior of the cylinder. The solutions used in the cylinder cleaning operation are transferred to one of the uranium precipitation systems where residual uranium is removed by precipitation methods.

The cylinder cleaning system is designed to provide internal cleaning, of 10- and 14-ton UF_6 cylinders in a safe and efficient manner. The cylinder testing system is designed to dry, inspect, and hydrostatically test 2 ½-, 10-, and 14-ton UF_6 cylinders in a safe and efficient manner. Criticality limits are discussed in Section 5.2, Appendix A, Section 3.4.

The cylinder cleaning facility and its components are briefly discussed below.

3.8.1.1.3.1 Positioning Fixture

A fixture is provided to support and orient each cylinder to be cleaned. This positional flexibility permits the spray system to contact inside surfaces of the cylinder and the spent solution to be adequately drained from the cylinder.

3.8.1.1.3.2 Spray System

The spray system includes a small pump, a drain pan to collect wash solution as it is drained from the cylinder, two wash solution tanks, and a manually operated spray nozzle used to spray internal surfaces of the cylinder.

3.8.1.1.3.3 Drying System

The drying system for cylinders consists of two banks of radiant heaters capable of heating cylinders. Additionally, a dry air purge is used to aid in drying. A dew-point meter is used to determine when the proper dew point is obtained.

3.8.1.1.3.4 Hydrostatic Test System

The hydrostatic test system consists of an air-operated metering pump, associated piping and supply tanks for water supply, drain, and evacuation capability for the cylinders at cylinder saddles in the test area.

3.8.1.1.4 Degreasers

3.8.1.1.4.1 Branson Degreaser

The Branson Degreaser is designed to clean oil and grease from metal parts using an aqueous cleaning solvent combined with ultrasonics to aid in removing the grease.

3.8.1.1.4.2 Lewis Degreaser

The Lewis degreaser is designed to remove oil and grease from equipment. The solution used for cleaning is filtered to remove uranium and other contaminants and reused. Small parts are dipped into an ultrasonic tank to be cleaned. After cleaning, they are rinsed off and removed to dry.

3.8.1.1.5 Cleaning Tanks

Eight cleaning and rinse solution tanks are installed in the C-400 building (Note: the HCl tank is divided and considered two tanks).

The tanks contain the following: alkali, chromic acid, troxide, hydrochloric acid (HCl), hot water, waste water, and cold water. The tanks containing troxide, chromic acid, and wastewater have internal brick liners that protect the tanks from chemical attack. The HCl tank is constructed of mild steel and is rubber-lined to prevent acid attack to the tank structure/housing. The solutions are steam heated via steel coils in both ends of the alkali and hot water tanks and heat exchangers in both ends of the troxide tank and wastewater tank. A temperature controller is provided at each steam-heated tank that actuates a steam control valve to maintain the desired temperature. A bypass is also provided around the control valves to manually control the steam during startup of the solution tanks. The water tanks are used strictly for rinsing.

Ventilation for the cleaning tanks is provided by exhaust fans connected by ductwork to a plenum room below the tanks. The fans pull on this room which pulls at the top freeboard section of each tank. The exhaust fans are located in the fan room annex in the C-400 partial basement. The ventilation system exhausts to the atmosphere via stacks located on the east side of the C-400 building.

Spheres that float on the solution surface may be used to form a cover to minimize solution vaporization.

3.8.1.1.5.1 Alkali Tank

Commercial alkaline material is used to make an aqueous solution for the cleaning medium.

3.8.1.1.5.2 Chromic Acid Tank

The chromic acid tank utilizes an aqueous solution of sodium dichromate and sulfuric acid (H_2SO_4) which acts as a strong oxidizing or "pickling" agent for copper bearing metals and some aluminum parts. Because of the nature of the operations at ambient temperatures, the solution may be used for long periods of time before draining and recharging is required. Occasional additions of sodium dichromate and H_2SO_4, as determined by laboratory analysis, maintain the proper concentrations.

3.8.1.1.5.3 Troxide Tanks

Troxide is a trade name for sodium hydrogen sulfate. Although the sulfate is now purchased from other vendors, troxide has become synonymous with sodium hydrogen sulfate. The troxide solution is used to remove rust, scale, or other oxidation products.

3.8.1.1.5.4 Hydrochloric Acid Tank

Ventilation for the hydrochloric acid tank is provided via exhaust ports surrounding the tank perimeter above the liquid level. Steam heat exchangers are utilized to maintain the desired operating temperature. The "pickling" solution, as it is commonly called, is formulated from HCl, water and Armohib-28 inhibitor. The inhibitor is used to prevent acid attack of steel items that are processed. The purpose of the HCl "pickling tank" is to remove rust or scale from steel items.

3.8.1.1.6 Drum Crusher

A drum crusher is used to crush empty drums to reduce the volume of waste.

3.8.1.1.7 Compressor Disassembly/Assembly Pit

The C-400 Compressor Pit is used primarily for disassembly of axial compressors but can be used to assemble compressors as required. The compressor pit is equipped with a stairwell, turning fixture, and disassembly fixture. The turning fixture is used to orient the compressor between the horizontal and vertical positions. The disassembly fixture is used to remove the compressor rotor from the stator.

The compressor disassembly operation is the same for both "00" and "000"compressors. The compressor is removed from the cascade and moved to C-400 where it is placed in a horizontal position on the main building floor just south of the disassembly pit. The intake and discharge openings are covered to prevent dust, foreign objects, etc., from entering the compressor cavities. While on the main floor, the compressor seals and associated hardware are removed. The compressor is then disassembled. Components of the compressor may then be decontaminated.

Compressors may also be assembled in the pit.

3.8.1.1.8 Spray Booth

Enrichment equipment, such as compressors, converters, process gas coolers, condensers, large valves, and associated equipment may be decontaminated in the C-400 spray booth. Controls to prevent criticality accidents are described below and in Section 5.2, Appendix A, Sections 3.1 and 3.5.

The spray booth consists of a stainless steel-lined housing with doors to allow for equipment movement into and out of the decontamination system. The roof is constructed of structural steel with a stainless steel liner and is equipped with a hatch to allow access by overhead crane. The floor is constructed of reinforced concrete and sloped to ensure adequate drainage of the wash solutions. The concrete floor is covered with a stainless steel floor pan to protect the concrete from corrosion that would be caused from the wash solutions.

Two pumps are located outside the spray booth: a spray pump, and a return pump. The drain from the spray booth connects to the return pump for transfer to the solution storage tanks.

There are four sets of stainless steel tanks associated with the spray booth. Each set of tanks is installed with equalizing and overflow piping as well as separate inlet and outlet piping to/from the spray booth.

The return pump is also electrically interlocked with a flow-sensing device in the storage tanks' overflow piping. This interlock is provided to prevent continued pumping of solution into the overflowed tanks. The overflow sensor automatically shuts down the return pump upon sensing any flow back to the spray booth floor pan from the storage tanks.

All valves in the tank sets have actuators that are spring-to-close, air-to-open (i.e., spring action closes valve on air supply failure). Actuation of a valve in one tank set precludes operation of the valves in any other tank set (electrical interlock). Therefore only one tank set can be used at a time. The result of a power outage is the closing of any open valves. The valves will remain closed upon resumption of power and must be reopened by relay action via pushbutton control.

Valves within a tank set are also interlocked to ensure proper order of operation. The return valve must be open when the supply valve is open to ensure that the solution is pumped back into the proper tank. When the supply valve is closed, the return valve may be opened or closed. This allows solution remaining in the system after the supply valve is closed to be pumped into the proper tank. When a return valve or a return valve and a supply valve within a tank set are open, all other supply and return valves are closed.

C-400 Operations personnel are able to monitor the levels of any solution by viewing the level gauge on each set of storage tanks.

The primary method of operation for the spray booth is using the high-pressure water jet to decontaminate equipment. All four tank sets are used to accumulate contaminated solution. The solutions are sampled and transferred to uranium precipitation.

The large volume spray booth has an exhaust fan. The exhaust fan is utilized during spray booth cleaning operations. The exhaust system controls are located on the spray booth control panel.

The spray booth facility utilizes one monitoring system; an overflow alarm system. This system detects tank overflow and shuts down the return pump.

Contaminated solutions are periodically transferred to the C-400 or C-409 uranium precipitation systems for processing. Sampling is performed prior to transfer to ensure the criticality safety limits for the receiving system are met.

An inadvertent transfer of a solution that does not meet the criticality safety limits of the receiving system could result in a criticality accident. To prevent inadvertent transfer to the C-400 receiving tanks, a Key Interlock System is employed which requires separate keylock operation by two persons to put the transfer valve in the C-400 position. The two key-interlocked switches are spring return to neutral from the C-400 position and are sufficiently far apart that two operators are required to operate them simultaneously. The keys are controlled by the front line manager. The Key Interlock System is an AEF important to safety as described in Section 3.15. Inadvertent transfer to the C-409 system is prevented by controls on the introduction of solutions to the NaOH mix tank as described in Section 3.8.2.2.

3.8.1.1.9 Dry Honers

There are two dry honers in the C-400 building that differ in size and ventilation capacity but operate similarly. The small dry honer is approved for use on material exposed up to 5.5 wt % ^{235}U. The larger dry honer is presently not used pending completion of the criticality safety analysis of the operation and approval for use.

Each dry honer unit consists of the following: blast generator, metering valve and diffusion disc, blast hose, blast nozzle, blast cabinet, ventilating reclaimer system, vacuum hose (connects blast cabinet to ventilating reclaimer system), remote controls, air regulator, and air lines and valves. Each dry honer requires electrical power (to operate blower for the ventilating reclaimer system) and a dry air supply (to operate controls and furnish airflow at the required pressure for honing).

The blast cabinets have access doors, viewing windows, a work cart with a round turntable (tracks extend outside blast cabinets), rubber gloves (attached through the cabinet wall), and an air hose for blowing dust off items after honing. The ventilating reclaimer system consists of a blower, filter bags, cyclone, vibrating screen, vacuum booster (an air jet used to increase vacuum when external blast gun is used), and dump valve (returns used abrasive to blast generator). The small dry honer has a blower for the ventilating reclaimer system. The greater capacity of the large dry honer blower permits a larger blast cabinet.

The types of abrasives that may be used in both units are glass beads, garnet, and aluminum oxide. The large dry honer has the capability to clean or abrade equipment that cannot be chemically cleaned. The smaller dry honer unit may be used to clean small parts and disassembled seal parts that are received in the receiving booth and subsequently dismantled in the seal disassembly area. The spent abrasive is collected in drums for proper disposal.

3.8.1.2. C-409 Building

3.8.1.2.1 Receiving Booth

The receiving booth is available and suitable for a wide variety of uses, consistent with other floor areas in the facility. The booth has HEPA filtration and consists of sheet metal housing. Two large doors provide access to an enclosed area and a jib hoist crane provides the necessary equipment handling capability.

3.8.1.2.2 Cylinder Cleaning and Testing Facility

The cylinder cleaning facility may be used to chemically clean and remove uranium deposits from empty product cylinders. This high-assay cylinder cleaning facility is designed for washing UF_6 cylinders with heels up to 5.5 wt % ^{235}U.

UF_6 cylinders are important to safety as described in Sections 3.7 and 3.15.

3.8.1.2.2.1 Cylinder Cleaning

The first step in the cleaning process is the dissolution and removal of the nonvolatile uranium compounds. The dissolution of enriched uranium compounds forming aqueous solutions in a large vessel requires controls to prevent nuclear criticality.

Cylinder cleaning is accomplished by placing the cylinder on a positioning fixture and rotating the cylinder around its axis and tilting either end up to allow the solution to decontaminate the cylinder walls and clean the cylinder heads.

As cleaning solution is drained into the cylinder, gases released from the reaction are processed through the geometrically favorable HF scrubber treatment system. The scrubber treatment system vents to the atmosphere.

Pumping scrubber solution through an injector that is connected to an evacuation hose generates the vacuum used to pull the gases into the scrubber. In the event the ejector malfunctions and forces scrubber solution back into the cylinder, the HF scrubber recycle pump will shutdown when either the evacuation hose loses vacuum or the exit of the ejector loses flow. The shutdown circuitry and the pump are both connected to the same electrical supply. This ensures that the pump will not run should power be lost to the shutdown circuitry.

3.8.1.2.3 Hand Tables

The hand-table was initially designed for the decontamination and cleaning of small equipment parts. A floor pan of favorable geometry is located under all the hand-table equipment.

The hand-table is divided into staging, cleaning, and drying operations. The cleaning operation involves three individual sinks for washing, rinsing, and collection. The hand-table prevents spillage of solutions into the drip pan. The hand-table drains to maximum 21 liter poly bottles.

3.8.2 Uranium Precipitation

Uranium precipitation operations conducted at the C-400 and C-409 buildings involve the processing of uranium bearing solutions. Controls utilized to prevent criticality accidents are described below and in Section 5.2, Appendix A, Sections 3.2 and 3.3.

3.8.2.1 C-400 Building

3.8.2.1.1 Uranium Contaminated Solution, Receiving, and Storage Facility

The contaminated solution receiving and storage facility receives uranium bearing solutions from the C-400 cylinder wash and C-400 spray booth.

This facility consists of twelve stainless steel tanks. Criticality limits are discussed in Section 5.2, Appendix A, Section 3.2. The tanks are used in pairs connected by equalizing lines and are considered one tank set. One tank set (receiving tanks) is used for transferring solutions. The other five pairs are used for storage of solutions. Other equipment consists of one recycle pump associated with the two receiving tanks, one transfer pump which transfers the solution from the receiving tanks to any storage tank set, and one transfer pump which transfers the solution to the sodium hydroxide (NaOH) No. 4 dissolver or lime precipitation No. 5 dissolver. Solutions containing less than 1.0 wt % ^{235}U are transferred to the lime precipitation system or the NaOH precipitation system.

The drain lines from each tank set, (receiving tanks included) are designed with single-key interlock valves.

The receiving tanks are charged from the generating areas (spray booth, cylinder wash, etc.) via proper valving and transfer pumps.

Solutions meeting the criticality safety limits of the precipitation systems are transferred for further processing. Isotopic dilution is performed if necessary to meet specified limits.

3.8.2.1.2 Uranium Precipitation

The major components of the uranium precipitation system consist of the No. 4 dissolver, the No. 5 dissolver, the ion exchange unit, and the B-collection tank. Each component is discussed below.

The No. 4 dissolver consists of four slurry tanks, a pH adjustment tank, a rotary vacuum filter, a silencer-separator, six filtrate tanks, a precoat tank, four pumps, associated piping, valves, and instrumentation and controls. Solution from the receiving and storage tanks can be acidified, mixed, precipitated, and filtered in this process. The precipitate (sludge) generated by the No. 4 dissolver process is stored in plastic lined drums and transferred to waste management. The filtrate is transferred to the No. 5 dissolver where it can be processed.

The No. 5 dissolver consists of a precipitation tank, a rotary vacuum filter, a silence-separator, a series of eleven filtrate tanks, a precoat tank, pumps, associated piping, valves, and instrumentation and controls. Solution from the receiving and storage tanks can be acidified, mixed, precipitated, and filtered in this process. The precipitate (sludge) generated by the No. 5 dissolver process is stored in plastic lined drums and transferred to waste management. The filtrate from the No. 5 dissolver is routed to the filtrate storage tanks. The solution is processed through the ion exchange unit to the B-collection tank for sampling before final release, or may be reprocessed or used as makeup to the chemical cleaning tanks.

The ion exchange unit consists of three ion exchange columns, a prefilter, feed pump, resin slurry pump, a resin dewatering tank, associated piping, valves, and instrumentation and controls. Each ion exchange column contains exchange resin designed to remove ^{99}Tc. Solution from the No. 5 dissolver filtrate tanks is routed through the ion exchanger to the B-collection tank before discharge. As the resin becomes exhausted, it is sluiced to the dewatering tank and removed from the system. The expended resin is placed in plastic-lined drums and transferred to waste management. New resin is fluidized in drums and sluiced to the appropriate column by the resin slurry pump.

Accountability scales weigh the precipitate. These scales are important to safety as described in Section 3.15.

The B-collection tank holds treated water from the process systems until samples can be taken and analyzed to ensure release parameters are within specification, as described in Section 5.1.1.2, before discharge. Contents of the tank may be recycled through the ion exchange unit or the No. 5 dissolver for additional treatment as needed.

3.8.2.2 C-409 Building

3.8.2.2.1 Uranium Contaminated Solution Acidifying and Storage Facility

The solution acidifying and storage tanks facility includes 16 stainless steel solution tanks, 2 solution transfer pumps, a nitric acid day tank, and a nitric acid metering tank. The tanks are designed to meet criticality safety limits as described in Section 5.2, Appendix A, Section 3.3. They are arranged in groups of four connected by equalizing lines. Each group is considered one tank set. One tank set can be used to acidify the uranium solution and the remaining three tank sets are to store solution. The nitric acid system consists of a day tank and a metering tank located outside the stainless steel floor pan. Compressed nitrogen provides the motive force to transfer nitric acid from the day tank to the metering tank and from the metering tank to the acidifying tanks. The nitric acid day and metering tanks are located within a dike.

The acidifying tank set is equipped with a transfer pump for recirculation of solution within the acidifying tanks and for transfer of solution to the solution storage tanks or precipitation tanks. The solution storage tank sets are equipped with a transfer pump for recirculation of solution within the storage tanks sets, for transfer between storage tanks sets, and for transfer of solution to the precipitation tanks.

The acidifying tanks are designed to collect uranium bearing solutions from the C-409 cylinder wash, the C-409 hand tables, and from the C-400 Spray Booth. Solution can be transferred to the acidifying tanks via transfer lines connection the operations in C-409 and via a C-400 to C-409 transfer line. The C-400 to C-409 transfer line can be prevented from being placed in service via installation of a blind flange in C-409 and elbow removal and blind flange installation in C-400. This configuration allows a reduction in administrative controls for criticality safety.

The contents of the acidifying tanks can be circulated by opening the suction and recirculation valves associated with the transfer pump and starting the pump. Nitric acid can be added to the tanks by opening the valves from the nitric acid metering tank to the pump suction line and opening the nitrogen valve to the metering tank. Once the solution in the acidifying tanks is at the desired pH, the solution can be transferred to the solution storage tanks.

One solution tank in each tank set is equipped with two liquid level sensors. Should the liquid level reach either of these switches, the transfer pump serving that tank set will trip. Should the liquid level reach the second level switch, a visual and audible alarm will sound at the local control panel in C-409.

All storage, acidification, precipitation, and filtrate tanks share a common overflow and vent line. If a tank should overflow, the overflow is discharged onto the stainless steel floor pan. The vent line also exhausts near the floor pan.

3.8.2.2.2 Precipitation System

The precipitation and filtration system consists of six precipitation tanks, eight filtrate tanks, slurry tank, filtrate accumulator tank, solution addition tank, and a rotary vacuum filter unit. The precipitation tanks and filtrate tanks share a common overflow and vent line with the storage and acidifying tanks. If a tank should overflow, the overflow is discharged to the stainless steel floor pan. The vent line also exhausts near the floor pan. All wetted system components are stainless steel.

The precipitation tanks can receive solution from the solution addition tank, or from the filtrate, storage, or acidifying tanks sets. Each of the precipitation tanks is equipped with an inlet and outlet isolation valve and can be individually selected for use. A precipitation recirculation pump allows solution in the tanks to be recirculated, transferred tank to tank, or transferred to the rotary filter unit for processing. The pump also directs flow through an eductor to allow solution to be drawn from the solution addition tank or back from the rotary filter unit. Each precipitation tank is equipped with two liquid level sensors. Liquid reaching either of the sensors trips the storage transfer pump, the precipitation recirculation pump, and the filtrate recirculation pump. Liquid reaching the second sensor actuates a visible and audible alarm.

The solution addition tank provides a method for introducing solution directly into the precipitation tanks. NaOH can be introduced and blended with the uranium solution in the precipitation tanks to raise the pH and precipitate uranium compounds for subsequent removal by the rotary filter unit. A NaOH storage container is located on a stand above the solution addition tank to facilitate NaOH addition. Examples of other solutions that can be introduced include uranium solutions from C-710, solutions drained from C-409 during maintenance or sampling, uranium solutions from C-400 operations, and nitric acid. Nitric acid can also be added in a similar manner to the acidification process at the acidifying tanks.

The rotary vacuum filter unit consists of a rotary drum filter, filtrate receiver with mist eliminator, vacuum pump with silencer separator, precoat tank, and a filtrate pump. The precoat tank is equipped with a mixer to suspend diatomaceous earth into a water slurry and a precoat slurry pump to deliver the slurry to the rotary filter drum. The vacuum pump provides a suction on the internal cavity of the rotary filter drum to draw solution through the filter. The vacuum pump silencer separator separates condensate from the vacuum pump discharge and reduces the sound level emitted. Solution drawn through the filter media collects in the filtrate receiver. A filtrate pump pumps the filtered solution to the filtrate tanks or to the precipitation tanks. Precipitate from the solution being filtered collects on the outside of the rotary filter drum. The precipitate and filter media is removed by a knife edge as the filter drum rotates and is stored in 5.5 gallon drums.

Eight filtrate tanks provide for collection and storage of filtrate from the rotary drum filter unit. All eight tanks are connected and operate as a single tank. One of the tanks is equipped with a high liquid level sensor that actuates a visible and audible alarm.

A filtrate recirculation pump allows filtrate in the tanks to be recirculated, transferred to another tank set in the system, or transferred to a portable tank for subsequent discharge/disposal.

The criticality safety aspects of this system are discussed in Section 5.2, Appendix A, Section 3.3.

3.8.2.2.3 Filtrate Monitoring

The filtrate receiver tank utilizes two level monitoring systems to control the level of solution in the filtrate receiver tank and minimize the risk of a criticality accident due to excessive volume. Solution is pulled into the filtrate receiver tank via a vacuum pump from the system and pumped out to other holding tanks using a filtrate pump. The vacuum pump is required to be operational prior to introducing solution into the system and must be operational to introduce solution into the filtrate receiver tank. One set of the level controls is used to start and stop the filtrate pump based upon the amount of solution in the filtrate receiver tank and is used for normal system control. This system provides for low level, high level, and high-high level alarms and functions to start the filtrate pump on a high level condition and shuts the filtrate pump down on a low

level condition. In addition, another set of instrumentation is used to monitor the level of solution in the tank and provide another high-high level sensor to detect the condition and shutdown the vacuum pump. Shutting down the vacuum pump stops the flow of solution into the filtrate pump.

Both level control systems use 120-volt AC power supplied from a 480/120-volt control transformer. The 480-volt supply for this monitoring system is the same as for the pumps associated with the system. Loss of either the 480-volt or 120-volt power will result in shutdown of the system.

The filtrate monitors are important to safety as described in Table 3.15-3.

3.8.3 Fluorine System

The fluorine system primarily consists of C-410-K, C-410-D, and the distribution piping, valves, and instrumentation (see Figure 3.8-1). Fluorine is purchased as a 20% fluorine/80% nitrogen molar mixture and it is delivered to PGDP in DOT-approved multi-tube trailers. A full DOT-approved trailer nominally contains 1800 lbs of fluorine at 2000 psig that is distributed in eight separate tubes (i.e., nominally 225 lbs of fluorine per tube). One nominally full and one nominally empty (i.e., heeled) multi-tube trailer may be stored in both the C-745-A and C-745-B storage yards. When needed, a full multi-tube trailer is moved to C-410-K, Fluorine Facility, where the gas pressure is reduced to defined levels and is then fed to the storage tanks or the pressure reducing manifolds in C-410-D (Fluorine Storage Building). The pressure of the gas mixture is further reduced at the C-410-D pressure reducing manifolds then fed to the fluorine distribution header for distribution to other plant locations. Fluorine is distributed from C-410-D as needed through a piping system to the Purge and Product Building (C-310), the Process Buildings (C-331, C-333, C-335, and C-337), and the Drying Agent Storage Building (C-350). The amount of fluorine stored in C-745-A/C-745-B storage yards and the C-410-D/C-410-K complex exceeds the threshold quantity for fluorine defined in 29 CFR 1910.119, Appendix A. Therefore, the design and operation of these facilities require the implementation of elements for process safety management identified in this regulation.

This section addresses only the receipt, storage and distribution of F_2 to the above buildings. The utilization of F_2 is addressed in Sections 3.3.4 and 3.3.5. The F_2 System is important to safety as described in

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Section 3.15. In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the administrative controls described in Section 3.8.7.1 for F_2 storage, transport, connection and disconnection ensure safe operation. Additional administrative controls associated with F_2 distribution are described in Section 3.8.7.2.

3.8.3.1 C-410-K Fluorine Building

The C-410-K building is located just west of the C-410-D Fluorine Storage Facility. The single-story building has a center wall with roll-up door that divides the building into two sections. The west end is open on the sides and end. The east end is enclosed, insulated, and heated. When fluorine is needed, a multi-tube trailer is installed for use in C-410-K. Each trailer tube is equipped with an isolation valve that is connected to a manifold. A pigtail (i.e., a flexible hose) is used to connect the trailer manifold to the system piping in the west end of C-410-K. This piping connects to the pressure reducing manifold located in the enclosed portion of C-410-K. Administrative controls identified in Section 3.8.7.2 restrict the number of tubes that may be valved open to the trailer manifold to limit the amount of fluorine that could be released due to a pigtail failure. The gas pressure is reduced to a nominal 130 psig at the C-410-K pressure reducing manifold and is then either transferred to the storage tanks or to the F_2 distribution header pressure reducing manifold in C-410-D. The ambient atmosphere in C-410-K is monitored and an alarm is activated if the F_2 concentration exceeds specified limits.

The pressure reducing manifold regulators in C-410-K are housed in a ventilated enclosure. Isolation valves in this manifold will automatically close and an alarm is activated if the F_2 concentration in the enclosure's ventilation exhaust exceeds specified limits. Pneumatically operated valves in the manifold will also automatically close if pressure exceeds specified limits during tube feeding or heeling operations. During tube feeding operations, pneumatically controlled valves will automatically close and an alarm is activated if pressure down stream of the pressure reducing manifold (i.e., on the C-410-K process side) exceeds specified limits or if the up stream piping experiences a rapid pressure drop that exceeds specified limits. The high pressure control protects down stream equipment from a potential pressure regulation control failure during tube feed operations and the rapid pressure drop control minimizes the release that could result from a pigtail/connection failure. During tube heeling operations, the feeding pressure regulation controls can be bypassed. However, a control valve in the bypass line will not open unless the pressure up stream of the valve (i.e., on the multi-tube trailer side) is below a specified pressure. This control ensures that only low pressure tubes can be valved in to the process system during tube heeling operations. Isolation valves will automatically close and an alarm is activated if the down steam pressure is higher than the up stream pressure. This control minimizes back feed if a pigtail/connection failure occurs during heeling operations. If these control valves fail during operation, system equipment is protected by a pressure relief system on the low pressure side of the pressure reducing manifold. The pressure relief system is rated for a pressure of 165 psig and it is piped to vent excess pressure to an elevated release point upon activation.

3.8.3.2 C-410-D Fluorine Storage Facility

Fluorine is transferred to the C-410-D distribution header either from the C-410-D storage tanks or from the C-410-K multi-tube trailer. The C-410-D Fluorine Storage Building contains three tanks (nominal 1,000 ft^3 capacity each) used to store a mixture of 20% F_2 and 80 % N_2 (molar). The tanks are ASME code-stamped and are rated for a maximum working pressure of 165 psig at 250°F. Each tank is equipped with a pressure relief system rated for a differential pressure of 165 psig. Upon activation, the C-410-D tank pressure relief system will vent excess system pressure to an elevated release point. The pressure in the C-410-D storage tanks and piping is maintained up to a nominal 130 psig during normal operation. The ambient atmosphere in C-410-D is monitored and an alarm is activated if the F_2 concentration exceeds specified limits.

The fluorine distribution header in C-410-D is supported by two pressure reducing manifolds. The manifold regulators are housed in separate ventilated enclosures. One manifold is typically bypassed while the other is used to regulate the pressure of the fluorine distribution header to a nominal 5 psig. Isolation valves in these manifolds will automatically close and an alarm is activated if the F_2 concentration in the enclosures' ventilation exhaust exceeds specified limits. Pneumatically operated isolation valves in the pressure reducing manifolds automatically close if the pressure in the fluorine distribution header exceeds specified limits. The low-pressure portion of the distribution line is equipped with a pressure relief system that is rated at 50 psig. Upon activation, this pressure relief system will vent excess pressure to an elevated release point. The pressure relief system on the low pressure side of the fluorine distribution line protects down stream equipment should the pressure reducing manifolds on the fluorine distribution header fail.

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3.8.3.3 Fluorine Distribution Piping

A F_2 mixture at approximately 5 psig is routed from C-410-D to use points in C-310, C-331, C-333, C-335, C-337, and C-350 by piping constructed of F_2 and ClF_3 compatible materials as described in Section 3.3.4. Normally, a header located outside of the tie-line housing is used as the F_2 header, but the piping discussed for ClF_3 distribution in Section 3.8.4.2 may also be used for F_2 distribution.

3.8.3.4 Key Instrumentation

The Fluorine System contains the following key instrumentation, controls, and alarms:

- Ambient F_2 levels in the C-410-D building are monitored by an F_2 sensor. If the concentration exceeds the setpoint, the sensor activates an alarm at the control panel in the C-410-K and C-400 buildings, and the system activates visual and audible alarms at C-410-D.
- Ambient F_2 levels in the C-410-K building are monitored by an F_2 sensor. If the F_2 concentration exceeds the sensor setpoint, the detection system alarms at the control panel in C-410-K and remotely in C-400, and the system activates building visual and audible alarms in C-410-K.
- F_2 sensors are used to monitor the exhaust from both ventilated enclosures housing the pressure reducing regulators in C-410-D. Isolation valves in these manifolds automatically close if the F_2 concentration in the enclosures' ventilation exhaust exceeds specified limits. The detection system also activates an alarm at the control panel in C-410-K and remotely in C-400, and the system activates local building visual and audible alarms in C-410-D.
- An F_2 sensor is used to monitor the exhaust from the ventilated enclosure housing the pressure reducing regulators in C-410-K. Isolation valves in this manifold automatically close if the F_2 concentration in the enclosure's ventilation exhaust exceeds specified limits. The detection system also activates an alarm at the control panels in C-410 K and remotely in C-400, and the system activates building visual and audible alarms in C-410-K.
- Pressure sensors monitor the operation of the C-410-D and C-410-K pressure reducing manifolds. If the pressure exceeds specified limits, the system automatically closes isolation valves and an alarm is activated at the control panel in C-410-K and remotely in C-400.
- The piping between the rupture disks in the pressure relief system used on the storage tanks and the distribution header in C-410-D are monitored. A reading above atmospheric would indicate rupture disk leakage.

- The pressure relief system used with the C-410-K pressure reducing manifold includes a rupture disc plus a pressure relief valve that, upon activation, will reset at a specified pressure. The piping between the rupture disk and the pressure relief valve is monitored. A reading above atmospheric pressure would indicate rupture disk leakage.
- 120VAC supplies power to the C-410-D and C-410-K F_2 release detection and alarm systems.

The high pressure relief systems and the fluorine detection alarms identified in this list represent the equipment important to safety associated with the Fluorine System as addressed in SAR Section 3.15.8.

3.8.4 Chlorine Trifluoride System

Liquid chlorine trifluoride (ClF_3) is delivered to the site in cylinders that meet DOT specifications. These cylinders are stored in C-745-B. The cylinders are transferred as needed to the C-350, Drying Agent Storage Building. There the liquid begins to vaporize and the ClF_3 gas is fed into the C-350 $ClF_3/N_2/F_2$ (mixed gas) storage tank which is used to provide mixed gas to the distribution piping. This piping permits the controlled flow of the mixed gas to the buildings for cell treatment on an as-needed basis.

This section addresses only the receipt, storage, and distribution of ClF_3 to the buildings. The utilization of ClF_3 is addressed in Section 3.3.5. In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the administrative controls described in Section 3.8.7.1 for ClF_3 storage, transport, connection and disconnection ensure safe operation. Additional administrative controls associated with ClF_3 distribution are described in Section 3.8.7.2.

The ClF_3 Systems consist of C-745-B, the ClF_3 charging facilities, the mixed gas storage tanks, and the distribution piping.

ClF_3 is restricted to less than the threshold quantity established by 29 CFR 1910.119, Appendix A. Administrative controls further limit the amount of ClF_3 at any one location to less than 1000 lbs.

3.8.4.1 C-350 Drying Agent Storage Building

The C-350 building is located in the central plant area, south of the C-335, Process Building. The main section of the building houses the east mixed gas storage tank (mixture of ClF_3, N_2 and F_2), the north extension houses the ClF_3 charging cabinet and cylinder storage area, and an adjacent structure houses the west mixed gas storage tank (Mixture of ClF_3, N_2 and F_2). See Figure 3.8-2.

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The north extension of the C-350 building houses the ClF_3 charging stand. The stand consists of a steel charging cabinet designed to house a single ClF_3 cylinder, a cylinder scale, manifold piping, a pigtail for a ClF_3 cylinder connection, an HF detection sensor, and a ventilation duct. The cabinet is equipped with a viewing window. A mechanism is attached to the cylinder valve during tank charging operations that allows the valve to be manually operated from outside of the building. The charging cabinet scale indicates the liquid ClF_3 quantity in the feed cylinder. Normally, a cylinder containing up to approximately 160-lb of liquid ClF_3 is connected to the pigtail. The connected cylinder is secured to the cabinet by a metal band and a valve retainer to prevent the cylinder or cylinder valve from turning when the cylinder valve is operated. The ClF_3 cylinder valve is closed when charging is complete. Spare cylinders, as well as empties, are secured to the building wall.

From the feed cylinder on the charging stand, gaseous ClF_3 flows to the east and west mixed gas storage tanks. The charging stand scale indicates the quantity in the cylinder. A F_2/N_2 mixture from the F_2 System header is added to the tanks to produce mixed gas. Each tank has a nominal capacity of 2,000 ft^3. The maximum allowable working pressure for the east tank is 16 psig at 200°F and for the west tank is 15 psig at 300°F. Tank operating pressure is maintained below atmospheric pressure. During charging operations, gas flow into the tanks is normally controlled locally from the C-350 building using manual valves. However, flow to the tanks is automatically isolated by closure of F_2/N_2 and ClF_3 charging valves when either tank setpoint pressure is reached. Tank pressure during charging operations is monitored locally and in the C-335 building ACR.

The west portion of the north extension houses the ClF_3 cylinder storage racks and the ClF_3 leak detection panel. Administrative controls dictate that a maximum of 2 full and 4 empty cylinders are stored in C-350.

HF detectors are located in each room to detect leaks. HF detectors are acceptable for this purpose because the fluorine in the gas compounds combines rapidly with moisture in the air to form HF as a reaction product.

The Conditioning Gas Feed System within C-350 provides monitoring and control of mixed gas and fluorine pressures during storage and distribution and is important to safety as described in Section 3.15 (see Figure 3.8-2). The Conditioning Gas Feed System contains the following key instrumentation, controls, and alarms:

- A continuous record of the pressure in the east and west mixed gas storage tanks (mixture of ClF_3, F_2 and N_2) is maintained in the C-335 building ACR.

- If either storage tank reaches its high pressure setpoint, audible and visual alarms in the C-335 building ACR are actuated.

- If either storage tank reaches its high-high pressure setpoint, visual alarms are actuated in the C-350 building.

- High-high pressure in either the east or west mixed gas storage tank (F_2, ClF_3 and N_2 mixture) isolates the affected tank from the ClF_3 and F_2/N_2 supplies by initiating closure of control valves

.

- If ambient concentrations of HF in the C-350 building exceed the setpoint, HF detectors actuate audible and visual alarms locally, in the C-335 building ACR, and at the C-300,Central Control Building.

120VAC supplies power to the HF detection system and associated alarms and to the 24VDC power supply. 24VDC supplies power to the leak detector sensors and to detection panel lights.

3.8.4.2 Mixed Gas Distribution System

Mixed gas at below atmospheric pressure is routed from C-350 to use points in C-310, C-331, and C-335 by piping constructed of F_2 and ClF_3 compatible materials as listed in Section 3.3.4. Two distribution pipes connect these facilities to the storage tank manifolds in C-350. Cross-connect valving permits transfer of mixed gas through either of these headers. Additional piping between C-331 and the C-333, Process Building and between C-335 and the C-337, Process Building permits routing of mixed gas to the "000" buildings.

3.8.5 Nitric Acid

Nitric acid (HNO_3) is used in the various cleaning operations conducted at the C-400 building as discussed in Section 3.8.1. Receipt, storage, and transfer of HNO_3 at C-400 is discussed below.

3.8.5.1 Nitric Acid Receipt and Storage

The C-400 nitric acid system consists of an outside storage tank, an inside storage (day) tank, and piping and valves required for the receipt and transfer of nitric acid.

The C-407 Nitric Acid Storage Tank is located near C-400. Overpressure protection is provided by a relief valve. A concrete dike with an acid resistant coating surrounds the tank.

3.8.5.2 Nitric Acid Transfer

From the storage tank, nitric acid can be transferred to the day tank located in the C-400 cleaning building.

The day tank supplies acid to the C-400 uranium precipitation dissolver systems. Overpressure protection is provided by a relief valve. A concrete dike surrounds the day tank.

The tank also contains a level probe which will cause lights on a local panel to energize, reflecting the tank's acid level. The high level indicating light is electrically interlocked with the transfer pump such that when the light energizes, the acid transfer will automatically shut off and an audible alarm will sound.

Transfer of acid from the day tank is accomplished by applying dry air pressure to the tank. Acid is first transferred to a metering tank through the C-400 building distribution system. Dry air pressure is then applied to the metering tank to transfer acid to the dissolvers.

If the acid transferring system is not in service, then addition of nitric acid to the dissolvers can be made by adding nitric acid from portable containers into the dissolvers. In addition, nitric acid may be transferred in portable containers to various locations within C-400 to be utilized as a decontamination agent as necessary.

3.8.6 Miscellaneous Operations

Miscellaneous operations conducted at C-400 include safety equipment cleaning and laundry. Pressure transmitter cleaning capability is provided in C-409.

3.8.6.1 Safety Equipment Cleaning

A separate area in the C-400 building is devoted to the cleaning and inspection of safety equipment. A washer, electric tumble dryer, oven-type dryer, and hand tables can be used to clean gloves, boots, protective suits, respirator face pieces, and other gear.

3.8.6.2 Laundry

The C-400 laundry can process protective clothing and towels from changehouses located throughout the plant. Soiled mops from the janitorial service can also be cleaned in the facility.

Also included as part of the laundry facility is a sewing room where clothing can be mended.

After drying, the cleaned items are monitored as required and returned to their respective locations within the plant.

3.8.6.3 C-409 Pressure Transmitter Cleaning

A transmitter is cleaned by pumping distilled water through it and collecting the wastewater. The water is recirculated through the system until the conductivity of the water flowing out of the transmitter is acceptable. The water is forced through the transmitters by the use of a small pump. The water washes the uranium and other materials out of the internal cavity into the collection cylinders. The conductivity of the water is measured to determine when the transmitters are cleaned.

3.8.7 Administrative Controls

3.8.7.1 Administrative Controls – Toxic Gas Storage/Transport/Connect/Disconnect

Note: The hazards addressed by these Administrative Controls are F_2, Cl_2 , and ClF_3.

1. DOT – approved valve covers are in place on Cl_2 and ClF_3 cylinders or containers during storage and on-site transport operations. Valve covers may be removed for leak testing and connections to process piping.

2. Only cylinder or tube trailer pigtails that have been inspected, approved, and tagged by a qualified inspector shall be used for above atmospheric pressure operation.

3. Cylinder and tube trailer connections shall be leak tested before placing a cylinder or tube in service.

4. Lines shall be purged and evacuated or approved controls established prior to opening the primary system to prevent personnel exposure.

5. Any on-site personnel who could be exposed to the release should detect the release via smell or sight. This material at low concentrations is very irritating to the human senses. Therefore, detection should be easily accomplished.

6. Upon detection of a significant release of toxic gas, immediate evacuation is required to minimize exposure and notification of the release to emergency response personnel.

7. Operator training shall provide for proper handling of the applicable toxic gas as well as notification of any releases to emergency response personnel should a major release of toxic gas occur.

8. Chlorine vacuum regulators are periodically replaced according to a preventive maintenance schedule.

9. One nominally full and one nominally empty (i.e., heeled) multi-tube trailer may be stored in both the C-745-A and C-745-B storage yards.

10. If the F_2/N_2 multi-tube trailer is equipped with wrench-operated isolation valves, then these valves are operated with a torque wrench to prevent over-torquing.

3.8.7.2 Administrative Controls – Toxic Gas Distribution Process

Fluorine (F_2)

1. All replacement gaskets, flanges, and valves are cleaned prior to admitting any F_2 to remove foreign material that may react with the F_2.

2. Preconditioning of replacement equipment is required to minimize failures of the primary system due to reactions with the gas.

3. Valving line-ups are required to reposition the F_2 block valves and the Lockout/Tagout program provides administrative controls to prevent inadvertent opening of the system.

4. Two operational personnel are required during valving in of tubes.

5. Operating procedures restrict the number of tubes that can be valved open to the common trailer manifold to the equivalent of one full tube. For the purposes of this control, the phrase "equalent of one full tube" means less than or equal to 250 lbs of F_2. This weight limit encompasses a single tube that contains approximately a 10% overfill from the nominal tube operating pressure. Multiple tubes can be valved open to the common trailer manifold (e.g., during heeling operations) provided the combined fluorine inventory of the opened tubes does not exceed the "equivalent of one full tube" limit.

Chlorine Trifluoride (ClF_3)

1. All replacement gaskets, flanges, and valves are cleaned prior to admitting any ClF_3, F_2 or mixed gases to remove foreign material that may react with these gases.

2. Preconditioning of replacement equipment is required to minimize failures of the primary system due to reactions with the gas.

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3. Valving line-ups are required to reposition the ClF_3, F2 or mixed gases block valves and the Lockout/Tagout program provides administrative controls to prevent inadvertent opening of the system.

4. Two operational personnel are required during cylinder changes.

5. Operator training shall provide for proper handling of the applicable toxic gas as well as notification of any releases to emergency response personnel should a major release of toxic gas occur.

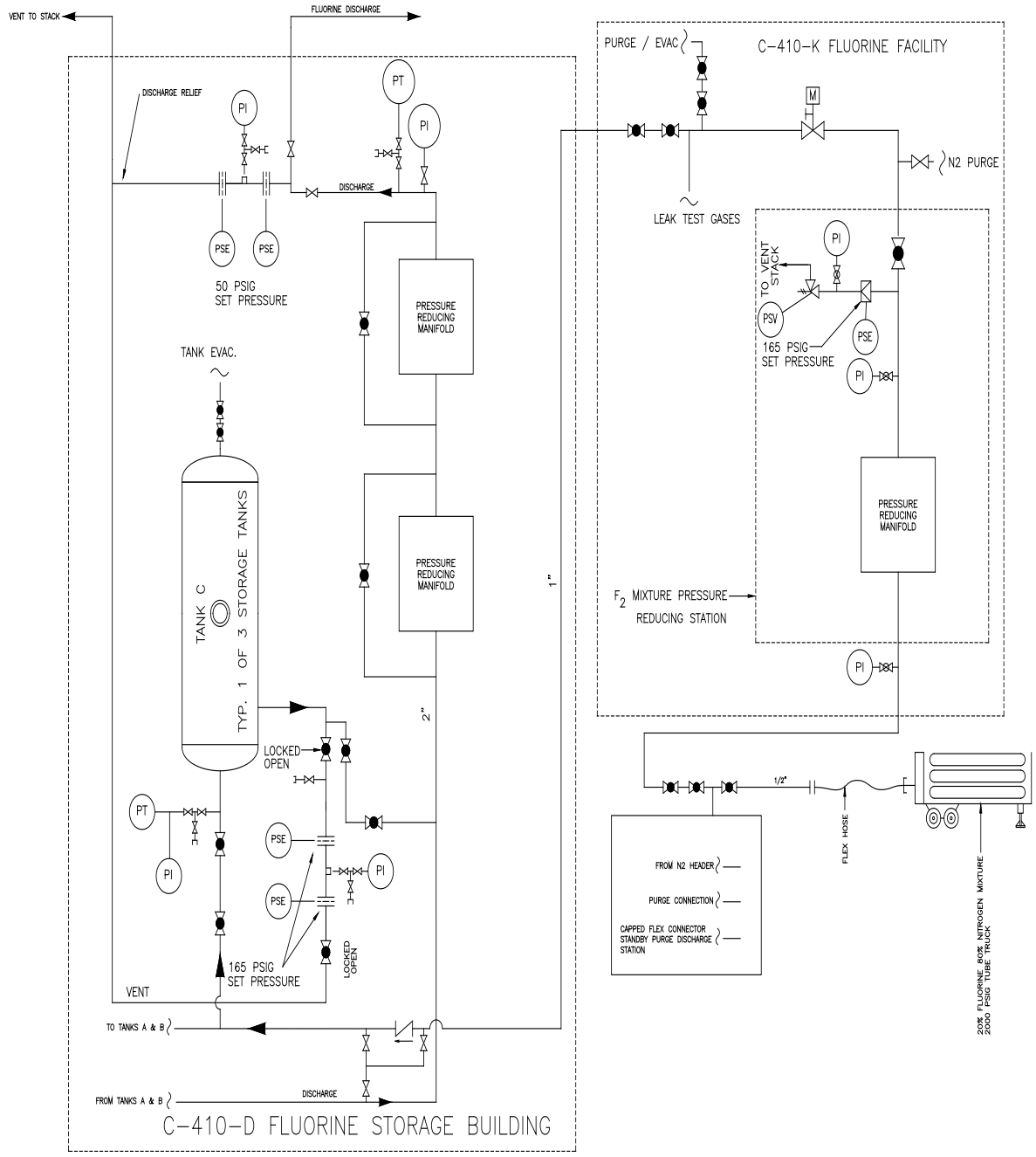

Figure 3.8-1. Fluorine System

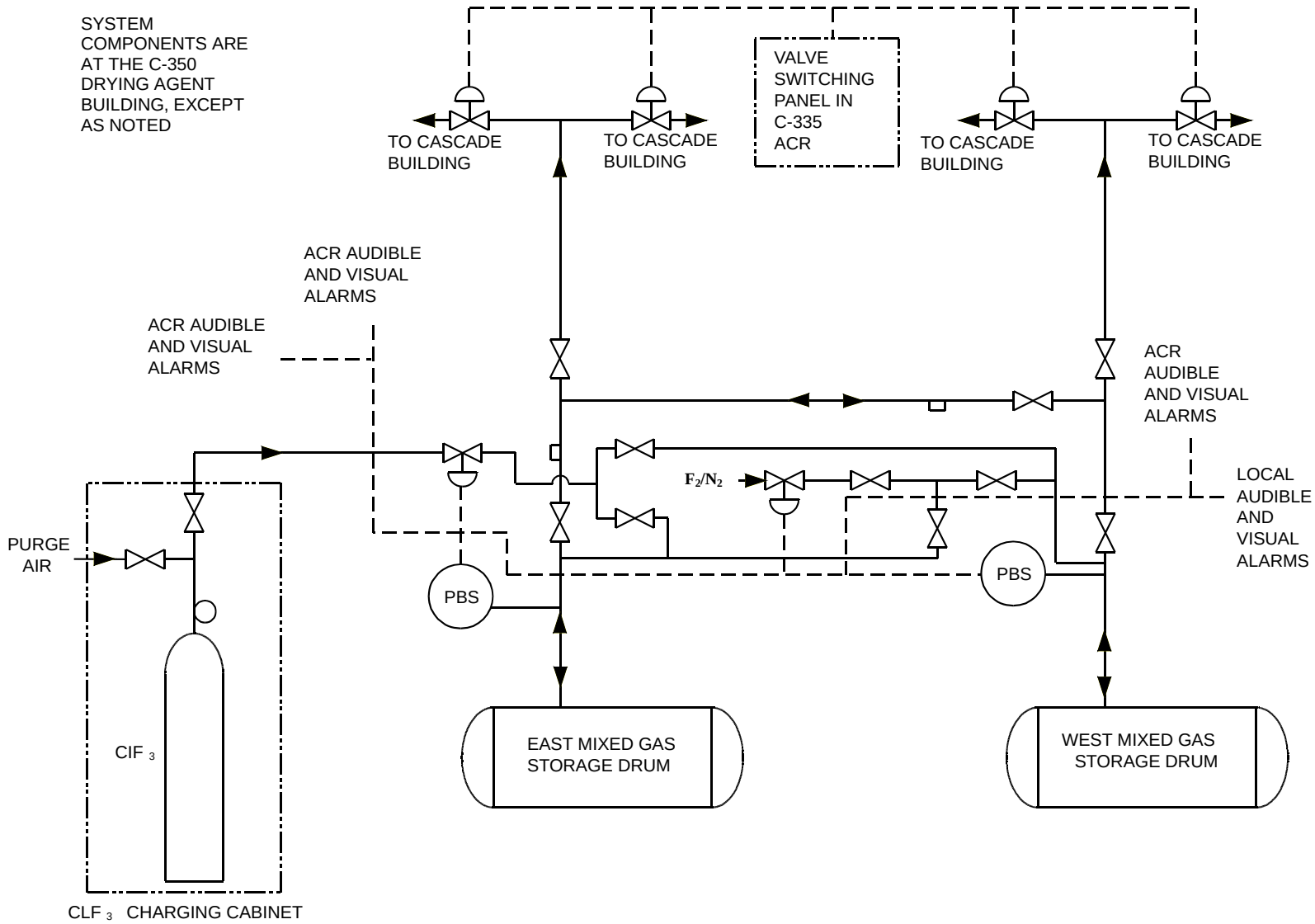

Figure 3.8-2. Conditioning Gas Feed System

3.9 UTILITIES

The gaseous diffusion process requires a number of auxiliary or utility systems which are essential for plant operation but are not directly concerned with isotope enrichment. However, for adequate isotope enrichment operations the usage of some utilities, particularly electricity and water, require extensive distribution systems. The major utilities described below include electrical, water, steam, compressed air, nitrogen, and chlorine and sulfuric acid for water treatment. Incidental utilities addressed are the oxygen and acetylene facilities. Other utilities which include fuel oil, propane, and natural gas, are discussed in Section 3.13.3.

3.9.1 Plant Electrical System

3.9.1.1 AC Electrical Systems

Electrical power is normally provided by off site electrical power suppliers. Power is received over 161-kV transmission lines at plant switchyards where transformers reduce the voltage to 14-kV and distribute it to 14-kV buses. These 14-kV buses supply feeders which distribute power to the process buildings and the various plant auxiliary buildings.

Each “000” and “00” process building is served by a 161-kV switchyard and a 14-kV Switch House. The C-531-2 Switchyard and the C-533-2 Switchyard share a common C-532 Relay House which houses control, instrumentation, and protective relays for the 161-kV power. The C-535-2 Switchyard and the C-537-2 Switchyard have a similar C-536 Relay House arrangement. The 14-kV buses are also located at the switch houses. Feeders from the 14-kV buses supply power to process substations located on the ground floor of the process buildings. Power for the process substations in C-310 is received from the C-531, 14-kV Switch House. These substations contain a transformer, which reduces the voltage to 4,160 volts or 2,400 volts, and switchgear that supplies power feeders to each enrichment cascade process motor.

Each process building is organized into units and each unit into cells. Each unit contains multiple process substations and each substation supplies multiple process motors. Typical diagrams showing the 161-kV, 14-kV, and process electrical systems are shown in Figures 3.9-1, 3.9-2 and 3.9-3. Each 161-kV bus supplies multiple power transformers and each 14-kV bus supplies multiple process substation feeders.

Power to the plant auxiliary buildings and the process auxiliary substations is also supplied by 14-kV feeders from the 14-kV buses. Each process auxiliary unit has multiple substations each supplied from a different feeder and they are interconnected on the secondary side for high reliability. Most plant auxiliary buildings are equipped with one or more double-ended substations with each end supplied by a different 14-kV feeder. The 14-kV feeders supplying these substations are of the looping type and may supply several different substations.

3.9.1.1.1 Paducah Area 161-kV Transmission System

The 161-kV transmission system provides power to the plant and is an interconnection point between several offsite electrical power suppliers.

Power is transmitted to the various plant switchyards by multiple 161-kV overhead lines. Transmission voltages are maintained at appropriate levels to achieve efficient operation of electrical equipment.

The electrical power system is subject to faults which, if not isolated quickly, may reduce the system voltage so low that the entire system becomes unstable and can cause a total power failure. Protective relays are installed in the electrical system to detect, locate, and isolate the majority of these detrimental conditions.

3.9.1.1.2 161-kV Switchyards

The 161-kV switchyard equipment consists primarily of five major items:

- Incoming 161-kV power lines (discussed above)
- Protective Relays
- 161-kV buses
- Oil circuit breakers
- Power transformers

3.9.1.1.2.1 Protective Relays

Protective relays are installed for the 161-kV transmission system to isolate faulted lines by disconnecting them from their source of energy and load during abnormal conditions. These relay schemes have backup relays to provide protection in case of malfunction of the initial relay. Facilities are available to do routine maintenance and testing on line relays without removing the lines from service.

3.9.1.1.2.2 161-kV Buses

All incoming transmission lines connect through oil circuit breakers (OCBs) and disconnect switches to the buses in the 161-kV switchyards. The 161-kV bus on each side of the switchyard supplies power through the OCBs to the power transformers. The switchyards are arranged in a “breaker-and-a-half scheme” which utilizes two buses with rows of three interconnected OCBs and associated switches. Normal operation would have both buses energized and all OCBs closed. Either bus or any breaker can be removed from service without interruption of power flow or disruption of relay protection. This layout optimizes equipment flexibility, maintenance, and switchyard reliability.

The 161-kV buses are designed to withstand the maximum fault current available. The loss of one bus for any reason will normally not interrupt power.

Switchyard vehicular entry is controlled. Electrical clearances in each switchyard comply with industry standards, providing reliability of operation and safety for personnel under all conditions. Personnel are protected from abnormal ground voltage gradients by a grounding system. All OCBs and

transformers in the yard have automatic fire sprinkler systems and equipment is located to provide isolation and segregation, to reduce the spread of fire.

3.9.1.1.2.3 Oil Circuit Breakers

OCBs have a dual use. They are used for opening and closing circuits to energize or de-energize equipment. This use is commonly associated with normal power system operations. Secondly, they are used to isolate electrical faults and overloads when initiated by the protective relay systems.

There are many OCBs in the switchyards. The OCB's employ an air-operated, charged-spring operating mechanism. Compressed air closes the OCB interrupter contacts and charges the OCB opening spring. The charged spring provides a fail-safe means of opening the OCB.

Safe operation and maintenance of the OCBs are assured in several ways. In addition to physical separation of the units to minimize spread of fire and explosion damage, each is provided with an automatic fire protection sprinkler system. Malfunctions are reduced by use of the charged-spring design and a protective relaying system for controlled operation during abnormal conditions. In addition to the normal relaying, each breaker has a breaker-failure back-up relaying scheme. If a breaker fails to open by primary relay operation, adjacent breakers will operate to isolate the fault.

Auxiliary systems for the OCBs consist of a self-contained compressed air supply that consists of an air storage tank and compressor for each OCB. A normal and alternate power source is provided for the compressor motor to improve reliability.

3.9.1.1.2.4 Power Transformers (161-kV and 14-kV)

The power transformers reduce the line transmission voltage, 161-kV, to the nominal 14-kV distribution voltage. The OCB arrangement ("breaker-and-a-half scheme") provides two OCBs to control the source electrical supply to each of the transformers. Only one breaker is required to feed the transformer. However, the second breaker provides an alternate source of power during maintenance and provides additional system reliability.

There are many transformers in the various switchyards. One transformer in each of the four switchyards is designated as the reserve unit and can be used as a replacement for any other transformer in that particular yard. Each transformer has a tap-changing mechanism used to raise or lower the secondary voltage as required. This tap-changer is controlled either manually or automatically at the switch houses, or manually at the CCF, located in the C-300 Central Control Building. Some transformer's load tap changers can be DC powered and operated on batteries or manually. Some transformer's load tap changers can be AC powered and operated manually upon the loss of AC power.

Each transformer is protected from fire by physical separation and by automatic fire sprinklers. The gas blanket on the transformer is sampled periodically for products that indicate internal electrical arcing and incipient faults. Lightning arrestors are installed on the transformer terminals.

Transformers are protected by an electrical relaying system which isolates and de-energizes the unit when faults, overloads, and other abnormal conditions occur. This back-up relaying scheme enhances the reliability of the system.

3.9.1.1.3 14-kV Distribution System

The 14-kV distribution system is used to provide power to various substations throughout the plant. The 14-kV distribution system is composed of five major types of electrical equipment:

- Transition bus ductwork
- 14-kV switchgear
- 14-kV feeder cables
- 14-kV synchronous condensers
- 14-kV static capacitors

The transition bus ductwork transfers power from the low voltage terminals of the power transformers to the 14-kV switchgear. The switchgear then transfers power to the process transformers and auxiliary transformers via 14-kV feeder cables. The synchronous condensers and 14-kV static capacitors are used for power factor improvement and voltage regulation. They are connected to the 14-kV switchgear via electrical power feeder cables.

3.9.1.1.3.1 Transition Bus Ductwork

The 14-kV power is supplied from the transformers to the switchgear via isolated phase bus ducts, each consisting of a metal enclosure containing insulator-supported conductors.

The main current carrying parts of the bus duct are protected by zones of relaying used to detect faults within the protected zone.

3.9.1.1.3.2 14 kV Switchgear

The 14-kV switchgear provides the means for disconnecting and protecting electrical equipment. Each switchgear typically has multiple adjacent air-operated circuit breaker (ACB) cubicles, each containing an ACB and interconnecting bus conductors. A common 14-kV bus is connected to each ACB. Each unit is composed of various combinations of cubicles. A typical switchgear feeder cubicle contains an ACB with the necessary electrical bus conductors to receive power from the 14-kV bus and to supply power to process distribution 14-kV feeder cables. Each ACB cubicle contains an air-operated opening and closing mechanism and instrument and current transformers for monitoring the amount of current flowing through the breaker and feeder. One cubicle of the switchgear is reserved for the bus potential transformers which are sensing devices for relaying and voltage monitoring. When required, the switchgear also has breakers to connect the switchgear bus to the synchronous condensers and 14-kV static capacitors. Each ACB contains manually operated disconnect switches which, when opened, physically disconnect the ACB from sources of electrical power and allow routine maintenance to be performed without removal of the entire switchgear from service.

To assure proper operation of the air-operated ACB opening mechanism, minimum air pressure is maintained by an air compressor system in each switch house.

ACB's serve a variety of 14-kV equipment. To assure proper operation of the air-operated opening mechanisms for these breakers, a minimum air pressure is maintained. The minimum operating pressure is slightly above the low pressure lockout device setting. If the lockout actuates, the breaker is inoperable until air pressure is restored to a higher value.

3.9.1.1.3.3 14-kV Feeder Cables

The feeder cables deliver power from the 14-kV switchgear to the process and auxiliary substations. The 14-kV feeder cable system includes all cables delivering power from the 14-kV switchgear, and the structures necessary to support them. The cables are installed in either underground conduit or overhead cable trays which support, protect, and route each feeder from the 14-kV switchgear ACB to the process or auxiliary substation. Some auxiliary 14-kV distribution feeder circuits are installed overhead on utility poles.

The 14-kV overhead cables are positioned to avoid mechanical damage by vehicular traffic.

3.9.1.1.3.4 14-kV Synchronous Condensers

Since the load is mostly induction motors, a lagging power factor is produced which must be corrected to provide acceptable area voltages. Both synchronous condensers and static capacitors are used for power factor improvement and to maintain voltage levels.

There are synchronous condensers in the C-531-1, C-535-1 and C-537-1 Switch Houses. The synchronous condensers are large, hydrogen-cooled, three-phase synchronous motors running overexcited.

Each synchronous condenser is tied to a 14-kV bus via cables and an ACB. Protective relaying devices are located in the switch house control room.

The condenser shell contains hydrogen for the cooling gas. Automatic sprinkler systems are provided underneath the units and around the lube oil pumps for fire protection. The condensers can be run in air when necessary but the capability is reduced for such operations.

3.9.1.1.3.5 14-kV Static Capacitors

In addition to synchronous condensers, static capacitors are used as another means of correcting and improving the power factor. The plant has several 14-kV static capacitor banks; each connected to a 14-kV bus through three-phase cables and an ACB.

3.9.1.1.4 Process Electrical System

The process electrical system provides power to the process buildings. It consists of transformers, static capacitors, switchgear, controls and associated circuits. The transformers reduce the voltage to the proper level for use by the process motors. Switchgear distributes the power and provides on-off switching to the motors. Power factor correction is provided by static capacitors. The process electrical system is powered from the 14-kV busses located in the Switch Houses and the Switch Houses are powered from the 161-kV transformers located in the Switch Yards (see Figures 3.9-1, 3.9-2 and 3.9-3).

3.9.1.1.4.1 Process Transformers

The primary function of the process transformers is to supply power to the process motors. The main process electrical equipment in the process buildings is divided into units with ten cells per unit. Each unit is equipped with the required quantity and sizes of transformers. Typical process cells receive process power from appropriate 14-kV transformers. The 14-kV transformers reduce the voltage to the required level for the respective cells; C-331 and C-335 (14-kV/4,160 VAC), C-333 and C-337 (14-kV/2,400 VAC), C-310 (14-kV/480 VAC), (see Figures 3.9-1, 3.9-2 and 3.9-3).

Smaller 480-120/208 volt transformers supply power to various distribution panels throughout the process buildings. These lower voltages are required for input or control power for various important to safety systems that are described in Section 3.15.

The 14-kV/4,160-volt and 14-kV/2,400-volt transformers are protected by differential relays which sense the current magnitude difference between the input and output current of the transformer. The secondary bus is protected by overcurrent relays, which sense current above a predetermined value. Protective relays are also used to protect 480-volt transformers and buses. These relays sense the abnormality and operate to trip the breakers necessary to isolate the trouble. The 480 VAC distribution circuits are usually protected with breakers with built-in overcurrent devices that cause the breaker to open when an overcurrent is sensed.

3.9.1.1.4.2 Process Switchgear

The process switchgear provides a method for distributing power to, disconnecting and protecting the motors and feeders supplied by the process transformer. Each transformer with its associated switchgear makes one substation.

Vital parts of metal-clad switchgear enclosures and breakers are made of flame retardant materials. The design presents a minimum fire hazard and is suitable for indoor installation without being placed in a vault. Switchgear buses are vital and are designed to carry the available fault current until circuit breakers can open and interrupt the fault. Circuit breakers are rated to interrupt the maximum fault current that is available at the bus.

3.9.1.1.4.3 Static Capacitors

Static capacitors in the “000” buildings (C-333 and C-337) and in the “00” buildings (C-331 and C-335) are in separate cabinets from the process substations but are electrically tied directly to the substation secondary buses. The units are used to improve power factor, maintain voltage and decrease feeder cable loading. Some cells may not have static capacitors.

3.9.1.1.4.4 AC Auxiliary Power

Separate substations for AC auxiliary power are fed from the 14-kV switchgear.

The substations contain 14-kV to 480-volt transformers. Each 480 VAC transformer in a unit is fed from a separate 14-kV feeder and switchgear bus located in one of the switch houses. In those units that have a fifth transformer, two auxiliary transformers share the same 14-kV feeder. The loss of a switchgear and feeder will affect only one transformer (two transformers, for the "fifth transformer arrangement") in a unit. The secondaries of the transformer (480-volt side) are connected in such a manner that a loss of two of the four (or five) auxiliary transformers in a unit would still not cause a total loss of auxiliaries, although nonessential loads may have to be reduced.

The auxiliary substations have dry-type 14-kV to 480-volt transformers with associated circuit breakers, disconnect switches, controls and indications, all contained in a heavy metal box-like enclosure with access panels and emerging conduits to the electrical loads. The unit feeds lighting, ventilating fan motors, lube oil pumps, motor-operated valves, and the necessary loads other than the main process compressor loads.

There are 480-120/208 VAC transformers provided to supply low voltage AC power via distribution panels for the various systems throughout the process buildings. These transformers are fed from the 480-volt switchgear. The important to safety systems requiring 120 VAC are described in Section 3.15. In addition, there are lower voltage systems where the power supply is derived from 120 or 480 VAC systems (e.g., the circuits supported by 48 VAC power). DC power systems derived from low voltage AC power sources are described in 3.9.1.3.

3.9.1.2 AC Diesel Generators

3.9.1.2.1 Introduction

Although not important to safety, AC diesel generators (often referred to as "diesel generators" or just "generators") are an important component of the electrical power supply and distribution system. For numerous systems throughout the plant that are important to safety or critical to plant operations, diesel generators provide back-up AC power in the event of failure of the AC power system. Reliable and safe operation of AC powered equipment depends upon constant and secure DC control power. This reliability is provided by the diesel powered generators and DC storage batteries.

In some AC powered systems, diesel generators start automatically on loss of normal AC power and provide a direct source of AC power to the connected load through an automatic transfer switch. The diesel generators can provide a source of AC power to equipment that is important to safety or critical to plant operations until normal AC power can be restored or until other appropriate action is taken by plant operations personnel.

The DC power system contains many large electrical station storage batteries, located in dedicated battery rooms that are dispersed throughout the facility to provide DC power to systems that are important to safety or critical to plant operations. Some loads that are important to safety or critical to plant operations must be supplied even during a major power outage. This need is supplied by station batteries. The DC power systems are normally supplied power from rectifiers that are powered from the AC system. The rectifiers provide power to DC loads that are important to safety or critical to plant operations while also charging the DC system batteries. If the normal AC power supply fails, the diesel generators start automatically and automatic switching transfers the power source from normal AC power to the diesel generators. The diesel generators then provide AC power to critical equipment including the

rectifiers until normal AC power is restored or until plant operations personnel take other appropriate action.

In the unlikely event that both the normal AC power supply and the diesel generator power for a specific system or facility area fails, only lighting loads are transferred from AC power to DC power. All other loads requiring AC input power will be lost.

3.9.1.2.2 Diesel Generator Applications

3.9.1.2.2.1 Buildings With Diesel Generator AC Power Service

Many systems that are important to safety or critical to plant operations rely on diesel generators to ensure reliable and safe operation. Diesel generators provide back-up AC power for a variety of equipment and systems in the following buildings:

C-200	Guard and Fire Headquarters
C-300	Central Control Building The CCF receives backup AC power from a diesel generator located in C-310. Batteries in the basement of C-300 supply DC power for control power and backup lighting.
C-310	Purge and Product Building
C-315	Surge and Waste Building
C-331	Process Building
C-333	Process Building
C-335	Process Building
C-337	Process Building
C-400-A	Emergency Power for Critical Alarms (this generator is powered by propane)
C-600	Steam Plant & Associated Utility Appurtenant Structures (The backup generator for C-600 is located in the area of C-607)
C-607	Emergency Air Compressor Generator Building
C-611-H	Filter Building and Pump Station

All five of the major cascade buildings, C-310, C-331, C-333, C-335 and C-337, have backup AC diesel generators. C-331 and C-335 each have two backup AC diesel generators; C-333 and C-337 each have three backup AC diesel generators and C-310 has one backup AC diesel generator.

Backup power for the C-315 building is provided by the AC diesel generator located in the C-331 building.

In addition to the buildings listed in this section, which are important to the production process, some other buildings also have backup generators or other backup power supplies.

3.9.1.2.2.2 Diesel Generators and Process Building AC Power Failure

The stage motors stop during a power failure reducing the cell pressure to subatmospheric. Diesel generators start automatically to furnish power to close valves in order to prevent assay mixing and to allow stage pressures to be monitored.

3.9.1.2.2.3 Diesel Generators and Process Building DC Power Failure

The DC control systems in the cascade control power to the process motors. Reliable and safe operation of the AC power equipment depends upon a constant and secure DC control power. This reliability is provided by the diesel power generators and storage batteries.

Reliable operation of cascade operations equipment that is important to safety or critical to plant operations is essential during total building power failures. Under the present system, backup generator power can be supplied to the following:

1. Selected seal exhaust pumps,
2. Motor-operated valves,
3. Datum pump motors,
4. Line recorders,
5. Mass spectrometers, and
6. Lighting and battery chargers in C-331, C-333, C-335, C-337, and C-310.

3.9.1.2.3 Diesel Generator Starting, Operation and Testing

Diesel generators are maintained so that they can be started and operated automatically and pick-up the load automatically when AC power fails. If automatic start fails, the diesel generators can be started manually. The diesel generators are started by compressed air from storage tanks. The readiness of the backup diesel generators is ensured by regular maintenance, periodic starting, running and testing.

3.9.1.3 DC Electrical Systems

3.9.1.3.1 DC Systems Overview

There are numerous independent DC electrical power systems within the plant. A typical DC power system consists of a battery, rectifier(s), a distribution cabinet (contains the respective circuit breaker load served by the battery), and the necessary wiring circuits that serve the various DC loads. Each rectifier (battery charger) is powered from a 480-volt AC or lower voltage power source. The rectifier produces DC output power that supplies the various DC loads and also charges the battery. In the event of failure of both the “normal” (off-site power) AC power and the “back-up” (on-site diesel generator), if one exists, AC power sources that serve a rectifier, or in the event of a direct failure of the rectifier, the battery assumes the rectifier load. The DC battery serves the same loads as the subject rectifier.

The DC electrical power system for alarm power consists of only a rectifier and a distribution cabinet. If AC power to the rectifier is lost, of if the rectifier itself fails, the system is automatically transferred to the control power DC system via an automatic transfer switch.

The DC control and alarm power for C-300 are part of the same system. The primary system consists of a rectifier and distribution cabinet which normally supply the loads. A battery with its own battery charger is connected to the system via a transfer switch. If the AC power or rectifier fail, the system is automatically transferred to the battery.

There are multiple batteries of varying voltages, and multiple battery rooms, in many buildings. These multiple batteries and their associated distribution cabinets and wiring are often collectively referred to as the "DC System," the "DC Power System," the "DC Power Distribution System" or by other similar terms. These various batteries include several specific voltage levels (for example, one voltage level is the "250-volt DC power system"). The plant has 250, 125 and 48-volt batteries and associated DC Power Distribution Systems.

There are numerous independent DC electrical power distribution systems of the same or a similar configuration that operate at the same voltage level within various buildings at the plant.

The purpose of the various DC electrical power systems at the plant is to assure the uninterrupted supply of control and alarm power to systems and components that are important to assuring safe operation of plant systems and equipment as well as assuring the safety of personnel. Some of the various DC electrical systems are also important to the uninterrupted operation of various plant production processes. The portion of the DC power distribution system that is important to safety is identified in Section 3.15.

3.9.1.3.2 DC Systems Applications

3.9.1.3.2.1 Switch Houses and their Associated Relay Houses and Switchyards

Certain DC electrical loads that are important to safety or critical to plant operations that are located in the switch houses, and their associated relay houses and switchyards must continue to receive reliable DC power even during a loss of both normal and back-up AC power. To ensure this, a 250-VDC station battery is located in each switch house. The power from the 250-VDC batteries is distributed through 250-VDC buses. Each of these 250-VDC batteries and their associated 250-VDC bus configuration provides a highly reliable backup power system.

DC loads that are important to safety or critical to plant operations that are located in the switch house and associated relay house and switchyard are powered from the switch house 250-VDC bus system. Battery chargers that are connected to the buses power the 250-VDC buses located in the switch houses. Through the 250-VDC buses, the battery chargers also maintain the station batteries in a fully-charged state of readiness by supplying a charge to the batteries as long as the battery chargers are receiving AC power. Each switch house battery has two battery chargers. There is one charger for normal service and one spare charger for use should the normal charger fail or should the normal charger be out of service for maintenance. When both normal and back-up battery chargers are not available to

supply these important DC loads, the DC buses and associated loads are supplied from stored energy from the respective 250-VDC batteries.

The 250-VDC system in the switch house supplies power that is necessary to operate the DC powered 161-kV transformer tap changers (manual or automatic), oil circuit breakers (OCBs), 14-kV air circuit breakers (ACBs) control circuit, switch house relay functions, alarm systems, and backup lighting for the switch houses and their associated relay houses. A control panel located in each switch house control room distributes, monitors and controls the DC System power that is associated with the respective switch houses, relay houses and switchyards.

A DC electrical system is also used to provide power for the protective relay system and other systems in the switch houses, relay houses and switchyards that are important to safety or critical to plant operations.

Loss of DC control power to loads that are important to safety or critical to plant operations can occur. This occurrence is highly unlikely. If protective relaying capability is lost for any reason, the affected equipment is manually shut down until repairs are made.

3.9.1.3.2.2 Process Building DC Power

The process building local control panels require 250-volt DC power to control breakers in the switch houses, process substations and process auxiliary substations. 125-volt DC control and back-up alarm power is required in the ACR and for selected backup lights. 125-volt DC also provides power to the CAAS horns and lights.

A rectifier with a three-phase 480-volt AC input provides DC power in each unit and charges the battery. If the rectifier fails, the battery will carry the load until AC power is restored. The system consists of a battery, an AC rectifier (battery charger), a DC power distribution cabinet, and all wiring circuits necessary to connect the load. The referenced equipment is located in each battery room in each process building. If the battery charger's normal power source is lost due to a total building power failure, it will automatically be fed by the building backup diesel generator (refer to Figures 3.9-4, 3.9-5, 3.9-6 and 3.9-7 for the DC power distribution system supporting the shutdown of the stage compressor motors and the C-315 high speed withdrawal motors).

The DC control systems are important in the cascade to provide control power to the process equipment protective devices. Reliable and safe operation of the AC power equipment depends upon a constant and secure DC control power. The diesel power generators and storage batteries provide this reliability.

3.9.1.3.2.3 Central Control Facility (CCF)

The CCF requires 125-volt and 48-volt DC Power to assure that operations functions can be successfully accomplished.

125-VDC power is required at the CCF for shutdown of compressor motors in buildings C-310, C-331, C-333, C-335 and C-337, as well as the shut-down of P&E and interbuilding booster pump motors

(see Figures 3.9-4, 3.9-5, and 3.9-6). Additionally, 125-VDC power is required for emergency lighting, local substation control power, OCB control, ACB control and communications.

A rectifier with a 480 VAC input serves the DC power load and charges the battery. The 125 VDC system consists of a battery, battery charger, DC power distribution cabinet and necessary wiring circuits to connect the load. The battery is located in a battery room in the basement of C-300. The supporting equipment is located in adjacent rooms.

48-VDC power is required at the CCF for illumination of the "loss of 120 VAC power" indicator lights on the Control Console. 48-VDC power is also required to support the actuation of the CAAS building horns and lights, as well as operation of the evacuation alarm system.

A rectifier with a 120/208 VAC input serves the DC power load and charges the battery. The 48 VDC system consists of a battery, battery charger, DC power distribution cabinet and necessary wiring circuits to connect the load. The battery is located in a battery room in the basement of C-300. The supporting equipment is located in adjacent rooms.

3.9.1.3.2.4 Supervisory Control and Data Acquisition

The SCADA system provides monitoring and/or control of selected portions of the plant electrical system. Information provided by SCADA maximizes the operator's effectiveness in monitoring and controlling selected portions of the plant electrical system. The SCADA system provides data such that a single component failure will not compromise the overall performance of the system.

3.9.2 Water Systems

Facilities are provided for the treatment of supply water and the treatment of waste water. Facilities and piping systems are provided for the distribution of supply water and the removal of waste water.

Raw water is taken from the Ohio River, treated and supplied for numerous, varied uses. Raw water, normally treated by softening, flocculation, disinfection, and settling is referred to as settled water and is divided for use in the sanitary and fire water system (SFWS) and plant water system (PWS). Settled water for use in the SFWS is filtered, post disinfected and used to supply potable water, fire water, the chilled water system and other uses. Settled water for use in the PWS receives no further treatment and is used to supply the recirculating cooling water (RCW) system and the High Pressure Fire Water System (HPFWS), (see Figure 3.9-8 for a general schematic diagram of the various plant water systems and their inter-connections).

Waste water streams are treated as required to meet the effluent limitations of the Kentucky Pollutant Discharge Elimination System (KPDES) Permit prior to discharge into receiving streams. Waste water streams are treated at various treatment facilities, for example, the C-615 Sewage Disposal Plant, Collection System and Appurtenant Structures or the C-616 Liquid Pollution Abatement and Appurtenant Structures.

3.9.2.1 Raw Water System

The raw water supply source for the plant is the Ohio River, downstream of the confluence of the Ohio, Cumberland and Tennessee Rivers. Raw water is taken from the Ohio River at a pumping station operated by TVA under contract to USEC at the Shawnee Steam Plant. The pumping station uses vertical turbine pumps that are located in pump wells. The pump groups are supplied from separate electrical buses through a double ended substation so an interruption of either bus does not impact the plant water supply.

The raw water pumps discharge into one or both of two pipe lines that carry the water to the C-611 Water Treatment Plant Distribution System and Appurtenant Structures. Regardless of whether the lines are being operated separately or simultaneously, the raw water system can supply a sufficient water flow to C-611 to maintain the maximum cascade power load.

Protection of the raw water system from zebra mussels is provided by an anti-mollusk chemical feed system.

3.9.2.2 Water Treatment Plant

The processes used for raw water treatment at C-611 are both physical and chemical. The various processes for raw water treatment that provide softened water are briefly described in the following paragraphs. Mechanical outages and/or raw water conditions adverse to softening and/or flocculation may alter this normal treatment process.

The cold lime-soda ash process is employed at C-611 for softening the water. A coagulant aid is also used when conditions require.

Softening is followed by flocculation and prechlorination, and then by settling prior to further treatment for the sanitary and fire water system (SFWS) or as settled for the plant water system (PWS). Predisinfection is carried out after the softening process which reduces chlorine consumers.

After leaving the flocculator basin, water flows to the settling basins. Settled water leaving the settling basins is divided for use in the SFWS and the PWS.

3.9.2.3 Sanitary and Fire Water System

Settled water for the SFWS is processed through sand filters for the removal of suspended particles, referred to as turbidity. The filters are operated to maintain the turbidity in the SFWS per Kentucky Public and Semipublic Drinking Water Regulations. Under normal operations, the effluent of the filters is post-chlorinated and then flows to the clearwell for supply to the SFWS.

Post-chlorination is performed to ensure an adequate disinfectant concentration in the water before entering the distribution system. Samples are taken of the water entering the distribution system and at various locations in the distribution system to ensure that chlorine levels in the distribution system remain at or above the minimum value of the Kentucky Public and Semipublic Drinking Water Regulations. Additionally, the sanitary and fire water system is routinely sampled for bacteriological analyses, with the

samples tested by an independent, certified laboratory, per Kentucky Public and Semipublic Drinking Water Regulations.

Water for the SFWS is pumped from the clearwell, located at C-611, into two mains which convey the water to the SFWS distribution system. Electric motor, dual drive electric motor/diesel engine driven, and diesel engine pumps are used to supply the SFWS as required by demand usage of water.

The SFWS within the fenced portion of the plant is a system of underground mains. These mains supply sanitary water for drinking, boiler makeup water, laundry, firewater, and numerous other operations that require sanitary water and sanitary water to the DOE DUF_6 Conversion Plant.

The firewater demands arise from fire hydrants located around various buildings and from sprinkler and other fire suppression systems in buildings when such systems are provided and they are not supplied by the HPFWS.

The C-611-O Sanitary Water Storage Tank, located east of the C-631-02 Cooling Tower, floats on the system during normal operation and has a maximum capacity of 250,000 gallons at overflow.

3.9.2.4 Plant Water/RCW System

The plant water system supplies makeup water to the RCW system serving the C-310, C-315, C-331, C-333, C-335, C-337, C-360 Toll Transfer and Sampling Building, C-631 RCW Pump House and Appurtenant Structures, C-633 RCW Pump House and Appurtenant Structures, C-635 RCW Pump House and Appurtenant Structure, and C-637 RCW Pump House and Appurtenant Structures areas. This system also supplies side stream cooling water to the C-600 Steam Plant & Associated Utility Appurtenant Structures. In addition, the plant water system normally supplies the water charge and makeup water for the HPFWS and water to the DOE DUF_6 Conversion Plant.

Settled water intended for use in the PWS flows to the plant water pumps located at C-611. Electrically driven pumps supply the PWS as required by demand. The plant water flows through a normally looped system to supply the recirculating cooling water systems, C-631, C-633, C-635, and C-637. Plant water may also be supplied to the recirculating water systems by gravity during periods of low cascade power load or an outage of the pumps.

There are two booster pump stations located within the PWS. The C-611-P Pump House provides the side stream cooling water for use in C-600. The C-611-T Booster Pump Station (Plant Water) is located in one leg of the looped system, and can be used to supply plant water to the recirculating cooling systems in the event of an outage of the pumps located at C-611.

Water lost through evaporation in the cooling towers is made up by the plant water system. Evaporation causes the dissolved minerals in the recirculating cooling water to concentrate. To prevent solids accumulations from exceeding desired levels, a blowdown stream is provided. The blowdown stream is routed to C-616 for treatment before discharge to the receiving stream.

3.9.2.5 High Pressure Fire Water System

The High Pressure Fire Water System (HPFWS) supplies water to C-310, C-315, C-331, C-333, C-335, and C-337 process buildings, the C-310-A Product Withdrawal Building, the C-360 Toll Transfer and Sampling Building, the C-620 Air Compressor Room, the C-631-03 Pump House (Firewater), and the RCW blend pump houses. It also supplies the water spray systems in the RCW cooling towers. (see Figure 3.9-9).

The HPFWS consists of a distribution piping network, a 300,000-gallon elevated storage tank [C-611-R Water Tank – RCW Fire Water (High Pressure)], a water supply reservoir (C-631-02 cooling tower basin) and four water pumps (housed in C-631). The distribution piping network is a system consisting of underground mains and smaller lead-in pipes, automatic wet pipe sprinkler systems that distribute high pressure fire water to the point of use at sprinkler heads in the process buildings, and the RCW cooling towers (see Figure 3.9-9). The lead-ins serve as tie lines which connect each automatic sprinkler system within a process building to the HPFWS distribution system. A single control valve [i.e. a post indicator valve (PIV)] is located in each lead-in as a single control point for potential isolation of the sprinkler system. Many sectional isolation valves are located in the distribution piping system to permit isolation of one or more building sprinkler systems should the need arise.

Water can be supplied to the HPFWS from the RCW system via four water pumps located in C-631. Water pumps 2 and 3 are located in C-631-03. They take suction from the C-631-02 cooling tower basin. Pumps 5 and 6 are located in the C-631-01 Pump House. They take suction from the C-631-01 wet well. The C-631-01 wet well is connected to the C-631-02 cooling tower basin via a flume (see Figure 3.9-8). All four water pumps discharge into the HPFWS distribution loops. Pumps 2, 3 and 5 are electrically driven. The power supply for these pumps can be transformer 2PH3, 2PH4A or 2PH4B (13.8 kV-4,160 VAC) depending on how the associated 4,160 VAC switchgear bus, bus supply breakers, and bus tie breakers are configured. All circuit breakers that are fed from the 4,160 VAC switchgear main bus are equipped with protective relays. Pump 6 is driven by a diesel engine. The diesel engine is equipped with a fuel oil supply tank and fuel supply system that transfers fuel oil from the fuel oil supply tank to the diesel engine. The diesel engine is also equipped with an electric starting mechanism that is powered by batteries. Pumps 2, 3, 5 and 6 are connected by piping to the HPFWS distribution network. A pump may be used to perform routine pressure maintenance on the 300,000-gallon elevated storage tank (C-611-R) that floats on the HPFWS. Each of the water pumps starts automatically on a drop in HPFWS pressure. Each pump can be started remotely from the CCF, located in the C-300 facility, but the pumps can not be stopped from the CCF. Each pump can be started and stopped manually at the local pump control panel. All pumps and associated equipment are interconnected with the appropriate associated circuitry that is required for the High Pressure Fire Water System to function properly.

When a demand is placed on the HPFWS, water from the elevated storage tank flows into the distribution network to replace water that has been discharged. When the tank's water level has dropped to a preset limit, makeup water is pumped to the tank, automatically or manually. If the water level in the tank continues to drop, pressure switches in the water system will automatically activate the C-631

pumps. The elevated storage tank provides a gravity-fed supply of water to the fire sprinkler system that meets the functional requirements for flow rates, pressures, and duration. The various sprinkler systems are actuated automatically by the heat of a fire opening sprinkler heads thus initiating the flow of water through the system. The following table lists the capacity and type of each pump.

Pump No.	Capacity (gpm)	Motor Type
2	4625	Electric
3	4625	Electric
5	4500	Electric
6	4500	Diesel

With all pumps operating, a maximum of approximately 18,250 gpm is available to accommodate fire water needs. Should the water demand exceed the amount available (once the 300,000-gallon tank, C-611-R, has emptied) from the C-631-02 basin, the plant water system can supply up to approximately 25,000 gpm to the basin. In addition, approximately 9,000 gpm can be pumped to the basin from C-633 using the crossover piping and valve arrangement.

3.9.2.6 C-600 Chilled Water System

The C-600 chilled water system supplies water for air conditioning and humidity control equipment in various buildings.

3.9.2.7 Process Waste Heat Utilization System

A hot water heating system is used in some auxiliary service buildings. This system consists of a pumping station to supply hot water from the C-335 process RCW System, a piping distribution system to provide both supply and return water piping to each building and heating coils in each of the buildings for transferring the heat from the hot RCW to the building ambient air.

The RCW supply and return lines for the system are connected to the C-335 RCW system.

3.9.3 C-616 Liquid Pollution Abatement and Appurtenant Structures

The RCW systems are treated for corrosion control. A blowdown is used to control the buildup of soluble salts and nondissolved impurities, as a result of RCW evaporation. The corrosion inhibitors and other contaminants in the blowdown prohibit direct discharge of this water to the receiving stream (Big Bayou creek). The C-616 plant treats this waste water to lower the concentrations below the limits of the Kentucky Pollutant Discharge Elimination System (KPDES) permit.

The C-616 plant uses both chemical and physical processes to precipitate contaminants in the blowdown water for removal.

The C-616-F Full Flow Lagoon receives the effluent of the waste water treatment plant. Sludge generated in the clarifiers is routed to the lagoon for storage. Liquid and solid effluents are sampled and analyzed in accordance with accepted methods to ensure compliance with the KPDES permit.

3.9.4 C-615 Sewage Disposal Plant, Collection System and Appurtenant Structures

Sanitary sewage is waste water from various plant sanitary conveniences, cafeteria kitchen wastes, shower water, C-400 Cleaning Building and Appurtenant Structures, floor drains in some buildings, and small users of once through cooling water.

The sanitary sewage system consists of a collection system, flush tanks, lift stations, and a treatment plant at C-615. The collection system is a network of piping and manholes that carry the waste water from plant buildings to the C-615. Flush tanks are located at points of low flow to prevent solid buildup in the piping. Lift stations pump waste water from low to higher elevations to maintain gravity flow in the collection system.

The C-615 uses physical, biological and chemical treatment methods prior to discharging its effluent to Big Bayou Creek. The C-615 facility normally utilizes primary and secondary settling for the removal of settleable and floatable solids with anaerobic digestion. Biological oxygen demand is reduced by a trickling filter. KPDES permit-required samples are reported. The C-615 treats sanitary sewage to comply with the limits set forth in the KPDES permit.

3.9.5 Plant Steam and Condensate System

The C-600 steam plant consists of three steam-generating units, associated auxiliaries, and some other systems unrelated to steam generation. All generating units can burn fuel oil, two can burn pulverized coal, and one can burn natural gas. The steam plant supplies saturated steam continuously and on demand to specified buildings. Steam is distributed at approximately 100 psig through above-ground pipelines that form a looped distribution system. The pressure may be reduced to desired operating pressure inside buildings at steam reducing stations.

The condensate system piping follows the same routes as the steam system piping. This system functions as a method of removing the water formed by the cooling of the steam via steam traps. A portion of the condensate formed is returned to C-600 for reheating.

An exception to this flow of condensate is the autoclave areas. The condensate formed in the C-333-A Feed Vaporization Facility, C-337-A Feed Vaporization Facility, and C-360 are routed into condensate drains or appropriate waste containers (Sections 3.2 and 3.6).

3.9.6 Plant Air System

Dry compressed air (may also be referred to as “plant air”, “compressed air”, “instrument air”, “process air”, “air” or by other terms containing the word “air”) is required for plant operations. Pneumatic instruments, controllers, and valves are used for control of the many varied processes within the plant. Dry compressed air is also used in the enrichment process to operate purge and evacuation systems. In addition, dry compressed air is used for plant support production equipment operations,

steam plant operations, laboratory facilities, test facilities, maintenance functions, and other miscellaneous uses. Compressed air is also the source of air that is used to operate ACB opening mechanisms. The important to safety systems that are supported by plant air are described in Section 3.15.

Dry compressed air is normally supplied from three air compressor stations, C-600, C-620 Air Compressor Room, and C-335. An auxiliary compressor station in the C-607 Emergency Air Compressor Generator Building provides a backup supply source of dry compressed air. The various air compressors have different drive mechanisms. The C-600 compressed air station has both steam driven and electrically driven compressors. The air compressors in C-620, C-335 and C-607 are electrically driven. C-607 has a backup emergency diesel generator equipped with an automatic transfer switch that can power the air compressor system in C-607 if failure of the normal AC power supply should occur. Air compressor stations may be operated separately or together to maintain a sufficient feed supply of dry compressed air to the plant air distribution headers. Pressure reducing stations are located in required areas to provide appropriate reduced pressures for various applications.

3.9.6.1 Auxiliary Equipment

The air compressor auxiliary equipment at the three production stations is not identical; however, the process is similar in all cases. The function of the air compressor auxiliary equipment is to remove atmospheric particulates, moisture, and oil from the compressed air prior to the air entering the compressed air distribution system.

The air compressors at the three production stations have intercoolers between stages. Each unit has aftercoolers. The intercoolers and aftercooler are cooled with water from the SFWS, RCW, and/or chilled water systems. Drains are provided on the air side of the coolers to continuously drain off moisture and oil that condense from the compressed air.

After leaving the aftercooler, the air stream enters a receiver. The receiver is a large tank that provides a surge volume, dampens pressure pulsations and collects condensed moisture. Accumulated moisture is discharged from the bottom of the receiver tank.

Air leaves the receiver and passes through air drying beds. The air drying beds are large vessels filled with drying media, arranged in groups of two so that one bed can be renewed while the other bed is being used to dry the compressed air. A pair of drying beds and associated equipment is considered a drying unit. Air leaving a drying unit passes through a filter designed to trap entrained drying media that may pass through the dryer beds. Air stream moisture content is normally continuously monitored with a hygrometer to confirm that the air moisture is within acceptable limits.

To maintain a constant air header pressure, the total air supplied must equal the total usage on demand. Compressed air demand varies; therefore, a means of controlling the compressor output is necessary. The different models of compressors use various methods for matching compressor output to system demand. These methods vary from changing the compressor speed to the use of clearance pockets.

Air production is measured at the three compressor stations by orifice meters. A pressure indicator in C-300 monitors overall system pressure. When system pressures begin to drop, the shift superintendent acts to increase output or to coordinate usage.

The air distribution system is arranged in a loop configuration to tie the major points of consumption together in such a manner that portions of the system can be taken out of service for maintenance while maintaining an uninterrupted supply of dry compressed air.

3.9.7 Plant Nitrogen System

Nitrogen is received in liquid and gas forms from off-site suppliers, stored on site and made available for use in three forms; as a low pressure gas in the plant nitrogen distribution system, as a high pressure bottled gas and in liquid form.

3.9.7.1 Vaporized Nitrogen System

The vaporized N_2 system consists of equipment necessary to receive, store, dispense, and control the rate of evaporation of liquid N_2.

3.9.7.2 High Pressure Nitrogen System Storage Tanks

Three vertical storage tanks supply liquid N_2 for various uses. Each storage tank is a double wall vessel with space between the walls. The inner vessel is a rated pressure vessel. The outer vessel or jacket forms a seal for evacuating space between the inner and outer vessel walls. The space is filled with an insulating material for additional thermal insulation.

3.9.7.3 Storage Tank Pressure Build System

The storage tank pressure build system maintains the desired pressure in the storage tank. The pressure build system automatically maintains adequate gaseous pressure in the tank to maintain flow to the ambient air-type vaporizer. If the tank pressure drops below a minimum pressure set point, a regulator opens and admits liquid N_2 into an ambient air vaporizer, which is an ambient air heat exchanger. A line pressure regulator controls nitrogen gas flow into the vaporized nitrogen system distribution line.

3.9.7.4 Storage Tank Economizer System

Although the storage tanks are well insulated, heat leaks will vaporize liquid N_2 and eventually exceed maximum rated pressure unless relieved. When this occurs, a regulator in the vent line opens at a preset high pressure and directs the gas to the liquid draw line enroute to the vaporizer; thus no gas is lost. If no liquid is being withdrawn from the tank, the gas is then vented to the atmosphere.

3.9.7.5 Gaseous Nitrogen Distribution

The gaseous nitrogen produced by the liquid nitrogen vaporizing equipment is distributed to users in the plant through a piping system. The piping is arranged in loops. The loop arrangement of the

distribution system makes it possible for sections of the system to be out of service without interrupting the supply of nitrogen to the principal users.

A preset nitrogen pressure is maintained in the distribution system. A pressure reducing station manifold and a metering system located near the various points of use reduce nitrogen pressure to the desired level.

3.9.7.6 Warm Converter

The warm converter unit is designed to fill high pressure N_2 cylinders. The high pressure is obtained by "bottling" liquid N_2 and applying heat, by admitting steam to a coil immersed in a water bath surrounding the container of liquid N_2. The high pressure vaporized N_2 is valved into the cylinders through a cylinder filling manifold.

3.9.7.7 Liquid Nitrogen Cryogenic Container Filling Unit

There are several uses of N_2 in liquid form throughout the plant. The liquid nitrogen is transported from the liquid N_2 storage tank at C-600 to the various points of use in cryogenic containers. The cryogenic containers are filled at the liquid N_2 cryogenic container filling unit located near the No. 1 liquid N_2 storage tank. The filling unit consists of a gravity-type manifold connected to the liquid phase of the liquid N_2 storage tank. The manifold has valved positions which accommodate the filling of cryogenic containers.

3.9.8 Plant Oxygen and Acetylene Systems

Oxygen and acetylene are the two gases used to fuel portable hand torches and machine-guided torches. The oxygen system combined with the acetylene system are commonly known as the oxyacetylene system which supplies the C-720 building.

3.9.9 Chlorine System

Liquid chlorine is delivered on-site by a private vendor, normally in one-ton containers and 150-lb. cylinders. The one-ton containers are stored at the C-745-A Cylinder Yard, while the 150-lb. cylinders are stored in C-615, where they are used. Chlorine is primarily used for biocide protection, which is part of the overall water treatment process at C-611, and to control the growth of micro-organisms in the RCW systems at the C-631, C-633, C-635, and C-637 pump houses.

Portions of the Chlorine System are important to safety as described in Section 3.15. Chlorine leak detectors and associated alarms at each facility require 120 VAC power.

3.9.9.1 C-611-B Head House/C-611-S Corrosion Inhibitor Building Feed Facilities

Equipment for handling and injecting chlorine gas into the softened and filtered water is located at two separate locations in the C-611 facilities. One location is the pre-chlorination facility in C-611-B and

the other is the post-chlorination facility in C-611-S. The C-611-B chlorination system has four chlorinators and positions for four containers and the C-611-S chlorination system has two chlorinators and positions for two containers. See Section 3.9.2.2 for a description of operations at the water treatment plant.

The C-611-B chlorine feed facility, located in a separate room on the north side of the building, houses the chlorinators and the chlorine containers. This room also includes an exhaust fan, and remote shutoff capability for the in-service container and chlorine gas detection equipment (see Section 3.9.9.4). There are four solution type chlorinators, normally one in service and three used as needed, located at the C-611-B chlorine feed facility. Of the four containers present in the room, two are normally in service feeding, and the other two containers are on standby, either empty awaiting removal, or full waiting to be placed in service when the containers that are presently feeding are exhausted.

The C-611-S chlorine feed facility, located in a separate room on the northeast corner of the building, houses the chlorinators and the chlorine containers. This room also includes an exhaust fan, remote shut-off capability for the in-service container, and chlorine gas detection equipment (see Section 3.9.9.4). There are two solution type chlorinators; normally one in service and one used as needed, located at the C-611-S chlorine feed facility. Of the two containers present in the room, one is normally in service feeding, and the other container is on standby, either empty awaiting removal, or full waiting to be placed in service when the container that is presently feeding is exhausted.

Each of the containers at the C-611-B and C-611-S chlorine feed facilities is equipped with a container mounted vacuum regulator that reduces container pressure to a vacuum. Chlorine gas is then conveyed to the chlorinator at a vacuum avoiding pressurized lines.

3.9.9.2 RCW Pump Houses

The RCW pump houses C-631 and C-635 each have one chlorinator and positions for two containers. The C-633 and C-637 pump houses each have one chlorinator and positions for four containers. The RCW chlorination facilities are similar except for the number of chlorine container positions available in each room as noted above. The pump house chlorination rooms are located in one corner of their respective pump house buildings. The chlorination rooms contain chlorine gas detection equipment (see Section 3.9.9.4).

Of the two or four chlorine containers normally present in the room, half of the total number in the room are normally valved to supply the chlorinator at any time. The other container(s) is on standby, either empty awaiting removal, or full waiting to be placed in service. Each of the containers in the pump house chlorine feed facilities is equipped with a container mounted vacuum regulator that reduces container pressure to a partial vacuum. Chlorine gas is then conveyed to the chlorinator at a partial vacuum avoiding pressurized lines and minimizing leaks due to a line break.

Remote shut-off capability is provided in the C-631, C-633, C-635 and C-637 chlorine feed facilities to isolate the chlorine containers in the event of a chlorine leak in the room.

3.9.9.3 C-615 Waste Treatment Plant

Chlorine is also used at the C-615 for post-disinfection. The quantity of chlorine kept at C-615 is administratively controlled below the 29 Code of Federal Regulations (CFR) 1910.119, Appendix A, process threshold quantity. Therefore, the C-615 sewage disposal plant is not covered by the process safety management standard.

The C-615 chlorine feed facility, located in a separate room on the southwest corner of the building, houses the chlorinator, chlorine containers, exhaust fan, and chlorine gas detection system (see Section 3.9.9.4). The room houses two 150-lb. chlorine containers, one of which is normally in use and the other is in standby ready to be automatically put into service upon depletion of the other container. Each container is connected to a vacuum regulator that reduces the cylinder pressure to a vacuum. Chlorine gas is then conveyed to the chlorinator at a vacuum, avoiding pressurized lines.

3.9.9.4 Chlorine Detection and Alarm Systems

The atmosphere within the chlorine feed facilities at C-611, the RCW pump houses, and C-615 is monitored by a chlorine leak detection and alarm system. Each chlorine feed facility is equipped with a sensor in the feed room and another sensor in the vacuum regulator vent line, except C-615. The C-615 chlorine feed room is equipped with only a single sensor. The output of the detectors indicate chlorine gas concentration and provide a visual and audible alarm when the chlorine gas concentration exceeds a specified level. The RCW pump house chlorine feed facilities chlorine release alarms sound locally and at the Central Control Facility (CCF) in the C-300 Central Control Building. The C-611 chlorine feed facilities chlorine release alarms sound locally and in the C-611-H facility. The C-615 chlorine release alarm sounds only locally. 120 VAC power is required for operation of the system.

3.9.9.5 Chlorine Containers

The primary design code, standards, and specifications for the containers are outlined in CFR Title 49, Part 179, Section 300, Subpart E, “Specifications for Multi-Unit Tank Car Tanks” (Classes DOT-106A and 110 AW). The containers are designed and fabricated in accordance with this regulation, specifically DOT Specification 106A500X.

All containers are equipped with fusible metal plug safety relief devices. The fusible metal is designed to melt at a specific temperature, thus relieving pressure and preventing rupture of the container in case of fire or other exposure to high temperature.

3.9.9.6 Chlorine Administrative Controls

The Chlorine System is important to safety as described in Section 3.15. In addition to the administrative controls in Chapter 4.0 and those controls covered by programs and plans, the administrative controls described in Section 3.8.7.1 ensure safe operation.

3.9.10 Sulfuric Acid System

Sulfuric acid (H_2SO_4) is purchased from and delivered by an off site vendor. It is normally used at the C-631, C-633, C-635 and C-637 RCW pump houses for pH control of the RCW.

3.9.10.1 C-616 Sulfuric Acid (H_2SO_4) Storage Area

Sulfuric acid handling and storage facilities in the C-616 area include an unloading dock, air lines to the unloading dock and the storage tanks, acid transfer lines, and two acid storage tanks. Two bulk storage tanks are located within a concrete diked area.

3.9.10.2 Sulfuric Acid Storage Areas and the RCW Pumphouse Feed Facilities

Sulfuric acid is used at the C-631, C-633, C-635, and C-637 pumphouse feed facilities to maintain the pH of the RCW. The rate of sulfuric acid usage depends upon the cascade power level. Sulfuric acid is received in railroad tank cars or highway tanker trucks, and is unloaded to either of the C-616 storage tanks. From the C-616 sulfuric acid storage tanks, sulfuric acid may be transferred to portable acid pigs, transported to the pumphouse feed facilities and fed into the RCW system.

3.9.10.2.1 Pumphouse Feed Facilities

The pumphouse feed facilities house one portable sulfuric acid pig, a day tank, interconnecting sulfuric acid lines from the pig to the day tank and to the RCW system, plant air from the instruments to the pig and day tank, and a safety shower.

A monitoring system to read the level in the day tank and portable pig is located in each of the four pump houses adjacent to the portable pig and day tank. The monitoring system can read either the acid pig or the day tank level.

3.9.10.3 Feeding of Sulfuric Acid to the RCW

Sulfuric acid is fed into the RCW at the four pump houses for pH control. The day tank is used to maintain acid feed to the RCW system when the portable pig is being refilled at the C-616 acid transfer station. Acid flow to the RCW is controlled manually by valve setting or by the use of a manually set metering pump.

The RCW pH is normally read in each pump house control room and in the CCF.

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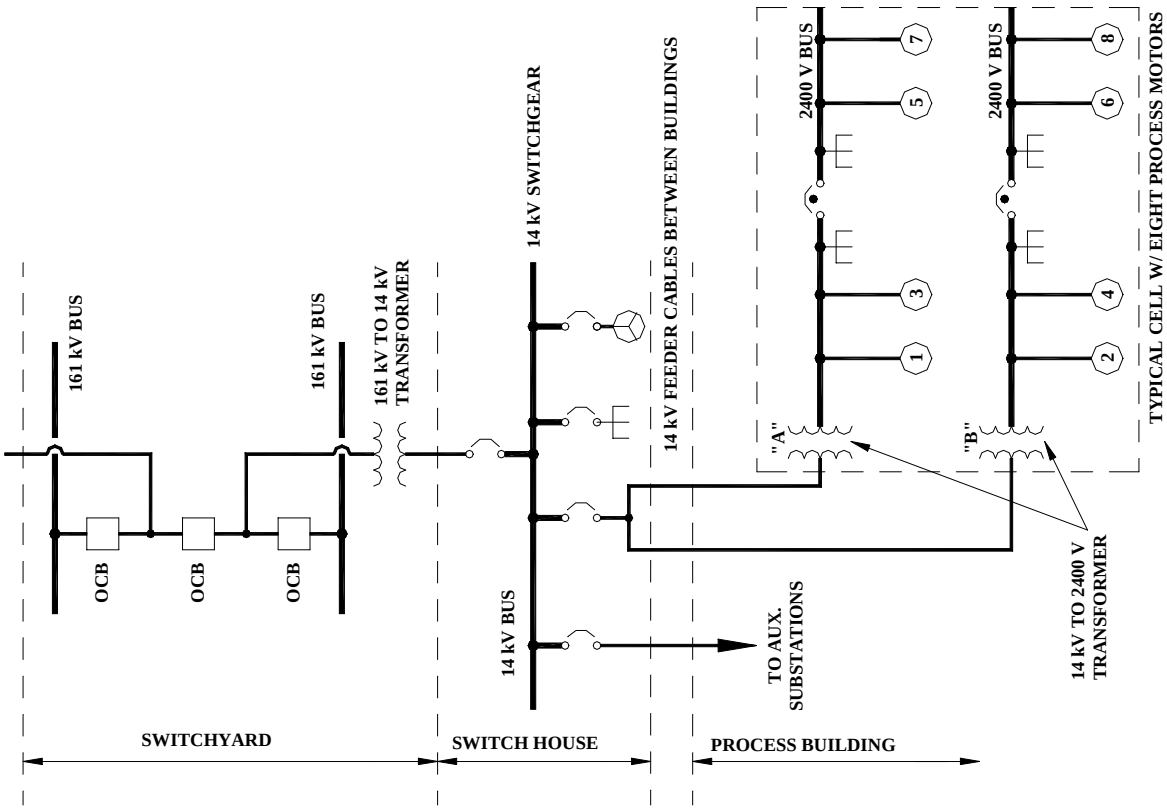


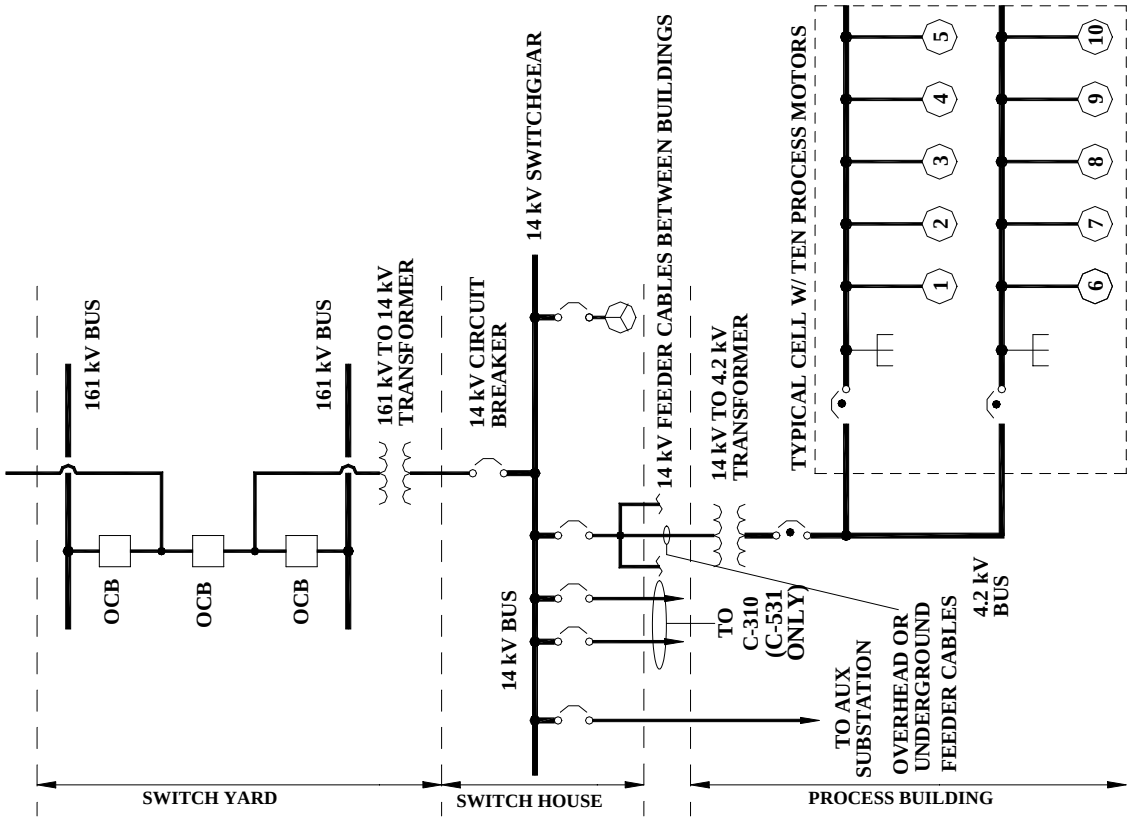
LEGEND

- **Bus symbol (heavy line) with cable connection (lighter weight line). If applicable, bus voltage is noted on drawing.**
- **Cable symbol showing cable to cable connection.**
- **Transformer - voltage noted on drawing. Letter designation, if shown, denotes Substation "A" or Substation "B"**
- **161 kV Oil Circuit Breaker (OCB).**
- **14 kV Air Circuit Breaker (ACB)**
- **2,400 V Circuit Breaker**
- **Process Motor (8 per cell typical)**
- **Static Capacitor**
- **Synchronous Condenser**

NOTE:

1. **This figure is a general diagrammatic representation only. The actual arrangement of process motors and the quantity and location of static capacitors may vary.**

Figure 3.9-1. C-333 and C-337 Typical Electrical Power Diagram.



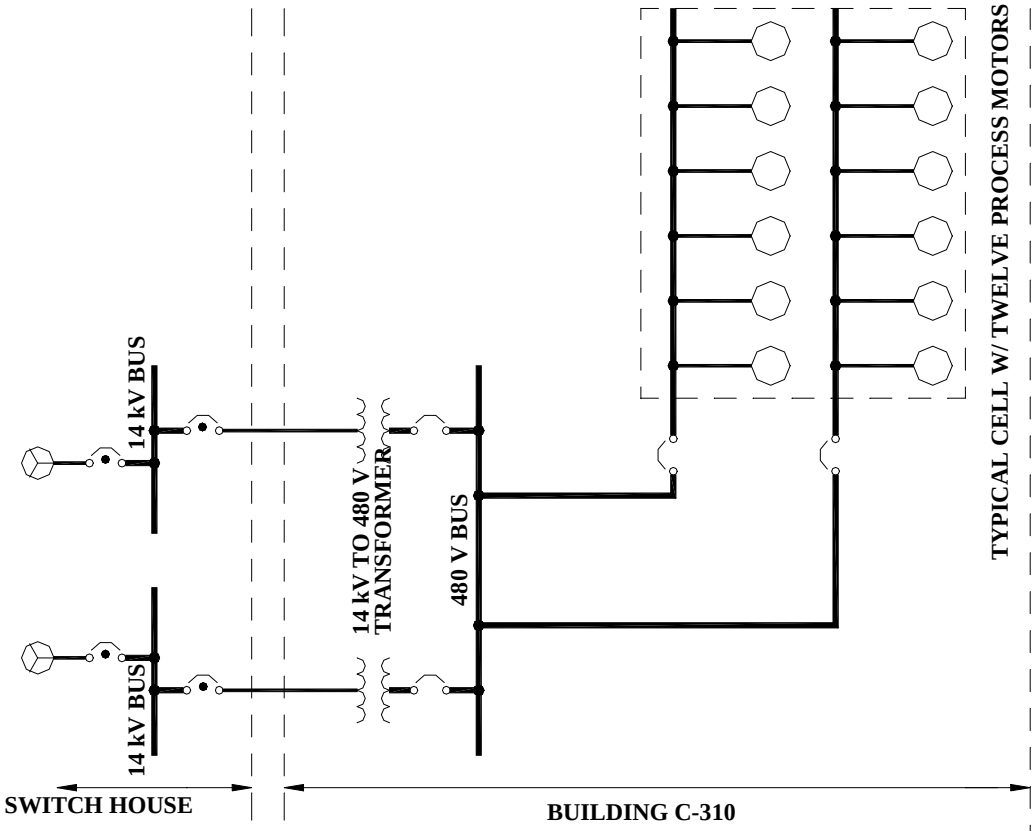
LEGEND

- **Bus symbol (heavy line) with cable connection (lighter weight line). If applicable, bus voltage is noted on drawing.**
- **Cable symbol showing cable to cable connection.**
- **Transformer - voltage noted on drawing.**
- **161 kV Oil Circuit Breaker (OCB).**
- **5 kV Circuit Breaker**
- **14 kV Air Circuit Breaker (ACB)**
- **Process Motor (10 per cell typical)**
- **Static Capacitor**
- **Synchronous Condenser**

NOTE:

1. This figure is a general diagrammatic representation only. The actual arrangement of process motors and the quantity and location of static capacitors may vary.

Figure 3.9-2. C-331 and C-335 Typical Electrical Power Diagram.



LEGEND

- **Bus symbol (heavy line) with cable connection (lighter weight line). If applicable, bus voltage is noted on drawing.**
- **Cable symbol showing cable to cable connection.**
- **Transformer - voltage noted on drawing.**
- **480 V Circuit Breaker**
- **14 kV Circuit Breaker**
- **Process Motor (12 per cell typical)**
- **Synchronous Condenser**

NOTE:

1. **Cells 2, 4, 6 and 8 differ from the diagram in that two cells are connected to the same double-ended substation.**

Figure 3.9-3. C-310 Typical Electrical Power Diagram.

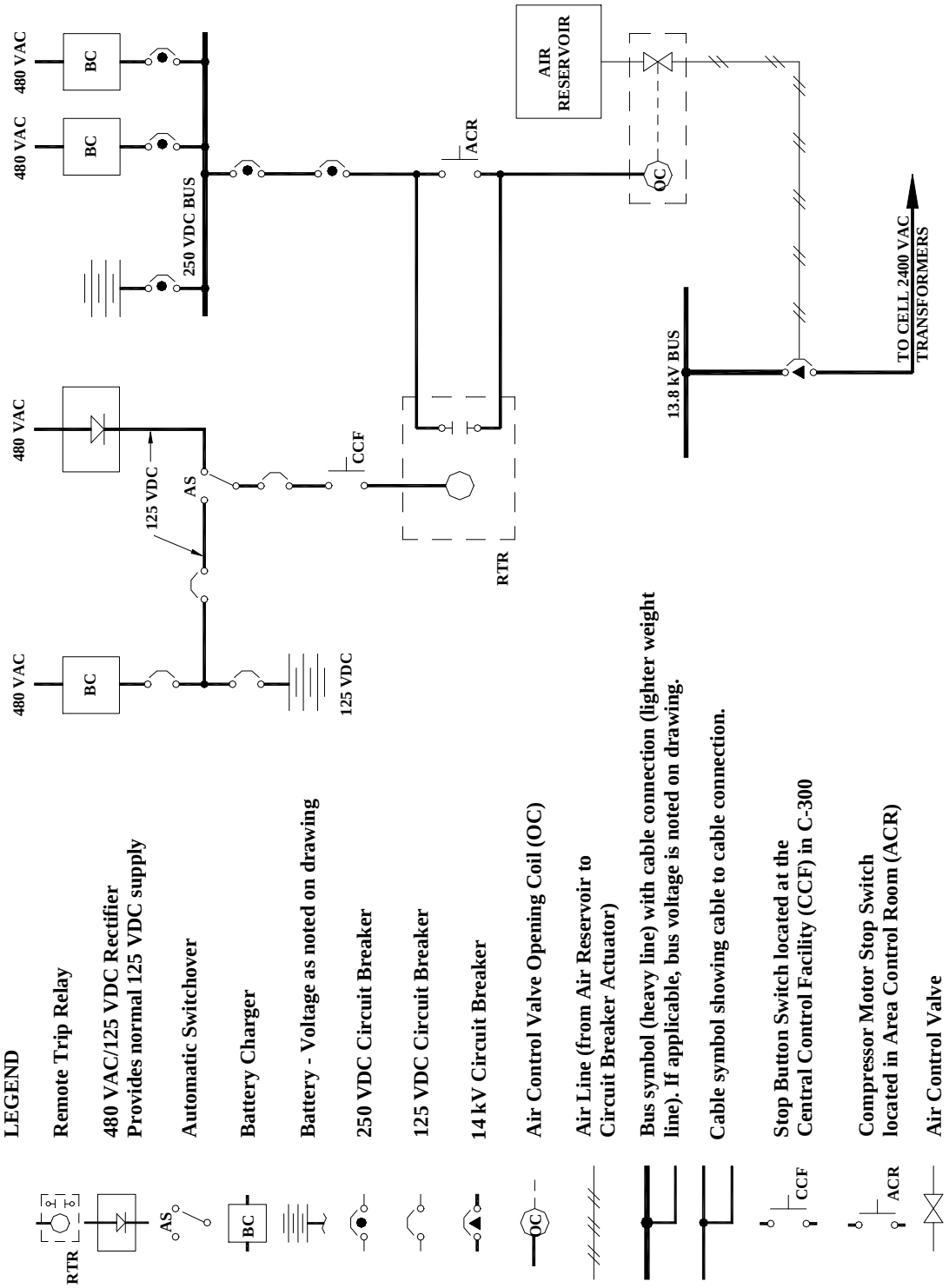


Figure 3.9-4. DC Power Supply to Typical Cell Remote Manual Shutdown System for C-333 or C-337 Cell.

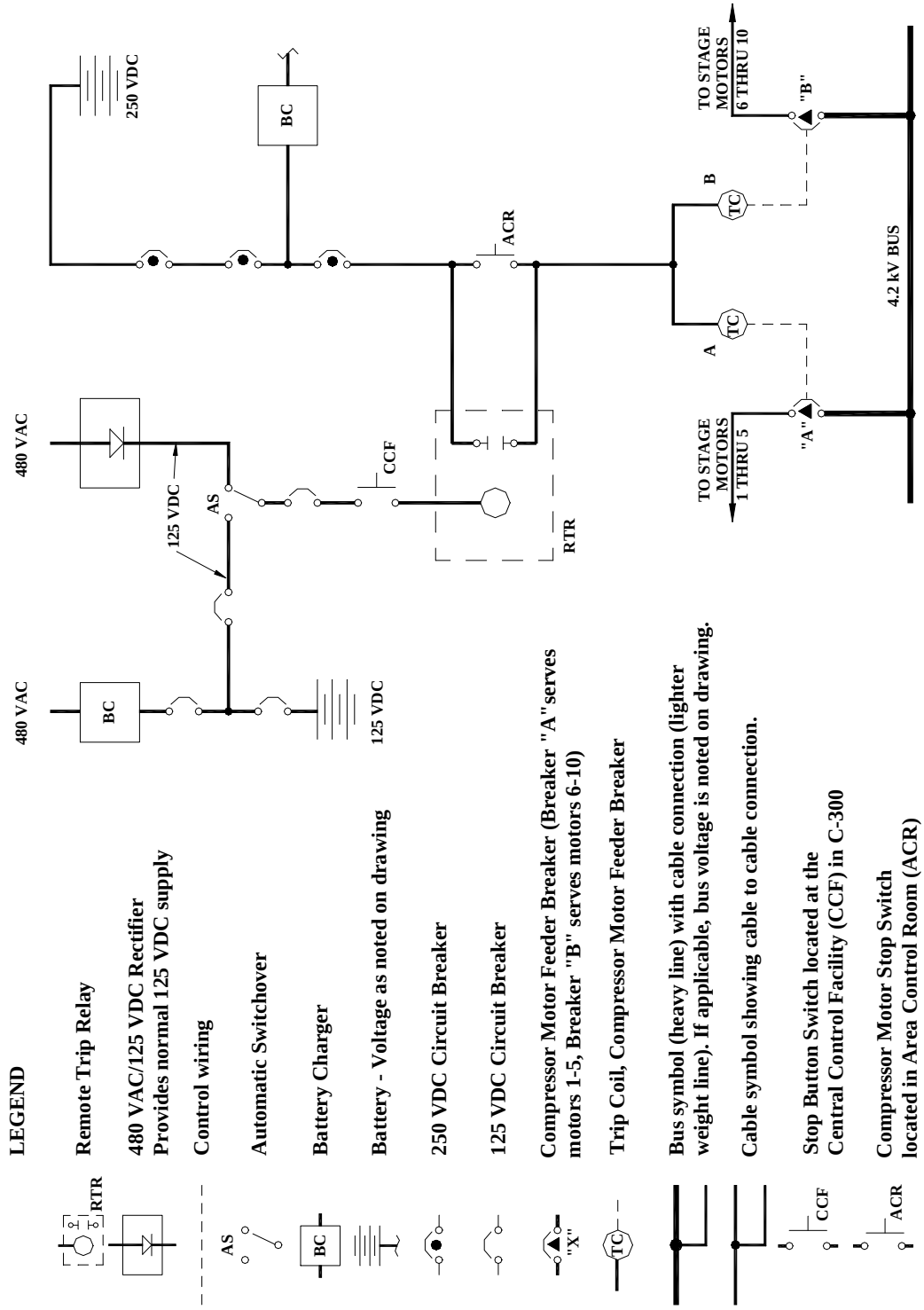


Figure 3.9-5. DC Power Supply to Typical Cell Remote Manual Shutdown System for C331 or C335 cell.

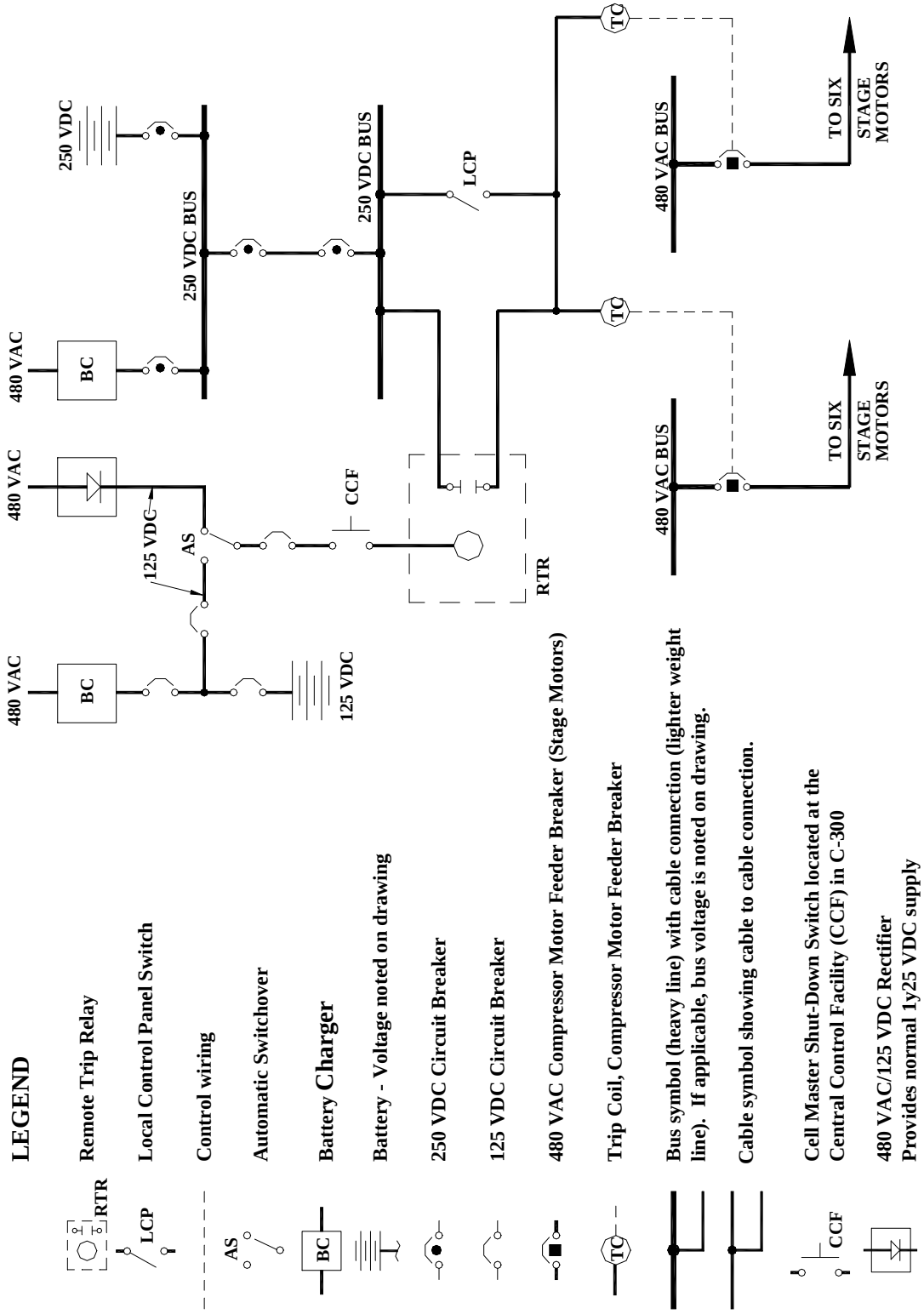


Figure 3.9-6. DC Power Supply to Typical Cell Remote Manual Shutdown System for C-310 Cell.

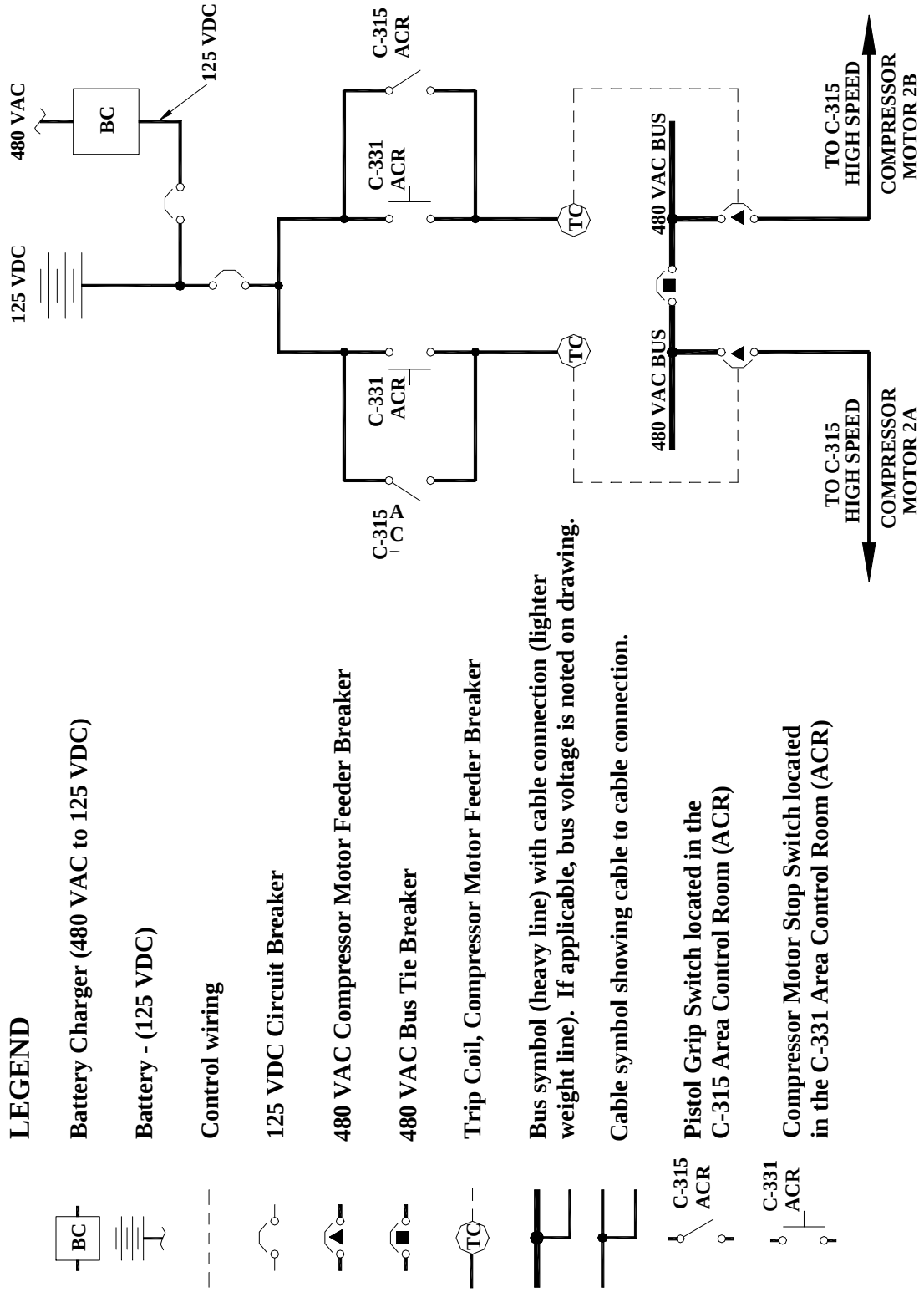


Figure 3.9-7. Manual Trip Circuit for C-315 High Speed Withdrawal Motors.

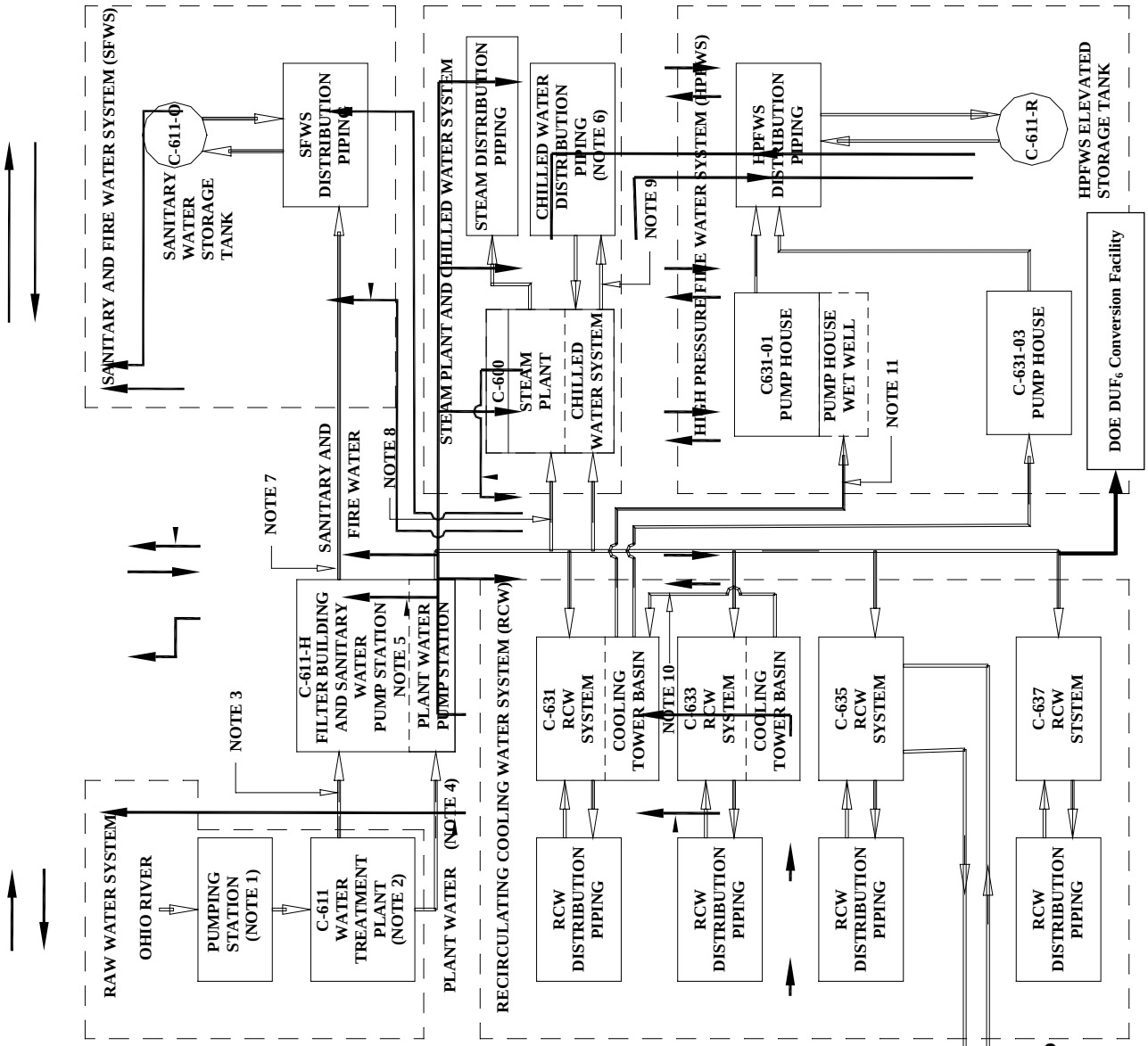


Figure 3.9-8. Plant Water System Inter-Connections

NOTES

1. PUMPING STATION IS OPERATED BY TVA AT SHAWNEE STEAM PLANT
2. WATER TREATMENT MAY INCLUDE COLD LIME - SODA SOFTENING, FLOCCULATION, DISINFECTION AND SETTLING. THE PRODUCT IS SETTLED WATER.
3. SETTLED WATER TO FILTER BUILDING, SANITARY WATER PUMP STATION AND PLANT WATER PUMP STATION.
4. PLANT WATER IS SETTLED WATER.
5. WATER IS FILTERED AND POST DISINFECTED. THE PRODUCT IS SANITARY AND FIRE WATER.
6. CHILLED WATER IS DISTRIBUTED TO VARIOUS SERVICE BUILDINGS.
7. SANITARY AND FIRE WATER IS PUMPED FROM THE C-611-H CLEARWELL INTO THE SFWS DISTRIBUTION MAINS.
8. THE C-611-P BOOSTER PUMP STATION IN THE PWS PROVIDES SIDE STREAM COOLING WATER FOR THE C-600 STEAM PLANT.
9. WATER FLOWS THROUGH THE CHILLED WATER SYSTEM FROM THE C-600 CHILLED WATER WET WELL OR THE PLANT WATER SYSTEM.
10. CROSSOVER PIPING FROM C-633 TO C-631.
11. FLUME CONNECTING C-631 BASIN TO C-631-01 PUMP HOUSE WET WELL.

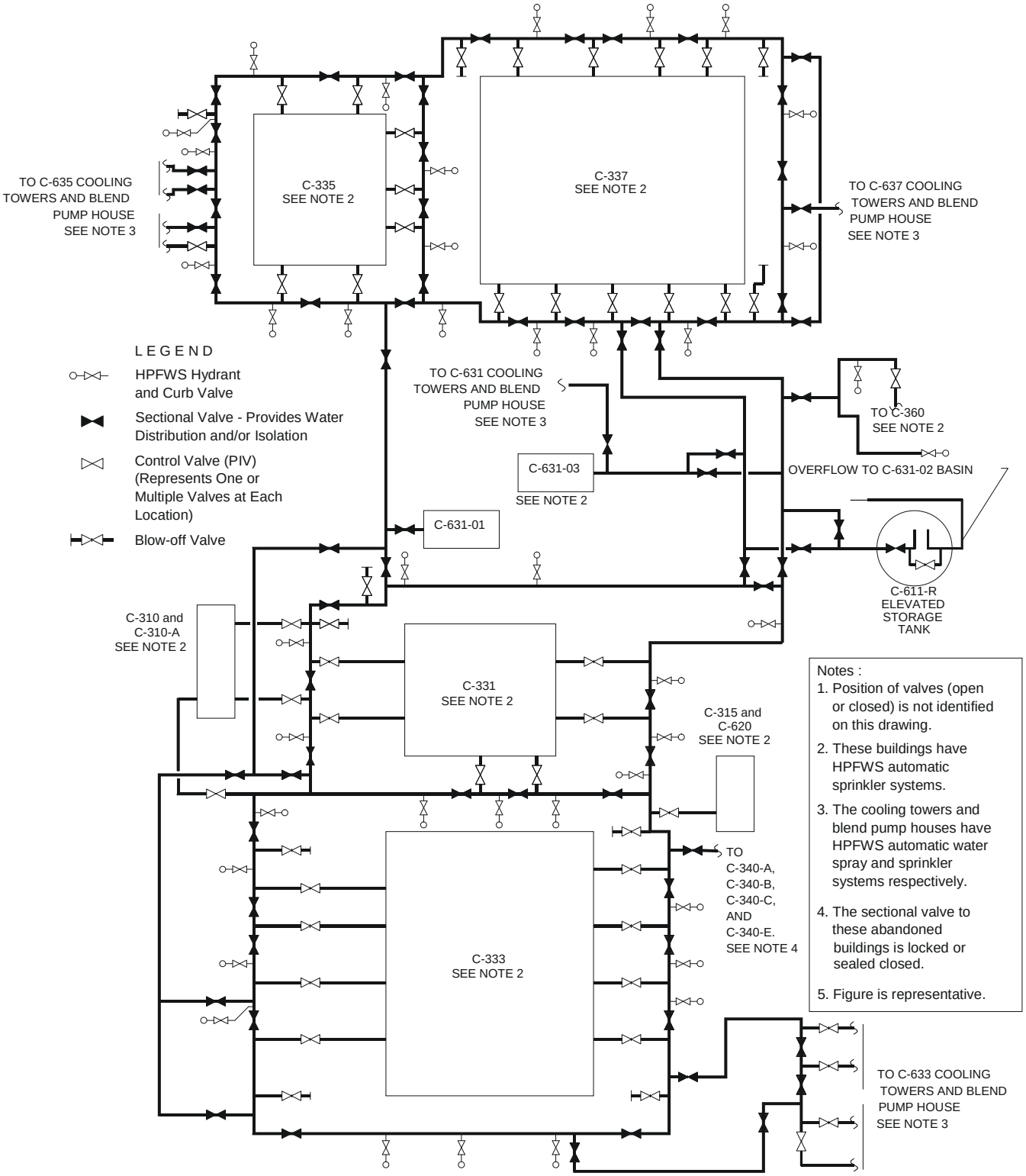


Figure 3.9-9. High Pressure Fire Water System

3.10 MANAGEMENT OF MIXED AND RADIOACTIVE WASTE

The purpose of this section is to describe the PGDP facilities employed in the management of mixed and radioactive wastes. The details of the processes are in the Radioactive Waste Management Program.

3.10.1 Waste Segregation and Collection

Wastes are collected and packaged, where feasible, by the waste generator. Wastes known to be suitable for release to unrestricted areas based on the point and process of generation are segregated at the source, when possible, from wastes not suitable for release to unrestricted areas. Wastes from areas controlled for transferable radioactive contamination are considered potentially contaminated until characterized. Wastes requiring characterization to determine whether they may be released to unrestricted areas are segregated upon completion of such characterization.

The area around certain plant operations is designated as a Fissile Control Area (FCA) for the accumulation of potentially fissile waste. FCAs are identified where possible by unique markings. Currently this is shown by using orange lines along the edges of a gray background painted on the floor surrounding the operation. Radioactive wastes that have the potential to be fissile as described in the SAR, Section 5.2, are generated, handled, and stored using safe volume, spacing, or geometry controls which are implemented through Nuclear Criticality Safety Approvals. When ready for disposal, potentially fissile waste is characterized according to applicable Nuclear Criticality Safety Approvals. Changes to fissile waste operations are approved by Nuclear Criticality Safety. Further discussion of fissile waste handling is discussed in Chapter 5.2, Appendix A, Sections 5.2 and 5.3.

Containers, including packaging, known to contain radioactive waste are labeled in accordance with 10 CFR 20.1904, “Labeling Containers,” or are managed in accordance with 10 CFR 20.1905, “Exemptions to Labeling Requirements,” with exceptions as noted in Section 5.3 of the PGDP SAR.

3.10.2 Radioactive Waste Storage

Wastes regulated for radiological content only are stored at designated waste storage facilities after being relocated from areas managed by waste generating organizations. Fissile/Potentially fissile waste may be temporarily stored in designated areas in any of the buildings that process/handle this type material. Mixed waste 90 day accumulation areas are set up as needed to meet NRC and EPA regulations.

Liquid and solid low-level radwaste (LLRW) are stored in C-754, Low-Level Waste Storage, C-754-B, Low-Level Waste Storage, C-746-Q1, High Assay Waste Storage Facility, C-727, Heat Treating Facility, and C-757, Solid and Low-Level Waste Processing Facility. Solid low-level waste may be stored in the C-745-J, Foreign Cylinder Storage Yard and the C-754-A Low-Level Waste Storage Area. The solid and low-level waste processing facility, C-757 may be utilized as a mixed waste shipment staging area. LLRW may be sorted and characterized for radiological content in this building. The C-754-A, C-754-B, and C-745-J process, store, and handle only NCS-exempt waste.

Building C-746-Q1 is important to safety as described in Section 3.15 since it is required to maintain structural integrity during evaluation basis natural phenomenon events (earthquake, high winds, and

flooding). Building C-746-Q1 also contains a Criticality Accident Alarm System. This system is important to safety as described in Section 3.15.

Other areas may be developed and designated as waste storage facilities as required by facility operations. If outdoor storage is necessary, radioactive wastes with transferable contamination are packaged in containers or wrapped and covered to prevent the release of radioactivity.

Permanent storage facilities are posted in accordance with 10 CFR 20.1902 according to area classification.

Access to LLRW and mixed waste storage containers is restricted to qualified radiological workers, or personnel who are escorted by qualified radiological workers. Containers and tanks are inspected routinely to identify and correct any leaks or other problems. When near-term treatment/disposal of mixed wastes is not an option, the mixed wastes are transferred to DOE-owned and operated facilities for storage until treatment and/or disposal can be accomplished. Such transfers are documented.

3.10.3 Radioactive Waste Treatment

Waste treatment facilities in the C-400, Cleaning Building And Appurtenant Structures and the C-409, Stabilization Building are operated for the removal of uranium from waste waters. These facilities are designed to treat aqueous wastes containing uranium. Solid treatment residues are managed as waste not suitable for release to unrestricted areas. Treated water is either recycled or discharged if characterized as suitable for release to unrestricted areas. Wastes may be treated in other off-site facilities as those options become available. Buildings C-400 and C-409 are important to safety structures as described in Section 3.15 (similar to C-746-Q1).

Mixed wastes, which cannot be treated in USEC facilities, are transferred to DOE facilities or off-site commercial waste facilities.

3.11 LABORATORY

The primary missions of the Laboratory are to supply quality analytical services, to provide process support for existing equipment and systems, and provide technology recommendations for new equipment and system requirements in support of the gaseous diffusion plant(s).

In addition, the Laboratory may provide analytical services as they relate to materials that are not of diffusion plant(s) origin under the Cabinet for Health Services Commonwealth of Kentucky Radioactive Material License. These services are provided to the DOE and other off-site customers under contract agreements.

Laboratory and office facilities are housed in the C-709, Plant Laboratory Annex, and the C-710, Technical Services building and Appurtenant Structures. The C-710 building is an important to safety structure as described in Section 3.15 and is required to maintain structural integrity during evaluation basis natural phenomenon events (earthquake, high winds, and flooding).

Laboratories in C-710 may be used for fissile and non-fissile operations. C-709 laboratories may be used only for non-fissile operations.

Since the laboratories provide analyses on product assay uranium, a potential for criticality exists. The NCS controls implemented to prevent criticality accidents are described in Chapter 5.2, Appendix A, Section 4.0.

The C-710 building is equipped with a Criticality Accident Alarm System (CAAS). C-709 has CAAS audibility. This system is important to safety as described in Section 3.15.

3.11.1 Building Support Systems

The C-709 and C-710 buildings are supplied with compressed air, steam, nitrogen, oxygen, sanitary water and chilled water by the plant utility systems. Propane gas is supplied from a tank located north of the facility. These utilities are distributed where needed to the C-709 and C-710 laboratories and are capable of isolation in the event of a leak or maintenance. Operations in the C-709 and C-710 buildings may require the use of compressed and/or corrosive gases. Gas cylinder of H_2, F_2, UF_6, ClF_3, and HF are used to supply these gases where needed in the C-709 and C-710 laboratories. Additional Administrative Controls not found in Chapter 4.0 or in controls covered by programs and plans are described in Section 3.8.7 for ensuring safe handling of F_2, Cl_2, and ClF_3. Distilled or deionized water is available in C-709 and in C-710. Both C-709 and C-710 have a building vacuum system with vacuum pumps located in their ground level mechanical rooms. The laboratories are serviced by fume hoods, which are vented to the roof. One of these fume hoods in the C-710 building is equipped with wash-down units and is designated as a perchloric acid hood.

The C-709 and C-710 back docks are used as building receiving areas. Waste accumulation areas are established as required in the Laboratory. There are designated areas in C-710 for storage of Manhattan district (MD) and other miscellaneous cylinders containing UF_6 standards, storage of uranium salvage materials which are stored in NCS approved containers, and storage of organic solvents, acids, small gas standards, bulk pump oil, and other products.

Several other auxiliary areas are designated as storage areas. The C-710-A, Gas Cylinder Storage Building, is a covered area at the east side of C-710 used for the storage of gas cylinders and is divided

into four compartments separated by concrete walls. The separate compartments are used for segregating gas cylinders according to chemical compatibility. The C-710-B, Storage Facility, is available for storage of surplus shipping and laboratory supplies. C-711, Gas Manifold, is a covered area that may be used for storage.

3.11.2 Analytical Laboratories

Environmental and waste samples enter the laboratory though a sample-receiving laboratory. Some of these samples are extracted and partially characterized according to Resource Conservation and Recovery Act (RCRA) regulations before entering other laboratories in the C-710 complex.

Uranium process samples are received in the subsampling laboratory area and returned through this area, except for certain samples for isotopic analysis. UF_6 samples are received in 2S cylinders or smaller containers. The subsampling areas are used for subsampling uranium compounds (chiefly UF_6), sample container preparation, and salvaging excess uranium materials.

UF_6 is routinely liquefied in this area by heating containers in steam baths. Liquefaction is required for subsampling as well as for homogenization. The subsampling lab handles sample cylinders, sampling tubes, MD cylinders, cold traps, drums/carboys, and solid uranium salvage. Hazardous substances (UF_6, F2, etc.) are transferred in hoods. This area includes several fume hoods that vent directly to the building roof.

The analytical laboratories provide a variety of analyses in support of the cascade/withdrawal process as well as environmental, safety, and health issues.

Instrumentation supporting these laboratories includes mass spectrometers, infrared spectrophotometers, atomic absorption, gas chromatography and other instrumentation. Laboratory accountability balances are used for UF_6 accountability and are important to safety as described in Section 3.15.

Sample matrices include waters, soils, solids, oils, air filters, smears, bioassay, UF_6, decontamination and recovery material, gas samples, waste and other material. These samples may contain various contaminants, both radiological and non-radiological.

Typical functions of the laboratories include:

- UF_6 analysis for purity, assay, and impurities.
- Uranium analysis for assay.

- Radiochemical analysis of various matrices.

- Organic analysis of various matrices for contaminants and component identification.

- Inorganic analysis including wet chemical analysis and instrumentation for metal impurities, component identification, and other miscellaneous constituents.

- NDA—Storage, setup calibration, and testing of NDA measuring equipment prior to use.

- Management and tracking of samples.

3.11.3 Technology Laboratories

The technology laboratories are used for testing and technical support activities associated with barrier and cascade chemistry, materials, instrumentation, process systems and equipment, environmental, safety, and health issues, and non-destructive assay (NDA) measurements.

Typical engineering instrumentation, lab equipment, and machine shop type equipment support these laboratories. A self-contained, portable fume hood with a HEPA filtration system is available for use.

Materials and testing may include UF_6, process gases, waters soils, oils, trapping materials, uranium compounds, and other radioactive nuclides.

Testing, in general, is of a non-routine nature and will vary according to plant need. Typical functions of the laboratories may include:

- Materials and Chemistry—perform fluoride trapping studies, material stability tests, thermal analysis, coolant corrosion studies, and exposure tests involving PCB/lube oil and other chemicals. Performs tests involving solid uranium fluorides and contaminated trapping materials.

- Environmental—perform various tests in support of environmental, safety, and health issues, chemical and cleaning processes, RCW systems, and plant utility system.

- Metallurgy—perform materials specification development/verification, metallurgical examination, corrosive studies and failure analysis.

- Instrumentation—Test various instrumentation and system components.

- Valve Testing—Perform qualification testing of replacement process valves or examination of existing valves.

- Barrier—Perform testing, troubleshooting, and support activities for barrier and cascade chemistry.

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3.12 COMMUNICATIONS AND ALARM SYSTEMS

Communications and alarm systems at PGDP include the telecommunications, radio, and data communications systems, the On-Site Warning and Evacuation Systems and the Public Warning System.

3.12.1 Telecommunications System

The telecommunications system is composed of three telephone systems. They are the commercial telephone system, private automatic exchange (PAX) System, and emergency telephone system (ETS).

The primary telephone system for handling plant communication services such as voice, fax, modem, and voice mail is the commercial telephone system. This system is a private branch exchange (PBX) system designed to handle the plant's administrative telephone needs which includes local calls and toll (long distance) calls.

The PAX phone system network covers most operating areas and extends into all major process buildings. The C-320 building contains the equipment necessary for automatic switching of the PAX telephone system.

ETS consist of “red handset” telephones located in most production areas along with other key locations throughout the plant where emergency communication may be required. These automatic ring-down “red handset” telephones place the caller in immediate contact with personnel stationed in the Central Control Facility (CCF). They may also be connected to other ETS stations through trunk switching at the C-300 console.

3.12.2 Radio Communication Systems

3.12.2.1 Plant Radio Network

The radio network used at the plant permits rapid and efficient communications that are necessary for normal plant activities as well as for plant emergency conditions. Key employees have access to the Radio network from hand held units.

3.12.2.2 Section Deleted

3.12.2.3 Section Deleted

3.12.2.4 Section Deleted

3.12.2.5 Emergency Communication Systems

Personnel involved in the handling of plant emergencies use radio units with access to the plant radio network. Key supervisory personnel have access to radio units. Most emergency vehicles are equipped with radio network units since the radio network is used during emergency situations.

Other radio systems exist under mutual aid agreements with local and state emergency agencies.

The plant is also a station point for the NAWAS (Federal Emergency Management Agency's National Area Warning System). Telephones along with other necessary equipment for NAWAS are located in the C-200 and C-300 buildings.

3.12.2.6 Power Radio Network

Normal communication with electric power suppliers is by telephone over power lines. The power radio network is used for emergency communication between the plant and the suppliers of electric power whenever normal methods of communication are inoperable. This radio is located in the central control facility in C-300 and operates on a frequency common to the electrical suppliers.

3.12.3 Data Communications

Several miscellaneous telecommunications systems are in use throughout the plant. These systems are operated for the transmission or reception of signals, writings, images, or sounds. These include systems such as facsimile transmission devices, data communications devices, and cryptographic devices.

3.12.4 On-Site Warning and Evacuation Systems

The On-Site Warning and Evacuation systems are important to safety systems as described in Section 3.15. These systems provide evacuation instructions or notification in the event of an incident requiring evacuation or sheltering of plant personnel. The On-Site Warning and Evacuation Systems consists of the Public Address System and the Building Evacuation Alarm System.

3.12.4.1 Public Address System

The plant utilizes a Public Address System that provides voice communications to the plant site. A hi-low tone on this system is used in an emergency to signal personnel to listen to the subsequent public address (PA) announcement. The system consists of speakers, control consoles, amplifiers, power sources and wiring. The PA system is tested daily.

PA messages are normally initiated from the C-300 CCF. The security office in the basement of C-200 can be used to broadcast messages if C-300 is unavailable. The C-200 system is a slave to the C-300 master control. If both the C-300 CCF and the C-200 building are unavailable, then broadcasting can be done from the PA system controls located in the C-300 basement. The messages are distributed by the transmission of audio and control voltages through underground and overhead cable. These voltages are distributed to each building where they supply signals to drive a building amplifier and associated speakers. Some buildings have individual local PA systems with supervisory override from C-300. The C-720 building has four different local systems while the C-200 and C-400 buildings all have local systems. Messages can also be sent to independent exterior speakers located throughout the plant site and can be broadcast over the radio network.

3.12.4.1.1 Equipment Description and Functions

Groups of speakers and their associated power amplifiers are located inside and outside plant buildings. Each building group is controlled as one unit. The building speakers are referred to as the internal PA. The amplifiers are powered by 120 VAC.

There are independent exterior PA speakers located through out the plant. These external speakers are referred to as the exterior PA. The exterior PA speaker assemblies are pole mounted. These assemblies include the controls, speakers, 24 VDC batteries, and a battery charger. The charger is powered by 120 VAC.

A computer with a touchscreen monitor is located on the C-300 cascade console along with a microphone, audio playback device, and a HI-LO tone generator. The touchscreen is used to provide the commands to the PA system. It contains various display screens, and a command can be initiated by touching the appropriate screen feature. The HI-LO tone generator produces the tone to be broadcast to indicate an emergency. The microphone and/or audio playback device are used to broadcast voice messages.

The message view keypad, also located on the C-300 console, is an alternate to using the touchscreen monitor and can activate and monitor the same functions. However the selection of individual buildings or areas requires typing in this information.

The PA components in C-300 are mainly in the PA cabinets located in the C-300 basement. The major components of these cabinets include:

- Industrial computer – Interfaces between the cabinet touchscreen monitor and the programmable logic controllers (PLCs).

- PLCs (two, one as backup) – Process the commands from the two touchscreen/computers, the keypad, and the C-200 system.

- Amplifiers (two, one as backup) – Amplify the audio signals and outputs to the "Talk Bus".

- 24 VDC power supply – Supplies power to the switching relay, PLC I/O card and message view keypad.

- 48 VDC power supply – Supplies power to key the amplifiers.

- Uninterruptible power supply – Provides power to PA system components inside the cabinets.

- Touchscreen monitor – Initiates the PA commands if the C-300 CCF and C-200 capability is lost.

The components in C-200 are a microphone and amplifier. The microphone has an override switch allowing C-200 to cut into the system. Only voice messages can occur from C-200.

3.12.4.1.2 Instrumentation, Controls and Alarms

The C-300 CCF touchscreen monitor can select most combinations of building or exterior speakers. Some of the major commands are:

- ALL CALL – Activates all exterior speakers, building speakers, and the radio network.

- HI-LO – Activates the ALL CALL and initiates the HI-LO tone used to precede emergency announcements.

- INT PA – Activates all building speakers.

- EXT PA – Activates all exterior speakers not associated with a specific building.

- RADIO – Activates the radio network.

Various screens can be displayed to provide status of the equipment. An example would be the SYSTEM STATUS screen which provides the status of the PLCs.

Visual alarms (flashing lights) are provided if either of the PLCs or main amplifiers malfunction, or if normal 24 VDC or 48 VDC power is lost.

3.12.4.1.3 Support Systems

120 VAC power is provided to the internal PA building amplifiers and the external PA pole mounted battery-charging circuits. Loss of AC power renders the internal PA system inoperable. The external PA system amplifiers, circuits, and speakers are powered from the 24 VDC batteries and will remain operational until battery power is depleted. The battery charging circuit will be inoperable.

3.12.4.2 Building Evacuation Alarm System

The plant utilizes horns or howlers in the buildings to signal building evacuation. The horns and howlers are also used to signal personnel where the PA system and hi-low tone may not be audible (such as the process buildings). The evacuation system consists of horns, howlers, control cabinets, and power and air supplies. The system is tested weekly from C-300 and quarterly from the individual buildings.

The evacuation system can be activated from the C-300 CCF cascade console or from individual buildings in the ACR or at the control cabinet just outside the ACR. There are two types of signals that are initiated, Alert or Take Cover (also known as Attack). The Alert signal consists of continuous 3 to 5 minute blasts on the building horns and howlers. The Take Cover signal consists of intermittent 2-second blasts on the building horns and howlers.

3.12.4.2.1 Equipment Description and Functions

Switches for the two functions are located on the cascade console in the C-300 CCF. These switches activate relays and start the appropriate timing circuit in the control cabinet located in C-320. The C-320 cabinet interfaces with the building relays to activate the howlers and horns. The fire evacuation horns are used for the evacuation signal for those non-cascade buildings that do not have evacuation horns or howlers. 120 VAC and 48 VDC are supplied to the C-320 control cabinet signaling circuits.

Both the Alert and Take Cover commands can also be initiated locally from the cascade building systems. Switches for performing the functions locally at a particular cascade building are located in the ACR and also on front of the building control cabinet. The building control cabinet consists of both 125 VDC relays (including 125 VDC time delay relays) and timers to activate the horns and howlers and provide the proper signal.

The horns and howlers are placed in high noise areas within the buildings. 125 VDC solenoid valves activate the air supply to the horns. The howlers use 120 VAC but are activated by 125 VDC relays.

3.12.4.2.2 Instrumentation, Controls and Alarms

The only controls are the initiating switches at the various locations. There are ”on” lights for the switches, but the only status provided to ensure activation is hearing the warning sound or via voice communications. The system relies upon periodic testing to ensure integrity.

3.12.4.2.3 Support Systems

120 VAC power is supplied to the building howlers, the electric horns, the C-320 control cabinet, and some fire evacuation horns. Since the non-cascade buildings, including C-315, only have electric horns, loss of 120 VAC power will render the evacuation system in these buildings inoperable. The cascade building air horns can still be initiated locally.

Air horns are installed only in the cascade buildings and are supplied by plant air. A header supplied by multiple compressors provides air to these horns. Loss of plant air renders the horns inoperable. The cascade buildings contain both howlers and horns, and the howlers will still function if AC power is available.

125 VDC from the plant system supply the building control cabinets. The solenoid valves for the cascade building horns and the activating relays for the howlers utilize this DC power. Loss of 125 VDC would therefore render the system inoperable.

The C-320 control cabinet and some of the fire evacuation horns are supplied 48 VDC power. Loss of this power would render all non-cascade buildings inoperable. The cascade buildings' evacuation system could still be activated locally.

3.12.5 Public Warning Systems

The Public Warning System (PWS) is an important to safety system as described in Section 3.15. This system provides warning to the off-site public within the immediate notification area (INA) to take protective action. This system consists of sirens, towers, and control consoles.

3.12.5.1 Equipment Description and Functions

The central control console, located within C-300, consists of a computer, peripheral equipment, and a field interface unit (FIU). This console activates the warning system. The FIU communicates between the computer and the remote terminal units (RTUs) mounted on the towers. The RF signals to the sirens are initiated from the control console.

The 911 Emergency Center in Paducah, Ky. also interfaces with the RTUs. It contains a touchscreen and a FIU. This center has the capability to activate the sirens but is not part of the important to safety system.

Sirens and their associated power and control equipment are mounted on towers at four locations around the plant. Each location has two fully equipped towers providing backup to each other. RTUs on the tower provide activation and monitoring of the sirens. Each siren contains two battery chargers and a 24 VDC battery. The battery chargers are powered by 120 VAC. Operational testing of the Public Warning System sirens is conducted monthly either from C-300 or from the 911 Emergency Center.

3.12.5.2 Instrumentation, Controls, and Alarms

Activation and monitoring of the PWS is accomplished at the central console computer. There are passwords and administrative controls to prevent inadvertent operation of this system. A map screen is available that displays the various siren locations. Once the alert button is clicked, the start button can be clicked starting the sirens. The computer provides visual and audible verification of siren activation. A failure of the sirens to activate will be indicated by the word "Fail" appearing on the start button. A printout of the siren activation can be obtained. A "Full" status indicates proper activation.

If siren activation cannot be accomplished from C-300, the 911 Emergency Center can be requested to activate the system. Administrative controls between the two activation sites ensure proper control.

The FIU queries the RTU periodically for status of voltages and other parameters. This information is available at the C-300 console.

Audible alarms are received at the C-300 console for:

- Malfunctions during siren activation
- Door at the siren location opened
- Communication problem between RTU and siren
- Problem with battery charging system (Loss of 120 VAC)
- Low battery power to the siren
- Communication problem between RTU and FIU

3.12.5.3 Support Systems

The central console has an uninterruptible power supply that allows it to operate during loss of normal AC power.

The 120 VAC power to the siren battery chargers is required to support the system. The 24 VDC batteries are provided to supply power for the sirens. The sirens will still function, upon loss of AC power, until the batteries are depleted.

3.12.6 Criticality Accident Alarm System

The Criticality Accident Alarm System (CAAS) is designed to detect gamma radiation levels that would result from the minimum criticality accident of concern and to activate the building evacuation alarms and alarms in the C-300 Central Control Facility (CCF). The CAAS comprises numerous radiation detector instruments integrated into a single alarm system with primary annunciation on the radiation alarm system console (RASC) in the CCF. The CAAS is important to safety as described in Section 3.15. The PGDP Nuclear Criticality Safety section establishes criteria for the CAAS that satisfies

the requirements of the American National Standards Institute Standard ANSI/ANS-8.3 except as listed in Chapter 1, Appendix A. Figure 3.12-1 shows a typical simplified schematic of the CAAS.

3.12.6.1 Equipment Descriptions and Functions

The CAAS consists of the following subsystems and components: radiation detector cluster units, the portable CAAS, radiation alarm cabinets, alarm horn units, the building horn relay cabinets, and the annunciation system in the CCF. The subsystems and components that comprise the CAAS are described in the following subsections.

3.12.6.1.1 Radiation Detector Cluster Unit

Radiation detector cluster units detect gamma radiation from criticality events and initiate evacuation alarms and signals. A radiation detector cluster unit consists of three gamma detector modules, one logic module, and the housing. The radiation detector cluster unit is referred to as a “cluster” while any one of the three instruments, which comprise the cluster, is designated a “detector module.” When a cluster alarms, it activates the CAAS building horn(s), the external building warning lights, and the audible and visual alarms on the RASC. The audible alarms warn personnel to evacuate the area immediately. Table 3.12-1 lists the locations of the clusters. If the gamma radiation field intensity exceeds the alarm set point, the detector module sends an alarm status to the logic module.. The outputs of these detector modules are connected into a voting logic matrix such that at least two detector modules, or under some faulted conditions one detector module, must alarm to give a criticality incident alarm.

Each of the three detector modules in a cluster consists of a gamma detector tube assembly which contains the following: a gamma detector tube; a power supply and signal processing printed circuit boards; a battery backup power supply pack; fuses for both AC and battery power supplies; two light-emitting diode (LED) lights to indicate FAULT ALARM or RAD ALARM status when appropriate; and a front panel with indicators and self-test electronic controls for the diagnosis of any malfunction or for the calibration, adjustment, and testing of the cluster. The three detector modules are interconnected through the motherboard to the cluster logic module. Each detector module is also designed to function as a self-contained gamma monitor.

An important part of the detector module is the gamma detector tube assembly. This assembly detects gamma radiation from a criticality event and provides an amplified alarm signal from a buffer amplifier to the electronic circuits in the cluster. If the gamma radiation field intensity is large enough that the signal exceeds the alarm setpoint, the detector module sends an alarm status signal to the cluster logic module. The logic circuit in the cluster logic module compares the inputs from the three detector modules according to a preset "voting" scheme and causes an alarm output if appropriate.

Each detector module has three possible states: Normal, Fault Alarm, and Radiation Alarm. If a component in a detector module fails and causes the signal level to drop to a fault alarm point, the detector module will go into the Fault State, actuating the FAULT ALARM light on the front panel. If a detector module goes into the Fault State, the cluster logic module will detect it, then activate an audible alarm and turn on a trouble light at the RASC. Radiation levels of 10 mR/h or more above the background reading will exceed the cluster’s alarm set point, and the cluster alarms. In this state, the RAD ALARM light on the front panel of the detector module will turn on.

The detector module contains provisions for continually determining whether the gamma detector tube and associated electronic circuits are in good working order. If for any reason a fault has occurred, a fault status signal is generated and sent to the cluster's electronics for reporting system status to the RASC. Each cluster is designed to operate independently of the 120 VAC power supply for a minimum of four hours.

A backup power supply is also provided for each of the three detector modules in a cluster. The batteries, if defective (open, shorted, or discharged), will not affect the operation of the unit if AC power is present. Provided one detector module contains an operable backup power supply, the cluster logic module will continue to correctly report the status of the unit.

3.12.6.1.2 Portable CAAS Units

The portable CAAS units are similar in design and function to the permanent clusters. These portable units may be used in situations where temporary conditions create the potential for a criticality, such as monitoring fissile waste storage areas. The portable CAAS units are provided with electronic local alarm horns. The electronic horns are connected to a backup power supply.

3.12.6.1.3 Radiation Alarm Cabinet

The radiation alarm cabinets (RACs) are located in the primary building that they support. These cabinets are the routing points for all local cluster inputs to the building alarms and the CCF. The building horns are either electronic or are air-operated horns and are located in each building to sound an evacuation alarm should the local cluster detect a criticality. The warning lights are installed at various locations on/in the building to provide a visual signal of the alarm condition.

3.12.6.1.4 Alarm Horn Units

The alarm horn units consist of an air supply system, air whistles, electronic horns and associated piping and electrical system. The piping is routed to a main air supply header which is then routed to an accumulator (air storage tank) located outside of the building. The accumulators are maintained at a pressure that will supply the proper air whistle pressure necessary to blow the horns. Air is supplied to the accumulators from the plant air system. Sufficient available air capacity is ensured by maintaining the minimum pressure, based on the number of accumulators in service, above that necessary to blow all the horns for a minimum of two minutes

The air supply from the air accumulators to the air whistles is controlled by individual pressure control valves, which maintain supply pressure to the air whistles at their design pressure. These control valves are located in the piping between the accumulators and each solenoid valve. These control valves are spring loaded, diaphragm actuated, valves. The valves are opened by spring pressure and closed by control air pressure. Therefore they fail open on loss of control air pressure.

Air whistles have been appropriately located in/on the process buildings to provide an adequate warning signal level. In areas such as the building area control rooms (ACRs), maintenance shops, locker rooms, and C-746-Q1, where the installation of air whistles was impractical due to the amplitude of the whistle signal at large distances, electronic horns were installed.

The CAAS building horns can be manually controlled by the horn control switch operating in conjunction with the HORN PERMISSIVE switch, both of which are located on the RASC. These switches are also used to disable the CAAS building horns during testing or maintenance to prevent unwanted alarm signals.

3.12.6.1.5 Building Horn Relay Cabinets

The building horn relay cabinets (BHRCs) in each building also contain a loss of power relay and indicating light. The purpose of this relay is to provide an alarm signal upon a loss of power to the CAAS building horns and uninterruptible power system (UPS), where applicable. The alarm signal is indicated by a cluster trouble alarm at the CCF and a loss of power light inside the BHRC.

3.12.6.1.6 Accumulators

The accumulators are filled using an air compressor located inside the building. The input to the air compressor is from the plant air system. The output is directly into the accumulator. The accumulators are monitored for pressure such that the compressors recharge the accumulators at a set pressure. If the system falls below a set pressure, which is above the limit for 2-minute operation of the air whistles, a cluster trouble alarm is generated in the CCF. The air compressor installation is designed such that quick removal and replacement can be accomplished should replacement become necessary.

3.12.6.1.7 Slaved Buildings

Slaved buildings are buildings located within the 12 Rad radius from a CAAS alarmed building or area that did not meet audibility requirements. These buildings are equipped with an air operated horn unit similar to the unit described above, or an electronic evacuation horn that produces a similar sound. When a cluster alarms, the CAAS building alarm horn in buildings slaved to that cluster are also activated. Slaved buildings are noted in Table 3.12-1.

3.12.6.1.8 Radiation Warning Lights

Red radiation warning lights are installed in/on buildings/areas with CAAS or buildings/areas that are slaved. The lights are activated by a signal from the building RAC.

3.12.6.1.9 C-300 Central Control Facility Alarms and Controls

The RASC in the CCF is designed to give alarm indications and locations. The panel displays indicating lights showing the condition of the alarm system. Controls for resetting the alarm units, individual CAAS building horn lockouts and devices for remote sounding of the CAAS building horns, are part of the features included in the CCF.

After the incident commander has acknowledged the radiation alarm, the detector modules may be reset. CAAS building horns in other areas may be energized for complete personnel evacuation.

3.12.6.2 Instrumentation, Controls, and Alarms

The detector module monitors three alarms states: Normal, Fault Alarms, and Radiation Alarms. If only one detector module alarms, the cluster logic module considers it a malfunction and generates a trouble alarm on the RASC. If two detector modules alarm at the same time, the cluster logic module considers it genuine and generates a radiation alarm. If two detector modules are already in the Fault State and the third detector module alarms, the cluster logic module generates a Radiation Alarm.

When a cluster enters a Radiation Alarm condition, the following events occur:

- A signal is transmitted to the RASC.
- The radiation warning lights are actuated.
- The CAAS building horns are actuated.
- The CAAS building horns and radiation warning light(s) in slaved buildings, if applicable, are actuated.

A trouble alarm will be transmitted to the RASC whenever any of the following occurs:

- Line power failure
- Module removal
- Cable separation
- Loss of air accumulator supply pressure (where applicable)
- Loss of signal at a detector module
- Indication of radiation detection by only one detector module
- Loss of power to horn circuits and UPS (where applicable)
- External temperature below cluster's specified minimum operating temperature (where applicable).

3.12.6.3 Maintenance and Testing Requirements

Annual verification of operability of the clusters is performed using a radiation source. Annual verification of local alarm operability is performed. An integrated test of the entire CAAS is performed on an annual basis in accordance with ANSI/ANS 8.3, Section 6.4.

Accumulator air pressure is checked quarterly to verify it is greater than that necessary to sound the horns for at least two minutes. All CAAS batteries/UPSs are tested annually and the horns are sounded annually.

3.12.6.4 Administrative Controls

In addition to the administrative controls in Chapter 4, and those controls covered by programs and plans, the following ensure safe operation of the CAAS:

1. When CAAS detection and/or alarm is declared inoperable, all non-essential personnel are required to be evacuated from the affected area.

2. Essential personnel that must remain in an area where the CAAS detectibility is declared inoperable must obtain permission of the Plant Shift Superintendent/Manager in Charge in order to remain in, or to enter, the affected area.

3. Essential personnel that must remain in an area where the CAAS detectibility is declared inoperable must wear personal alarming dosimeters (PADs). When CAAS inoperability is due to audibility loss, the essential personnel must have radio in constant communication with the CCF or a PAD.

3.12.6.5 Support Systems

Support systems for the CAAS in Buildings C-310/310-A, C-331, C-333/333-A, C-335, C-337/337-A, C-360, C-400 and C-409 are important to safety as described in Section 3.15. These support systems include the CAAS air accumulator, 120 VAC, 125 VDC, and 48 VDC. The CAAS air accumulator is supplied by the plant air system and contains an adequate supply of air to allow a two-minute warning sound. The primary 120 VAC is supplied by each building power distribution system. The 120 VAC power system is required for the cluster units, portable CAAS (where applicable), building horn solenoid valves (in buildings C-333-A, C-360. C-400, and C-409) and electronic horns in Buildings C-360, C-400 and C-409. The cluster units, electronic horns, and portable CAAS are provided with a battery backup power supply. An uninterruptible power supply (UPS) provides backup power to the building horn solenoid valves in buildings C-333-A, C-360, C-400 and C-409 and electronic horns in buildings C-360, C-400, and C-409. The 125 VDC is supplied by each building power distribution system. The 125 VDC power is required for the building horn solenoid valves. Loss of this power causes the valves to fail as is. The 48 VDC power is supplied from the C-300 48 VDC circuit and is required for the actuation of the building horns. A battery power supply is provided for the electronic horn in Building C-720-M.

Support systems for Buildings C-710 and C-709 are important to safety as described in Section 3.15. These support systems include 120 VAC power, 48 VDC and 24 VDC power. The primary 120 VAC is supplied by each building distribution power system. The 120 VAC power is required for the cluster units, the electronic horns, and the portable CAAS (where applicable). Backup and/or DC battery power is provided for the cluster units, the portable CAAS clusters and the electronic horns. The 48 VDC is supplied by the C-300 48 VDC circuit and is required for supervisory circuits monitoring CAAS status. The 24 VDC UPS is supplied to support the actuation of the building horns.

Support systems for C-720 are important to safety as described in Section 3.15. These support systems include 120 VAC power, 24 VDC power, and 48 VDC power. The primary 120 VAC power is supplied by the C-720 power distribution system. The 120 VAC power is required for the cluster units, the portable CAAS (where applicable). The cluster units and portable CAAS are provided with backup battery power. The 24 VDC power is supplied by two 12 volt batteries connected in series and is required for the building horns. The 48 VDC power is supplied from the C-300 circuit and is required to support the actuation of the building horns.

Support systems for C-746-Q1 are important to safety as described in Section 3.15. These support systems include 120 VAC power and 48 VDC power. The primary 120 VAC is supplied by the C-746-Q1 power distribution system. The 120 VAC and/or backup DC power is required for the cluster units, the portable CAAS (where applicable) and the building horns. The cluster unit, portable CAAS and building horn are provided with a backup battery power supply. The 48 VDC power is supplied from the C-300 circuit and is required to support the actuation of the building horns.

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Table 3.12-1. Criticality Clusters and Building Horns

Building	Clusters	Building Alarms
C-310/310-A	G and H	Building horns and lights.
C-331	J, K, and L[1]	Building horns and lights. Clusters will also actuate horns and lights associated with the C-331/335 tie line, and horns in C-410-D.
C-333	Z and AJ	Building horns and lights. Either cluster will also actuate horns in C-333-A.
C-333-A	AA and AB	Building horns. Either cluster will also actuate building horns and lights in C-333
C-335	A, B, C[2], and AF	Building horns and lights. Clusters will also actuate horns and lights associated with the C-331/335 tie line, and horns in C-350 and C-410-D.
C-337	T, U, V, W, X, Y, and AK	Building horns and lights. Clusters in C-337 will also actuate building horns in C-337-A and horns associated with the C-337-A/C-360 tie line located in C-637-1.
C-337-A	N	Building horns. Cluster N in C-337-A will actuate building horns and lights in C-337 and horns associated with the C-337A/360 tie line, located in C-637-1.
C-360	R and S	Building horns and lights. Either cluster will also actuate building horn and lights in C-360-A.
C-400	D and E	Building horns and lights. Either cluster will also actuate building horns in C-400-A.
C-409	P and AE	Building horns and lights. Either cluster will also actuate the building horn in C-720-M.
C-710	AM, AN, AP, AQ, AR	Building horns and lights. Any cluster will also actuate building horns and lights in C-709.
C-720	AL	Building horn and lights. Cluster will also actuate building horns in C-720-C, C-720-M, C-720-K, C-720-R, C-720-S, and C-728.
C-746-Q1	AD	Building horns and lights.

[1] Portable Cluster when installed in C-331 has alarm contacts in parallel with Cluster L.
[2] Portable Cluster when installed in C-335 has alarm contacts in parallel with Cluster C.

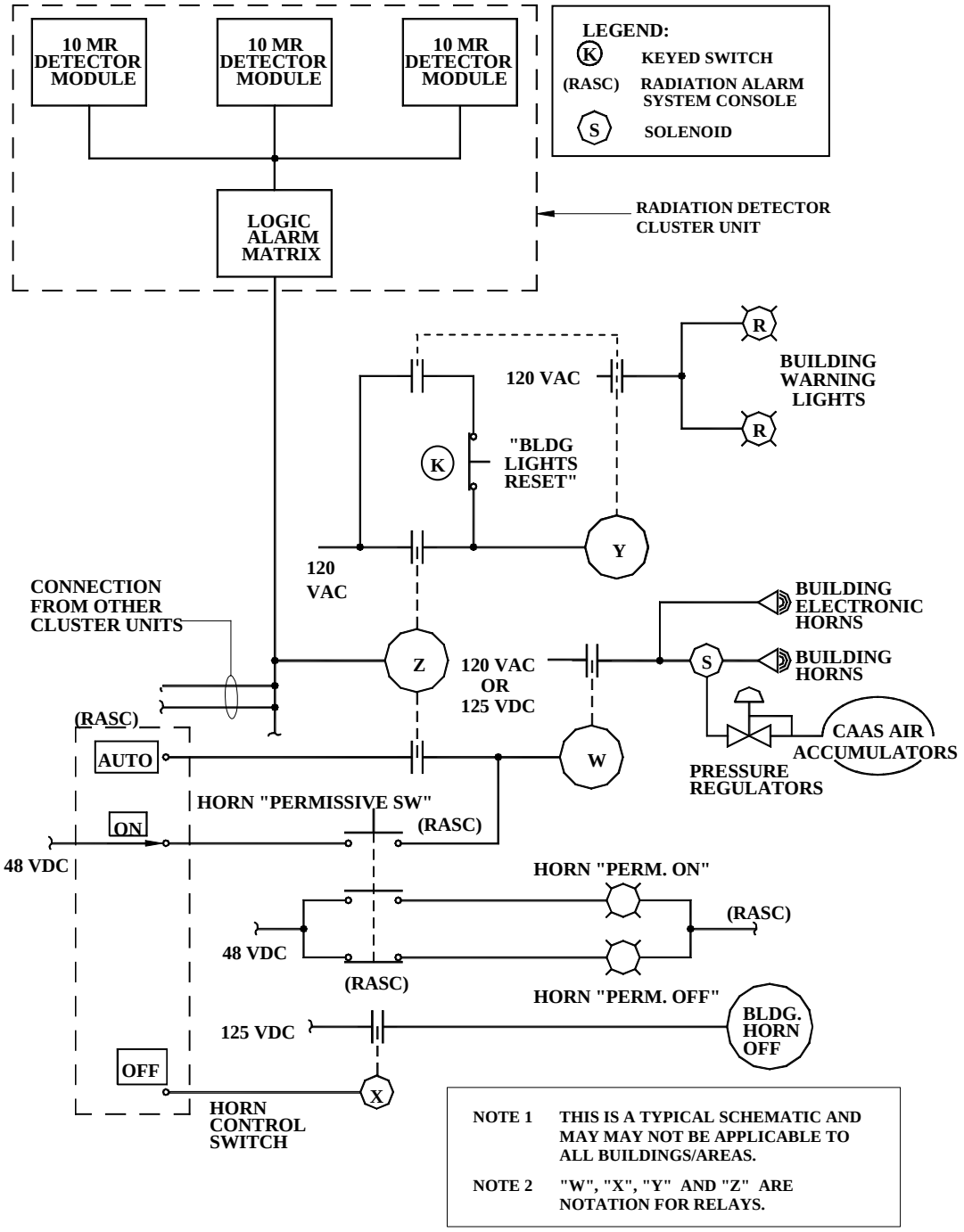

Figure 3.12-1. Simplified Schematic of CAAS

3.13 MAINTENANCE

Enrichment Plant Maintenance supports Operations by providing planning, estimating, and safe and reliable performance of preventive, predictive, and corrective maintenance and support services on plant facilities and equipment. Scheduling and coordinating for maintenance is performed by Production Support & Product Scheduling. Maintenance and Production Support & Product Scheduling units are described in Sections 6.1 and 6.4.

The machine shops fabricate, modify, and repair plant process and auxiliary equipment. Machine, welding, and metal working facilities and services are provided to meet the needs of plant operation. The welding facility includes an x-ray machine to aid in weld inspections. Expert services are provided for sheet metal, cranes and elevators, repairs to valves, pumps and compressors, high-efficiency particulate filter maintenance, and heating, ventilation and air conditioning.

The electrical and instrument shops provide motor repair, electrical relay work and testing, radiation instrument calibration, pneumatic instrumentation work, fabricating electrical equipment and systems, maintaining telephone and alarm systems, and calibrating measurement and testing equipment (M&TE) and other instrumentation.

Facility maintenance ensures upkeep and facility improvements to the plant site including painting, capital upgrades, roads and grounds, mobile equipment management and repairs, custodial services, asbestos abatement, carpentry, material erection, UF_6 cylinder handling, locksmithing, and heavy equipment operation.

The materials management program includes general materials receiving, warehousing, shipping, trafficking, and control to support enrichment operations and plant-site related activities. Inventories are maintained to assure timely availability of parts, tools, equipment, and general inventory to meet plant needs. GDP Procurement and Materials controls the low bay area of C-720 related with shipping/receiving and stores.

Additional maintenance program information can be found in Section 6.4.

3.13.1 Maintenance Facilities

The primary maintenance facility is C-720. This building is divided into a low-bay stores area, a high-bay maintenance area, and a mezzanine level with offices and work areas for administrative support personnel, and is serviced by north and south truck alleys. The stores area provides storage room for material and supplies necessary to maintain operations that are not specifically provided elsewhere. The maintenance area has space for shops to fabricate and repair equipment used in the enrichment process. Several different types of jib and overhead cranes support maintenance activities in the C-720 shops.

Another major maintenance facility is the C-724-A, Carpenter Shop Annex and C-724-B, Carpenter Shop. This building houses the carpenter shop, and sign and paint shops.

The C-750, Garage and Appurtenant Structures is also an important maintenance facility at PGDP. It is a typical fully equipped garage facility providing areas to service and maintain plant automotive and

heavy equipment. Hazardous materials associated with the garage are typical industrial materials. Equipment with fixed contamination may also be handled at this facility.

Buildings C-720, Maintenance and Stores Building and Appurtenant Structures, C-720-A, Compressor Shop Addition, C-720-B, Machine Shop Addition, C-720-C, Converter Shop Addition, and C-720-K, Instrument Shop Addition are important to safety and are required to maintain structural integrity during evaluation basis natural phenomenon events (earthquake, high winds, and flooding). The boundary definitions for these buildings are described in Table 3.15-2.

3.13.2 Maintenance Activities

3.13.2.1 Normetex Pump Maintenance

Normetex pumps are periodically removed from service and transported to C-720 for maintenance. The maintenance of the Normetex pumps involves replacement of the pump parts, an overhaul of the pump bearings and shaft, an evacuation test, and an operational test. Since parts may be contaminated, they are disposed of accordingly.

3.13.2.2 Section Deleted

3.13.2.3 Process Motor Repair

Process motor repairs are performed in C-720. The process motor repair area is designed to repair electrical motors and, occasionally, transformers from various areas of the plant.

Due to the limited knowledge regarding the amount of uranium on the motors, all incoming motors are surveyed before arrival in C-720. Motor disassembly takes place in this area. Minor servicing of the motor includes brake work and bearings replacement. Major work includes more thorough disassembly of the motor, such as separation of the stator and rotor.

3.13.2.4 C-720 General Machining

As process equipment in the cascade fails or for other reasons needs repair or routine maintenance, it is moved to C-720 for general machining and repair. This equipment may be contaminated with enriched

uranium. This process equipment includes compressor shafts and compressor blades; centrifugal pump shafts, casings, and impellers; valve stems, special compressor parts, and other equipment.

Removal of large deposits takes place at the process building at the time of equipment removal. Before the equipment is moved to C-720, it may be taken to C-400, Cleaning Building and Appurtenant Structures. Upon arrival at C-400, the removed process equipment may be disassembled and component parts are decontaminated and cleaned as necessary. Radiological surveys on each decontaminated part will be made.

Machining equipment includes large milling machines, lathes, drill presses, grinders, and other cutting equipment. Operations with this equipment will result in removal of material from process equipment parts which could include a small amount of enriched uranium. The material removed will include metal chips, shavings, or grinding dust which will accumulate in catch basins beneath machining equipment or on the machine shop floor. This material is exempted from NCS controls and disposed as contaminated metal waste.

Machining operations on fissile or potentially fissile items will be performed without the use of the machine recirculating coolant system. Small amounts of coolant may be applied from hand-held squeeze bottles or from a coolant mist sprayer. The amount of coolant used is minimized.

3.13.2.5 C-720 Process G-17 Valve Repair

Decontamination and disassembly of Model G-17 valves is accomplished in C-400 and valve repair and reassembly is performed in C-720-C. The disassembly process includes scarfing of the bonnet flange weld.

Maintenance checks the bellows for leakage using a pressure test. If necessary, the bellows are removed which involves a grinding operation to free the bellows from the support disc on the valve stem. Reassembly of the valve may include requirements for material buildup welding, grinding, and machining.

3.13.2.6 Repair of Expansion Joints in C-720 Fabrication Shop

The process buildings contain numerous expansion joints that periodically require repair which is accomplished in the building C-720 fabrication shop. In addition, expansion joints may be received from off-site for repair and replacement in the PGDP process buildings.

Following disassembly and decontamination in C-400, expansion joint components are returned to the C-720 fabrication shop for repair.

3.13.2.7 C-720 Repair and Handling of Converters

The converters are contaminated by process gas and must be handled accordingly. The most common type of failure for converters is in the cooler, either in the aluminum-to-steel transition joints or a leak in the tubes. The aluminum-to-steel transition joints are removed and replaced. Maintenance of

leaking cooler tubes is performed using plant procedures. Converters are repaired in C-720-C and retested in accordance with current plant procedures.

3.13.3 Fuel Storage Facilities

Various types of fuels are used in the daily operation of PGDP. Storage is provided for these fuels in different locations and quantities in order to furnish safe, efficient accessibility for their utilization. Fuel tanks and associated equipment at these facilities have electrical grounding in accordance with the national electrical codes. Also, the tank installations comply with OSHA fire protection regulations.

3.13.3.1 Gasoline and Diesel Fuel

Gasoline and diesel fuel are the primary fuels for vehicular equipment and emergency equipment generators. As can be seen in Tables 3.13-1 and 3.13-2 storage tanks for gasoline and diesel fuel, respectively, are scattered throughout the plant to provide convenient access for refueling equipment. Larger tanks are used where the demand warrants.

3.13.3.2 Fuel Oil

Fuel oil is maintained in storage tanks to fuel the C-600, Steam Plant & Associated Utility Appurtenant Structures boilers. Table 3.13-3 shows the quantities of fuel oil storage at the C-601 facility. The fuel oil tanks associated with the C-600 building (C-601-A, Steam Plant Fuel Storage Tank (Center), and C-601-B, Steam Plant Fuel Storage Tank (South) have fire protection which consists of an automatic foam system. The C-601-D Tank is not used for fuel storage, but is available for emergency storage.

3.13.3.3 Propane

Propane is used for furnaces and, in a few cases, as fuel for emergency generators. See Table 3.13-4 for information concerning the plant propane tanks.

3.13.3.4 Coal and Natural Gas

A coal storage yard and a coal bunker are located on the north side of C-600. The coal is stored in these areas until it is needed as fuel for the combustion process within the C-600 steam plant. The coal handling facility incorporates a dust suppression system and a fire protection system.

The C-600 building can use a natural gas line to supply the No. 1 boiler. Information about miscellaneous fuel storage is shown in Table 3.13-5.

3.13.4 Miscellaneous Facilities

There are several miscellaneous storage yards at PGDP. Two of these are C-740, Material Yard and C-740-C, Miscellaneous Materials Storage Yard. The C-740 yard is used to store bulk material for use in the plant construction program. Included are pipe and various structural members. The C-740-C storage yard is easily accessible for unloading materials delivered by semi-trailer. Two others are the C-745-X and C-745-Y Equipment Storage Yards. These are primarily used to store failed cascade equipment.

Other miscellaneous storage yards are C-746-H1, PEM Storage Slab and C-746-H2, PEM Storage Slab. These are grade elevation concrete storage slabs that are used primarily for storage of miscellaneous materials components.

Table 3.13-1. Gasoline Storage

Location	Fire Protection	Maximum Quantity (gallon)	Dike	Use
C-333 W	Fire extinguisher	300 1000	Yes No (Double Wall)	Vehicular fuel
C-337 S	Fire extinguisher	300 1000	Yes No (Double Wall)	Vehicular fuel
C-751	N/A Underground	10,000	Underground	Vehicular fuel

Table 3.13-2. Diesel Fuel Storage

Location	Fire Protection	Maximum Quantity (gallons)	Dike	Use
C-200 N	Fire Station	300	Yes	Generator
C-333 (3)	Sprinkler	275	Yes	Generator
C-337 (3)	Sprinkler	275	Yes	Generator
C-310 (1)	Sprinkler	275	Yes	Generator
C-331 (2)	Sprinkler	275	Yes	Generator
C-335 (2)	Sprinkler	275	Yes	Generator
C-611 (1)	Fire extinguisher	1,000	Yes	Generator and pumps
C-751	N/A Underground	10,000	Underground	Storage
C-631-1	Sprinkler	400	Yes	HPFWS Pump
C-631-3	None	400	Yes	HPFWS Pump
C-337 S	Fire extinguisher	200	Yes	Generator equipment fuel
C-333 W	Fire extinguisher	200	Yes	Vehicular fuel

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Table 3.13-3. Fuel Oil Storage

Location	Fire Protection	Maximum Quantity (gallons)	Dike	Use
C-601-A	Auto. foam sys.	420,000	Yes	Fuel to boilers
C-601-B	Auto. foam sys.	420,000	Yes	Fuel to boilers
Text Deleted				

Table 3.13-4. Propane Storage

Location and No. of Tanks	Fire Protection	Maximum Quantity (gallons)	Barricaded	Use
C-750 N (2)	Fire extinguisher	1,000	Yes	To fill LPG tanks on light trucks
C-710 N	None	1,000	Yes	Labs
Text Deleted				
C-400 (2)	None	1,000	Yes	Generator
Text Deleted				

Table 3.13-5. Miscellaneous Fuel Storage

Fuel	Location	Fire Protection	Maximum Quantity	Dike	Use
Coal	C-600 W bunker N yard	Dry pipe-type system	250-ton 30,000-ton capacity	None	Fuel for steam plant boilers (Nos. 2 and 3)
Natural gas	C-600	None	Gas Pipe Line	None	No. 1 boiler

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3.14 ADMINISTRATION FACILITIES

Facilities used for the conduct of administrative, clerical, and other support work at PGDP are discussed in this section (For building names, numbers and locations, see Figure 2.1-4).

3.14.1 C-100 Administration Building

This building houses administrative, support, and clerical personnel, and is divided into areas for accounting, administration, data processing, employment, and reproduction services, regulatory offices or services, design engineering services, drawing services, records management vaults, conference and training facilities.

3.14.2 Other Permanent Structures

There are many permanent structures at the PGDP that house a variety of functions. Many of these structures also have administration facilities located within or closely associated with them. The administration facilities may be contained in the primary permanent structure or they may be contained in a smaller associated structure.

3.14.3 Office Trailers

There are numerous office trailers at the PGDP. These office trailers serve a variety of administrative functions. The specific administrative function(s) of an office trailer as well as its physical location may change periodically, as the need arises.

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3.15 SAFETY SYSTEM CLASSIFICATION

3.15.1 Introduction

Section 3.15 provides details on those facility structures, systems, and components (SSCs) that are classified as Q or AQ as a result of the hazard and accident analysis presented in Chapter 4. SSC classification is based on the criteria for Q and AQ SSCs given in Section 4.2.2.

Chapter 4 provides a description of the methodology used to select the essential controls that are necessary to operate the plant within the appropriate Evaluation Guidelines (EGs). The technical basis for determining the SSCs that are necessary to provide these essential controls is derived from the results of the hazard and accident analysis described in Chapter 4. Descriptions are provided of the attributes (i.e., functional requirements and performance criteria) required to support the safety functions identified in the hazard and accident analyses and to support subsequent derivation of the Technical Safety Requirements (TSRs). Information provided in this section includes:

- Identification of Q and AQ SSCs, including their safety functions;
- Identification of support systems necessary for these SSCs to perform their safety functions;
- Identification of the functional requirements necessary for Q and AQ SSCs to perform their required safety functions;
- Identification of the performance criteria necessary to provide reasonable assurance that the functional requirements will be met; and
- Specific classification of Q and AQ portions of SSCs and definition of the overall SSC boundaries.

Systems and controls that are used to prevent criticality are identified in the Nuclear Criticality Safety (NCS) program. Those systems that serve as Active Engineered Features (AEFs) are identified, along with their boundaries, in Section 3.15.10.

Other SSCs were not specifically classified as a result of the hazard and accident analysis but are identified as AQ due to their importance to facility operations. The boundaries for these systems are included in Table 3.15-2.

The application of the graded approach to this chapter provides a guide to determining the classification of SSCs (i.e., Q or AQ) and the level of documentation and analysis needed to support the attributes of the SSCs. As defined in Section 4.2.2, Q SSCs are required to prevent and/or mitigate Evaluation Basis Events (EBEs) that could exceed any EBE off-site EG. AQ SSCs are more concerned with on-site accident consequences (worker safety). In general, because of their importance to the protection of off-site public health and safety, Q SSCs require more formality in establishing functional requirements and performance criteria than do AQ SSCs.

The safety function and functional requirements are defined commensurate with the level of detail from the hazard and accident analysis. For example, the hazard and accident analysis identifies that the UF_6 compressor motor manual trip systems (Section 3.15.3.1) are important to prevent or minimize releases from the cascade in events such as a B-stream block valve closure event. The UF_6 compressor motor manual trip systems consist of the cell remote manual shutdown systems for the enrichment and purge cascades, and the trip systems for the interbuilding booster and purge and evacuation (P&E) compressor motors. The safety function and

functional requirements are developed based on this level of detail to include trip systems associated with "00" and "000" cell compressor motors, and interbuilding booster compressor motors. The system evaluation and system classification subsections further delineate the essential portions of the system required to meet the safety functions and functional requirements to include a justification for any exceptions. The boundaries of Q, AQ, and NCS AEF SSCs are provided in Tables 3.15-1, 3.15-2, and 3.15-3, respectively. Support system boundaries are included in the boundaries of the supported SSCs if loss of the support system does not result in the supported SSC failing in a safe manner.

3.15.2 UF_6 Feed Facilities

3.15.2.1 Autoclave High Pressure Isolation System

3.15.2.1.1 Safety Function

The autoclave high pressure isolation system is designed to contain a release of UF_6 inside the autoclave. The system detects high autoclave pressure and isolates all active isolation valves to ensure that the following safety objectives are accomplished:

- The UF_6 primary system temperature for the category A or B UF_6 cylinder being heated inside an autoclave is maintained below the temperature that assures an ullage inside the cylinder is maintained.
- The UF_6 primary system temperature for the category C UF_6 cylinder being heated inside the autoclave is maintained below the temperature that assures that no liquid UF_6 is formed inside the cylinder.
- The release of UF_6 and its reaction products to the atmosphere from a UF_6 primary system failure inside an autoclave is maintained below the amount that would result in exceeding either the radiological or nonradiological off-site exposure EGs for the EBE category.

3.15.2.1.2 Functional Requirements

The autoclave high pressure isolation system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety function independent of plant/instrument air supply to the facility.
- The system shall be capable of accomplishing the required safety function independent of the normal AC power supply to the facility.
- The system shall be capable of having two detectors to sense autoclave high pressure.
- Isolation of the autoclave active valves shall be accomplished within 15 seconds from autoclave pressure exceeding the required actuation pressure for the system.

3.15.2.1.3 System Evaluation

The autoclave high pressure isolation system was evaluated to assess its ability to accomplish its required safety functions. Two separate calculations were performed to analyze transient conditions involving specific limiting events associated with the safety functions. In addition, a fault tree analysis was performed to determine the system's ability to accomplish the safety functions. The results of these evaluations are provided in this section.

Safety function analysis. The first safety function required of this system is to protect the integrity of the UF_6 cylinder being heated. A review of the autoclave operations determined that the limiting event for evaluating this safety function is autoclave steam control valve fails open (Section 4.3.2.2.2). For this event, the steam control valve fails open, resulting in a pressure increase (transient) in the autoclave. The primary concern for this event is cylinder overheating, which for category A and B cylinders (mode 5) leads to cylinder overpressurization from loss of cylinder ullage that could possibly lead to cylinder rupture. For heating category C cylinders (mode 7) the overheating leads to liquefaction of the UF_6 and overpressurization that could possibly lead to cylinder rupture. Three different evaluations were performed to verify the maximum temperature of the cylinder being heated was maintained below the allowable values. Three different initial conditions were evaluated. The first condition was for a 14-ton, 48G thin-wall cylinder filled to 28,000 lb (12,700 kg) with the maximum allowable noncondensables. This cylinder must be heated to greater than 235°F (112°C) before dropping below 5% ullage based on ANSI N14.1. This evaluation assumed the maximum amount of allowable noncondensables inside the cylinder, all UF_6 is liquefied, and the cylinder is filled to 28,000 lb (12,700 kg) to ensure that protection would be provided for the most limiting event. The evaluation also assumed that the initial temperature inside the autoclave is less than 230°F (110°C). The autoclave steam pressure control system (see Section 3.15.2.7) ensures that the initial temperature conditions inside the autoclave are maintained. The second initial condition assumed the initial temperature was 240°F (116°C). Although the same cylinder (i.e., 48G thin wall, high-volume) would not be allowed to be heated at this temperature, the heat transfer rates were considered conservative to determine if 250°F (121°C) would be exceeded. The third condition assumed heating of any category C cylinder with any quantity of UF_6. This analysis assumed a initial condition temperature less than 142.9 (61.6°C). This lower temperature is maintained by the autoclave temperature control system (see Section 3.15.2.10) and ensures that the initial temperature conditions inside the autoclave are maintained.

When the steam control valve fails open, a rapid pressure rise occurs inside the autoclave and quickly reaches the 15-psig (205 kPa) actuation pressure of the autoclave high pressure isolation system. The analysis assumes that (1) it takes 15 seconds for the steam isolation valves to terminate the event after the 15 psig (205 kPa) actuation pressure is reached and (2) steam flow into the autoclave remains full until the valves are completely closed. For category A and B cylinders, using a conservative assumption that all of the heat added to the autoclave during the transient is then transferred to the liquid UF_6, the final temperature of the UF_6 would still be less than 245°F (118°C) for the lower initial temperature and less than 250°F (121°C) for the higher initial temperature. For category C cylinders, it was conservatively assumed that the autoclave and UF_6 cylinder would absorb the heat, but none of the heat would escape to the environment. The analysis showed that the temperature of the UF_6 remained below the triple point temperature of 147.3°F (64.1°C) and that no liquid UF_6 was formed. The present steam supply isolation valves have a valve-stroke time less than the assumed 15 seconds and are tested periodically to verify that the system can complete an isolation of the steam supply within 15 seconds. Based on this analysis, the autoclave high pressure isolation system will prevent the UF_6 primary system pressure from exceeding the allowable temperatures for the most limiting cylinder and worst-case transient, provided the actuation pressure is ≤ 15 psig (205 kPa) and the steam supply valve will close in ≤ 15 seconds after the actuation pressure is reached.

In the event of a UF_6 release inside the autoclave, the second safety function of this system is to limit the release of UF_6 reaction products to the atmosphere to less than the radiological and nonradiological EGs for the EBE category. To accomplish this safety function, the autoclave high pressure isolation system works with the autoclave primary containment system to detect high pressure inside the autoclave and close the autoclave containment isolation valves before the release and subsequent exposures exceed these guidelines. A review of the autoclave operations determined that the limiting event for evaluating this safety function is cylinder failure inside autoclave (see Section 4.3.2.2.14). For this event, the cylinder integrity is lost and UF_6 is released inside the autoclave. The primary concern for this event are isolating the autoclave and limiting the amount of material released to the atmosphere.

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To determine the amount of UF_6 released and the consequences of a release, the following initial conditions were assumed. The initial temperature of the UF_6 is assumed to be ≤240°F (116°C), the autoclave is closed and the steam valves are open, UF_6 is completely liquefied and the water level in the autoclave is below the shell of the autoclave at the drain. The only requirement to be addressed for this system is to detect the failure of the UF_6 primary system and accomplish isolation of the autoclave to prevent exceeding the EGs. Once isolation is accomplished, the requirement for containing the reaction products of the release is addressed by the autoclave primary containment system. This event was evaluated in Section 4.3.2.2.14, and the consequences were determined to be below the applicable EGs.

Due to the rapid response of this system upon detection of high autoclave pressure (i.e., 15-second isolation), the environmental conditions associated with the system during operation are basically normal operational conditions.

Based on this analysis, the autoclave high pressure isolation system will prevent exceeding the off-site EGs for the most limiting UF_6 primary system integrity failure inside an autoclave, provided the actuation pressure is ≤15 psig (205 kPa) and the autoclave isolation valves will close in ≤15 seconds after the actuation pressure is reached.

Qualitative fault tree analysis. In addition to the safety function analysis, a fault tree analysis was performed in accordance with Section 4.3.1.1.3.

The fault tree analysis concluded that the autoclave high pressure isolation system can perform its required safety functions and meets the functional requirements specified
.

3.15.2.1.4 System Classification

The autoclave high pressure isolation system is required to perform the following functions:

- Prevent a cylinder failure inside the autoclave as a result of overheating the cylinder (e.g., autoclave steam control valve fails open).
- Mitigate releases to the atmosphere from releases inside the autoclave (e.g., a pigtail failure inside autoclave or cylinder failure inside autoclave).

These release events are classified as EBEs whose consequences could exceed the off-site radiological/nonradiological EGs if the autoclave high pressure isolation system failed to perform its safety functions. Therefore, the autoclave high pressure isolation system meets the criteria for classification as a Q system.

This system is also identified as an NCS AEF (see Section 3.15.10.5.2). Therefore, the autoclave high pressure isolation system is classified AQ-NCS.

3.15.2.1.5 Boundary

The Q boundaries for the autoclave high pressure isolation system are defined in Table 3.15-1. The AQ-NCS boundaries for this system are defined in Table 3.15-3.

3.15.2.2 Autoclave Manual Isolation System

3.15.2.2.1 Safety Function

The autoclave manual isolation system shall initiate UF_6 line isolation upon operator action to ensure that the release of UF_6 and its reaction products for isolable events outside the autoclave are maintained below the radiological and nonradiological EGs for the EBE category.

3.15.2.2.2 Functional Requirements

The autoclave manual isolation system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be capable of accomplishing the required safety function independent of plant/instrument air supply to the facility.
- The system shall be capable of accomplishing the required safety function independent of the normal AC power supply to the facility.
- Isolation of the autoclave active valves shall be accomplished within 30 seconds from detection of the release.
- Remote switches shall be located where operator action can be accomplished upon evacuation of the facility.

3.15.2.2.3 System Evaluation

The autoclave manual isolation system was evaluated to assess its ability to accomplish its required safety function. A fault tree analysis was performed to determine the system's capability to meet the safety function. The results of the evaluation are provided in this section.

Safety function analysis. The safety function required of this system is to limit the quantity of UF_6 released to less than the radiological and nonradiological EGs for the EBE category. A review of facility operations determined that the pigtail/line failure outside autoclave event is the limiting event for this system (see Section 4.3.2.2.10). Specifically, two scenarios could result from this initiating event: (1) rupture of a feed line while feeding a cylinder to the cascade and (2) failure of an evacuation header while heeling a cylinder. For both scenarios, operators in the facility are capable of detecting the release. For significant releases of UF_6, visual detection of the release is easily accomplished due to the reaction products forming smoke.

For each scenario, a rupture in a feed line while feeding a 14-ton cylinder to the cascade results in the worst-case gaseous release (see Section 4.3.2.2.10). The requirements for this system are to

provide the capability to isolate the lines within a 30-second time frame after actuation of the system and have accessability for the operators to actuate the system. Operator response to the event is addressed in Section 4.3.2.2.10. The system provided an isolation signal to the autoclave high pressure isolation system (see Section 3.15.2.1) and thus the system can isolate the required valves to perform the required safety function. The environmental conditions associated with this circuitry is not significantly different, other than the "smoke" generated from the reaction of UF_6 and the moist air, than normal operation due to the required response time and the operator. For an evaluation of the remaining functional requirements, see the qualitative fault tree analysis below.

Based on the operator presence in the facility for these types of releases, the autoclave manual isolation system can accomplish the required safety functions and prevent exceeding the EBE EGs for the facility.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the system can meet the functional requirements previously described.

3.15.2.2.4 System Classification

The autoclave manual isolation system is required to perform the following safety function:

- Mitigate a line failure outside of the autoclave.

This release event is classified as an EBE whose consequences could exceed the off-site radiological/nonradiological EGs if the remote feed isolation system failed to perform its safety function. Therefore, the autoclave manual isolation system meets the criteria for classification as a Q system.

3.15.2.2.5 Boundary

The Q boundaries for the autoclave manual isolation system are defined in Table 3.15-1.

3.15.2.3 Autoclave Primary Containment System

3.15.2.3.1 Safety Function

This system is required to prevent a release of UF_6 from exceeding the off-site radiological and nonradiological EGs for the EBE category during modes when the autoclave is closed.

3.15.2.3.2 Functional Requirements

The autoclave primary containment shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be designed to withstand the evaluation basis earthquake and maintain UF_6 primary system integrity when connected to the UF_6 primary system.

- The system shall be designed to withstand the evaluation basis wind loading and maintain UF_6 primary system integrity when connected to the UF6 primary system.
- The system shall be designed to withstand the maximum pressure generated after a release of UF_6 should a breach occur during operation without structural failure of the autoclave (other active systems may be considered in combination with this requirement).
- Penetrations to the autoclave shall be protected by one of the following methods: (1) two automatic isolation valves, (2) one valve that is normally closed and manually operated or the autoclave pressure relief system configuration, or (3) a closed piping system outside the autoclave (e.g., instrument lines/instruments) which are rated for the same pressure as the autoclaves.

3.15.2.3.3 System Evaluation

This system is required to prevent a release of UF6 from exceeding the off-site radiological and nonradiological EGs for the EBE category. As indicated in the functional requirements, there are four different functional requirements associated with meeting the required safety action.

The first and second functional requirements for this system are associated with preventing failure of the UF_6 primary system during earthquakes and high winds. The autoclaves have been evaluated for natural phenomena effects and have been found to meet the functional requirements. Since the integrity of the UF_6 primary system is maintained, there is no requirement to accomplish autoclave isolation during the EBE natural phenomena events.

The last two functional requirements are associated with UF_6 primary system failures occurring inside the autoclave during normal operations. The autoclave is required to minimize the release of the reaction products to the atmosphere to prevent exceeding the EBE EGs. The fourth functional requirement is associated with requiring all penetrations to have isolation capability. Any actions required to meet this requirement are addressed by the analysis presented in Section 3.15.2.1.3 with the exception of the penetrations not automatically isolated by the autoclave high pressure isolation system. The penetrations that have active valves are protected by two valves in series except the vacuum breaker line at the feed facility. The vacuum breaker line has a relief valve that is maintained in the closed position by the autoclave pressure. Other penetrations are also protected by at least one normally closed manual valve or passive device (i.e., autoclave pressure relief system) or is a closed system outside the autoclave (e.g., instrument lines). The protective devices and closed outside systems are rated for the same pressure as the autoclaves. Therefore, this functional requirement is met.

The last functional requirement deals with the autoclave environment after a failure has occurred in the UF_6 primary system. Failure of the autoclave containment boundary could result in an uncontrolled release of UF_6 and its reaction products that exceeds the off-site radiological/nonradiological EGs. A review of the autoclave operations determined that the limiting (bounding) event for evaluating this safety function is cylinder failure (see Section 4.3.2.2.14). For this event, the initial temperature of the UF_6 is assumed to be $\leq$ 240°F (116°C), the autoclave is closed and the steam valves are open, UF_6 is completely liquefied and the water level in the autoclave is below the shell of the autoclave at the drain. These conditions are identical to those described in Section 3.15.2.1.3 for a cylinder failure inside the autoclave. The primary concern

for this event is the pressure rise inside the autoclave due to the reaction of UF_6 and steam. A large UF_6 release into an autoclave could threaten the MAWP of the autoclave.

Two different sources of water are available inside an autoclave to react with a postulated release of UF_6. The first source is the steam supply for heating the autoclave. Assuming a 100-psig (791 kPa) steam supply, the flow of steam into the autoclave is prevented when the pressure in the autoclave exceeds 100 psig (791 kPa). Therefore, only the moisture allowed into the autoclave prior to its reaching 100 psig (791 kPa) will be available for the reaction with UF_6. Isolation of the steam supply is completed within 15 seconds after 15 psig (205 kPa) is reached in the autoclave by the autoclave high pressure isolation system (see Section 3.15.2.1).

The second source of water for reaction with the UF_6 is the steam condensate collecting in the bottom of the autoclave, on the equipment inside the autoclave, and in the drain system. Normal operation of the autoclave requires the drain line to remain open to prevent a buildup of water in the bottom of the autoclave. The autoclave water inventory control system (see Section 3.15.2.5) provides additional assurance that condensate does not accumulate in the autoclave by detecting a buildup of water in the drain and initiating isolation of the steam supply line. Based on these controls, the amount of water available for reaction with UF_6 is limited to the amount of water that is normally present inside the autoclave during heating conditions. The analysis for this scenario predicted a final pressure that is less than the autoclave's MAWP for all cylinder and autoclave configurations. Based on this analysis, this system will withstand the potential pressures generated after a cylinder failure inside an autoclave provided the initial conditions are maintained.

Although the structural integrity of the autoclave is not threatened by the pressure transient, two other concerns must also be addressed. These are the temperatures associated with the transient and the potential for leakage past the autoclave seal and associated isolation valves. The autoclave design temperature rating is 250°F (121°C). The analysis discussed above also determined the temperature transient associated with the event. Although the reaction products of the release (i.e., HF and UO_2F_2) have a relatively high temperature, the transient is short lived, and very little impact on the temperature of the autoclave shell and valves is experienced. The temperature effects on the autoclave seal were also reviewed and found to be within allowable temperatures. This keeps the autoclave and its components below its design temperature rating. The final area of concern is associated with the leak rate of the autoclave at the elevated pressures/temperatures. A periodic leak-rate test of the autoclave is performed to ensure that the system is capable of maintaining containment if the shell is pressurized. These tests are performed at a minimum of 90 psig (722 kPa) with a maximum allowable leak rate of 10 psi/hr (69 kPa/hr) or 12 scfm (20.4 m^3/h). These values were considered in the analysis and the source term/consequence was also considered in the accident analysis in Section 4.3.2.2.13 with acceptable results. Based on these analyses, the autoclave primary containment system can accomplish the required safety function and functional requirements.

3.15.2.3.4 System Classification

The autoclave primary containment system, the autoclave vessel and penetrations out to the isolation valves, is required to mitigate the following:

- Releases of UF_6 inside an autoclave (e.g., a pigtail/line failure inside autoclave); and
- Releases of UF_6 inside an autoclave due to cylinder failure.

These release events are classified as EBEs whose consequences could exceed the off-site radiological/nonradiological EGs if the autoclave does not maintain integrity. Therefore, the autoclave primary containment system is classified as a Q system.

3.15.2.3.5 Boundary

The Q boundaries for the autoclave primary containment system are defined in Table 3.15-1.

3.15.2.4 UF6 Primary System

3.15.2.4.1 Safety Function

The UF_6 primary system shall provide UF_6 primary system integrity for the processes that contain gaseous and liquid UF_6.

3.15.2.4.2 Functional Requirements

The UF_6 primary system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be designed to withstand the evaluation basis earthquake and maintain UF_6 primary system integrity.
- The system shall be designed to withstand the evaluation basis wind loading and maintain UF_6 primary system integrity.
- The system shall be designed to withstand the normal operating temperatures and pressures and maintain UF6 primary system integrity.

3.15.2.4.3 System Evaluation

This system is required to provide UF_6 primary system integrity for the processes that contain gaseous and liquid UF_6. The safety function is accomplished by retaining integrity during normal operations and upset events (e.g., autoclave steam control valve fails open, Section 4.3.2.2.2). The system is designed to withstand normal pressures and temperatures encountered during feed operations. Pressure-reducing devices (i.e., flow control valves, etc.) are used where the design of the UF_6 primary system is not the same value as that encountered inside the cylinder for the autoclaves. Additionally, the pigtails used inside the autoclaves are pressure and leak tested prior to introduction of the UF_6 after each new connection is made.

In addition, the system is required to maintain UF_6 primary system integrity during an evaluation basis earthquake and evaluation basis wind loading. The UF_6 primary system was evaluated to assess its ability to withstand earthquake and high wind events. The results of this evaluation indicated that the UF_6 primary system piping could withstand the wind loadings and any potential impacts from debris. Also

this evaluation showed that the system is capable of performing its safety function following an evaluation basis earthquake. The feed facility UF_6 primary system can accomplish its required safety function.

3.15.2.4.4 System Classification

The UF_6 primary system is required to:

- Prevent a large release of UF_6 to the atmosphere during normal operations; and
- Prevent a large release of UF_6 during upset events that do not specifically address failures of the UF6 primary system.

An unmitigated liquid/gaseous UF_6 release from a cylinder in an autoclave has the potential to exceed off-site EGs. Therefore, the portions of the UF_6 primary system in the feed facilities up to the second isolation valve meet the criteria for classification as a Q system. Portions of the UF_6 primary system after the second isolation valve to the cascade will only contain gaseous UF_6 and are classified as AQ consistent with the UF_6 primary system in the cascade (see Section 3.15.3.3).

3.15.2.4.5 Boundary

The Q and AQ boundaries for the UF_6 primary system for the feed processes are defined in Tables 3.15-1 and 3.15-2, respectively.

3.15.2.5 Autoclave Water Inventory Control System

3.15.2.5.1 Function

The autoclave water inventory control system limits the amount of water present inside the autoclave during normal operation to ensure initial conditions are preserved.

3.15.2.5.2 Functional Requirements

The autoclave water inventory control system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety functions independent of any support systems.
- The system shall detect condensate levels that exceed the top of the drain at the autoclave shell and isolate sources of the steam to the autoclave.

3.15.2.5.3 System Evaluation

The autoclave water inventory control system was evaluated to assess its ability to accomplish its required safety function. In addition, a qualitative fault tree analysis was performed to determine the system's capability to accomplish the required safety function. The results of these analyses are provided in this section.

Safety function analysis. The required safety function for the autoclave water inventory control system is to maintain the initial condition assumed by the accident analysis: during normal operation, the autoclave drain valves are open to provide a condensate drain path when steam is being applied to the autoclave environment, preventing accumulation of condensate in the drain. The analysis described in Sections 3.15.2.1 and 3.15.2.3 assumed the level of water inside the autoclave is no higher than the top of the drain at the autoclave shell. The detectors in the drain line are located below this assumed elevation. The autoclave water inventory control system accomplishes its safety function by detecting a high condensate level prior to reaching the assumed level and isolating the steam supply to the autoclave.

Therefore, provided the autoclave water inventory control system can detect water levels prior to reaching the top of the drain line, and provided the same system initiates isolation of steam sources, the safety function is met.

Qualitative fault tree analysis. In addition to the safety function analysis, a fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the autoclave water inventory control system can meet the functional requirements described previously.

3.15.2.5.4 System Classification

The autoclave water inventory control system is required to preserve an initial condition of the accident analysis (i.e., limit the initial amount of water present inside the autoclave during normal operation); but the system provides no safety function to mitigate the event. Therefore, the autoclave water inventory control system meets the criteria for classification as an AQ system.

This system is also identified as an NCS AEF (see Section 3.15.10.5.1). Therefore, the autoclave water inventory control system is classified as AQ-NCS.

3.15.2.5.5 Boundary

The AQ and AQ-NCS boundaries for the autoclave water inventory control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.2.6 High Cylinder Pressure System

3.15.2.6.1 Safety Function

The high cylinder pressure system ensures that the following safety functions are accomplished:

- The system ensures that UF_6 will not reach the liquid state in the controlled feeding mode of operation.
- The system minimizes the potential for a loss of UF_6 primary system integrity during upset events that cause a pressure increase in the UF_6 primary system.

3.15.2.6.2 Functional Requirements

The high cylinder pressure system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety function independent of any support systems.
- The system shall detect high cylinder pressure and isolate the sources of steam to the autoclave.

3.15.2.6.3 System Evaluation

The high cylinder pressure system was evaluated to assess its ability to accomplish the required safety function. The results of this evaluation are provided in this section.

The safety function is to maintain the normal operating pressure of the UF_6 primary system below the MAWP of the cylinder. This function provides direct control of the UF_6 pressure inside the cylinder. The system is designed to detect a cylinder pressure equal to or less than the actuation pressure for the system and to close the steam supply block valves. The cylinder with the lowest MAWP is rated for 100 psig (791 kPa). Therefore, the system actuation is set at ≤ 100 psig (791 kPa) during normal heating cycles. For the controlled feeding mode, the activation must occur at <22 psia (152 kPa). This maximum initial pressure is assumed in the controlled feeding mode of operation and analysis of each of the initiating events for this operating mode (See Section 4.3.2.2.2). Based on these requirements, the safety function for this system can be accomplished.

3.15.2.6.4 System Classification

The high cylinder pressure system is required to:

- Maintain the initial conditions assumed in the accident analysis for the controlled feeding mode.
- Minimize the potential for UF_6 primary system integrity failures due to pressure transients.

This minimizes the potential for on-site personnel exposure. However, no credit is taken for this system to mitigate an event to meet off-site EGs for the EBE frequency. Therefore, the high cylinder pressure system meets the criteria for classification as an AQ system.

This system is also identified as an AEF (See Section 3.15.10.5.5). Therefore, the high cylinder pressure system is classified as AQ-NCS.

3.15.2.6.5 Boundary

The AQ and AQ-NCS boundaries for the high cylinder pressure system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.2.7 Autoclave Steam Pressure Control System

3.15.2.7.1 Safety Function

The autoclave steam pressure control system ensures that the UF_6 cylinder temperatures will not exceed the initial conditions assumed for different cylinder types when steam is being supplied to the autoclave environment during normal operating modes.

3.15.2.7.2 Functional Requirements

The autoclave steam pressure control system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be capable of accomplishing the required safety function independent of any support systems.
- The system shall detect high steam pressure and isolate the sources of steam to the autoclave to preserve initial conditions.

3.15.2.7.3 System Evaluation

The autoclave steam pressure control system was evaluated to assess its ability to accomplish its required safety function. In addition, a fault tree analysis was performed to determine the system's capability to accomplish the safety function. The results of these evaluations are provided in this section.

Safety function analysis. The autoclave steam pressure control system is required to maintain the UF_6 cylinder temperature to below the values assumed by the accident analysis. During normal heating operations (controlled feeding mode excluded), the autoclave is supplied with saturated steam in a pressurized autoclave. The analysis described in Sections 3.15.2.1 and 3.15.2.3 assumed the initial temperature of the UF_6 was no higher than 240°F (116°C) or 230°F (110°C) depending on cylinder category. This temperature corresponds to a saturated steam pressure of 10 psig (170 kPa) or 6 psig (102 kPa) respectively. The autoclave steam pressure control system accomplishes its safety function by detecting a high autoclave pressure at the assumed value and isolating the steam supply to the autoclave. Therefore, the safety function for this system can be accomplished.

Qualitative fault tree analysis. In addition to the safety function analysis, a fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the autoclave steam pressure control system can meet the functional requirements previously described.

3.15.2.7.4 System Classification

This system is required to perform the following functions:

- Preserve initial conditions assumed in the accident analysis (i.e., limit the initial cylinder temperature to ≤240°F [116°C]).

- Preserve NCS analyzed limits (i.e., limit the autoclave internal pressure and temperature to ≤8 psig and ≤235°F [113°C] respectively).

Once an initiating event occurs, the autoclave steam pressure control system provides no safety function to mitigate the events. Therefore, this system's safety function, preserving the initial temperature conditions of the analysis, meets the criteria for classification as an AQ system.

This system is also identified as an NCS AEF (see Section 3.15.10.5.3). Therefore, the autoclave steam pressure control system is classified as an AQ-NCS system.

3.15.2.7.5 Boundary

The AQ and AQ-NCS boundaries for the autoclave steam pressure control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.2.8 Autoclave Pressure Relief System

3.15.2.8.1 Safety Function

The autoclave pressure relief system shall prevent over-pressurization of an autoclave by relieving excess pressure and reclosing of the vent path following a release.

3.15.2.8.2 System Classification

Although the autoclave pressure relief system does not meet the Q or AQ classification criteria specified in Section 4.2.2, the autoclave pressure relief system is conservatively classified as Q.

3.15.2.8.3 Boundary

The Q boundaries for the autoclave pressure relief system are defined in Table 3.15-1.

3.15.2.9 C-337-A Jet Station Barrier Frame

3.15.2.9.1 Safety Function

The structural design features of the C-337-A jet station barrier frame shall prevent a horizontal impact from a crane-carried load resulting in UF_6 primary system failure in the C-337-A jet station.

3.15.2.9.2 Functional Requirements

The C-337-A jet station barrier frame shall be designed in accordance with the following requirements to ensure the capability to accomplish the required safety function:

- The C-337-A jet station barrier frame shall be designed such that a horizontal impact from a crane-carried load shall not result in a breach of the UF_6 primary system piping in the jet station.

3.15.2.9.3 System Evaluation

A steel barrier frame protects the C-337-A jet station piping to preclude a horizontal impact from

a crane-carried load resulting in UF_6 primary system failure. The most credible horizontal impact scenario involves a cylinder filled with solid UF_6 coasting past the autoclave position and impacting the barrier frame due to an operator error or a mechanical/electrical crane failure. Analysis determined that a 14-ton cylinder/barrier frame collision for fast speed conditions (i.e., 175-185 feet per minute) would cause the barrier frame to become permanently deformed, but the frame would not collapse. Evaluation of lower speed collisions indicates that the frame would remain in the elastic condition and return to its original position. The barrier frame did not come into contact with the UF_6 primary system piping in any of the evaluated cylinder/barrier frame collision scenarios. Therefore, the C-337-A jet station barrier frame can perform its intended safety function.

3.15.2.9.4 System Classification

The C-337-A jet station barrier frame is credited for preventing a horizontal impact from a crane-carried load resulting in UF_6 primary system failure. The C-337-A jet station barrier frame meets the criteria specified in Section 4.3.2 for classification as a Q system.

3.15.2.9.5 Boundary

The Q boundary for the C-337-A jet station barrier frame is defined in Table 3.15-1.

3.15.2.10 Autoclave Temperature Control System

This system is required only during controlled feeding to prevent the liquefaction of the UF_6 within the cylinder when the autoclave is closed.

3.15.2.10.1 Safety Function

The autoclave temperature control system ensures that the UF_6 cylinder temperature will not exceed the initial conditions assumed so that the UF_6 triple point temperature is not reached even under credible accident conditions. This ensures that the UF_6 remains in the solid/gaseous state when steam is being applied during the controlled feeding mode.

3.15.2.10.2 Functional Requirements

The autoclave temperature control system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function.

- The system shall be capable of accomplishing the required safety function independent of any support system.
- The system shall detect high cylinder temperature and isolate the sources of steam to the autoclave.

3.15.2.10.3 System Evaluation

The autoclave temperature control system was evaluated to assess its ability to accomplish its safety function. The results of this evaluation are provided in this section.

The autoclave temperature control system is required to maintain UF_6 temperature to below the values assumed by the accident analysis. During the controlled feeding mode of operation, the autoclave is supplied with saturated steam. The safety function analysis described in Section 3.15.2.1 assumed the initial temperature of the UF_6 was less than 142.9°F (61.6°C). This corresponds to a saturated steam pressure well below atmospheric pressure. The autoclave vacuum breaker will open to maintain autoclave pressure near atmospheric pressure. The autoclave temperature control system accomplishes its safety function by detecting a high UF_6 cylinder temperature at a predetermined value and isolating the steam supply block valves and the thermovent line block valve to the autoclave.

The autoclave temperature control system is designed to detect high cylinder wall temperature and isolate the steam supply to the autoclave independent of any support system. In addition, loss of power or air pressure will cause the closure of the steam supply block valves and the thermovent line block valve from the autoclave. Therefore, the safety function of this system can be accomplished.

3.15.2.10.4 System Classification

This system is required to perform the following function:

- Preserve initial conditions assumed in the accident analysis (i.e., limit the initial cylinder temperature to ≤ 142.9°F (61.6°C).

Once the initiating event occurs, the autoclave temperature control system provides no safety function to mitigate the events. Therefore, this system's safety function, preserving the initial conditions of the analysis, meets the criteria for classification as an AQ system.

3.15.2.10.5 Boundary

The AQ boundaries for the autoclave temperature control system are defined in Table 3.15-2.

3.15.3 Enrichment Facilities

3.15.3.1 UF_6 Compressor Motor Manual Trip Systems

The UF_6 compressor motor manual trip systems consist of the cell remote manual shutdown systems for the enrichment and purge cascades, and the trip systems for the interbuilding booster and purge and evacuation (P&E) compressor motors. The DC power distribution system is discussed in Section 3.15.3.2.

3.15.3.1.1 Safety Function

The UF_6 compressor motor manual trip systems shall shut down all applicable motors connected to the trip circuit to:

- Reduce the operating pressure/temperature to minimize the potential for UF_6 primary system integrity failure and
- Reduce the operating pressure to minimize the release of UF_6 and its reaction products to the atmosphere after a failure in the UF_6 primary system integrity.

3.15.3.1.2 Functional Requirements

The UF_6 compressor motor manual trip systems shall be capable of:

- Tripping the cell and booster compressor motors in the enrichment cascade from the area control room (ACR) and
- Tripping the cell and interbuilding booster compressor motors in the enrichment cascade from the central control facility (CCF).

3.15.3.1.3 System Evaluation

The UF_6 compressor motor manual trip systems were evaluated to assess their ability to accomplish their required safety function. In addition, a fault tree analysis was performed to determine system capabilities to accomplish their safety functions. The results of these evaluations are provided in this section.

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The UF_6 compressor motor manual trip systems are made up of various circuits associated with the enrichment cascade, purge cascade, interbuilding booster, and P&E booster compressor motors. Some of the systems shut down individual compressors (i.e., interbuilding boosters and P&E boosters) and others shut down all compressors within a cell (i.e., the cell remote manual shutdown system for the enrichment and purge cascades). The remote switch will initiate a trip signal to the trip coil of the electrical circuit breaker or the air control valve opening coil of the air circuit breaker inside the switchgear. The trip coil or opening coil will then energize via the switchgear DC control power supply and trip the associated breaker which disconnects motive power to the associated compressors.

Safety function analysis. The hazards and accident analysis took credit for tripping operating compressors for several different transients to reduce UF_6 primary system pressure and temperature to minimize the potential for a loss of UF_6 primary system integrity. In addition, tripping operating compressors was also assumed to occur for several UF_6 release events to reduce UF_6 primary system pressure and minimize releases from the operating equipment. Tripping the compressors (cell or booster compressor motors) will accomplish all of these safety functions. Compressor operation provides the main source of pressurization for the UF_6 primary system. In addition, the heat of compression is the primary source of heat input for the UF_6 primary system. Therefore, by tripping the compressors associated with operating equipment, both UF_6 primary system pressure and the need for UF_6 primary system cooling are significantly reduced to accomplish the required safety function. Tripping of the compressors is the only requirement needed to bring a cell or interbuilding booster below atmospheric pressure. When cell motors are stopped, the cell pressure decreases rapidly (i.e., within seconds based on operational history) due to pressure equalization between the A-line and B-line. Repressurization of the cell is inhibited by the flow resistance of the compressors and other equipment within the cell. A trip of the compressors eliminates the heat input into the system generated by the compression process. The time response associated with these events could range from several seconds up to several minutes depending on the initial operating conditions of the cell (e.g., above or below atmospheric pressure) and the severity of the operational transient (e.g., B-line block valve closure, loss of recirculating cooling water [RCW]).

In case of an earthquake, all of the compressor motors in the process buildings can be manually tripped from the switchyard. An evaluation basis earthquake will typically cause a loss of power which will stop the compressors. If the power is still available, the switchyard will still be functional, and the switchgear should still be capable of tripping the power to the process buildings and the compressor motors. Assuming that the compressors can be tripped from the switchyard eliminates the need for DC control power following an evaluation basis earthquake to trip the compressor motors (see Section 3.15.3.2).

The functional requirements associated with this system are addressed below in the qualitative fault tree analysis. Based on the analysis above, the system can accomplish the required safety functions.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis of the UF_6 compressor motor manual trip system was performed in accordance with Section 4.3.1.1.3.

The functional requirements for these systems are to have the ability to trip compressors from (1) the associated ACR for all of the equipment and (2) the CCF for the cell and interbuilding booster

compressors within the enrichment cascade. The fault tree analysis indicates that all of the cell compressor motors, the P&E booster compressor motors, and some of the interbuilding booster compressor motors can be tripped from the ACR (except for the compressors in C-310) and the CCF. Some of the interbuilding booster compressor motors can be tripped from the CCF but not the ACR. Therefore, with the exception of the compressors in C-310 and some of the interbuilding booster compressors, the functional requirements for these systems are met. The cell remote manual shutdown systems for the enrichment and purge cascade compressor motors in C-310 are not required to satisfy the functional requirements of the UF_6 compressor motor manual trip systems. The amount of UF_6 material at risk in the purge cascade and the portion of the enrichment cascade in C-310 is small. A UF_6 release from the cascade processes in C-310 would be small because these cells operate below atmospheric pressure. The exposure of workers within the building from these small releases will be minimized by evacuation. In addition, compressor motors in C-310 can be stopped by tripping the C-310 cells at the cell panels, and process gas flow to and from C-310 may be stopped by splitting the cascade between C-335 and C-310. Thus, it is not essential to trip the compressors in C-310 from the ACR or CCF. Additional trip capabilities for all of the compressor motors are also provided at the applicable switchgear; however, these additional locations are not required to accomplish the safety function.

The interbuilding boosters are part of the enrichment process and are typically fed from an operating cell and then discharged to another operating cell. Therefore, for the purpose of accomplishing a reduction of UF_6 primary system pressure, tripping of cells upstream and downstream of the interbuilding booster compressors from the ACR can accomplish the required safety function for those interbuilding boosters that do not have trip capability in the ACR. In addition, if necessary, tripping of the boosters can be accomplished from the CCF. Additional trip capabilities are also provided at the local cell panel (LCP) and the applicable switchgear, if necessary, to accomplish the safety function in emergency situations. However, these additional locations are not required to accomplish the safety function.

In addition, there are several locations available to trip a cell or booster station including feeder breakers upstream of the cell or booster station feeder breakers. If a cell or booster station breaker failed to trip, the probability of the failure of the next breaker in series becomes multiplicative. Thus the probability is reduced to a low value. In addition, the probability of the failure occurring at the same time and in the same area where the UF_6 release occurs is multiplicative. If a cell or booster station cannot be tripped, the compressor motors in the cells upstream and downstream can be tripped, which will also reduce the pressure in the area of concern.

The air circuit breakers have individual air reservoirs to provide the pneumatic force needed to open the breaker if the normal air supply provided by the compressed air stations for the switchgear is lost. If air is lost in an air reservoir for one of the air circuit breakers, other circuit breakers in that feed path may be tripped.

One specific area of concern associated with this system that could impact the system's ability to accomplish its required function is the location of some of the circuits in the tunnels from the process buildings to the CCF. These areas have the potential for some localized flooding during large storms. The electrical circuits associated with the compressor trip circuit are the control circuits that are 250 VDC and lower and the power circuits that are 2.4 kV and higher. The motive power circuits are typically routed

from the operating floor up to the compressors, with the exception being those fed directly from the switchyard. The switchyard power circuits are routed either underground or in overhead dedicated banks of electrical cable trays. The only cables that could be affected by localized flooding during large storms would be those routed underground. The most likely failure mode for motive power cables routed underground would be either an open circuit or a short to ground. Either case would result in tripping of the associated load, which would accomplish the required safety function. Hot shorts, associated with these cables, which are caused by water intrusion, would be unlikely due to the grounding effects of water. This is not considered credible. Spurious operation of the control trip circuits would accomplish the required safety function and is not addressed further. An open circuit in the control cables could result in the inability to accomplish the required safety function from the ACR or CCF. However, the likelihood of several simultaneous failures (required to prevent accomplishing the required safety function) is unlikely and is not considered credible. Single circuit failures are considered credible based on past operational history. If the capability to trip one or more compressors is lost (e.g., due to a loss of DC control power), the capability to trip cells upstream and downstream of the affected areas or to trip the affected cells from an alternate location is still available to reduce overall pressure. In addition, the capability is also provided to accomplish one trip of the compressors at the applicable switchgear via a push button without the aid of DC control power or the trip circuit. If necessary, these actions could be taken to accomplish the required function. Local trip capability of switchgear is provided independent of the functional requirements on all switchgear.

Based on the diversity of the capability to trip operating compressors via various breakers, and the low probability of failure, the UF_6 compressor motor manual trip systems have the capability to meet the functional requirements.

3.15.3.1.4 System Classification

Trip capability from the ACR associated with the “00" and “000" enrichment cells in C-331, C-333, C-335, and C-337 is required to prevent or mitigate UF_6 primary system failure accidents to maintain site boundary consequences within EGs. Therefore, the cell remote manual shutdown system is classified as Q.

Failures associated with the interbuilding booster and P&E booster compressors can be mitigated by tripping adjacent enrichment cell compressor motors. Therefore, the trip systems associated with the interbuilding boosters and P&E boosters are classified as NS, and the cell remote manual shutdown system in the ACR for the associated adjacent enrichment cell compressor motors are classified as Q.

Due to the low UF_6 pressures and mass flow rates in Building C-310, and personnel evacuation action in the event of a UF_6 primary system failure, trip capability for the C-310 compressors is not essential. Although the trip capability for the C-310 compressors does not meet the Q or AQ classification criteria specified in Section 4.2.2, the LCP trip for C-310 compressors is conservatively classified as AQ.

The cell remote manual shutdown system in the CCF associated with the enrichment cells in C-331, C-333, C-335, and C-337 is required during a facility evacuation to maintain initial conditions. Therefore, this system is classified as AQ.

3.15.3.1.5 Boundary

The Q and AQ boundaries of the cell remote manual shutdown system are defined in Tables 3.15-1 and 3.15-2, respectively.

3.15.3.2 DC Power Distribution System

The DC power distribution system consists of the 250-VDC and 125-VDC distribution systems that are required to support the UF_6 compressor motor manual trip systems described in Section 3.15.3.1. 250-VDC power is required to trip compressors motors from the LCPs, ACRs, and the CCF, and 125-VDC power is only required to trip compressor motors from the CCF.

3.15.3.2.1 Safety Function

The DC power distribution system shall provide the support control power required by the compressor motor manual trip systems to perform their safety function.

3.15.3.2.2 Functional Requirements

The DC power distribution system shall have the capability to operate the UF_6 compressor motor manual trip systems following a loss of AC power.

3.15.3.2.3 System Evaluation

The safety function required of the DC control power system is to provide the support control power required by the UF_6 compressor motor manual trip systems to perform their safety function. The DC power distribution system consists of standard industrial batteries, controls, and distribution circuits that supply 250-V and 125-VDC power to operate the compressor motor circuit breakers from the remote locations. Cell tripping is classified as a momentary load per IEEE Standard 485-1983 (Reference 3.15-1), and as such, it represents a small instantaneous ampere-hour load on the total battery banks. Based on this, the batteries can provide sufficient DC power upon the loss of the normal AC power supply to perform a momentary trip of the compressor motors. If the DC control power systems are lost, other breakers upstream of the cell feeder breakers can be used to trip the compressor motors. For some equipment (e.g., “00” compressors), the upstream feeder breakers are served by separate DC control power systems in the switch houses that would be available if the DC control power system in the process building should fail. For other equipment (e.g., “000” compressors), the motor circuit breakers are located in the switchyard, and these use the DC control power systems in the switch houses. In all cases, the circuit breakers can be tripped manually at the switchgear if the DC control power system in the switch house should fail. The system is not required to withstand the effects of natural phenomena hazards (see Section 3.15.3.1.3). Environmental conditions for this equipment would be similar to the UF_6 compressor motor manual trip systems since they are also located on the ground floor, in the switchyard, or in the CCF. Based on the analysis above, the system can accomplish the required safety function and meet the functional requirement.

3.15.3.2.4 System Classification

The 250-VDC power distribution system is required for the operation of the Q and AQ UF_6 compressor motor manual trip systems (see Section 3.15.3.1). Consequently, it is classified as Q. The 125-VDC power distribution system is only required for operation of the AQ UF_6 compressor motor manual trip system. Therefore, it is classified as AQ.

3.15.3.2.5 Boundary

The Q and AQ boundaries of the DC power system are defined in Tables 3.15-1 and 3.15-2, respectively.

3.15.3.3 UF6 Primary System

The UF_6 primary system is the UF_6 containment barrier in the enrichment cascade and associated equipment. The UF_6 primary system includes the enrichment cascade equipment, cascade auxiliary equipment, purge cascade equipment, freezer/sublimer (F/S) UF_6 process equipment, and 5.5 wt.% UF_6/R-114 separation process equipment.

3.15.3.3.1 Safety Function

The UF_6 primary system shall provide primary system integrity for the processes that contain gaseous UF_6 in the enrichment and purge cascade facilities to prevent the release of UF_6 during normal operation, and to prevent gross failures during evaluation basis natural phenomena events.

3.15.3.3.2 Functional Requirements

The UF_6 primary systems in the cascade facilities shall be designed to maintain primary system integrity during normal operating temperatures/pressures and to prevent gross failure following evaluation basis natural phenomena events.

3.15.3.3.3 System Evaluation

The UF6 primary system for the enrichment cascade handles gaseous UF_6 from the feed points to the withdrawal points. The converters, vessels, piping, coolers, compressors, valve bodies, etc., provide the UF_6 primary system integrity for the enrichment cascade process. The enrichment cascade also includes the cascade auxiliary equipment connected to the cascade to provide support for cascade operations. This equipment includes booster systems, surge drums, piping, valves, seal systems, seal exhaust systems, wet air evacuation systems, etc., that handle gaseous UF_6 and that provide the UF_6 primary system integrity for these processes. The purge cascade uses the same type of equipment as does the enrichment cascade. It extends from the withdrawal points to the vents where purged light gases are released to the atmosphere. The UF_6 primary systems also include the F/S and 5.5 wt.% UF_6/R-114 separation system.

The UF_6 primary system is required to provide integrity for the cascades and the supporting processes that handle UF_6. This safety function is accomplished by retaining UF_6 primary system integrity during normal operating temperatures/pressures.

The UF_6 primary system in the enrichment cascade which is intended to operate above atmospheric pressure is also required to maintain UF_6 primary system integrity during evaluation basis natural phenomena events. The effects of evaluation basis natural phenomena events on the UF_6 primary system of the enrichment cascade in C-310, C-331, C-333, C-335, C-337, and the tie lines were evaluated. The results indicate that the UF_6 primary system integrity is maintained in evaluation basis high wind and flood events. As indicated in the flood and high wind event scenarios in Section 4.3.2.5.1 and 4.3.2.5.2, the UF_6 primary system will not have any significant UF_6 release during these evaluation basis events. Some of the equipment and piping in the cascade facilities does not meet the performance criteria for the 250-yr return evaluation basis earthquake (EBE) (see Section 4.3.2.5.3). Tables 3.15-4 through 3.15-9 list the equipment, piping, and components with high-confidence-low-probability-of-failure (HCLPF) capacities less than the EBE for buildings C-310, C-315, C-331, C-333, C-335, and C-337. The HCLPF capacities were determined by seismic database comparison methods. For each item, the seismic capacity, annual probability of failure, location, and comments are provided. The capacities reported in the tables are the capacities of the weakest member(s) whose failure could potentially cause a UF_6 release in the process gas systems. These items were evaluated further using finite element analysis and empirical test data to determine if a loss of pressure boundary was likely and to estimate the hole size that would result, if the pressure boundary was breached. In some cases, this further analysis indicated that although some deformation could be experienced, the deformation would not be sufficient to affect the pressure boundary. Equipment, piping, and components with capacities less than the evaluation basis earthquake but that still maintain pressure boundary integrity are noted in the tables with an asterisk (*). In addition, potential seismic interactions of the cell housings and the stage compressors were evaluated. Failure of the cell housings did not adversely impact a UF_6 pressure boundary.

The analysis of the earthquake event in Section 4.3.2.5.3 assumed failure of the remaining components listed in the tables (i.e., those without an asterisk). The portions of the enrichment cascade operating above atmospheric pressure may release some UF_6, while the portions operating at subatmospheric pressure will result in inleakage with a negligible loss of UF_6. The most significant failures associated with this event are failures at the booster stations that supply the tie line between the “000” and “00” buildings. These failures were evaluated in the earthquake event scenario in Section 4.3.2.5.3, and the potential consequences were assessed. With the exception of the failures identified and evaluated, the portions of the enrichment cascade that are intended to operate above atmospheric pressure will accomplish the safety function of not having gross failures of the UF_6 primary system integrity in evaluation basis natural phenomena events. For the portions of the enrichment cascade that are operated only at subatmospheric pressure, the purge cascade, and the Hortonspheres, the capacity to retain their UF_6 primary system integrity is not required in evaluation basis natural phenomena events. This is based on the subatmospheric pressure and minimal releases should the UF_6 primary system fail.

Based on these evaluations, the UF_6 primary system can accomplish the required safety functions with the exceptions noted.

3.15.3.3.4 System Classification

The essential functions of the UF_6 primary system are to (1) maintain UF_6 primary system integrity during normal operating temperatures and pressures, and (2) prevent failures in the above atmospheric portions of the enrichment cascade beyond those assumed in the evaluation basis earthquake analysis. The system provides no additional protection once a release occurs. The UF_6 primary system is classified as AQ in accordance with the criteria in Section 4.2.2. This classification applies to process piping 2 inches and larger, expansion joints, valves, and process equipment that provide the UF_6 containment pressure boundary. Process piping less than 2 inches is classified as NS.

3.15.3.3.5 Boundary

The AQ boundaries for the UF_6 primary system for the enrichment processes are defined in Table 3.15-2.

3.15.3.4 High-Pressure Relief Systems

3.15.3.4.1 Safety Function

The R-114 coolant overpressure control system in the enrichment cascade and in the purge cascade, the R-114 coolant overpressure control system in the withdrawal process, and the UF_6 high-pressure relief system in the F/S process provides pressure relief to prevent overpressurizing the interfacing UF_6 primary system. The potential for a release of UF_6 from an overpressure failure of the UF_6 primary system is minimized. This minimizes the potential for the exposure of on-site personnel.

3.15.3.4.2 Functional Requirements

Each system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- Each relief system shall provide pressure relief for the primary UF6 system or the coolant system to minimize the potential for the failure of the UF6 primary system integrity of these systems.
- Each relief device shall be rated at or below the design pressure rating of the equipment it is protecting.
- Each relief system shall be capable of providing overpressure protection without control signals, AC, or DC power.

3.15.3.4.3 System Evaluation

The R-114 coolant overpressure control system for each cell coolant system consists of a manual block valve, one or two rupture disks, associated piping, and diffuser (if applicable). All of the rupture disk assemblies are separated from the coolant system by the manual block valve that must be sealed in the open position when the coolant system is in operation.

The F/S UF_6 high-pressure relief system for each F/S system consists of a rupture disk, a block valve, and associated piping that provides a relief path to the A-line of the cascade.

The R-114 coolant overpressure control system at the withdrawal facilities consists of a rupture disk that relieves on high coolant pressure.

No support systems are needed for the relief systems to perform their safety functions.

The R-114 coolant overpressure control system in the enrichment cascade and the purge cascade prevents excess coolant pressure from rupturing the coolant system and releasing coolant into the UF_6 primary system that could result in the subsequent loss of UF_6 due to overpressurization of the UF_6 system. The coolant system pressure may increase following an event that results in a loss of cooling, such as a loss of RCW to the coolant system. The rupture disks are rated at or below the MAWP of the system being protected. This rating (with its allowable tolerances) will minimize the potential for the failure of the coolant system primary integrity. The accident analysis identified rupture of the coolant system into an off-stream cell as the only credible means for the event to progress to a failure of the UF_6 system integrity. In this condition, the amount of UF_6 is limited, and there is no potential for exceeding any of the off-site EGs.

The F/S UF_6 high-pressure relief system prevents overpressurization of the UF_6 primary system for (1) a release of coolant into the F/S vessel or (2) overheating. These events can only threaten the integrity of the UF_6 system when the F/S systems are isolated from the cascade. This system prevents the pressure from exceeding the capabilities of the UF_6 primary system. When the F/S systems are isolated, the systems are operating at subatmospheric pressure which would minimize the mass of UF_6 released. Thus, there is no potential for exceeding any of the off-site EGs.

The R-114 coolant overpressure control system at the withdrawal facilities was evaluated to assess its ability to accomplish its required safety function. The safety function is to minimize the potential for failure of the UF_6 primary system by relieving high coolant pressure before the UF_6/R-114 boundary integrity is threatened. To minimize the potential for failure in the coolant system and a potential UF_6 release, the system is designed to relieve at or below the MAWP of the coolant system. This rating (with its allowable tolerances) will minimize the potential for failure of the coolant system primary integrity.

The relief systems do not require control signals or AC or DC power to perform their functions. Based on the analysis above, the systems can accomplish the required safety functions and functional requirements.

3.15.3.4.4 System Classification

The high-pressure relief systems are used to minimize the potential overpressurization of the primary UF_6 or the coolant system. This prevents the potential loss of UF_6 primary system integrity and minimizes the potential exposure of on-site personnel to UF_6. Because the system operates to prevent

an accident but cannot directly result in exceeding off-site EGs, the high-pressure relief systems are classified as AQ.

3.15.3.4.5 Boundary

The AQ boundaries of the high-pressure relief systems are defined in Table 3.15-2.

3.15.3.5 Freezer/Sublimers High-High Weight Trip System

3.15.3.5.1 Safety Function

The F/S high-high weight trip system detects an accumulation of excessive solid UF_6 material inside the F/S vessel, isolates the vessel from the cascade and transfers out of the freeze operating mode to prevent further accumulation.

3.15.3.5.2 Functional Requirements

The F/S high-high weight trip system shall automatically close the B-line that is supplying UF_6 to the F/S system upon detection of a weight greater than or equal to the system set point to prevent excessive material from accumulating inside the F/S vessel.

3.15.3.5.3 System Evaluation

The F/S high-high weight trip system was evaluated to assess its ability to accomplish the required safety functions. In addition, a qualitative fault tree analysis was performed to determine the system capability to accomplish the safety functions. The results of these analyses are provided in this section.

The high-high weight trip system consists of three load (weight) cells mounted in the F/S vessel supports. Two separate instrument channels sum these three measurements to determine the total weight of the F/S vessel contents (R-114 coolant and UF_6). These weight measurements are compared to setpoints and if the setpoints are exceeded, the F/S vessel is isolated from the cascade B-Line and the F/S system is placed in a modified hot standby mode. Either action terminates the continued UF_6 accumulation in the vessel.

The high-high weight trip system requires 480 VAC, 120 VAC and 24 VDC electric power to perform its primary safety action, the isolation of the cascade B-Line.

Safety function analysis. The safety function of the system is to prevent excessive UF_6 from freezing in the vessel during the freeze mode of operation. Overfilling the F/S vessel could stress the tubes and the vessel walls due to thermal expansion of the solid UF_6 during a subsequent sublime mode. Rupture of the vessel violates the UF_6 primary system integrity and could allow a release of UF_6. Limiting the amount of material inside the vessel assures that solid UF_6 will not bridge the space between the tubes or between the tubes and the vessel wall. An analysis was conducted to determine the maximum amounts of UF_6 which could be frozen in the F/S vessels while preventing bridging of solid

UF_6 between tubes or between tubes and the vessel walls. These maximum amounts of UF_6 material are 11,900 lb

(5398 kg) of UF_6 for the 10-MW F/S vessels and 22,400 lb (10,161 kg) of UF_6 for the 20-MW F/S vessels. The system trip set points are established below these maximum amounts (with additional margin for any material that continues to enter the vessel during the time required for the B-line valve to close) to ensure bridging cannot occur. The current system settings and instrument setpoints ensure the maximum net weight of UF_6 and coolant does not exceed 10,000 lb in any 10-MW F/S vessel or 20,000 lb in any 20-MW vessel. Based on the analysis above, the system can accomplish the required safety functions.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis was performed in accordance with Section 4.3.1.1.3. The analysis identifies the components that are required to function for the system to accomplish its safety functions. Although not required for the safety function, the diesel generators will provide backup power to trip the system and close the B-line block valve if normal AC power is lost. The fault tree analysis indicated that the equipment and its configuration can accomplish the function of isolating the F/S vessel from the B-line supply. Even if the system fails to trip or the B-line does not close the UF_6 primary system integrity would not fail unless the F/S was placed in the sublime mode. The failures that would prevent the system from tripping would also prevent the system from being placed in the sublime mode. The safety function analysis above indicates that the actuation of the system at the trip set point will prevent the accumulation of excessive UF_6 material in the F/S vessel. Thus, the system can accomplish the required functional requirements.

3.15.3.5.4 System Classification

The F/S high-high weight trip system prevents the overfilling and the potentially resulting rupture of the F/S vessel. Prevention of this accident prevents exposure of on-site personnel to UF_6. The F/S high-high weight trip system is classified as AQ on this basis.

The freezer/sublimer high-high weight trip system is identified as an NCS AEF for F/Ss exposed to greater than or equal to 1.0 wt. % ^{235}U and, thus, is classified as an AQ-NCS system (See Section 3.15.10.1.4).

3.15.3.5.5 Boundary

The AQ and AQ-NCS boundaries of the freezer/sublimer high-high weight trip system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.3.6 Motor Load Indicators

3.15.3.6.1 Safety Function

The motor load indicators shall provide an indication of significant changes in compressor motor loads (e.g., surging of the compressors and the compressor motors).

3.15.3.6.2 Functional Requirements

The motor load indicators shall provide an indication of large changes in the compressor motor loads for:

- The cell and interbuilding booster compressor motors in the enrichment and purge cascades in the ACR,
- The cell compressor motors (enrichment cascade only) in the CCF, and;
- The C-315 high-speed compressor motor in the ACR and C-331.

3.15.3.6.3 System Evaluation

The primary function of the motor load indicators is to provide an indication of abnormal compressor operation that could lead to failure. Using ammeter indications in the ACR for the individual compressor motors, operators can quickly identify various malfunctions of process equipment. Any inexplicable change in normal amp load is quickly investigated by the operators. Compressor load changes can be caused by such events as compressor failures, inadvertent B-stream block valve closure (see Section 4.3.2.1.3), stage control valve closure (see Section 4.3.2.1.2), or failures of the UF_6 primary system pressure boundary that cause inleakage or a release of UF_6. Compressor surging will produce large swings in the motor loads. The load swings caused by compressor surging are large enough to be seen even during plant load changes. These early indications alert the operator that one of these events may be occurring and minimize the response time to take mitigative actions. If an ammeter should malfunction, the load changes can be seen on the ammeters for the compressor motors in stages adjacent to the stage that is experiencing the compressor surging.

Monitoring of the C-310 compressors is not considered essential. The amount of UF_6 material at risk in the purge cascade and the portion of the enrichment cascade in C-310 is small. The purge cascade and enrichment cascade cells in this building do not have sufficient hazards to cause significant on-site consequences beyond the immediate area, even if the primary system were to fail. The consequences for workers in the immediate area of a UF_6 release within the purge cascade will be minimized by evacuation.

Motor load indicators are provided in the ACR for interbuilding booster compressors, however they are not considered essential. Motor load indicators associated with the adjacent enrichment cell compressor motors will provide adequate indication of a booster compressor abnormality that could lead to an analyzed UF_6 release.

In scenarios involving evacuation of the process buildings, the motor load indicators in the CCF are used to monitor the compressors for the enrichment cascade and inform the operators to trip their motors if there is an indication of large load changes that could be representative of a pressure increase after the evacuation. The motor load indicators in the CCF monitor the total cell load for all of the compressors in a cell rather than for each individual stage. Although the motor load indicators in the CCF will be less sensitive than those in the ACR, they will be able to indicate significant compressor load changes. In scenarios involving evacuation of the C-315 tails withdrawal facility, the motor load indicators in the C-331 ACR are used to monitor C-315 high-speed withdrawal compressors.

Based on this evaluation, the system can accomplish the required safety function and functional requirements.

3.15.3.6.4 System Classification

The motor load indicators are used to monitor the performance of UF_6 compressors and provide an indication of abnormal compressor motor operation. The essential portions of the system include ammeters in the ACR ad CCF associated with the "00" and "000" compressor motors and ammeters in the C-315 and C-331 ACRs associated with the C-315 high-speed compressor motors. The system is used to prevent UF_6 release accidents but it is not essential to mitigate these accidents to protect the offsite public. Based on these considerations, the system is classified as AQ.

3.15.3.6.5 Boundary

The AQ boundaries for the otor load indicator system are defined in Table 3.15.-2.

3.15.3.7 Datum Systems

A datum system is a fixed volume system of precisely controlled air pressure. This pressure is used as an absolute reference pressure to process differential pressure transmitters. Accurate pressure measurements from the datum system are also of primary importance to account for uranium in the cascade. A datum pressure makes it possible to use narrower range instruments to take measurements in wide pressure ranges. Nuclear Material Control and Accountability (NMC&A) requirements for inventory measurements are accomplished by using both low pressure datum system and the high pressure datum system.

3.15.3.7.1 Low Pressure Datum System

3.15.3.7.1.1. Safety Function

The low datum pressure system provides reference for the A-line suction pressure. This is an analog guage fed from a pressure transmitter. The cell A-line suction pressure indicator is on the cell panel.

3.15.3.7.1.2. *Section Deleted*

3.15.3.7.1.3. *Section Deleted*

3.15.3.7.1.4. System Classification

Although the low pressure datum system does not meet the Q or AQ classification criteria specified in Section 4.2.2, this system is conservatively classified as AQ.

3.15.3.7.1.5. Boundary

The AQ boundary for the low datum pressure system are defined in Table 3.15-2.

3.15.3.7.2 High Pressure Datum System

3.15.3.7.2.1. Safety Function

The high pressure datum system provides precise control of cascade pressure and provides the pressure information necessary to calculate the inventory of the cascade when necessary.

3.15.3.7.2.2. *Section Deleted*

3.15.3.7.2.3. *Section Deleted*

3.15.3.7.2.4. System Classification

Although the high pressure datum system does not meet the Q or AQ classification criteria specified in Section 4.2.2, this system is consevatively classified as AQ.

3.15.3.7.2.5. Boundary

The AQ boundaries for the high datum pressure system are defined in Table 3.15-2.

3.15.3.8 Freezer/Sublimers R-114 High-Pressure Relief System

3.15.3.8.1 Safety Function

The freezer/sublimers R-114 high-pressure relief system in the F/S process provide pressure relief to prevent overpressurizing the interfacing UF6 primary system. This system is included in the Section since the TSRs require that the associated manual block valve be sealed open, except for maintenance, to assure the rupture disks are exposed to system pressure.

3.15.3.8.2 System Classification

Although the freezer/sublimers R-114 high-pressure relief system does not meet the Q or AQ classification criteria specified in Section 4.2.2, the freezer/sublimers R-114 high-pressure relief system is conservatively classified as AQ.

3.15.3.8.3 Boundary

The AQ boundaries of the freezer/sublimers R-114 high-pressure relief system are defined in Table 3.15-2.

3.15.4 Withdrawal Facilities

3.15.4.1 UF6 Release Detection and Isolation System - Low Voltage ("New") System at the Withdrawal Stations

3.15.4.1.1 Safety Function

The UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations shall be capable of isolating the withdrawal station to prevent exceeding the radiological/nonradiological EGs for the EBE category.

3.15.4.1.2 Functional Requirements

The UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations includes (1) automatic UF_6 detection and isolation and (2) manual isolation. The system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety function independent of the plant air supply.

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- The system shall be capable of accomplishing the required safety function independent of the normal AC power supply to the facility.
- The automatic detection and isolation portion of the system shall be capable of detecting UF6 and isolating the withdrawal position pigtail at both ends.
- The automatic detection and isolation portion of the system shall close the cylinder valve and isolate the withdrawal header for the station within 30 seconds after actuation of the ionization detectors.
- The manual isolation portion of the system shall be capable of isolating the liquid source and shall be accessible outside the withdrawal room.

3.15.4.1.3 System Evaluation

The UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations was evaluated to assess its ability to accomplish its required safety function. In addition, a qualitative fault tree analysis was performed to determine the system's capability to accomplish its safety function. The results of these evaluations are provided in this section.

Safety function analysis. The safety function required of this system is to limit the release of UF_6 and its reaction products to less than the radiological/nonradiological EGs for an EBE. A review of the withdrawal facility operations determined that the bounding event for this system is pigtail failure at withdrawal position, described in Section 4.3.2.2.11. In order for the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations to accomplish its safety function, the system must detect a UF_6 release at the withdrawal position and close the isolation valves before the release exceeds these guidelines. In addition, manual isolation must be capable of isolating the withdrawal station.

The hazard and accident analyses assumed that a significant UF_6 release at a withdrawal position would be detected by the withdrawal position detectors within 15 seconds and the liquid source is automatically isolated (i.e., the liquid block valves and the cylinder valve close, isolating the pigtail from the accumulator and the cylinder) within 30 seconds after initiation to close. This event was evaluated in Section 4.3.2.2.11 and the consequences were determined to be below the applicable EGs.

It is assumed in the event of a UF_6 release on one position that the detector heads on the other withdrawal positions would activate. Therefore the nitrogen backup system must have the capability to close all positions with air valved to the air motor. While the accident analysis only requires the liquid block, emergency liquid block and cylinder valve to close on the position with the release, the air/nitrogen system is designed and has been tested to close multiple positions.

The manual isolation capability for the system is provided to permit operational flexibility for conditions where the automatic detection capability of the system is out of service. Under this operating condition, a continual surveillance is established to ensure the affected areas are monitored for potential UF_6 releases. If a release is detected, then surveillance personnel will notify the control room operators to activate the isolation system as they evacuate the area affected by the release in accordance with the plant's see and flee policy. Once notified, operators can then use switches/pushbuttons located in the ACR to manually activate the isolation system. It is expected that the isolation system can be manually activated within the same 15-second time frame nominally assumed for automatic activation of the isolation system.

Based on this analysis, the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations will prevent exceeding the radiological and nonradiological EGs for the most limiting UF_6 primary system integrity failure at a withdrawal position provided the system automatically closes the isolation valves within 45 seconds after the release occurs. Events where the cylinder valve can not be closed due to the event are addressed in Section 4.3.2.2.11.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis of the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations was performed in accordance with Section 4.3.1.1.3 to evaluate the capability of the system to accomplish its required safety function. The ability of the system to meet the functional requirements is described below.

As indicated in the functional requirements, the system is required to accomplish the required safety function independent of normal plant air and electrical supply. The system configuration can accomplish its required safety function independent of the normal plant air and electrical distribution system with the exception of the nitrogen bottle backup to the normal plant air system (valve closers) for withdrawal stations 3 and 4 and the backup air supply for withdrawal station 5. The nitrogen bottle and air accumulator backups are considered part of this system and are required to be tested periodically to verify their operability. Therefore, the system can accomplish its required safety function independent of normal plant air.

The UF_6 detectors are required for the automatic detection system. Should these detectors become inoperable because of the detectors themselves or the power supply, a continuous smoke watch is instituted to allow for quick detection to initiate manual isolation.

In addition to the functional requirements associated with the loss of electric power and air, the automatic operation of the system is required to isolate equipment within 30 seconds after actuation of the UF_6 detectors. The analysis assumes the detectors will actuate within 15 seconds after a significant release. Past operational history with the UF_6 detectors has indicated a response time of less than 15 seconds for any significant release due to the significant amount of smoke generated by the release. Valve closure time is verified periodically by surveillance tests to ensure the 30-second closure time is met. Therefore, the system can accomplish the required automatic detection and isolation.

The manual activation portion of the isolation system is required to be accessible from locations outside of the withdrawal room since a release would necessitate evacuation of the affected area. Upon detection of a release, surveillance personnel notify personnel in the control area to initiate activation of the isolation system. Once notified, control room operators can then use switches/pushbuttons located in the ACR to manually activate the isolation system. The control room will not be affected by the release in the time frame needed for operators to take mitigative actions. Therefore, the manual isolation functional requirement is achieved by the system configuration.

Based on the capability to detect and isolate a release and the various controls associated with the system, the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations can meet its functional requirements.

3.15.4.1.4 System Classification

The UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations is required for mitigation of a pigtail failure at withdrawal station event (see Section 4.3.2.2.11). This release event is classified as an EBE that could exceed the off-site nonradiological EGs if the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations fails to perform its safety function. Therefore, the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations meets the criteria for classification as a Q system.

This system is also identified as an NCS AEF (see Section 3.15.10.4.10). Therefore, this system is classified as AQ-NCS.

3.15.4.1.5 Boundary

The Q and AQ-NCS boundaries for the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.4.2 Compressor Motor Manual Trip System

The compressor motor manual trip system provides the capability to rapidly deenergize the high-speed centrifugal withdrawal compressors in C-315 (there are no centrifugal compressors used in the product withdrawal operations performed in C-310). This trip capability can be actuated from the C-315 ACR or the C-331 ACR. An administrative control is in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. The following discussion represents the existing analysis and it is retained until it is superceded by further analysis.

3.15.4.2.1 Safety Function

The compressor motor manual trip system for the C-315 high-speed compressors shall shut down all applicable motors connected to the trip circuit to (1) minimize the source of frictional heating associated with a compressor failure that would cause a UF_6/hot metal reaction and (2) minimize the amount of UF_6 released in events involving failure of the UF_6 primary system.

3.15.4.2.2 Functional Requirements

The compressor motor manual trip system shall be capable of tripping the compressor motors from the C-315 and C-331 ACRs to ensure the system's capability to accomplish the required safety function.

3.15.4.2.3 System Evaluation

The compressor motor manual trip system was evaluated to assess its ability to accomplish its required safety function. The results of this evaluation are provided below.

Safety function analysis. A loss of physical integrity associated in the low-speed centrifugal withdrawal compressors would result in air inleakage since both the inlet and outlet sides of the low speed centrifugal compressors operate at sub-atmospheric pressures. However, should the high-speed centrifugal withdrawal compressors suffer a similar type of failure, a UF_6 gas release could be expected since the high speed compressors operate with discharge pressures that are above atmospheric pressure. The accident analysis credited the compressor motor manual trip system for tripping the high-speed compressors to (1) minimize the source of frictional heating associated with a compressor failure that would cause a UF_6/hot metal reaction and (2) minimize the amount of UF_6 released in events involving failure of the UF_6 primary system. Tripping the compressor will quickly reduce the frictional heating associated with various compressor failures, thereby minimizing the potential for a self-sustaining UF_6/hot metal reaction. Should a self-sustaining UF_6/hot metal reaction or other primary system failure event occur, then tripping the high-speed withdrawal compressors would also minimize the potential UF_6 release associated with the UF_6 primary system failures. However, release mitigation associated with the system is only required for protection of on-site workers since consequence analysis indicates that unmitigated failure events (Sections 4.3.2.2.1 and 4.3.2.2.12) do not exceed off-site exposure guidelines.

Should the C-331 ACR (primary trip location for operations involving the C-315 withdrawal high-speed compressors) be evacuated for any reason, operators would have the capability to trip the compressors from C-315.

Based on the analysis above, the compressor motor manual trip system can accomplish the required safety functions.

3.15.4.2.4 System Classification

An administrative control is in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. Because of this administrative control, the compressor motor manual trip systems for the C-315 high-speed centrifugal compressors do not meet the Q or AQ classification criteria specified in Section 4.2.2. However, the existing analysis for the UF_6/hot metal reaction event (Section 4.3.2.2.1) credits this system for mitigating on-site personnel exposure. Therefore the AQ classification of this system will be conservatively retained until the further analyses are completed.

3.15.4.2.5 Boundary

The AQ boundaries for the compressor motor manual trip are defined in Table 3.15-2.

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3.15.4.3 DC Power Distribution System

The compressor motor manual trip circuit requires 125-VDC control power to trip the compressor motor circuit breakers from the ACR. This DC power system is basically the same as that described in Section 3.15.3.2, however, CCF capability is not required.

The DC power distribution system supports the compressor motor manual trip system associated with the C-315 high-speed compressors. Administrative controls are in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. Because of this administrative control, the C-315 compressor motor manual trip system and its supporting power distribution system do not meet the Q or AQ classification criteria specified in Section 4.2.2. However, the existing analysis for the UF_6/hot metal reaction event (Section 4.3.2.2.1) credits both the compressor motor manual trip system and its supporting DC power distribution system for mitigating on-site personnel exposure. Therefore the AQ classification of this system will be conservatively retained until the further analyses are completed.

3.15.4.4 Motor Load Indicators

The motor load indicators are used in the C-315 withdrawal facility to support operation of the high-speed centrifugal pumps. Administrative controls are in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. Because of this administrative control, the motor load indicator systems for the C-315 high-speed centrifugal compressors do not meet the Q or AQ classification criteria specified in Section 4.2.2. However, the existing analysis for the UF_6/hot metal reaction event (Section 4.3.2.2.1) credits this system for mitigating on-site personnel exposure. Therefore the AQ classification of this system will be conservatively retained until the further analyses are completed.

3.15.4.5 UF6 Primary System

3.15.4.5.1 <u>Safety Function</u>

The UF_6 primary system shall provide UF_6 primary system integrity for the withdrawal processes that contain gaseous and liquid UF_6.

3.15.4.5.2 <u>Functional Requirements</u>

The UF_6 primary system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be designed to withstand the evaluation basis earthquake and maintain UF6 primary system integrity.
- The system shall be designed to withstand the evaluation basis wind loading and maintain UF6 primary system integrity.
- The system shall be designed to withstand the normal operating temperatures/pressures and maintain UF6 primary system integrity.

3.15.4.5.3 <u>System Evaluation</u>

This system is required to provide UF_6 primary system integrity for the processes that contain gaseous and liquid UF_6. The safety function is accomplished by retaining integrity during normal operations and upset events. The system is designed to withstand normal pressures and temperatures encountered during withdrawal operations. Pressure-reducing devices are used where the design of the UF_6 primary system is not the same value as that encountered inside the cylinder for the autoclaves and at the discharge of the compression source for the withdrawal piping. Additionally, the pigtails used at the withdrawal stations are pressure and leak tested prior to introduction of the UF_6 after each new connection is made.

In addition, the system is required to maintain UF_6 primary system integrity during an evaluation basis earthquake and evaluation basis wind loading. The UF_6 primary system was evaluated to assess its ability to withstand high wind and earthquake events. The results of this evaluation indicated that the UF_6 primary system piping could withstand the wind loadings and any potential impacts from debris. The UF_6 primary system was also evaluated to assess its ability to withstand an evaluation basis earthquake event. This evaluation showed that the system is capable of performing its safety function following an evaluation basis earthquake.

Tables 3.15-8 and 3.15-9 address the seismic capabilities of the UF_6 primary system in the withdrawal facilities. All capabilities less than the EBE occur in portions of the system containing gaseous UF_6 operating at subatmospheric pressure. As evaluated in Section 4.3.2.5.3, these do not contribute to any source term from the withdrawal facilities.

3.15.4.5.4 System Classification

The UF_6 primary system is required to:

- Prevent a large release of UF6 to the atmosphere during normal operations; and
- Prevent a large release of UF6 to the atmosphere during upset conditions not specifically related to failure of the UF6 primary system.

A large release of liquid UF_6 has the potential to exceed off-site EGs if the UF_6 primary system integrity fails. Therefore, the portions of the UF_6 primary system that could contain liquid UF_6 (e.g., condensers, accumulators, and piping downstream of the condensers) meet the criteria for classification as Q.

Failure of the high pressure gas piping in the withdrawal facility has been evaluated in various accident analyses (See Sections 4.3.2.2.12 and 4.3.2.2.17). These analyses indicate that the consequences of unmitigated releases associated with the postulated failure events would exceed off-site guidelines for the accident category. Therefore, the high pressure portion of the UF_6 primary system from the discharge of the Normetex pumps to the inlet of the condensers, including the pump recycle line, meet the criteria for classification as Q.

Failure of the sub-atmospheric gas piping in the withdrawal facilities is expected to result in air in-leakage rather than a significant UF_6 release. Although no significant UF_6 release is postulated for failure in the sub-atmospheric piping and equipment, the sub-atmospheric gas piping in the withdrawal facilities 2 inches and larger in diameter is conservatively categorized as AQ. Sub-atmospheric gas piping less than 2 inches in diameter is classified as non-safety.

3.15.4.5.5 Boundary

The Q and AQ boundaries for the UF_6 primary system for the withdrawal processes are defined in Table 3.15-1 and 3.15-2 respectively.

3.15.4.6 High-Pressure Relief Systems

See Section 3.15.3.4 for information on the safety function, functional requirements, system description, system evaluation, justification for system classification, and boundaries for this system for the withdrawal compression-loop coolant high pressure relief system for the withdrawal facilities.

3.15.4.7 Section Deleted

3.15.4.7.1 Section Deleted

3.15.4.7.2 Section Deleted

3.15.4.7.3 Section Deleted

3.15.4.7.4 Section Deleted

3.15.4.7.5 Section Deleted

3.15.4.8 UF6 Release Detection System - Normetex Pump

3.15.4.8.1 Safety Function

The safety function of the UF_6 release detection system - Normetex pump is to provide an automatic and manual means of: (1) tripping the compression source to minimize the consequences of the release, and (2) isolating the pump from sources of UF_6 that are above atmospheric pressure (e.g., close the discharge block valve).

3.15.4.8.2 Functional Requirements

The UF_6 release detection system - Normetex pump shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall monitor the designated areas of the facility for UF6 releases outside of the UF6 primary system.

- The system shall provide a means of tripping the compression source upon indication of a UF6 release from the UF6 primary system.
- The system shall provide a means of isolating the pump from sources of UF6 that are above atmospheric pressure (e.g., closing the discharge valve) upon indication of a UF6 release from the UF6 primary system.
- The manual portion of the system shall be capable of tripping and isolating the pump and shall be accessible in the ACR.

3.15.4.8.3 System Evaluation

The safety functions of the UF_6 Release Detection System - Normetex Pump are to detect a UF_6 release from the UF_6 primary system, providing an automatic and manual means of tripping the compression source, and isolating the pump from sources of UF_6 that are above atmospheric pressure (e.g., closing the discharge valve). Each Normetex pump is equipped with multiple ionization (smoke) detectors, including one located on the pump's expansion joint, which is the most likely failure point in the system. UF_6 released to the atmosphere will react with moisture in the air and form HF in the form of a visible smoke that is detectable by the ionizing smoke detectors. If any two adjacent detectors alarm, the system provides the capability to trip the pump and close the discharge valve. The UF_6 Release Detection System for the C-310 side withdrawal Normetex pump includes three heads inside the housing and three heads outside, which provides for three different combinations (two out of three) of fired heads at either location to be able to trip the pump. The detectors require 200 VDC, and the detector signal conditioners require 120-VAC power to perform their safety functions. Operating history has shown the system to be capable of detecting releases, tripping the compression source, and isolating the pump from sources of UF_6 that are above atmospheric pressure (e.g., closing the discharge block valve). The manual shutdown and isolation capability is provided to permit operational flexibility for conditions where the automatic detection and/or shutdown and isolation capability of the system is out of service. Under this operating condition, a continual surveillance (smoke watch) is established to ensure the affected areas are monitored for potential UF_6 releases. If a release is detected, then surveillance personnel will notify the control room operators to use the emergency stop button as they evacuate the area affected by the release in accordance with the plant's see and flee policy. As described in SAR, Section 4.3.2.2.17, the bounding UF_6 release scenario for Normetex pumps can continue unmitigated for 373 seconds before exceeding the AE off-site exposure guidelines. Surveillance personnel can detect a UF_6 release and the pump can be manually shut down and isolated well within this time frame. Based on these requirements and operating history, the safety function of the system can be accomplished.

3.15.4.8.4 System Classification

The UF_6 Release Detection System - Normetex Pump is credited for controlling postulated releases before they exceed off-site evaluation exposure guidelines (see Section 4.3.2.2.17). Therefore, this system meets the criteria for classification as a Q system in both the product and tail withdrawal facilities.

This system in C-310 is also identified as an NCS AEF (see Section 3.15.10.4.9). Therefore, this system in C-310 meets the criteria for classification as AQ-NCS.

3.15.4.8.5 Boundary

The Q boundary for the UF_6 Release Detection System - Normetex Pump is defined in Table 3.15-1. The AQ-NCS boundary for the C-310 UF_6 Release Detection System - Normetex Pump is defined in Table 3.15-3.

3.15.5 Toll Transfer and Sampling Facility

3.15.5.1 Autoclave High Pressure Isolation System

3.15.5.1.1 Safety Function

The autoclave high pressure isolation system is designed to contain a release of UF_6 inside the autoclave. The system detects high autoclave pressure and isolates all active isolation valves to ensure that the following safety objectives are accomplished:

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- The UF6 primary system temperature for the UF6 cylinder being heated inside an autoclave is maintained below the temperature that assures an ullage inside the cylinder is maintained.
- The release of UF6 and its reaction products to the atmosphere from a UF6 primary system failure inside an autoclave is maintained below the amount that would result in exceeding either the radiological or nonradiological exposure EGs for the EBE category.

3.15.5.1.2 Functional Requirements

The autoclave high pressure isolation system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety function independent of plant/instrument air supply to the facility.
- The system shall be capable of accomplishing the required safety function independent of normal AC power supply to the facility.
- The detection of high autoclave pressure shall be accomplished with two pressure sensors.
- Isolation of the autoclave active valves shall be accomplished within 15 seconds from autoclave pressure exceeding the required actuation pressure for the system.

3.15.5.1.3 System Evaluation

The autoclave high pressure isolation system was evaluated to assess its ability to accomplish its required safety functions. Two separate calculations were performed to analyze transient conditions involving specific limiting events associated with the safety functions. In addition, a fault tree analysis was performed to determine the system's ability to accomplish the safety functions. The results of these evaluations are provided in this section.

Safety function analysis. The first safety function required of this system is to protect the integrity of the UF_6 cylinder being heated. A review of the autoclave operations determined that the limiting event for evaluating this safety function is autoclave steam control valve fails open (Section 4.3.2.2.2). For this event, the steam control valve fails open, resulting in a pressure increase (transient) in the autoclave. The primary concern for this event is cylinder overheating, which leads to cylinder pressurization from loss of cylinder ullage, and possibly leading to cylinder rupture. Two different evaluations were performed to verify the maximum temperature of the cylinder being heated was maintained below the allowable values. Two different initial conditions were evaluated. The first condition was for a 14-ton, 48G thin-wall cylinder filled to 28,000 lb (12,700 kg) with the maximum allowable noncondensables. This cylinder must be heated to greater than 235°F (112°C) before dropping below 5% ullage based on ANSI N14.1. This evaluation assumed the maximum amount of allowable noncondensables inside the cylinder, all UF_6 is liquefied, and the cylinder is filled to 28,000 lb (12,700 kg) to ensure that protection would be provided for the most limiting event. The evaluation also assumed that the initial temperature inside the autoclave is less than 230°F (110°C). The autoclave steam pressure control system (see Section 3.15.5.7) ensures that the initial temperature conditions inside the autoclave are maintained. The second initial condition assumed the initial temperature was 240°F (116°C). Although the same cylinder (i.e., 48G thin wall, high-volume) would not be allowed to be heated at this

temperature, the heat transfer rates were considered conservative to determine if 250°F (121°C) would be exceeded.

When the steam control valve fails open, a rapid pressure rise occurs inside the autoclave and quickly reaches the 15-psig (205 kPa) actuation pressure of the autoclave high pressure isolation system. The analysis assumes that (1) it takes 15 seconds for the steam isolation valves to terminate the event after the 15 psig (205 kPa) actuation pressure is reached and (2) steam flow into the autoclave remains full until the valves are completely closed. Using a conservative assumption that all of the heat added to the autoclave during the transient is then transferred to the liquid UF_6, the final temperature of the UF_6 would still be less than 245°F (118°C) for the lower initial temperature and less than 250°F (121°C) for the higher initial temperature. The present steam supply isolation valves have a valve-stroke time less than the assumed 15 seconds and are tested periodically to verify that the system can complete an isolation of the steam supply within 15 seconds. Based on this analysis, the autoclave high pressure isolation system will prevent the UF_6 primary system pressure from exceeding the allowable temperatures for the most limiting cylinder and worst-case transient, provided the actuation pressure is ≤15 psig (205 kPa) and the steam supply valve will close in ≤15 seconds after the actuation pressure is reached.

In the event of a UF_6 release inside the autoclave, the second safety function of this system is to limit the release of UF_6 reaction products to the atmosphere to less than the radiological and nonradiological EGs for the EBE category. To accomplish this safety function, the autoclave high pressure isolation system works with the autoclave primary containment system to detect high pressure inside the autoclave and close the autoclave containment isolation valves before the release and subsequent exposures exceed these guidelines. A review of the autoclave operations determined that the limiting event for evaluating this safety function is cylinder failure inside autoclave (see Section 4.3.2.2.14). For this event, the cylinder integrity is lost and UF_6 is released inside the autoclave. The primary concern for this event is isolating the autoclave and limiting the amount of material released to the atmosphere.

To determine the amount of UF_6 released and the consequences of a release, the following initial conditions were assumed. The initial temperature of the UF_6 is assumed to be ≤240°F (116°C), the autoclave is closed and the steam valves are open, UF_6 is completely liquefied and the water level in the autoclave is below the shell of the autoclave at the drain. The only requirement to be addressed for this system is to detect the failure of the UF_6 primary system and accomplish isolation of the autoclave to prevent exceeding the EGs. Once isolation is accomplished, the requirement for containing the reaction products of the release is addressed by the autoclave primary containment system. This event was evaluated in Section 4.3.2.2.14, and the consequences were determined to be below the applicable EGs.

Due to the rapid response of this system upon detection of high autoclave pressure (i.e., 15-second isolation), the environmental conditions associated with the system during operation are basically normal operational conditions.

Based on this analysis, the autoclave high pressure isolation system will prevent exceeding the off-site EGs for the most limiting UF_6 primary system integrity failure inside an autoclave, provided the actuation pressure is ≤15 psig (205 kPa) and the autoclave isolation valves will close in ≤15 seconds after the actuation pressure is reached.

Qualitative fault tree analysis. In addition to the safety function analysis, a fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the system can meet the functional requirements previously described.

Based on the discussions above, the autoclave high pressure isolation system can perform its required safety functions and meets the functional requirements specified.

3.15.5.1.4 System Classification

The autoclave high pressure isolation system is required to perform the following functions:

- Prevent a cylinder failure inside the autoclave as a result of overheating the cylinder (e.g., autoclave steam control valve fails open).
- Mitigate releases to the atmosphere from releases inside the autoclave (e.g., a pigtail line failure inside autoclave or cylinder failure inside autoclave).

These release events are classified as EBEs whose consequences could exceed the off-site radiological/nonradiological EGs if the autoclave high pressure isolation system failed to perform its safety functions. Therefore, the autoclave high pressure isolation system meets the criteria for classification as a Q system.

This system is also identified as an NCS AEF (see Section 3.15.10.2.2). Therefore, the autoclave high pressure isolation system is classified as AQ-NCS.

3.15.5.1.5 Boundary

The Q and AQ-NCS boundaries for the autoclave high pressure isolation system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.5.2 UF6 Release Detection System - Zone 1 and Zone 4

3.15.5.2.1 Safety Function

In the toll transfer and sampling facility, the UF_6 release detection system detects releases in the laboratory area (zone 1) and the basement area (zone 4) and isolates the appropriate valves to limit the release of UF_6 to the atmosphere below the radiological and non-radiological EGs for the EBE category.

3.15.5.2.2 Functional Requirements

The UF_6 release detection system in zones 1 and 4 (toll transfer and sampling facility) shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be capable of accomplishing the required safety function independent of any support systems, specifically plant/instrument air and normal AC power supplies to the facility.
- Isolation of the receiving cylinder valve and zone 1 isolation valves shall be accomplished within 30 seconds from initiation of the system.
- Isolation of the zone 4 manifold isolation valves and transfer line block valve shall be accomplished within 10 seconds from initiation of the system.

3.15.5.2.3 System Evaluation

The UF_6 release detection systems (zones 1 and 4) were evaluated to assess their ability to accomplish the required safety function. In addition, a fault tree analysis was performed to determine the system capability to accomplish the safety function. The results of these evaluations are provided in this section.

Safety function analysis. The safety function required of this system is to limit the quantity of UF_6 released to less than the radiological and nonradiological EGs for the EBE category. A review of the facility operations determined that a pigtail/line failure outside autoclave event is the limiting event for this system (see Section 4.3.2.2.10 and 4.3.2.2.10.1). Any detector head (laboratory or basement receiving cylinder) is capable of detecting a release and initiating isolation. The primary concern for this event is isolating the autoclave and receiving cylinder to limit the amount of material released to the atmosphere.

The analysis assumed that UF_6 detectors would sense a release within 15 seconds and automatically close valves to isolate the UF_6 source. Zone 1 of the UF_6 release detection system would detect releases in the C-360 laboratory area and automatically isolate the UF_6 source by closing the appropriate UF_6 manifold isolation valves within 30 seconds after detection of the release. Zone 4 of the UF_6 release detection system would detect releases at the C-360 transfer station and automatically isolate the UF_6 source by closing the appropriate UF_6 manifold isolation valves, the transfer line block valve, and the receiving cylinder valve within 30 seconds after detection of the release. The analysis for a release from the Tc traps assumed the transfer line block valve and the autoclave isolation valves close within 10 seconds of system initiation. The release associated with the postulated failure in the C-360 transfer station is considered the bounding release due to the amount of material that may be released from the parent and daughter cylinder. The consequence analysis results indicate that the toxic exposure EGs for the bounding event are met.

Analysis of the automatic isolation of lines containing liquid UF_6 upon actuation of detectors in zones 1 or 4 revealed that plant air is relied on to accomplish the isolation of the UF_6 receiving cylinder valve. The plant air supply is normally used to operate the air motor that closes the receiving cylinder valve. However, the air supply for this system is backed-up by a nitrogen bottle and valving that automatically supports the cylinder valve closer upon loss of the normal supply. The backup nitrogen

supply is required for the UF_6 release detection system to perform its required safety function. Therefore, the plant air supply is not a required system.

The UF_6 alarm cabinet for this requires 200-VDC power to open the initiation relay contacts. This power is provided by a power supply that uses 120-VAC as an input. Activation of the initiation relay will de-energize the valve closure relay. Loss of 120-VAC electric power to the UF_6 alarm cabinet results in a trouble alarm. Only a 200-VDC power distribution component failure of this supervised circuit would result in a failure to generate an isolation signal. Therefore, the 120-VAC electric power supply to the down stream control relay is not required for the UF_6 release detection system to perform its required safety function.

Based on this analysis, the system will prevent exceeding the radiological and nonradiological EGs for the most limiting UF_6 primary system integrity failure at a transfer or sample station provided the system automatically closes the isolation valves within 45 seconds after the release occurs or 25 seconds for a release from the Tc traps. Events where the cylinder valve can not be closed due to the event are addressed in Section 4.3.2.2.10.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the system can meet the functional requirements described above.

3.15.5.2.4 System Classification

The UF_6 release detection systems in zones 1 and 4 is required to perform the following safety function:

- Mitigate pigtail/line failure outside of the autoclave.

This release event is classified as an EBE whose consequences could exceed the off-site nonradiological EGs if the UF_6 release detection systems in zones 1 and 4 failed to perform their safety function. Therefore, the UF_6 release detection systems in zones 1 and 4 meet the criteria for classification as Q systems.

Zones 1 and 4 of this system are also identified as NCS AEFs (see Sections 3.15.10.2.4 and 3.15.10.2.7, respectively). Therefore, these systems are classified as AQ-NCS.

3.15.5.2.5 Boundary

The Q and AQ-NCS boundaries for the UF_6 release detection system - zone 1 and zone 4 are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.5.3 Autoclave Primary Containment System

3.15.5.3.1 Safety Function

This system is required to prevent a release of UF_6 from exceeding the off-site radiological and nonradiological EGs for the EBE category during modes when the autoclave is closed.

3.15.5.3.2 Functional Requirements

The autoclave primary containment shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be designed to withstand the evaluation basis earthquake and maintain UF6 primary system integrity when connected to the UF6 primary system.
- The system shall be designed to withstand the evaluation basis wind loading and maintain UF6 primary system integrity when connected to the UF6 primary system.
- The system shall be designed to withstand the maximum pressure generated after a release of liquid UF6 should a breach occur during operation without structural failure of the autoclave (other active systems may be considered in combination with this requirement).
- Penetrations to the autoclave shall be protected by one of the following methods: (1) two automatic isolation valves, (2) one valve that is normally closed and manually operated or the autoclave pressure relief system configuration, or (3) a closed piping system outside the autoclave (e.g., instrument lines/instruments) which are rated for the same pressure as the autoclaves.

3.15.5.3.3 System Evaluation

This system is required to prevent a release of UF_6 from exceeding the off-site radiological and nonradiological EGs for the EBE category. As indicated in the functional requirements, there are four different functional requirements associated with meeting the required safety action.

The first and second requirements for this system are associated with preventing failure of the UF_6 primary system during earthquakes and high winds. The autoclaves have been evaluated for natural phenomena effects and meet the functional requirements. Since the integrity of the UF_6 primary system is maintained, there is no requirement to accomplish isolation of the autoclave since no release will occur.

The last two functional requirements are associated with UF_6 primary system integrity failures occurring inside the autoclave during normal operations. The autoclave is required to minimize the release of the reaction products to the atmosphere to prevent exceeding the EBE EGs. The fourth functional requirement is associated with requiring all penetrations to have isolation capability. Any actions required to meet this requirement are addressed by the analysis presented in Section 3.15.5.3 with the exception of the penetrations not automatically isolated by the autoclave high pressure isolation system. The penetrations that have active valves are protected by two valves in series except the roll and tilt motor buffer line at the toll transfer facility. The roll and tilt motor buffer line has a check valve that is used as a second isolation valve. Other penetrations are also protected by at least one normally closed manual valve or passive device (i.e., autoclave pressure relief system) or is a closed system outside

the autoclave (e.g., instrument lines). The protective devices and closed outside systems are rated for the same pressure as the autoclaves. Therefore, this functional requirement is met.

The last functional requirement deals with the autoclave environment after a failure has occurred in the UF_6 primary system. Failure of the autoclave containment boundary could result in an uncontrolled release of UF_6 and its reaction products that exceeds the off-site radiological/nonradiological EGs. A review of the autoclave operations determined that the limiting (bounding) event for evaluating this safety function is cylinder failure (see Section 4.3.2.2.14). For this event, the initial temperature of the UF_6 is assumed to be ≤240°F (116°C), the autoclave is closed and the steam valves are open, UF_6 is completely liquefied and the water level in the autoclave is below the shell of the autoclave at the drain. These conditions are identical to those described in Section 3.15.2.1 for a cylinder failure inside the autoclave. The primary concern for this event is the pressure rise inside the autoclave due to the reaction of UF_6 and steam. A large UF_6 release into an autoclave could threaten the MAWP of the autoclave.

Two different sources of water are available inside an autoclave to react with a postulated release of UF_6. The first source is the steam supply for heating the autoclave. Assuming a 100-psig (791 kPa) steam supply, the flow of steam into the autoclave is prevented when the pressure in the autoclave exceeds 100 psig (791 kPa). Therefore, only the moisture allowed into the autoclave prior to its reaching 100 psig (791 kPa) will be available for the reaction with UF_6. Isolation of the steam supply is completed within 15 seconds after 15 psig (205 kPa) is reached in the autoclave by the autoclave high pressure isolation system (see Section 3.15.2.1).

The second source of water for reaction with the UF_6 is the steam condensate collecting in the bottom of the autoclave, on the equipment inside the autoclave, and in the drain system. Normal operation of the autoclave requires the drain line to remain open to prevent a buildup of water in the bottom of the autoclave. The autoclave water inventory control system (see Section 3.15.2.5) provides additional assurance that condensate does not accumulate in the autoclave by detecting a buildup of water in the drain and initiating isolation of the steam supply line. Based on these controls, the amount of water available for reaction with UF_6 is limited to the amount of water that is normally present inside the autoclave during heating conditions. An analysis predicted a final pressure that is less than the autoclave's MAWP for all cylinder and autoclave configurations. Based on the analysis, this system will withstand the potential pressures generated after a cylinder failure inside an autoclave provided the initial conditions are maintained.

Although the structural integrity of the autoclave is not threatened by the pressure transient, two other concerns must also be addressed. These are the temperatures associated with the transient and the potential for leakage past the autoclave seal and associated isolation valves. The autoclave design temperature rating is 250°F (121°C). The analysis discussed above also determined the temperature transient associated with the event. Although the reaction products of the release (i.e., HF and UO_2F_2) have a relatively high temperature, the transient is short lived, and very little impact on the temperature of the autoclave shell and valves is experienced. The temperature effects on the autoclave seal were also reviewed and found to be within allowable temperatures. This keeps the autoclave and its components below its design temperature rating. The final area of concern is associated with the leak rate of the autoclave at the elevated pressures/temperatures. A periodic leak-rate test of the autoclave is performed

to ensure that the system is capable of maintaining containment if the shell is pressurized. These tests are performed at a minimum of 90 psig (722 kPa) with a maximum allowable leak rate of 10 psi/hr (69 kPa/hr) or 12 scfm (20.4 m^3/h). These values were considered in the analysis and the source term/consequences for the accident analysis in Section 4.3.2.2.13 with acceptable results. Based on these analyses, the autoclave primary containment system can accomplish the required safety function and functional requirements.

3.15.5.3.4 System Classification

The autoclave primary containment system, the autoclave vessel and penetrations out to the isolation valves, is required to mitigate the following:

- Releases inside an autoclave (e.g., a pigtail line failure inside an autoclave); and
- Releases inside an autoclave due to cylinder failure.

These release events are classified as EBEs whose consequence could exceed the off-site radiological/nonradiological EGs if the autoclave does not maintain integrity. Therefore, the autoclave primary containment system is classified as a Q system.

3.15.5.3.5 Boundary

The Q boundaries for the autoclave primary containment system are defined in Table 3.15-1.

3.15.5.4 UF6 Primary System

3.15.5.4.1 Safety Function

The UF_6 primary system shall provide primary system integrity for the processes that contain gaseous and liquid UF_6.

3.15.5.4.2 Functional Requirements

The UF_6 primary system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be designed to withstand the evaluation basis earthquake and maintain UF6 primary system integrity.
- The system shall be designed to withstand the evaluation basis wind loading and maintain UF6 primary system integrity.
- The system shall be designed to withstand the normal operating temperatures/pressures and maintain UF6 primary system integrity.

3.15.5.4.3 System Evaluation

This system is required to provide UF_6 primary system integrity for the processes that contain gaseous and liquid UF_6. The safety function is accomplished by retaining integrity during normal

operations and upset events (e.g., autoclave steam control valve fails open in Section 4.3.2.2.2). The system is designed to withstand normal pressures and temperatures encountered during transfer/sample operations. Additionally, the pigtails used inside the autoclaves are pressure and leak tested prior to introduction of the UF_6 after each new connection is made.

In addition, the system is required to maintain UF_6 primary system integrity during an evaluation basis earthquake and evaluation basis wind loading. The UF_6 primary system was evaluated to assess its ability to withstand earthquake and high wind events. The results of this evaluation indicated that the UF_6 primary system piping could withstand the wind loadings and any potential impacts from debris. Also, this evaluation showed that the system is capable of performing its safety function following an evaluation basis earthquake. The toll transfer facility UF_6 primary system can accomplish its required safety function.

3.15.5.4.4 System Classification

The UF_6 primary system is required to:

- Prevent a large release of UF6 to the atmosphere during normal operations; and
- Prevent a large release of UF6 during upset events that do not specifically address failures of the UF6 primary system.

A large release of liquid UF_6 has the potential to exceed off-site EGs if the UF_6 primary system integrity fails. Therefore, the portions of the UF_6 primary system at the toll transfer and sampling facility that could contain liquid UF_6 meet the criteria for classification as a Q system. Portions of the UF_6 primary system associated with evacuation piping would only be exposed to gaseous UF_6 and are classified as AQ consistent with the UF_6 primary system in the cascade (see Section 3.15.3.3).

3.15.5.4.5 Boundary

The Q and AQ boundaries for the UF_6 primary system for the toll transfer and sampling processes are defined in Tables 3.15-1 and 3.15-2, respectively.

3.15.5.5 Autoclave Water Inventory Control System

3.15.5.5.1 Safety Function

The autoclave water inventory control system limits the amount of water present inside the autoclave during normal operation to ensure initial conditions are preserved.

3.15.5.5.2 Functional Requirements

The autoclave water inventory control system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety functions independent of any support systems.

- The system shall detect condensate levels that exceed the top of the drain at the autoclave shell and isolate sources of the steam to the autoclave.

3.15.5.5.3 System Evaluation

The autoclave water inventory control system was evaluated to assess its ability to accomplish its required safety function. In addition, a qualitative fault tree analysis was performed to determine the system's capability to accomplish the required safety function. The results of these analyses are provided in this section.

Safety function analysis. The required safety function for the autoclave water inventory control system is to maintain the initial condition assumed by the accident analysis: during normal operation, the autoclave drain valves are open to provide a condensate drain path when steam is being applied to the autoclave environment, preventing accumulation of condensate in the drain. The analysis described in Sections 3.15.5.1 and 3.15.5.3 assumed the level of water inside the autoclave is no higher than the top of the drain at the autoclave shell. The detectors in the drain line are located below this assumed elevation. The autoclave water inventory control system accomplishes its safety function by detecting a high condensate level prior to reaching the assumed level and isolating the steam supply to the autoclave.

Therefore, provided the autoclave water inventory control system can detect water levels prior to reaching the top of the drain line, and provided the same system initiates steam line isolation, the safety function is met.

Qualitative fault tree analysis. In addition to the safety function analysis, a fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the autoclave water inventory control system can meet the functional requirements previously described.

3.15.5.5.4 System Classification

The autoclave water inventory control system is required to preserve an initial condition of the accident analysis (i.e., limit the initial amount of water present inside the autoclave during normal operation; but the system provides no safety function to mitigate the event. Therefore, this system meets the criteria for classification as an AQ system.

This system is also identified as an NCS AEF (see Section 3.15.10.2.1). Therefore, the autoclave water inventory control system is classified as AQ-NCS.

3.15.5.5.5 Boundary

The AQ and AQ-NCS boundaries for the autoclave water inventory control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.5.6 High Cylinder Pressure System

3.15.5.6.1 Safety Function

The high cylinder pressure system ensures that the following safety functions are accomplished:

- The system minimizes the potential for a loss of UF6 primary system integrity during upset events that cause a pressure increase in the UF6 primary system.

3.15.5.6.2 Functional Requirements

The high cylinder pressure system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety functions:

- The system shall be capable of accomplishing the required safety function independent of any support systems.
- The system shall detect high cylinder pressure and isolate the sources of steam to the autoclave.

3.15.5.6.3 System Evaluation

The high cylinder pressure system was evaluated to assess its ability to accomplish the required safety function. The results of this evaluation are provided in this section.

The safety function is to maintain the normal operating pressure of the UF_6 primary system below the MAWP of the cylinder. This function provides direct control of the UF_6 pressure inside the cylinder. The system is designed to detect a cylinder pressure equal to or less than the actuation pressure for the system and to close the steam supply block valves. The cylinder with the lowest MAWP is rated for 100 psig (791 kPa). Therefore, the system actuation is set at ≤100 psig (791 kPa) during normal heating cycles. Based on these requirements, the safety function for this system can be accomplished.

3.15.5.6.4 System Classification

The high cylinder pressure system is required to:

- Minimize the potential for UF_6 primary system integrity failures due to pressure transients.

This minimizes the potential for on-site personnel exposure. However, no credit is taken for this system to mitigate an event to meet off-site EGs for the EBE frequency. Therefore, the autoclave high cylinder pressure system meets the criteria for classification as an AQ system.

3.15.5.6.5 Boundary

The AQ boundaries for the high cylinder pressure system are defined in Table 3.15-2.

3.15.5.7 Autoclave Steam Pressure Control System

3.15.5.7.1 Safety Function

The autoclave steam pressure control system will sense autoclave pressure and isolate steam from the autoclave and the autoclave from the steam jet to:

- Ensure that the UF6 cylinder temperatures will not exceed the initial conditions assumed for different cylinder types when steam is being supplied to the autoclave environment during normal operating modes.
- Ensure that the release of UF_6 and its reaction products to the atmosphere from a limited UF_6 primary system failure inside an autoclave is maintained below the amount that would result in exceeding either the radiological or the nonradiological exposure EGs for the EBE category.

3.15.5.7.2 Functional Requirements

The autoclave steam pressure control system shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall be capable of accomplishing the required safety function independent of any support system.
- The system shall detect high steam pressure and isolate the sources of steam to the autoclave to preserve initial conditions.
- The system shall detect high autoclave pressure, isolate the sources of steam to the autoclave, and isolate the autoclave from the jet to terminate small UF6 releases from the autoclave steam jet during jetting operations.

3.15.5.7.3 System Evaluation

The autoclave steam pressure control system was evaluated to assess its ability to accomplish its required safety function. In addition, a fault tree analysis was performed to determine the system's capability to accomplish the safety function. The results of these evaluations are provided in this section.

Safety function analysis. The first safety function required of the autoclave steam pressure control system is to maintain the UF_6 cylinder temperature to below the values assumed by the accident analysis. During normal heating operations, the autoclave is supplied with saturated steam in a pressurized autoclave. The analysis described in Sections 3.15.5.1 and 3.15.5.3 assumed the initial temperature of the UF_6 was no higher than 240°F (116°C) or 230°F (110°C) depending on cylinder category. This temperature corresponds to a saturated steam pressure of 10 psig (170 kPa) or 6 psig (143 kPa) respectively. The autoclave steam pressure control system accomplishes its safety function by detecting a high autoclave pressure at the assumed value and isolating the steam supply to the autoclave. Therefore, the safety function for this system can be accomplished.

In the event of a limited UF_6 release inside the autoclave while jetting, the second safety function of the autoclave steam pressure control system is to limit the release of UF_6 reaction products to the atmosphere to less than the radiological and nonradiological EGs for the EBE category. To accomplish this safety function, the autoclave steam pressure control system will detect the high pressure inside the autoclave and close the steam block valves, isolating the autoclave from the jet and terminating the release through the jet discharge. When the jetting operation is stopped the autoclave high pressure isolation system, working with the autoclave primary containment system, will isolate the autoclave before the release and subsequent exposures exceed these guidelines.

Qualitative fault tree analysis. In addition to the safety function analysis, a qualitative fault tree analysis was performed in accordance with Section 4.3.1.1.3. The fault tree analysis concluded that the system can meet the functional requirements previously described.

3.15.5.7.4 System Classification

This system is required to perform the following functions:

- Preserve initial conditions assumed in the accident analysis (i.e., limit the initial cylinder temperature to ≤240°F [116°C]).
- Mitigate releases to the atmosphere from releases inside the autoclave (e.g., a pigtail line failure inside autoclave).
- Preserve NCS analyzed limits (i.e., limit the autoclave internal pressure and temperature to ≤8 psig and ≤235°F [113°C] respectively).

This system provides both preservation of initial temperature conditions and mitigation of release events that could exceed the off-site radiological/nonradiological EGs if the autoclave steam pressure control system failed to perform its safety function. Therefore, the autoclave steam pressure control system meets the criteria for classification as an AQ and Q system. The system will be classified as a Q system.

This system is also identified as an NCS AEF (see Section 3.15.10.2.3). Therefore, the autoclave steam pressure control system is classified as AQ-NCS.

3.15.5.7.5 Boundary

The Q and AQ-NCS boundaries for the autoclave steam pressure control system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.5.8 Autoclave Pressure Relief System

3.15.5.8.1 Safety Function

The autoclave pressure relief system shall prevent over-pressurization of an autoclave by relieving excess pressure and reclosing of the vent path following a release.

3.15.5.8.2 System Classification

Although the autoclave pressure relief system does not meet the Q or AQ classification criteria specified in Section 4.2.2, the autoclave pressure relief system is conservatively classified as Q.

3.15.5.8.3 Boundary

The Q boundaries for the autoclave pressure relief system are defined in Table 3.15-1.

3.15.6 Cylinder and Cylinder Handling Equipment

3.15.6.1 UF6 Cylinders

UF_6 cylinders are classified as either Q or AQ depending on their size. This section covers UF_6 cylinders in the following facilities:

- Feed vaporization facilities,
- Withdrawal facilities,
- Toll transfer facility, and
- UF6 cylinder handling/storage facilities.

3.15.6.1.1 Safety Function

UF_6 cylinders provide UF_6 primary system integrity to minimize the potential for releasing UF_6 to the atmosphere. Cylinders utilized to contain UF_6 are designed, built, and tested to ANSI N14.1 and used as prescribed in USEC-651 (reference Appendix A of Chapter 1 for clarification). This ensures safe

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containment of UF_6 throughout the enrichment process including transport, sampling, feeding, filling cylinders with product or tails UF_6 and preventing a release of liquid UF_6.

3.15.6.1.2 Functional Requirements

UF_6 cylinders shall be designed to meet ANSI N14.1 to ensure the capability to accomplish the required safety function.

3.15.6.1.3 System Evaluation

This system is required to minimize the potential for a release of UF_6 to the atmosphere. The safety function is accomplished by retaining its pressure retention boundary during normal operations and upset events, except those events that specifically address a breach of the UF_6 primary system (e.g., cylinder failure [see Section 4.3.2.2.15]).

The design requirements ensure that the cylinder can withstand the pressures/temperatures assumed in the accident analysis provided that the cylinder is filled within the shipping limits. Cylinders are inspected prior to heating and filling to ensure that there is no obvious damage, their weight is within established limits, and (for heating only) the pressures are ≤10 psia (69 kPa). Failure to meet any of these parameters could result in a failure of the cylinder integrity during normal heating or filling. A periodic hydrostatic pressure test is also required to allow filling to ensure that the integrity of the cylinder design is maintained. Cylinders manufactured prior to institution of the ANSI N14.1 standard may not meet the design requirements; specifically these cylinders lack a certified volume (water weight). These cylinders are typically designated only for storage of solid UF_6 and may not be heated in a closed autoclave. Certain serial numbers without certified volumes can be safely heated provided the limiting conditions specified in the Technical Specification Requirements are met. The autoclave provides protection should a breach in the cylinder occur during heating. Prior to being refilled, they must have their free volumes verified and be hydrostatically tested. Based on these requirements, the cylinders can accomplish the required safety function.

3.15.6.1.4 System Classification

The UF_6 cylinders are required to perform the following safety functions:

- Prevent a release of UF_6 to the atmosphere during normal operations; and
- Prevent a release of UF_6 to the atmosphere during upset events that do not include a failure of the cylinder.

The following factors were used in determining the system classification of the various UF_6 cylinders in use at the facilities:

- Cylinders approved (i.e., sized) for filling to greater than 500 lb (227 kg) of UF_6 are conservatively assumed to contain a sufficient amount of liquid UF_6 to exceed the off-site EGs for the EBE frequency category if a release were to occur. [A threshold analysis indicated that, in all cases, it takes more than 500 lb (227 kg) to exceed the 30-mg U dose at the site boundary (all cases that exceeded this dose were greater than 1000 lb [454 kg] of UF_6).]

- Cylinders that are not approved (i.e., sized) for holding greater than 500 lb (227 kg) of UF_6 do not have the capacity to contain sufficient material to result in significant off-site health effects.
- Cylinders capable of holding greater than 500 lb (227 kg) of UF_6 but not approved for filling may contain only solid UF_6 unless they are being heated in a closed autoclave.
- Cylinders containing only gaseous/solid UF_6, regardless of size, have the potential to exceed only the on-site EGs if the cylinder does not maintain its integrity.

Therefore, cylinders capable of holding more than 500 lb (227 kg) of UF_6 are classified as Q. Smaller cylinders (capable of holding no more than 500 lb [227 kg] of UF_6) are classified as AQ.

3.15.6.1.5 Boundary

The Q and AQ boundaries for the UF_6 cylinders are defined in Tables 3.15-1 and 3.15-2, respectively.

3.15.6.2 UF6 Cylinder Handling Cranes

The UF_6 cylinder handling cranes consist of those cranes and associated lifting fixtures in the feed, withdrawal, and the toll transfer and sampling facilities that are used to lift UF_6 cylinders. Facility-specific differences are noted where appropriate.

3.15.6.2.1 Safety Function

The UF_6 cylinder handling cranes in withdrawal facilities and the toll transfer and sampling facility are designed for the safe movement of liquid-filled UF_6 cylinders. Therefore, the required safety function of the UF_6 cylinder handling cranes in the withdrawal facilities and the toll transfer and sampling facility is not to fail in a manner that would cause a UF_6 primary system failure (i.e., a dropped liquid-filled cylinder).

The UF_6 cylinder handling cranes in the feed facilities provide for the safe movement of solid-filled UF_6 cylinders or other related loads over autoclaves that could contain liquid-filled UF_6 cylinders and over other feed facility process equipment. No feed facility UF_6 cylinder handling crane shall be allowed to lift liquid UF_6 cylinders at this time. Therefore, the required safety function for feed facility cranes is to not fail in a manner that would cause a UF_6 primary system integrity failure (i.e., rupture a cylinder in the autoclave).

3.15.6.2.2 Functional Requirements

The liquid UF_6 cylinder handling cranes shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The cranes shall be designed to withstand the evaluation basis earthquake and not fail in a manner such that the load will be dropped.
- The cranes shall be designed to withstand the evaluation basis wind loading and not fail in a manner such that the load will be dropped.
- The cranes shall be designed for the loads they will handle during operation of these facilities.
- The UF_6 cylinder handling cranes shall be designed so that when controls are released the cranes automatically stop except for small compensatory movements associated with activation of the mechanical braking mechanisms (e.g., evacuation of building).

3.15.6.2.3 System Evaluation

The required safety function is to not fail in a manner that causes UF_6 primary system failure (i.e., dropped cylinder) during normal operation, an evacuation of facility event, or natural phenomena events. The cranes are designed for the loads they will handle during normal operation of these facilities. Administrative controls require inspections of the cables, brakes, and other critical items to ensure that the crane can operate correctly. (Refer to Chapter 1, Appendix A for commitments to ANSI standard inspection and testing requirements). In addition, the cranes are designed so that when the controls are released (e.g., evacuation of facility event), only small compensatory movements occur due to momentum after the crane drive mechanism stops and brakes are applied but these movements have no safety significance. The cranes were evaluated to assess their ability to withstand natural phenomena events. The analyses indicated that the cranes will not have any structural damage, will remain in place, and will not release their loads during an evaluation basis earthquake and wind. Floods do not reach the elevation of the facility to threaten crane integrity.

Failure of the crane lifting components or load braking system while lifting a load could result in dropping the load and causing a UF_6 primary system failure. Therefore, a load test is performed periodically.

Engineering and administrative controls are also used with UF_6 cylinder handling cranes to minimize the risk of the cranes dropping a liquid cylinder, or similar weight load, on operating process equipment. The engineering controls for liquid handling cranes used in the various process buildings are discussed in Section 3.7.3.2. The administrative zone controls (such as for the feed facilities) are incorporated in the applicable procedures.

The withdrawal facilities in C-310 and C-315 are each equipped with two bridge cranes located on one runway. Both cranes in each facility are qualified for handling liquid-filled cylinders. However, administrative controls prevent simultaneous loading or operating of both cranes located on the same runway.

Based on the analysis, the cranes can accomplish the required safety function.

3.15.6.2.4 System Classification

The UF_6 cylinder handling cranes in the withdrawal facilities and the toll transfer and sampling facility are required to prevent dropping a liquid-filled UF_6 cylinder in a manner that could result in a cylinder failure event. The cylinder failure event (i.e., liquid-filled cylinder drop) is classified as an EBE whose consequences could exceed the off-site EGs if the cranes were to fail in a manner that resulted in the drop and failure of a liquid-filled cylinder. Therefore, the UF_6 cylinder handling cranes designed and approved for handling liquid-filled UF_6 cylinders meet the criteria for classification as a Q system.

The feed facility cranes are required to not fail in a manner that would cause a UF_6 primary system integrity failure (i.e., rupture a cylinder in the autoclave). The event is classified as an EBE whose consequences could exceed the off-site radiological/nonradiological EGs if the failure of a feed facility crane resulted in a physical integrity failure of a liquid cylinder in a autoclave. Therefore, these UF_6 handling cranes in the feed facilities meet the criteria for classification as a Q system.

3.15.6.2.5 Boundary

The Q boundaries for the UF_6 cylinder handling cranes, including associated lifting fixtures, are defined in Table 3.15-1.

3.15.6.3 Liquid UF6 Cylinder Handling Equipment

3.15.6.3.1 Safety Function

The liquid UF_6 cylinder handling equipment shall not fail in a manner to cause UF_6 primary system failure. The liquid UF_6 cylinder handling equipment provide for the safe movement of liquid UF_6 cylinders.

3.15.6.3.2 Functional Requirements

The liquid UF_6 cylinder handling equipment shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The cylinder handling equipment shall be designed to withstand the evaluation basis natural phenomena events (i.e., earthquake and high wind) such that the equipment will not fail during the evaluation basis natural phenomena events in a manner that would cause a UF6 release due to a dropped cylinder.
- The elevator and levelator in C-360 shall be designed in accordance with applicable ANSI standards (reference Appendix A of Chapter 1 for clarification) for the loads they will handle during operation of these facilities.
- Rail stops in the withdrawal facilities shall be designed to prevent scale cart movement beyond stops at the head of the cylinder scales in the withdrawal stations.
- Rail stops in the toll transfer and sampling facility shall be designed to prevent scale cart movement beyond stop at the levelator.
- Interlock switch must prevent scale cart movement when the levelator is not in fully raised position.

3.15.6.3.3 System Evaluation

The system includes the C-360 elevator and levelator, and scale carts. The required safety function associated with the liquid UF_6 cylinder handling equipment is that it must not fail in a manner that will result in the failure of a cylinder during normal operation, upset events that do not address failure of the equipment, or natural phenomena events. By protecting the integrity of the cylinders, this system provides protection for on-site personnel and the off-site public from releases that could result if the system failed. Administrative controls require that (1) the UF_6 cylinder handling equipment be approved for the applicable use before handling UF_6 cylinders, (2) filled cylinders must complete a prescribed cooldown period before they are moved with handling equipment not approved for use with liquid UF_6 cylinders, and (3) cylinder handling cranes be inspected daily (prior to first use) for obvious defects.

The C-360 elevator and levelator are designed according to the applicable ANSI standards (as specified in Chapter 1, Appendix A) for the loads they will handle during normal operation of these facilities. Administrative controls require inspections of the pumps, drives, and other critical items to ensure that the elevator and levelators can operate correctly. Seismic analysis indicates that the flow of hydraulic fluid to the elevator may be interrupted by a seismic event. However, a pressure actuated overspeed valve in the seismically resistant hydraulic piping will arrest the elevator's movement. In the

arrested configuration the elevator has been shown to be capable of resisting the evaluation basis seismic event.

The C-360 levelator does not meet the resistance criteria for the evaluation basis seismic event. However, the levelator is not considered to be a significant contributor to the risk of a UF_6 release due to an evaluation basis seismic event since the levelator is operated for only a few minutes during each use and the C-360 cranes are normally used to transport cylinders from the autoclave level to the storage yard located on the ground level. No modification to the levelator is necessary since the levelator is not the primary means used to move cylinders from the autoclave floor level to the ground level.

Rail stops used in C-310 and C-315 withdrawal facilities prevent scale cart movement beyond stops at the head of the cylinder scales in the withdrawal stations. Rail stops used in the C-360 toll transfer and sampling facility prevent scale cart movement beyond stops at the levelator. The interlock switch at the levelator prevents scale cart movement when the levelator is not in the fully raised position. The rail stops are used in these facilities to maintain primary system integrity during operations associated with the evacuation event (Section 4.3.2.2.4).

The scale carts were evaluated to assess their ability to withstand natural phenomena events. The analyses indicated that the scale carts will not have any structural damage, will remain in place, and will

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not release their loads during an evaluation basis earthquake. The scale carts are insensitive to evaluation basis wind loadings.

Floods do not reach the elevation of the facility and, therefore, do not threaten equipment capability.

Based on the design requirements and administrative controls, the safety function for the UF_6 cylinder handling equipment can be accomplished.

3.15.6.3.4 System Classification

Cylinder and pigtail failure events are classified as EBEs whose consequences could exceed off-site EGs if the liquid UF_6 cylinder handling equipment were to fail in a manner that caused a physical integrity failure of a liquid-filled cylinder or a pigtail during withdrawal, transfer, or sampling operations. Therefore, the liquid UF_6 cylinder handling equipment meets the criteria for classification as a Q system.

A postulated failure of a cylinder that has completed the prescribed cooldown period (see Section 4.3.2.2.3) would result in an initial wet-air in leakage. A relatively minor release could be expected after UF_6 reaction products pressurized the cylinder. However, workers in the immediate area would be able to evacuate before reaction products pressurized the cylinder and were released to the atmosphere. Therefore, equipment used to handle cylinders containing UF_6 after the prescribed cool down period are classified as non-safety equipment.

Liquid UF_6 cylinder handling equipment is also identified as an NCS AEF (see Section 3.15.10.2.9). Therefore, this equipment is classified as AQ-NCS.

3.15.6.3.5 Boundary

The Q and AQ-NCS boundaries for the liquid UF_6 cylinder handling equipment are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.6.4 Cylinder Weighing System

3.15.6.4.1 Safety Function

The cylinder weighing system shall provide a means for identifying cylinders with weights that exceed allowable limits. Cylinders with weights exceeding allowable limits defined in the TSRs are not allowed to be heated in the feed facilities or the toll transfer and sampling facility.

3.15.6.4.2 Functional Requirements

The cylinder weighing system shall be designed to ensure the capability to accomplish the required safety function. Cylinder weighing systems that are calibrated and tested to the tolerances specified by the NMC&A program (which are more stringent than the tolerances required by the accident analysis) meet the functional requirements necessary to accomplish their required safety function.

3.15.6.4.3 Safety Evaluation

The required safety function of the cylinder weighing system is to provide a means for identifying cylinders with weights that exceed allowable limits. The system accomplishes this safety function by providing an accurate measure of the cylinder's weight. By providing a means to detect a cylinder with a weight exceeding allowable limits, the likelihood of the cylinder being subsequently heated in an autoclave is reduced. Cylinder weighing systems are calibrated and tested to the tolerances specified by the NMC&A program. This accuracy requirement is more than adequate for the cylinder weighing system to perform its required safety function. As long as the system is functional, the safety function will be met.

3.15.6.4.4 System Classification

The cylinder weighing system is required to:

- provide a means for identifying cylinders with weights that exceed allowable limits.

The system provides no mitigation should a cylinder with excessive UF_6 be heated inside an autoclave. However, the system does provide a means of maintaining an analysis assumption that supports categorizing the accident scenario involving the heating of a cylinder with excessive UF_6 as an EBE. Therefore, this system's safety function meets the criteria for classification as an AQ system.

3.15.6.4.5 3.15.6.4.5 Boundary

The AQ boundaries for the cylinder weighing system are defined in Table 3.15-2.

3.15.6.5 Cylinder Scale Cart Movement Prevention System

3.15.6.5.1 Safety Function

The cylinder scale cart movement prevention system prevents moving a scale cart with a pressurized pigtail attached.

3.15.6.5.2 System Classification

The cylinder scale cart movement prevention system is used to prevent a pigtail failure due to inadvertent movement of the scale cart during cylinder filling or transfer operations. Postulated unmitigated pigtail failures during cylinder filling or transfer operations have the potential to exceed off-site exposure guidelines (see Sections 4.3.2.2.10 and 4.3.2.2.11). Therefore, the cylinder scale cart movement prevention system meets the criteria specified in Section 4.2.2 for classification as a Q system.

The cylinder scale cart movement prevention system is identified as an NCS AEF (see Section 3.15.10.2.8 and 3.15.10.4.11). Therefore, this system is classified as AQ-NCS.

3.15.6.5.3 Boundary

The Q and AQ-NCS boundaries for the cylinder scale cart movement prevention system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.7 General Facility Safety Support

3.15.7.1 Criticality Accident Alarm System

The criticality accident alarm system (CAAS) is located in the following facilities:

- Cascade facilities (C-331, C-333, C-335, and C-337);
- Feed facilities (C-333-A and C-337-A)
- Withdrawal facility (C-310/310-A);
- Toll transfer facility (C-360);
- Waste handling facility (C-746-Q1);
- Decontamination/cleaning facility (C-400);
- Stabilization building (C-409);
- Technical services building (C-710);
- Maintenance and stores building (C-720); and
- Other areas at the plant that may require temporary coverage.

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3.15.7.1.1 Safety Function

The safety function for the CAAS is to detect gamma radiation; provide a distinctive, audible signal that will alert personnel to evacuate the areas that are potentially affected; and provide an alarm in the central control facility for initiation of emergency response activities.

3.15.7.1.2 Functional Requirements

The functional requirements of ANSI/ANS 8.3 are applied to the CAAS as described in Chapter 1, Appendix A. In addition, the following functional requirement is also applied:

- The CAAS evacuation alarm system shall be able to perform its function without the aid of off-site AC electrical power.

3.15.7.1.3 System Evaluation

The CAAS meets the requirements of ANSI/ANS 8.3, except as noted in Chapter 1, Appendix A. The CAAS clusters are equipped with a DC battery backup with a design rating of a minimum of 4 hours upon loss of AC power to the cluster unit. The CAAS alarm actuation components are provided electrical power from associated building AC and DC distribution systems. These support systems include the building 120 VAC, 125 VDC, and 48 VDC power distributions systems. These power distributions systems have either battery banks or power from an uninterruptible power supply (UPS) as backup and either the AC and/or DC power supplies will provide power to actuate the building horns without off-site AC power. In addition to being independent of off-site electrical power, the building horns that require compressed air can operate for at least 2 min. The 2-min time frame is sufficient to meet the requirement of Section 4.4.1 of ANSI/ANS 8.3 which states that the alarm signal is for immediate evacuation purposes only.

3.15.7.1.4 System Classification

The CAAS is required to alert on-site personnel of a criticality event and the need for an immediate evacuation to minimize their exposure to radiation. Therefore, the CAAS meets the criteria for classification as an AQ system.

3.15.7.1.5 Boundary

The AQ boundaries for the criticality accident alarm system are defined in Table 3.15-2.

3.15.7.2 Fire Protection System

3.15.7.2.1 Safety Function

The fire protection system performs the following safety functions:

- Provides sufficient fire suppression capability for the cascade process buildings to minimize the likelihood of a large fire.

- Provides fire suppression for the withdrawal facilities in areas associated with handling liquid UF6 to minimize the likelihood of a fire large enough to cause a breach in the UF6 primary system.

3.15.7.2.2 Functional Requirements

The fire protection system accomplishes the required safety functions by satisfying the following functional requirements:

- Provide an average discharge density in excess of the required sprinkler discharge density for the cell floor and operating floor sprinkler systems in Buildings C-331, C-333, C-335, C-337, C-310, and C-315;
- Deliver the required discharge density to only one floor of a single building at a time;
- Deliver the required discharge density independent of pump operability for up to 30 min;
- Automatically initiates from a fire in any of the required buildings; and
- Provide automatic fire suppression capability to C-310-A to minimize the likelihood of large fires.

3.15.7.2.3 System Evaluation

Automatic sprinkler systems. An unmitigated lube oil fire in Buildings C-310, C-331, C-333, C-335, C-337, and C-315 could lead to significant consequences for on-site personnel. Although an unmitigated lube oil fire is not credible in C-310A due to lack of lube oil in this area, the C-310A sprinkler system is part of the C-310 sprinkler system and it is classified to the same level as the C-310 sprinkler system. Based on the credible fire scenarios and an analysis of unmitigated fire effects, operator action cannot be solely relied upon to prevent or mitigate large fires. Therefore, the automatic sprinkler systems protecting these buildings are required. The water used by the sprinkler systems is supplied by the high pressure fire water system (HPFWS). This system has a gridded distribution piping network, several fire water pumps, and an elevated storage tanks.

A hydraulic effectiveness study was performed for the existing sprinkler systems of the cell floors in the C-331 and the C-333 type buildings, and the operating floor in C-331. The calculated minimum and average available densities were identified. The existing sprinkler systems can provide an average density greater than required by NFPA-13 (as described in Chapter 1, Appendix A). Available sprinkler discharge densities for the cell floor in Buildings C-310 and C-315, and the operating floor in Buildings C-310, C-310A, C-315, C-333, C-335, and C-337 have not been reported, but analyses of the hydraulic effectiveness of the sprinkler systems in these buildings indicate that the systems are adequate.

High pressure fire water system. Buildings C-310, C-310-A, C-315, C-331, C-333, C-335, and C-337 are on the high pressure fire water system. The system design basis considers a sprinkler operating area slightly under 6000 ft^2 (557 m^2) for a lube oil spill fire on the cell (second) floors in the process buildings. For the operating (ground) floors, the maximum sprinkler operating area was determined to be 8400 ft^2 (780 m^2). These sprinkler operating areas for the cell and operating floors are used to define the evaluation basis fire. The highest sprinkler system flow rate is estimated to be 3200 gpm (12.1 m^3/min) for the operating floor. A 500 gpm (1.9 m^3/min) hose stream demand is added to the sprinkler system flow rate to obtain a maximum fire water flow rate of 3700 gpm (14.1 m^3/min) for the evaluation basis. The HPFWS fire water pumps each have a capacity that exceeds the 3700 gpm (14.1 m^3/min) maximum fire water flow rate.

The C-611-R elevated storage tank has a capacity of 300,000 gal (about 1135 m^3). When it is 90% full, the tank is capable of supplying the maximum flow rate for approximately 73 minutes with no HPFWS pumps operating. It is also capable of supplying 2250 gpm (8.6 m^3/min) with no pumps operating for a duration of two hours. This is slightly greater than 60% of the maximum flow demand.

3.15.7.2.4 System Classification

The fire protection system within the process buildings is required to:

- Minimize the potential for a large fire that could damage the UF6 primary system integrity in the enrichment cascade; the large fire event was not considered as having the potential for exceeding the off-site EBE EGs.
- Minimize the likelihood of a large fire that could threaten UF6 primary system integrity in the withdrawal facilities.

The combustible fuel loading in these facilities is controlled in accordance with the Fire Protection Program (see Section 5.4). Based on this, the fire protection systems within the scope of this section meet the criteria for classification as an AQ system.

3.15.7.2.5 Boundary

The AQ boundary for the high pressure fire water system is defined in Table 3.15-2.

3.15.7.3 UF6 Release Detection System

3.15.7.3.1 Safety Function

The UF_6 release detection system shall detect and annunciate in the ACR, UF_6 releases in enrichment cascade operating equipment that is operated above atmospheric pressure. The UF_6 release detection system for the feed, withdrawal, and toll transfer and sampling facilities shall detect UF_6 releases and provide an alarm to alert personnel to take appropriate action (i.e., investigate to verify a release occurred and, if necessary, evacuate the area affected by the release). Other systems that perform alarm and mitigation functions are discussed in other sections (see Sections 3.15.4.1, 3.15.4.8, and 3.15.5.2).

3.15.7.3.2 Functional Requirements

Each of the UF_6 detection systems in the areas of the enrichment cascade that are intended to be operated above atmospheric pressure, and in the withdrawal, feed, and toll transfer and sampling (zones 2, 3, and 5-8) facilities shall be designed in accordance with the following functional requirements to ensure the capability to accomplish the required safety function:

- The system shall monitor the designated areas of the facility for UF6 releases outside of the UF6 primary system.
- The system shall provide, in the ACR, an alarm indication of a UF6 release from the UF6 primary system.

3.15.7.3.3 System Evaluation

Enrichment cascade. The safety function of the system is to detect a UF_6 release from the UF_6 primary system and provide an alarm to alert on-site personnel in the ACR. This facilitates early detection by the operators allowing them to initiate required actions to minimize the release. The system is designed to detect releases in those areas that have the potential for a large UF_6 release and provide an alarm in the ACR.

The detector heads are located in “000” or “00” areas that are intended to be operated above atmospheric pressure. Detectors are installed inside cell housings, cell bypass housings, unit bypass housings, interbuilding tie-line housings, and in interbuilding booster stations. Operation of these detector heads is required during a UF_6 release. The detectors heads would be subjected to an environment associated with the release of UF_6 and its reaction products. However, the response time is relatively quick once the smoke is detected based on operational history. Once a detection signal is generated, the alarm circuit will be sealed in and operator action will be required to clear the alarm. Therefore, the environmental conditions during an event should not cause failure of the detection system. Additionally, there are multiple detector heads in each area to provide detection capability. Normal operation environments can also cause some spurious operations due to various causes and result in detector failures. These are typically detected during the testing process and the detector head will not reset. However, these are typically limited to one detector at a time. With multiple detectors located in each area, additional protection is provided to ensure system operability. Based on these requirements and evaluation, the system can accomplish the required safety function and meet its functional requirements.

Feed, toll transfer (zones 2, 3, and 5-8), and withdrawal facilities. The safety functions of the withdrawal, feed, and toll transfer and sampling facility UF_6 release detection systems are to detect a UF_6 release from the UF_6 primary system and provide an alarm to alert on-site personnel to take appropriate action (i.e., investigate to verify a release occurred and, if necessary, evacuate the area affected by the release). The systems are designed to detect releases in those areas that have the potential for a UF_6 release and provide an alarm inside the facility ACR. Operating history has shown the system to be capable of detecting releases and providing an alarm. Based on these requirements and operating history, the safety function of the system can be accomplished. Credit is also taken for these systems for nuclear criticality safety. See Section 3.15.10.2.7.

The withdrawal facilities are equipped with several systems that can detect and annunciate an alarm in the ACR upon a UF_6 release. These systems include: (1) the UF_6 release detection system - low voltage system at the UF_6 withdrawal room ceiling, (2) the UF_6 release detection system - high voltage ("old") system for UF_6 condensers, accumulator, and piping heated housings, and (3) UF_6 release detection system - high speed centrifugal pumps (C-315 only). A high-voltage (200 VDC) or low-voltage (24 VDC) UF_6 release detection system can be used to monitor the C-315 high speed centrifugal pumps. These systems are classified as alarm-only building UF_6 detection systems for operations performed within the withdrawal facilities. The low voltage UF_6 release detection systems is also credited for nuclear criticality safety by limiting the release of fissile material.

3.15.7.3.4 System Classification

The UF_6 release detection system that is located in any "000" or "00" areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, interbuilding tie-line housings and other piping and equipment housings) and in interbuilding booster stations are required to:

- Detect UF6 releases and annunciate in the ACR; and
- Be used, in conjunction with the compressor motor manual trip system, to reduce the UF_6 primary system pressure and minimize any UF_6 releases.

Use of this system in this manner will minimize exposure of on-site personnel to UF_6 and ensure the off-site EGs are not exceeded. Credit is taken for this system to prevent exceeding the off-site EBE EGs in the large UF_6 release to atmosphere (Section 4.3.2.1.7) EBE. Therefore, this system meets the criteria for classification as a Q system.

The UF_6 detection systems in the feed, toll transfer and sampling (zones 2, 3, and 5-8), and withdrawal facilities are required to:

- Aid in the detection of UF6 releases for several events, and
- Minimize the exposure to on-site personnel.

However, these systems are not essential for the protection of the off-site public since for any significant release of UF_6 material that could threaten off-site EBE EGs, other methods of indicating that

a release has occurred are also available (i.e., visual detection). These systems only provide an alarm to alert on-site personnel that a potential UF_6 release has occurred enabling them to take appropriate action (i.e., investigate to verify a release occurred and, if necessary, evacuate the area affected by the release). Therefore, these systems meet the criteria for classification as an AQ system.

3.15.7.3.5 Boundary

The Q, AQ, and AQ-NCS boundaries for the UF_6 release detection system are defined in Tables 3.15-1, 3.15-2, and 3.15-3 respectively.

3.15.7.4 Inventory Instrumentation Required for Nuclear Material Accountability

3.15.7.4.1 Safety Function

The inventory instrumentation performs a safeguards function by providing a means to demonstrate compliance with NMC&A requirements.

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3.15.7.4.2 ***Section Deleted***

3.15.7.4.3 ***Section Deleted***

3.15.7.4.4 **<u>System Classification</u>**

Although the inventory instrumentation required for nuclear material accountablity does not meet the Q or AQ classification criteria specified in Section 4.2.2, this systems is conservatively classified as AQ.

3.15.7.4.5 **<u>Boundary</u>**

The AQ boundaries for the inventory instrumentation required for nuclear material accountability are defined in Table 3.15-2.

3.15.7.5 Public Warning System

3.15.7.5.1 **<u>Safety Function</u>**

The public warning system~~s~~ provides warning to the public within a two mile radius of the plant in the event of an incident requiring evacuation or sheltering of the public.

3.15.7.5.2 ***Section Deleted***

3.15.7.5.3 ***Section Deleted***

3.15.7.5.4 **<u>System Classification</u>**

Although the public warning system does not meet the Q or AQ classification criteria specified in Section 4.2.2, this system is conservatively classified as AQ.

3.15.7.5.5 **<u>Boundary</u>**

The AQ boundaries for the public warning systems are defined in Table 3.15-2.

3.15.7.6 Onsite Warning/Evacuation Systems

3.15.7.6.1 Safety Function

The onsite warning/evacuation systems provide evacuation instructions or notification in the event of an incident requiring evacuation or sheltering of the plant personnel.

3.15.7.6.2 *Section Deleted*

3.15.7.6.3 *Section Deleted*

3.15.7.6.4 System Classification

Although the onsite warning/evacuation systems do not meet the Q or AQ classification criteria specified in Section 4.2.2, these systems are conservatively classified as AQ.

3.15.7.6.5 Boundary

The AQ boundaries for the onsite warning/evacuation systems are defined in Table 3.15-2.

3.15.7.7 *Section deleted*

3.15.7.8 Surge Drum Pressure/Room Temperature Instrumentation

3.15.7.8.1 Safety Function

The surge drum pressure instrumentation and room temperature instrumentation perform a safeguard function to provide pressure and temperature readings utilized in the NMC&A inventory calculations.

3.15.7.8.2 *Section Deleted*

3.15.7.8.3 *Section Deleted*

3.15.7.8.4 System Classification

Although the surge drum pressure/room temperature instrumentation does not meet the Q or AQ classification criteria specified in Section 4.2.2, this instumentation system is conservatively classified as AQ.

3.15.7.8.5 Boundary

The AQ boundaries for the surge drum pressure/room temperature instrumentation are defined in Table 3.15-2.

3.15.7.9 Mass Spectrometers

3.15.7.9.1 Safety Function

The C-310 mass spectrometers (one normal and one backup mass spectrometer) function to monitor product assay limits. The mass spectrometers in C-331 function to monitor tails assay (one mass spectrometer) and BOL assay (one mass spectrometer). The mass spectrometer in C-335 functions to monitor TOL assay (one mass spectrometer). The C-333 and C-337 (one in each facility) mass spectrometers function to monitor assay limits.

3.15.7.9.2 System Classification

Although the mass spectrometers do not meet the Q or AQ classification criteria specified in Section 4.2.2, the mass spectrometers are conservatively classified as AQ.

3.15.7.9.3 Boundary

The AQ boundaries of the mass spectrometers are defined in Table 3.15-2.

3.15.8 Non-Radiological Chemical Systems

The non-radiological chemical systems provide containment of non-radiological chemicals identified as part of the Chemical Safety Program described in Section 5.6.

The non-radiological chemical systems are defined for the following chemicals:

- Fluorine,
- Chlorine, and
- Chlorine trifluoride.

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3.15.8.1.1 Chemical Safety Function

The non-radiological chemical systems are required to perform the following chemical safety functions:

- Maintain integrity to the process, which minimizes the potential for releasing toxic gas into the atmosphere.
- Ensure that the fluorine primary system is relieved on high pressure to minimize the potential for a failure of the primary system integrity.
- Detect releases from the primary system and provide an alarm indication of the release.

3.15.8.1.2 Functional Requirements

The non-radiological chemical systems shall be designed and maintained for the intended service. The fluorine distribution system shall have pressure relief available on the low pressure side of the C-410-K multi-tube trailer pressure reducing station, the C-410-D storage tanks, and the fluorine distribution header in C-410-D. These systems shall actuate at or below the MAWP of the part with the lowest MAWP in the associated section of the fluorine distribution system. These systems discharge to an elevated release point upon activation. The toxic gas leakage detection system shall be designed to provide alarm indications upon detection of releases from the primary system.

3.15.8.1.3 System Evaluation

The non-radiological chemical systems are required to prevent releases of toxic gas to the atmosphere during normal operations. This safety function is accomplished by retaining system integrity during normal operations and upset events. The design requirements ensure that the primary systems can withstand the operating conditions assumed in the accident analysis and are appropriate for the chemical being used.

Primary ClF_3 system integrity is protected by maintaining tank pressure to less than atmospheric pressure. This minimizes the potential for a release of Mixed Gas from the storage tanks at the C-350 drying agent storage building. The ClF_3 is vaporized into the C-350 Mixed Gas storage tank which is used for controlled flow of the Mixed Gas. A release of Mixed Gas or F_2/N_2 from a ruptured primary system could result in an uncontrolled release at ground level.

The fluorine primary system integrity is protected by a pressure relief system available on the low pressure side of the C-410-K tube trailer pressure reducing station, the C-410-D storage tanks, and the fluorine distribution header in C-410-D. These relief systems vent to an elevated release point upon activation. A release of fluorine from a ruptured primary system could result in an uncontrolled release at ground level.

Toxic gas detectors are located in areas where a significant release of toxic gas could occur. The required safety action is to detect a release and provide indications of the release. The safety action is accomplished by having detectors appropriate to the toxic gas present (chlorine, fluorine, etc.) and providing both audible and visible alarm indications. The system provides on-site protection for personnel by detecting a release and alerting personnel to immediately evacuate the area.

3.15.8.1.4 System Classification

The non-radiological chemical systems are required to:

- Provide primary system integrity during normal operation for the toxic gas distribution process to minimize the consequences to on-site personnel from releases of toxic gases from the process (e.g., distribution system breaches).
- Minimize the potential for failure of the primary system integrity and provide protection for on-site personnel during pressure increase events;
- Detect a toxic gas release and provide alarm for personnel in the immediate vicinity of the release.

The non-radiological chemical systems are classified as AQ systems.

3.15.8.1.5 Boundary

The AQ boundaries for the non-radiological chemical systems are defined in Table 3.15-2.

3.15.9 Building Structures and Confinement

3.15.9.1 Process Buildings

The process buildings house the UF_6 primary systems including the feed facilities, enrichment and purge cascades, withdrawal facilities, and the toll transfer and sampling facility. These buildings include the enrichment process buildings (C-310, C-310-A, C-315, C-331, C-333, C-335, and C-337), the feed buildings (C-333-A, and C-337-A), and the toll transfer and sampling facility (C-360). This section includes the tie-line structures connecting the main cascade process buildings.

3.15.9.1.1 Safety Function

The process buildings provide a significant role in minimizing both the on-site and off-site releases of UF_6 and ensure that the following safety functions are accomplished:

- Provide limited holdup of UF6 releases to allow deposition of uranium and slower release rates to atmosphere (cascade facilities and withdrawal facilities only), and;
- Maintain structural integrity during evaluation basis natural phenomena events (i.e., earthquakes, high winds, and flooding) to the degree needed to prevent failure of the UF6 primary system.

3.15.9.1.2 Functional Requirements

The functional requirements are no different than the safety function.

3.15.9.1.3 System Evaluation

Process buildings C-310, C-310-A, C-315, C-331, C-333, C-335, and C-337 are the structural facilities housing the operations associated with the enrichment and purge cascade facilities and the

product and tails withdrawal processes. The process buildings are generally steel-framed structures with concrete block and siding walls. The roofs are generally steel frame covered with concrete or steel decking. The ground floors are reinforced, poured concrete.

The process buildings are inherently capable of providing holdup to minimize consequences from UF_6 releases originating inside the buildings for on-site personnel located outside the process buildings and for the off-site public. Credit is taken for building holdup and deposition in the calculations of the estimated consequences of UF_6 releases in the hazard analyses described in Section 4.2 and in the subsequent accident analyses described in Section 4.3 for events such as the large UF_6 release to atmosphere event (see Section 4.3.2.1.7). The exterior of the process buildings at the cell floor and above are the only portions of the building that are essential to accomplish this safety function. In addition, the safety function can be met regardless of ventilation system configuration. The building siding is credited for minimizing the available circulation paths for air and UF_6 reaction products. The safety function of the building siding is to control the air flow (building to atmosphere and vice versa) and thus give the internal UO_2F_2 particulates a chance to settle. Openings in the building siding which do not significantly increase the air flow of the building to atmosphere beyond that assumed for the summer conditions (all fans running with once-through circulation) are not expected to decrease the conservatism of the analysis results. Examples of openings which do not affect the analysis include openings in the cell floor access hatches or access doors, or openings below the cell floor.

The process buildings are also required to prevent a large release of UF_6 resulting from evaluation basis natural phenomena events. This safety function is accomplished by requiring the building support structures to maintain structural integrity during evaluation basis natural phenomena events to the degree needed to prevent failure of the UF_6 primary system. Table 3.15-10 summarizes the results of the natural phenomena event evaluations for the process buildings. As indicated in the table, the process buildings and tie line structures will not experience any structural damage that would result in an unanalyzed UF_6 release during an evaluation basis natural phenomena event.[1] However, as indicated in Table 3.15-10, Buildings C-331, C-333, C-335, and C-337 could experience some inleakage of water that may develop because of local ponding on the roof from heavy rainfall events (10,000-yr event). The analysis assumed all of the normal drainage paths were clogged, allowing no draining except over the parapets. This event would occur over a period of time, which allows for additional operator intervention prior to any inleakage occurring. The impact of water inleakage in a typical process building was reviewed, and no adverse impacts (i.e., loss of primary system integrity) were identified. Any inleakage to the cell floor would typically run to the open stairwells and floor drains, which would drain to the lower elevations. Some electrical equipment may be affected because of the water flow path. However, the likelihood of the combination of a heavy rainfall, all drainage paths being clogged, no operator intervention, and multiple electrical failures was not considered credible for these large buildings. It should be noted that compressor trip capability could also be accomplished from the switchyard if necessary to mitigate the effects of this event if it were to occur. Additionally, Table 3.15-10 indicates that Buildings C-310, C-315, C-331, C-333, C-335, and C-337 will experience damage during an evaluation basis high wind

[1] The modifications to Buildings C-331 and C-335 that are described in DOE/ORO-2026, Plan for Achieving Compliance with NRC Regulations at the Paducah Gaseous Diffusion Plant, Issue 36, Seismic Capability of Buildings C-331 and C-335, have been credited in this analysis.

event. The types of failures associated with an evaluation basis high wind event are siding or roofing being pulled away from the building. This would have no effect on the equipment inside of the buildings except for wind impact. Piping and equipment were reviewed in several facilities at the plant site, and no failures were identified because of wind loading. The process buildings help minimize the consequences to on-site and off-site personnel and thus help ensure that the EGs for the facility are not exceeded to the extent possible as a result of any of the events that are postulated for the facility. Based on these requirements and supporting evaluations, the C-310, C-310-A, C-315, C-331, C-333, C-335, and C-337 process buildings can accomplish the required safety functions.

Buildings C-333-A, C-337-A, and C-360 are required to maintain structural integrity during natural phenomena events to the degree necessary to prevent failure of the UF_6 primary system. This safety function is accomplished by requiring the structures to withstand evaluation basis natural phenomena events that could result in failures of the UF_6 primary system should the structure fail to maintain structural integrity. As indicated in Table 3.15-10, these facilities will not experience any structural damage due to evaluation basis earthquake, high wind or flood events. However, during a high wind event some of the siding at C-333-A or C-337-A may be pulled off due to winds greater than 50 mph (80 km/hr), and some of the roof decking may be pulled off at C-360 due to winds. The siding and roof decking are not a threat to the UF_6 primary system integrity since it is pulled off away from the interior of the structure and would not impact any equipment. Based on these requirements and evaluations, the feed facility and toll transfer and sampling structures can accomplish the required safety functions.

3.15.9.1.4 System Classification

The process building structures are required to (1) minimize the consequences of releases of UF_6 (see Section 4.3.2.1.7) and (2) prevent a release of UF_6 to the atmosphere as a result of building structural failure during natural phenomena events (see Section 4.3.2.5). Based on the criteria in Section 4.2.2, these structures are classified as AQ.

3.15.9.1.5 Boundary

The AQ boundaries of the process building structures are defined in Table 3.15-2.

3.15.9.2 Process Building Cranes

The process building cranes on the cell floor consist of the overhead bridge cranes and associated equipment in the enrichment and withdrawal facilities (Buildings C-310, C-315, C-331, C-333, C-335, and C-337). Process building cranes that are within the scope of this discussion include five cranes (two in Building C-310, and one each in Buildings C-315, C-333 and C-337) that are normally parked over cascade equipment, and any process building crane that is used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure.

3.15.9.2.1 Safety Function

The cell floor process building cranes shall not fail in a manner that will cause a large UF_6 release during:

- Normal operation,
- Natural phenomena events with the cranes in the parked position and
- A release of the crane controls during an evacuation event.

3.15.9.2.2 Functional Requirements

The system shall meet the following functional requirements to ensure the capability to accomplish the required safety functions:

- The process building cranes shall not fail from the parked position in a manner that will cause UF6 primary system failure during an evaluation basis natural phenomena event.
- The process building cranes shall be designed to prevent dropping of the load should the controls be released for any reason (e.g., evacuation of the facility).
- The process building cranes shall be designed for the loads they will handle during operation of these facilities.

3.15.9.2.3 System Evaluation

The process building cranes are required to be designed so that evaluation basis natural phenomena events will not result in a large release of UF_6 when the cranes are in the parked position. This safety function is accomplished by requiring the cranes to withstand evaluation basis natural phenomena events to the extent necessary to prevent failure of the UF_6 primary system. Additional assurance is provided by ongoing inspections and tests (Refer to Chapter 1, Appendix A for commitments to ANSI standard inspection and testing requirements).

The process building cranes are parked in a standby location when not in use. There are two cranes (one each in the C-333 and C-337 facilities) that are normally parked over unit bypass piping. Analysis indicates these process building cranes will not fall from their parked positions during an evaluation basis earthquake, and they are not affected by the evaluation basis flood or high wind events. The use of these building cranes for moving a heavy load is infrequent because it is only needed when a piece of major equipment has failed. They are also used for other infrequent tasks such as replacing lights. Thus, the moving of a heavy load with a crane or the use of a crane for other activities concurrent with an evaluation basis natural phenomena event is not considered a credible event.

In C-310, the process building cranes are parked over/near the Normetex pumps and their discharge piping. The discharge piping from the Normetex pumps crosses from C-310 to C-310A underneath the east process building crane. Evaluations determined that the process building cranes in C-310 would not fail from their parked positions during an evaluation basis earthquake. In the C-315 tails withdrawal facility, one process building crane is parked near (but not directly over) the Normetex pump on the southeast side of the building. Although this C-315 process building crane was not seismically evaluated, this crane is equipped with drop plates that will minimize the risk of it falling during an evaluation basis earthquake. Other process building cranes in the withdrawal facilities are not parked over/around process equipment that normally operates at above atmospheric pressures.

In lieu of evaluating the functional requirements associated with normal operations and evacuation of the process buildings, the following administrative control is in place to prevent a large UF_6 release:

- Process building cranes shall not be used to transport heavy equipment above/around process equipment that is operating above atmospheric pressure.

This administrative control precludes the potential for a large UF_6 release because crane failures that impact portions of the cascade that are operated below atmospheric pressure will result in inleakage to the cascade with minimal loss of UF_6.

Based on this evaluation, the process building cranes can accomplish the required safety functions.

3.15.9.2.4 System Classification

All process building cranes are administratively precluded from moving heavy loads over/near equipment that is operating above atmospheric pressure. Therefore, process building cranes are classified as non-safety equipment with the exception of the structural components of those cranes that are normally parked over/near equipment that operates above atmospheric pressure. There are five process building cranes that are normally parked over/near equipment that operates at above atmospheric pressure (two cranes are in C-310 and one crane is in each of C-315, C-333, and C-337). The structural components of these cranes are classified as safety-related to minimize the risk they would fall from their parked position during an evaluation basis earthquake and cause a UF_6 release by rupturing the piping and equipment located under/near them. The structural components of these cranes are classified to the same quality level as the pressurized equipment under/near them. Analysis indicates that crane failures that affect withdrawal process equipment operating at above atmospheric pressure could result in a release that exceeds EBE off-site exposure guidelines (see Sections 4.3.2.2.8 and 4.3.2.2.12). Therefore, the process building cranes in C-310 and C-315 that are normally parked over/near pressurized equipment are classified as Q. The structural components of the C-333 and C-337 cascade process building cranes that are normally parked over a unit bypass are classified as AQ.

3.15.9.2.5 Boundary

The Q boundaries of the process building cranes are defined in Table 3.15-1. The AQ boundaries for the process building cranes are defined in Table 3.15-2.

3.15.9.3 Cascade Equipment Housings

The cascade equipment housings enclose UF6 primary system piping and equipment. Although their principal function is to thermally insulate the high temperature equipment, they do provide holdup capacity in the event of a UF6 release from the UF6 primary system.

3.15.9.3.1 Safety Function

The cascade equipment housings shall provide a barrier for the release of UF6 from a UF6 primary system failure within the housing.

3.15.9.3.2 Functional Requirements

The functional requirement is to prevent an unimpeded release of UF_6 to the building following a UF_6 release within the housing from the UF_6 primary system.

3.15.9.3.3 System Evaluation

The cascade equipment housings are inherently capable of providing a barrier to UF_6 releases from a UF_6 primary system failure within the housing. This function serves to minimize exposure of local workers to UF_6, however the function is not considered essential for this receptor. Specific credit is taken in the accident analysis for holdup and deposition of UF_6 releases within the housing for events whose unmitigated consequences have the potential to impact the off-site public (see Sections 4.3.2.1.3 and 4.3.2.1.7). These events involve cascade piping and equipment that are operating above atmospheric pressure. The accident analysis modeling (see Section 4.3.2.1.7) shows that the UF_6 released into the equipment housing quickly escapes (via cracks, untightened seams, and a door that is assumed to swing open to the outside) to the remainder of the unit and eventually to other units (mostly to neighboring units). The model (MELCOR) used to characterize a release into a cell housing modeled the air flow rate from the housing, during normal operation, based on an approximate 327 ft^2 (or 30.4 m^2) opening in the surface area and leakage through the cell walls and open doorway. The 327 ft^2 opening was based on a possible 0.5 inch gap between each plate in the Cascade equipment housings. Since there are no obvious gaps between each panel in the PGDP Cascade equipment housing, a maximum Cascade equipment housing surface area opening of 327 ft^2 can be used for maintenance activities.

The only cascade equipment housings that are required as essential controls are those housings that could be configured in a manner that could invalidate the results of the accident analysis where specific credit is taken for holdup and deposition of material released into and ultimately out of the building. The cascade equipment housings that fall into this category are the housings that enclose cells or interbuilding booster stations which are intended to be operated above atmospheric pressure.

3.15.9.3.4 System Classification

In areas of the cascade that are operated above atmospheric pressure, the cell and interbuilding booster station housings are credited as reducing the amount of UF_6 released from the building by holdup and deposition of a portion of the release within the housings. These structures, in areas of the cascade that are intended to be operated above atmospheric pressure, are classified as AQ consistent with the process buildings and UF_6 primary system classification.

3.15.9.3.5 Boundary

The AQ boundary of the cascade equipment housings is defined in Table 3.15-2.

3.15.9.4 Miscellaneous Waste Storage & Handling and Support Structures

The miscellaneous waste storage & handling and support structures include the central control facility (C-300), the cleaning and stabilization buildings (C-400, and C-409), the laboratory (C-710), the maintenance and stores building (C-720), including the compressor shop (C-720-A), machine shop addition (C-720-B), converter shop addition (C-720-C), and instrument shop addition (C-720-K), and the high assay waste storage facility (C-746-Q1).

3.15.9.4.1 Safety Function

These miscellaneous buildings ensure the following safety function is accomplished:

- Maintain necessary structural integrity during evaluation basis natural phenomenon events (i.e., earthquakes, high winds, and flooding).

3.15.9.4.2 Functional Requirements

The functional requirements are no different than the safety function.

3.15.9.4.3 System Evaluation

These miscellaneous buildings are required to maintain structural integrity during evaluation basis natural phenomena events. As indicated in Table 3.15-10 and clarified below, these buildings will not experience structural failure due to evaluation basis earthquake, high wind, or flood events. Based on these requirements and evaluations, these buildings can accomplish the required safety function.

3.15.9.4.4 System Classification

These miscellaneous building structures are required to prevent building structural failure during natural phenomena events (see Section 4.3.2.5). Based on the criteria in Section 4.2.2, these structures are classified as AQ.

3.15.9.4.5 Boundary

The AQ boundaries of the miscellaneous waste storage & handling and support structures are defined in Table 3.15-2.

3.15.10 Nuclear Criticality Safety Active Engineered Features (AEFs)

This section provides a description of AEFs that are relied upon for nuclear criticality safety as discussed in Appendix A to Section 5.2. AEFs are defined as those systems that provide an automatic hardware response to particular process variables. These systems may be electrical, mechanical, hydraulic, or pneumatic in nature. AEFs do not include indicators and/or alarm functions that require operator response, since this response is ultimately administrative in nature. AEFs also do not include physical designs or properties of systems that are passive in nature. The NCSEs for particular operations specify the AEFs and describe their design intent and safety function.

3.15.10.1 UF_6 Enrichment Facilities

3.15.10.1.1 Section Deleted

3.15.10.1.2 Section Deleted

3.15.10.1.3 Section Deleted

3.15.10.1.4 Freezer/Sublimers (F/S) High-High Weight Trip System

3.15.10.1.4.1. Safety Function

The F/S high-high weight trip system ensures that the weight of UF_6 (and R-114) does not exceed 10,000 lbs for a 10-MW F/S or 20,000 lbs for a 20-MW F/S. This system is hard-wired and independent of the DPCS high-high weight trip. Excessive UF_6 could cause bridging between the F/S collection tubes. Under these conditions placing the F/S in the sublime mode could lead to the breach of the R-114 loop.

3.15.10.1.4.2. Functional Requirements

The F/S high-high weight trip system shall automatically close the UF_6 inlet B-line valve before the mass in a 10MW vessel reaches 10,000 lbs, and before the mass in a 20 MW vessel reaches 20,000 lbs.

3.15.10.1.4.3. System Evaluation

See Section 3.15.3.5.3 and Section 5.2, Appendix A.

3.15.10.1.4.4. System Classification

The F/S high-high weight trip system prevents the overfilling and the potentially resulting rupture of the F/S vessel. Prevention of this accident prevents exposure of on-site personnel to UF_6. The F/S high-high weight trip system is classified as AQ on this basis (see Section 3.15.3.5.4).

The freezer/sublimer high-high weight trip system is identified as an NCS AEF for F/Ss exposed to greater than or equal to 1.0 wt. % ^{235}U and, thus, is classified as an AQ-NCS system.

3.15.10.1.4.5. Boundary

The AQ-NCS boundaries of the F/S high-high weight trip system are defined in Table 3.15-3. The AQ boundaries are defined in Table 3.15-2.

3.15.10.2 C-360 UF6 Sampling and Transfer Facility

3.15.10.2.1 Autoclave Water Inventory Control System

3.15.10.2.1.1. Safety Function

The autoclave water inventory control system prevents an undesirable water inventory level in the autoclave which, in the event of a UF_6 release, could cause over-pressurization or a nuclear criticality. The system function is to detect an unacceptable water level resulting from a drain line plug or restriction and to shut off the steam flow to the autoclave.

3.15.10.2.1.2. Functional Requirements

The autoclave water inventory control system shall isolate the steam supply ensuring a water inventory less than the maximum acceptable water inventory within the autoclave.

3.15.10.2.1.3. System Evaluation

See Section 3.15.5.5.3 and Section 5.2, Appendix A.

3.15.10.2.1.4. System Classification

The autoclave water inventory control system is classified as AQ (see Section 3.15.5.5.4). The autoclave inventory control system is also identified as an NCS AEF. Therefore, this system is classified AQ-NCS.

3.15.10.2.1.5. Boundary

The AQ and AQ-NCS boundaries for the autoclave water inventory control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.10.2.2 Autoclave High Pressure Isolation System

3.15.10.2.2.1. Safety Function

The autoclave high pressure isolation system puts the autoclave into containment when the autoclave pressure reaches 15 psig. Such pressure could be the result of a breach of a UF_6 cylinder or associated piping. This isolation will contain UF_6 inside the autoclave precluding an uncontrolled release to the environment where criticality safety cannot be assured.

3.15.10.2.2.2. Functional Requirements

See Section 3.15.5.1.2.

3.15.10.2.2.3. System Evaluation

See Section 3.15.5.1.3 and Section 5.2, Appendix A.

3.15.10.2.2.4. System Classification

The autoclave high pressure isolation system is classified as a Q system (see Section 3.15.5.1.4). The autoclave high pressure isolation system is also identified as an NCS AEF. Therefore, this system is classified AQ-NCS.

3.15.10.2.2.5. Boundary

The Q and AQ-NCS boundaries for the autoclave high pressure isolation system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.3 Autoclave Steam Pressure Control System

3.15.10.2.3.1. Safety Function

The autoclave steam pressure control system maintains a maximum autoclave steam pressure of 8 psig for NCS purposes. This maximum pressure corresponds to a maximum temperature of 235°F (113°C). This temperature limit is used to control UF_6 releases from, and moderator intrusion into UF_6 systems. It acts as a moderation control.

3.15.10.2.3.2. Functional Requirements

See Section 3.15.5.7.2.

3.15.10.2.3.3. System Evaluation

See Section 3.15.5.7.3 and Section 5.2, Appendix A.

3.15.10.2.3.4. System Classification

The autoclave steam pressure control system is classified as Q (see Section 3.15.5.7.4).

The autoclave steam pressure control system is also identified as an NCS AEF. Therefore, this system is classified AQ-NCS.

3.15.10.2.3.5. Boundary

The Q and AQ-NCS boundaries for the autoclave steam pressure control system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.4 UF_6 Release Detection System - Zone 1

3.15.10.2.4.1. Safety Function

The UF_6 release detection system in Zone 1 isolates the UF_6 normal and transfer sample lines to preclude further releases of fissile material. Released UF_6 reacts with moisture in the air to form UO_2F_2 which further absorbs moisture from the air. UO_2F_2 and water in nonfavorable geometries have the potential to achieve criticality.

3.15.10.2.4.2. Functional Requirements

See Section 3.15.5.2.2, with the exception that valves xv-*50, xv-*51, xv-*48, and xv-*49 shall close within 15 seconds or less after detection of a UF_6 release.

3.15.10.2.4.3. System Evaluation

See Section 3.15.5.2.3, with the exception that valves xv-*50, xv-*51, xv-*48, and xv-*49 shall close within 15 seconds or less after detection of a UF_6 release, and Section 5.2, Appendix A.

3.15.10.2.4.4. System Classification

The UF_6 release detection system in Zone 1 is classified as a Q system (see Section 3.15.5.2.4).

The UF_6 release detection system in Zone 1 is also identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.2.4.5. Boundary

The Q and AQ-NCS boundaries for the UF_6 release detection system in Zone 1 are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.5 Autoclave Cylinder Roll Interlock System

3.15.10.2.5.1. Safety Function

The autoclave cylinder roll interlock system prevents a UF_6 cylinder from being rotated when a pigtail is attached to the cylinder and pressurized for either sampling or transfer of UF_6 to another cylinder. This interlock reduces the likelihood of a cylinder pigtail rupture and the potential for an uncontrolled release of UF_6 until the cylinder valve is isolated. This system, along with the autoclave high pressure isolation system, ensures the UF_6 release will be contained inside the autoclave precluding an uncontrolled release to the environment where criticality safety cannot be assured.

3.15.10.2.5.2. Functional Requirements

The Cylinder Roll Interlock System prevents rotation of the UF6 cylinder when a sampling or transfer pigtail is attached.

3.15.10.2.5.3. System Evaluation

See Section 3.6.7.8 and Section 5.2, Appendix A.

3.15.10.2.5.4. System Classification

The Cylinder Roll Interlock System is classified as AQ-NCS.

3.15.10.2.5.5. Boundary

The AQ-NCS boundaries for the Cylinder Roll Interlock System are defined in Table 3.15-3.

3.15.10.2.6 Interlock Switch Between C-360 Levelator and the Scale Cart Air Supply

3.15.10.2.6.1. Safety Function

Provides protection against rupture of a cylinder containing liquid UF_6.

3.15.10.2.6.2. Functional Requirements

The interlock switch shall prevent the scale cart from moving if the levelator is not in its fully raised position.

3.15.10.2.6.3. System Evaluation

See Section 3.15.6.3.3 and Section 5.2, Appendix A.

3.15.10.2.6.4. System Classification

The interlock switch between the C-360 levelator and the scale cart air supply is part of the liquid UF_6 handling equipment and is classified as Q (see Section 3.15.6.3.4).

The interlock switch is also identified as an NCS AEF. Therefore, the interlock switch between the C-360 levelator and the scale cart air supply is classified as AQ-NCS.

3.15.10.2.6.5. Boundary

The Q and AQ-NCS boundaries for Interlock Switch Between C-360 Levelator and the Scale Cart Air Supply are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.7 UF6 Release Detection System (Zones 2, 3, and 4)

3.15.10.2.7.1. Safety Function

The zone 2 and 3 UF_6 release detection systems detect releases above the autoclave locking rings and trip the elevator pit sump pump. The zone 4 UF_6 release detection system detects releases in the basement area of C-360, isolates the appropriate valves to limit the release of UF_6 to the atmosphere, and trips the elevator pit sump pump.

The safety function of the closure of appropriate valves in the transfer line is to act as a mass control by limiting the amount of UF_6 released. The safety function of tripping the elevator pit sump pump is to control release of material to an unknown geometry, thus acting as a geometry control.

3.15.10.2.7.2. Functional Requirements

The C-360 UF_6 release detection system (zones 2, 3, and 4) shall trip the elevator pit sump pump. See Section 3.15.5.2.2 for additional requirements for zone 4.

3.15.10.2.7.3. System Evaluation

See Section 3.15.5.2.3, 3.15.7.3.4, and Section 5.2, Appendix A.

3.15.10.2.7.4. System Classification

The UF_6 release detection systems (zones 2, 3, and 4) actuate closure of appropriate valves and shutdown of the elevator pit sump pump. These systems are identified as NCS AEFs and classified as AQ-NCS. The UF_6 release detection system zone 4 is also classified as a Q system (see Section 3.15.5.2.4). Zones 2 and 3 are also classified as AQ systems (see Section 3.15.7.3.4).

3.15.10.2.7.5. Boundary

The Q, AQ, and AQ-NCS boundaries for the UF_6 Release Detection System are defined in Tables 3.15-1, 3.15-2, and 3.15-3, respectively.

3.15.10.2.8 Cylinder Scale Cart Movement Prevention System

3.15.10.2.8.1. Safety Function

The cylinder scale cart movement prevention system prevents moving a scale cart with a pressurized pigtail attached.

3.15.10.2.8.2. Functional Requirements

Same as Safety Function.

3.15.10.2.8.3. System Evaluation

See Section 3.7.3.1.3.1 and Section 5.2, Appendix A.

3.15.10.2.8.4. System Classification

The Cylinder Scale Cart Movement Prevention System is classified as a Q system (see Section 3.15.6.5.2).

This system is also identified as an NCS AEF. Therefore, the Cylinder Scale Cart Movement Prevention System is classified as AQ-NCS.

3.15.10.2.8.5. <u>Boundary</u>

The Q and AQ-NCS boundaries for the Cylinder Scale Cart Movement Prevention System are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.9 Liquid UF6 Cylinder Handling Equipment

3.15.10.2.9.1. <u>Safety Function</u>

The liquid UF_6 cylinder handling equipment shall not fail in a manner to cause UF_6 primary system failure. The liquid UF_6 cylinder handling equipment provides for the safe movement of liquid UF_6 cylinders.

3.15.10.2.9.2. <u>Functional Requirements</u>

See Section 3.15.6.3.2

3.15.10.2.9.3. System Evaluation

See Section 3.15.6.3.3 and Section 5.2, Appendix A.

3.15.10.2.9.4. <u>System Classification</u>

The liquid UF_6 Cylinder Handling Equipment and is classified as a Q system (see Section 3.15.6.3.4).

This system is also identified as an NCS AEF. Therefore, the Liquid UF_6 Cylinder Handling Equipment is classified as AQ-NCS.

3.15.10.2.9.5. <u>Boundary</u>

The Q and AQ-NCS boundaries for the Liquid UF_6 Cylinder Handling Equipment are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.2.10 Section Deleted

3.15.10.3 C-400 Decontamination and Uranium Recovery Facility

3.15.10.3.1 Spray Booth Key Interlock for Solution Transfer

3.15.10.3.1.1. Safety Function

The key interlock for solution transfer requires two people to effect a transfer of solution from the favorable geometry spray booth tanks to potentially nonfavorable geometry systems. Two independently operated switches must be operated simultaneously. This engineered feature requires two people to act independently, each protects against transfer of high enrichment or high concentration solution to potentially nonfavorable geometry systems that may cause criticality.

3.15.10.3.1.2. Functional Requirements

The key interlock for solution transfer shall require two people operating the switches simultaneously to effect a transfer of solution from the spray booth tanks.

3.15.10.3.1.3. System Evaluation

See Section 3.8.1.1.8 and Section 5.2, Appendix A.

3.15.10.3.1.4. System Classification

The key interlock for solution transfer is classified as AQ-NCS.

3.15.10.3.1.5. Boundary

The AQ-NCS boundaries for the C-400 key interlock for solution transfer are defined in Table 3.15-3.

3.15.10.3.2 Section Deleted

3.15.10.3.3 C-409 Uranium Precipitation System Filtrate Receiver High-Level Actuation System for Filtrate Pump

3.15.10.3.3.1. 3.15.10.3.3.1 Safety Function

Actuation of the filtrate pump prevents filtrate solution from being inadvertently transferred to the vacuum pump and ultimately to potentially unsafe geometry.

3.15.10.3.3.2. Functional Requirements

The filtrate receiver high-level actuation system shall actuate the filtrate pump.

3.15.10.3.3.3. System Evaluation

See Section 3.8.2.2.3 and Section 5.2, Appendix A.

3.15.10.3.3.4. System Classification

The filtrate receiver high-level actuation system is classified AQ-NCS.

3.15.10.3.3.5. Boundary

The AQ-NCS boundaries for the filtrate receiver high-level actuation system are defined in Table 3.15-3.

3.15.10.3.4 C-409 Uranium Precipitation System Filtrate Receiver High-Level Shutoff System for Vacuum Pump

3.15.10.3.4.1. Safety Function

Shutoff of the vacuum pump prevents filtrate solution from being inadvertently transferred to potentially unsafe geometry.

3.15.10.3.4.2. Functional Requirements

The filtrate receiver high-level shutoff system shall de-energize the vacuum pump.

3.15.10.3.4.3. System Evaluation

See Section 3.8.2.2.3 and Section 5.2, Appendix A.

3.15.10.3.4.4. System Classification

The filtrate receiver high-level shutoff system is classified AQ-NCS.

3.15.10.3.4.5. Boundary

The AQ-NCS boundaries for the filtrate receiver high-level shutoff system are defined in Table 3.15-3.

3.15.10.3.5 C-409 Cylinder Wash HF Scrubber Recycle Pump Shutdown

3.15.10.3.5.1. Safety Function

This Shutdown ensures that scrubber solutions will not be forced into the cylinder in the event that the ejector gets plugged or damaged.

3.15.10.3.5.2. Functional Requirements

The HF Scrubber recycle pump shall shutdown when either the evacuation hose loses vacuum or the exit of the ejector loses flow.

3.15.10.3.5.3. System Evaluation

See Section 5.2, Appendix A.

3.15.10.3.5.4. System Classification

The C-409 Cylinder Wash HF Scrubber Recycle Pump Shutdown is identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.3.5.5. Boundary

The AQ-NCS boundaries for the C-409 Cylinder Wash HF Scrubber Recycle Pump Shutdown are defined in Table 3.15-3.

3.15.10.4 Product and Side Withdrawal System

3.15.10.4.1 *Section Deleted*

3.15.10.4.2 C-310 Normetex Pumps High Oil Pressure Trip

3.15.10.4.2.1. <u>Safety Function</u>

The Normetex pumps high oil pressure trip trips the pump to preclude pump damage and potential mixing of UF_6 and oil. UF_6 and oil in nonfavorable geometries have the potential to achieve criticality.

3.15.10.4.2.2. <u>Functional Requirements</u>

The Normetex pumps high oil pressure trip shall trip the Normetex pump and isolate the pump discharge.

3.15.10.4.2.3. <u>System Evaluation</u>

See Section 3.4.1.1.3 and Section 5.2, Appendix A.

3.15.10.4.2.4. System Classification

The Normetex pumps high oil pressure trip is classified as AQ-NCS.

3.15.10.4.2.5. Boundary

The AQ-NCS boundaries for the C-310 Normetex pumps high oil pressure trip are defined in Table 3.15-3.

3.15.10.4.3 C-310 Normetex Pumps Low Oil Flow Trip

3.15.10.4.3.1. Safety Function

The Normetex pumps low oil flow trip trips the pump to preclude pump damage and potential mixing of UF_6 and oil. UF_6 and oil in nonfavorable geometries have the potential to achieve criticality.

3.15.10.4.3.2. Functional Requirements

The Normetex pumps low oil flow trip shall trip the Normetex pump and isolate the pump discharge.

3.15.10.4.3.3. System Evaluation

See Section 3.4.1.1.4 and Section 5.2, Appendix A.

3.15.10.4.3.4. System Classification

The Normetex pumps low oil flow trip is classified as AQ-NCS.

3.15.10.4.3.5. Boundary

The AQ-NCS boundaries for the C-310 Normetex pumps low oil flow trip are defined in Table 3.15-3.

3.15.10.4.4 ***Section Deleted***

3.15.10.4.5 ***Section deleted***

3.15.10.4.6 ***Section deleted***

3.15.10.4.7 ***Section Deleted***

3.15.10.4.8 ***Section Deleted***

3.15.10.4.9 C-310 UF_6 Release Detection System - Normetex Pump

3.15.10.4.9.1. <u>Safety Function</u>

The UF_6 release detection system - Normetex pump trips the pump to preclude further releases of fissile material and the potential mixing of UF_6 and oil. Released UF_6 reacts with moisture in the air to form UO_2F_2 which further absorbs moisture from the air. UO_2F_2 and water and UF_6 and oil in nonfavorable geometries have the potential to achieve criticality.

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3.15.10.4.9.2. Functional Requirements

See Section 3.15.4.8.2.

3.15.10.4.9.3. System Evaluation

See Section 3.15.4.8.3 and Section 5.2, Appendix A.

3.15.10.4.9.4. System Classification

The UF6 release detection system - Normetex pump is classified as a Q system (see Section 3.15.4.8.4).

The UF6 release detection system - Normetex pump is also identified as an NCS AEF. Therefore, it is classified as AQ-NCS.

3.15.10.4.9.5. Boundary

The Q and AQ-NCS boundaries for the C-310 UF6 release detection system - Normetex pump are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.4.10 Product UF_6 Release Detection and Isolation System - Low Voltage ("New") System at the Withdrawal Stations

3.15.10.4.10.1. Safety Function

The product UF6 release detection and isolation system - low voltage ("new") system at the withdrawal stations isolates product cylinders to preclude further releases of fissile material. Released UF6 reacts with moisture in the air to form UO2F2 which further absorbs moisture from the air. UO2F2 and water in nonfavorable geometries have the potential to achieve criticality. This AEF does not include the manual isolation system.

3.15.10.4.10.2. Functional Requirements

See Section 3.15.4.1.2.

3.15.10.4.10.3. System Evaluation

See Section 3.15.4.1.3 and Section 5.2, Appendix A.

3.15.10.4.10.4. System Classification

The product UF6 release detection and isolation system - low voltage ("new") system at the withdrawal stations is classified as a Q system. See Section 3.15.4.1.4.

The product UF6 release detection and isolation system - low voltage ("new") system at the withdrawal stations is also identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.4.10.5. Boundary

The Q and AQ-NCS boundaries for the product UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.4.11 C-310 Scale Cart Movement Prevention System

3.15.10.4.11.1. Safety Function

The Scale Cart Movement Prevention System prevents moving a scale cart with a pressurized pigtail attached.

3.15.10.4.11.2. Functional Requirements

Same as Safety Function.

3.15.10.4.11.3. System Evaluation

See Section 3.7.3.1.3.1 and Section 5.2, Appendix A.

3.15.10.4.11.4. System Classification

The Scale Cart Movement Prevention System is classified as a Q system (see Section 3.15.6.5.2).

This system is also classified as as an NCS AEF. Therefore, the Scale Cart Movement Prevention System is classified as AQ-NCS.

3.15.10.4.11.5. Boundary

The Q and AQ-NCS boundaries for the Scale Cart Movement Prevention System are defined in Table 3.15-1 and 3.15-3, respectively.

3.15.10.4.12 C-310 Normetex Pump Discharge Block Valve Closure on Pump Trip

3.15.10.4.12.1. Safety Function

The C-310 Normetex pump discharge block valve is required to close upon a pump trip to isolate the pump from backflow of high pressure UF_6 into the pump. The backflow of UF_6 into the pump could challenge the integrity of the internal bellows and allow UF_6 to enter the pump oil resevoir. UF_6 and oil mixing in an unfavorable geometry with a sufficient mass of UF_6 have the potential to achieve a criticality. This safety function acts as a mass control by limiting the amount of UF_6 that could mix with the oil in the pump oil resevoir.

3.15.10.4.12.2. Functional Requirements

The C-310 Normetex pump discharge block valve shall close and isolate the pump discharge when the pump has tripped due to an automatic or manual pump trip. The air operator for the pump discharge block valve shall incorporate a fail-safe design whereas the valve closes when air pressure is removed from the operator.

3.15.10.4.12.3. System Evaluation

See Section 3.4.1.1.7 and Section 5.2, Appendix A.

3.15.10.4.12.4. System Classification

Normetex pump discharge valve closure to isolate the pump discharge from backflow of high pressure UF_6 into the pump is identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.4.12.5. Boundary

The AQ-NCS boundaries for the closure of the Normetex pump discharge block valve following a pump trip are described in Table 3.15-3.

3.15.10.5 UF_6 Feed Facilities

3.15.10.5.1 Autoclave Water Inventory Control System

3.15.10.5.1.1. Safety Function

The autoclave water inventory control system prevents an undesirable water inventory level in the autoclave which, in the event of a UF_6 release, could cause over-pressurization or a nuclear criticality. The system function is to detect an unacceptable water level resulting from a drain line plug or restriction and to shut off the steam flow to the autoclave.

3.15.10.5.1.2. Functional Requirements

The autoclave water inventory control system shall isolate the steam supply ensuring a water inventory less than the maximum acceptable water inventory within the autoclave.

3.15.10.5.1.3. System Evaluation

See Section 3.15.2.5.3 and Section 5.2, Appendix A.

3.15.10.5.1.4. System Classification

The autoclave water inventory control system is classified as AQ (see Section 3.15.2.5.4).

The autoclave water inventory control system is also identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.5.1.5. Boundary

The AQ and AQ-NCS boundaries for the autoclave water inventory control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.10.5.2 Autoclave High Pressure Isolation System

3.15.10.5.2.1. Safety Function

The autoclave high pressure isolation system puts the autoclave into containment when the autoclave pressure reaches 15 psig. Such pressure could be the result of a breach of a UF_6 cylinder or associated piping. This isolation will contain UF_6 inside the autoclave precluding an uncontrolled release to the environment where criticality safety cannot be assured.

3.15.10.5.2.2. Functional Requirements

See Section 3.15.2.1.2.

3.15.10.5.2.3. System Evaluation

See Section 3.15.2.1.3 and Section 5.2, Appendix A.

3.15.10.5.2.4. System Classification

The autoclave high pressure isolation system is classified as a Q system. See Section 3.15.2.1.4.

The autoclave high pressure isolation system is also indentified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.5.2.5. Boundary

The Q and AQ-NCS boundaries for the autoclave high pressure isolation system are defined in Tables 3.15-1 and 3.15-3, respectively.

3.15.10.5.3 Autoclave Steam Pressure Control System

3.15.10.5.3.1. Safety Function

The autoclave steam pressure control system maintains a maximum autoclave steam pressure of 8 psig for NCS purposes. This maximum pressure corresponds to a maximum temperature of 235°F (113°C). This temperature limit is used to control UF_6 releases from, and moderator intrusion into UF_6 systems. It acts as a moderation control.

3.15.10.5.3.2. Functional Requirements

See Section 3.15.2.7.2.

3.15.10.5.3.3. System Evaluation

See Section 3.15.2.7.3 and Section 5.2, Appendix A.

3.15.10.5.3.4. System Classification

The autoclave steam pressure control system is classified as AQ (see Section 3.15.2.7.4).

The autoclave steam pressure control system is also identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.5.3.5. Boundary

The AQ and AQ-NCS boundaries for the autoclave steam pressure control system are defined in Tables 3.15-2 and 3.15-3, respectively.

3.15.10.5.4 UF_6 Release Detection System C-337A

3.15.10.5.4.1. Safety Function

The UF_6 Release Detection System shall initiate UF_6 line isolation when any combination of four or more output signals are received from UF_6 detector head actuations in the C-337A facility. This action is required to ensure that the release of UF_6 and its reaction products for isolable events outside the autoclave are maintained below levels that could result in a nuclear criticality.

3.15.10.5.4.2. Functional Requirements

The UF_6 release detection system shall be capable of isolating all C-337A autoclaves when any combination of four or more output signals are received from UF_6 detector head actuations.

3.15.10.5.4.3. System Evaluation

See Section 5.2, Appendix A.

3.15.10.5.4.4. System Classification

The UF_6 release detection system in C-337A is identified as an NCS AEF. Therefore, this system is classified as AQ-NCS.

3.15.10.5.4.5. Boundary

The AQ-NCS boundaries for the UF_6 release detection system in C-337A are defined in Table 3.15-3.

3.15.10.5.5 High Cylinder Pressure System

3.15.10.5.5.1. Safety Function

The high cylinder pressure system, for use during the controlled feeding mode, shall isolate the steam supply to the C-337-A, 5E and 5W autoclaves to ensure the cylinder pressure is maintained <22 psia. The UF_6 cylinder high pressure system prevents over-pressurization of a damaged or overfilled (category C) UF_6 cylinder during the heating process. This pressure could be the result from excessive "light" gases or overfilling. The system contributes to nuclear criticality safety by preventing the release of UF_6 to areas with unfavorable geometry.

3.15.10.5.5.2. Functional Requirements

See Section 3.15.2.6.2.

3.15.10.5.5.3. System Evaluation

See Section 3.15.2.6.3 and Section 5.2, Appendix A.

3.15.10.5.5.4. System Classification

The high cylinder pressure system is classified as AQ (See 3.15.2.6.4).

The high cylinder pressure system is also identified as an NCS AEF. Therefore, this system is classified as an AQ-NCS system.

3.15.10.5.5.5. Boundary

The AQ and AQ-NCS boundaries for the high cylinder pressure system are defined in Table 3.15-2 and 3.15-3, respectively.

3.15.11 Nuclear Criticality Safety Passive SSCs

Passive structures, systems, and components that (1) are necessary to meet the double contingency principle for the prevention of an accidental nuclear criticality or (2) represent the single

control to prevent an accidental nuclear criticality where the double contingency principle is not met are identified in NCSEs/NCSAs.

Reference for Section 3.15

3.15-1 *Recommended Practice of Sizing Large Lead Storage Batteries for Generating Stations and Substations*, IEEE Standard 485-1983.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components.

System	Facility	Boundary Definition	Support Systems
Autoclave High Pressure Isolation System (Sections 3.15.2.1, 3.15.5.1, 3.15.10.2.2, and 3.15.10.5.2)	C-333-A C-337-A C-360	1. Pressure sensing instrumentation 2. Containment block valves, including steam supply, condensate drain, thermovent, feed header, purge air, conductivity sample and steam exhaust 3. Solenoid valves (operates the containment block valves) 4. Programmable logic controller (includes input/output modules) 5. Process piping from the autoclave shell to containment block valves, including piping between containment block valves 6. Autoclave shell, o-ring, shell locking ring, shell penetrations and connecting electrical signal and pneumatic lines	This system is fail safe upon loss of electric power or air.
Autoclave Manual Isolation System (Section 3.15.2.2)	C-333-A C-337-A	1. Containment Switches 2. Programmable logic controller (includes input/output modules) 3. UF6 line containment isolation valves 4. Solenoid valves (operates UF6 line isolation valves	No support systems are required.
Autoclave Primary Containment System (Sections 3.15.2.3, 3.15.5.3)	C-333-A C-337-A C-360	1. Autoclave vessel 2. Autoclave penetrations and isolation valves 3. Autoclave instrument lines 4. Autoclave pressure relief line up to and including the rupture disk.	No support systems are required.
UF6 Cylinder Pigtail (Sections 3.15.2.4, 3.15.4.5, 3.15.5.4)	C-333-A C-337-A C-360 C-310 C-315	1. Pigtail assembly, including tubing, adapter, and gaskets	No support systems are required.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Primary System (Sections 3.15.2.4, 3.15.5.4)	C-333-A C-337-A C-360	The UF_6 Primary System includes UF_6 process piping and valves. Only the characteristics of the system listed below which provide the UF_6 containment function are controlled as a Q SSC. 1. C-360 - All liquid UF_6 transfer and sample piping outside the second autoclave containment isolation valve. 2. All Autoclave Facilities - UF_6 process piping (pigtail) from the cylinder to the autoclave penetration (only autoclave systems in the open mode). 3. C-360 - Technetium Trap vessels. 4. C-360 - Surge volume.	No support systems are required.
Autoclave Steam Pressure Control System (Section 3.15.5.7)	C-360	1. Pressure sensing instrumentation 2. Steam supply block valves and thermovent block valves 3. Solenoid valves and relays 4. Associated circuitry to de-energize the air supply and solenoid valves back to first interrupt device.	No support systems are required.
Autoclave Pressure Relief System (Sections 3.15.2.8, 3.15.5.8)	C-333-A C-337-A C-360	1. Rupture Disk 2. Relief Valve 3. Butterfly valve downstream of the relief valve (C-333A and C-337A only) 4. Vent line piping to atmosphere 5. Instrumentation monitoring pressure between relief devices	No support systems are required.
C-337-A Jet Station Barrier Frame (Section 3.15.2.9)	C-337-A	1. Columns 2. Anchorage 3. Beams 4. Bracing 5. Connections	No support systems are required.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Cell Remote Manual Shutdown System and DC Power Distribution System (Sections 3.15.3.1 and 3.15.3.2)	C-331 C-333 C-335 C-337	1. Manual trip switches in the ACR for the C-331, C-333, C-335, and C-337 enrichment compressor motors 2. Associated trip coils, contacts and 250 VDC circuit breakers 3. Associated 13.8 kV ACB air reservoir and associated piping up to and including the pressure indicator on the common air header (For C-333 and C-337, only) 4. Associated relays, switches, and control wiring 5. Associated 250 VDC power supplies - 250 VDC battery banks associated with the ACR trip circuits - Associated 250 VDC control power breakers in distribution cabinets - DC circuit breakers in switchgear and substation supply - The associated wiring circuits to connect the relays and trip coils to the batteries Note: The trip systems for the P&E and interbuilding booster compressor motors are excluded from this boundary.	250 VDC control power (Section 3.15.3.2) Compressed air (For C-333 and C-337 only)

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Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Release Detection and Isolation System - Low Voltage ("New") System at the Withdrawal Stations (Section 3.15.4.1 and Section 3.15.10.4.10)	C-310 C-315	1. Low voltage UF_6 detector heads located above each withdrawal station. 2. UF_6 line isolation valves (e.g. liquid drain block valves and cylinder valves) 3. Backup N_2 supply for C-315 and C-310 withdrawal stations 3 and 4. 4. Backup Air Accumulator Tank System for C-310 withdrawal station 5. a. Air accumulator tank and relief valves on accumulator tank b. Air piping from accumulator tank to pressure regulators c. Accumulator low pressure switch, pressure indicator, and alarm d. Check valves in flow path of Plant Air System 5. Solenoid valves for block valve and cylinder valve actuation. 6. Associated circuitry to close the drain line block valve and cylinder valve. 7. Motor for the cylinder valve closure. 8. Cylinder valve closure assembly. 9. Air supply piping from the solenoid to the cylinder valve and drain line block valves. 10. Alarms and associated alarm circuitry. 11. Manual isolation switch (initiates closure of liquid block valves and cylinder valve). 12. 120-VAC from the process gas leak detection system back to the first breaker.	This system is fail safe upon loss of plant air or 120-VAC to the facility. 24-VDC is required for automatic detection. However, the 24-VDC supply for the system is converted from 120-VAC supplied to the UF_6 detector panel.
UF_6 Withdrawal Primary System (Section 3.15.4.5)	C-310 C-310-A C-315	1. The portion of the withdrawal UF_6 primary system that contains liquid UF_6 is classified as Q. This equipment includes the condensers, accumulators, and piping downstream of the condensers. UF_6 condenser and accumulator rupture discs, block valves and exhaust piping. This equipment includes: a. Condensers b. Accumulators c. Manifold valves d. Pigtails assembly, including the tubing, adapter, and gaskets e. Piping between the condensers and the manifold and vent line valves. Also the crossover piping between withdrawal points. f. Sampling station pipette, valves, and piping 2. The high-pressure gaseous portion of the UF_6 primary system from the discharge of the Normetex pumps to the inlet to the condensers, including the pump recycle line.	No support systems are required.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Release Detection System - Normetex Pump (Section 3.15.4.8 and 3.15.10.4.9)	C-310 C-315	1. UF_6 detector heads located above the Normetex pump discharge valve, expansion joint, pump housing, and pump flange for all C-315 pumps and C-310 east and west pumps. 2. Six UF_6 detector heads for the C-310 side withdrawal Normetex pump (three inside the housing and three outside the housing). 3. Discharge block valves. 4. Associated circuitry to trip the pump. The associated circuitry includes a programmable logic controller (and software) that determines whether pump trip is required and provides the trip signal. 5. ACR emergency stop button and associated circuitry. 6. 120-VAC power for the 200-VDC supply back to the first breaker.	200-VDC is required for detector heads to operate. 120-VAC is supplied to the system for internal conversion to 200-VDC. (Section 3.15.4.8.3) 120-VAC. (Section 3.15.4.8.3)
UF_6 Release Detection System - Zone 1 and 4 (Section 3.15.5.2, 3.15.10.2.4 and 3.15.10.2.7)	C-360	Zone 1 boundary: 1. UF_6 detector heads located in the laboratory area 2. UF_6 detector control panel 3. Sampling manifold and transfer line block valves 4. Solenoid valves, and associated circuitry to close the valves. 5. Alarms and associated alarm circuitry Zone 4 boundary: 1. UF_6 detector heads located in the transfer room 2. Autoclave drain line block valves 3. Transfer and sample line isolation valves 4. Cylinder valve closer 5. Backup N_2 supply 6. Associated solenoid valves and circuitry to close the valves. 7. Alarms and associated alarm circuitry	200-VDC is required for detector eads to operate. 120-VAC is supplied to the system for internal conversion to 200-VDC. (Section 3.15.5.2.3) 120-VAC (Section 3.15.5.2.3)

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Cylinders (Section 3.15.6.1)	C-310 C-310-A C-315 C-333-A C-337-A C-360 C-360-A C-400 C-409 C-745-A C-745-B C-745-E C-745-H C-745-Q C-745-R C-745-U C-745-V	1. Cylinders with the capacity of holding more than 500 lb (227 kg); 2. Cylinder valves; and 3. Cylinder plugs. The valve protector is classified as AQ.	No support systems are required (3.15.6.1.3).
UF_6 Cylinder Handling Cranes (Section 3.15.6.2)	C-333-A C-337-A	1. Crane structure and structural supports, the crane rails, the bridge, the mechanical rail stops at the end of the bridge, the trolley rails, the trolley, the reeving, the cable, lifting fixture (C-333-A West and C-337-A South) and the hooks (C-333-A East and C-337-A North). 2. Two hoist brakes 3. Emergency stop button 4. Geared up/down limit switch 5. Swivel bar/paddle-type limit switch 6. Relays/contactors for hoist brake control 7. Lifting fixture assembly 8. Wire rope legs 9. Travel brakes (Bridge, Trolley, and Polar Trolley where applicable).	No support systems are required. The crane brakes fail safe on loss of power.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Cylinder Handling Cranes (Section 3.15.6.2)	C-310 C-315	1. Crane structure and structural supports, the crane rails, the bridge, the mechanical rail stops at the end of the bridge, the trolley rails, the trolley, and the reeving. 2. Two hoist brakes 3. Relays for hoist brake control 4. Hoist motor contacts 5. Geared up/down limit switch 6. Two paddle-type limit switches 7. Emergency stop button 8. Associated circuitry 9. Lifting fixture assembly. 10. Wire rope legs	No support systems are required. The crane brake fails safe on loss of power.
UF_6 Cylinder Handling Cranes (Section 3.15.6.2)	C-360	1. Crane structure and structural supports, the crane rails, the bridge runway, mechanical rail stops at the end of the bridge, and trolley rails. Each bridge crane is equipped with one polar trolley hoist, with redundant reeving and a double-block design. 2. Two hoist brakes 3. Caliper brake 4. Geared up/down limit switch 5. Two paddle-type limit switches 6. Emergency stop button 7. Mechanical Continuity Monitor 8. Lifting fixture assembly. 9. Wire rope legs	No support systems are required. The crane brake fails safe on loss of power.

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Liquid UF_6 Cylinder Handling Equipment (Section 3.15.6.3 and 3.15.10.2.9)	C-310 C-315 C-360	1. Scale carts ; 2. C-360 levelator which includes: a. Hydraulic lift, b. The hydraulics, c. Rail stop, d. Interlock switch (prevents cart motion when levelator is not in position). 3. C-360 Elevator which includes: a. Hydraulic lift, b. Hydraulics, c. Elevator key lock, the interlock on the elevator door to prevent opening when the elevator floor is not level with the floor, and d. Deadman switch. 4. Rail stops located at the head of the C-310 and C-315 cylinder fill/weigh stations.	No support systems are required.
Cylinder Scale Cart Movement Prevention System (Sections 3.15.6.5 and 3.15.10.2.8)	C-310 C-315 C-360	1. Differential pressure sensors 2. Solenoid valves 3. Associated interlocks on the air supply to the scale cart.	The scale carts fail safe upon loss of air.
UF_6 Release Detection System (Section 3.15.7.3)	C-331 C-333 C-335 C-337	The UF_6 release detection system that is located in any “000” or “00” areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, and interbuilding tie-line housings) and in interbuilding booster stations, including: 1. Leak detector heads 2. Associated signal conditioners 3. Signal cable from the detector heads to the signal conditioner 4. Alarm annuciators in ACR 5. Electrical signal lines and associated alarm circuitry 6. 120 VAC power supply back to the first breaker 7. 125 VDC power supply back to the first breaker	120-VAC power - Required for the UF_6 release detection system to support 200 VDC power supply to the detectors 125 VDC power - Required to annunciate alarms in the ACR

Table 3.15-1. Boundary Definition for Q Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Process Building Cranes (Section 3.15.9.2)	C-310 C-315	Bridge crane rails, crane structure and structural supports for the C-310 and C-315 cranes parked over/near pressurized process piping or the Normetex pumps.	No support systems are required.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components.

System	Facility	Boundary Definition	Support Systems
Autoclave Water Inventory Control System (Sections 3.15.2.5, 3.15.5.5, 3.15.10.2.1, and 3.15.10.5.1)	C-333-A C-337-A C-360	See Table 3.15-3 for boundary definition.	No support systems are required
High Cylinder Pressure System (Sections 3.15.2.6 and 3.15.5.6)	C-333-A C-337-A C-360	1. Pressure sensing instruments. 2. Steam block valves and outboard thermovent isolation valve. 3. Solenoid valve (operates the steam block valve 4. Programmable logic controller (includes input/output modules) 5. Connecting electrical signal and pneumatic lines	No support systems are required
Autoclave Steam Pressure Control System (Sections 3.15.2.7, 3.15.10.2.3, and 3.15.10.5.3)	C-333-A C-337-A	See Table 3.15-1 for boundary definition.	No support systems are required
Autoclave Temperature Control System (Section 3.15.2.10)	C-337-A (A/C's 5E & 5W only)	1. Temperature sensing instrumentation 2. Steam supply block valves and thermovent block valve 3. Solenoid valves and relays (operates the block valves) 4. Controlled feeding mode key lock switch 5. Programmable logic controller (includes input/output modules) 6. Connecting electrical signal and pneumatic lines	No support systems are required.
Cell Remote Manual Shutdown System and DC Power Distribution System (Sections 3.15.3.1 and 3.15.3.2)	C-300	1. Manual trip switches in the CCF for the C-331, C-333, C-335, and C-337 enrichment compressor motors 2. 125 VDC auxiliary trip relays for CCF trips 3. Associated ACB relays, switches and control wiring 4. 125 VDC battery banks 5. Associated wiring circuits to connect the relays and trip coils to the batteries	125 VDC control power (Section 3.15.3.2)
	C-310	1. Pistol grip trip switches at the local cell panel (LCP) for the enrichment and purge compressor motors 2. Associated trip coils, contacts, and 250 VDC circuit breakers 3. Associated relays, switches, and control wiring 4. Associated 250 VDC power supplies - 250 VDC battery banks associated with the LPC trip circuits - Associated 250 VDC control and alarm power breakers in distribution cabinets - DC circuit breakers in switchgear and substation supply - The associated wiring circuits to connect the relays and trip coils to the batteries	250 VDC control power (Section 3.15.3.2)

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Primary Systems (Section 3.15.2.4)	C-333-A C-337-A	1. UF_6 process piping and valve bodies from, but not including, the second autoclave containment valve to, but not including, the first isolation valve inside the associated cascade building.	No support systems are required.
UF_6 Primary Systems (Sections 3.15.5.4)	C-360	1. Evacuation piping from, but not including, the liquid UF_6 transfer or sampling piping isolation valves up to and including evacuation drums.	No support systems are required.
UF_6 Primary Systems (Sections 3.15.3.3 and 3.15.4.5)	C-310 C-310A C-315 C-331 C-333 C-335 C-337	1. UF_6 primary system includes UF_6 process gas piping 2 in. and larger, expansion joints, seal assemblies, process gas coolers, valves, and equipment containing UF_6. Only the characteristics of the systems listed below which provide a UF_6 containment function are controlled as AQ SSCs. Internal parts (e.g., compressor blades, barrier, etc.) that do not form part of the UF_6 pressure boundary are not AQ. a. C-331, C-333, C-335, and C-337 - From the entry point(s) into the building to the exit points(s) from the building. b. C-310 - From the entry point(s) into the building to the withdrawal point. c. UF_6 tie lines - Interbuilding tie lines from the exit points from a building to the entry point(s) to the next building. d. C-310, C-310A, and C-315 sub-atmospheric piping and equipment used in the withdrawal facilities associated with supplying/returning UF_6 gas to the cascade. 2. Covers that are attached to openings on installed or removed equipment when the purpose of the cover is to provide a containment boundary.	No support systems are required.

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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
R-114 Coolant Overpressure Control System, Freezer/Sublimer UF_6 High Pressure Relief System, R-114 Coolant Overpressure Control System in the Withdrawal Process (Section 3.15.3.4, and 3.15.4.6)	C-310 C-315 C-331 C-333 C-335 C-337	1. Rupture disks 2. Manual block valve between the equipment being protected and the rupture disc or between the rupture disc and a low pressure relief path. 3. Piping from the rupture disc either back to the equipment being protected or to a transition to a larger pipe. 4. Diffusers (if applicable)	No support systems are required.
Freezer/Sublimer High-High Weight Trip System (Section 3.15.3.5 and 3.15.10.1.4)	C-331 C-333 C-335 C-337	The Freezer/Sublimer High-High Weight Trip System boundary includes: 1. F/S High-High Weight Detection System (independent of the DPCS High-High Weight Trip) 2. Interconnecting circuitry 3. Motor operated UF_6 inlet valve including 480 VAC breaker 4. Motor operated UF_6 return valve 5. Air operated weight control valve 6. Air operated UF_6 vent valve 7. Air operated R-114 bypass valve On the RCW loop, the boundary includes: 1. Air operated 3-way RCW valve 2. Associated circuitry to position the valve	480 VAC power - Required for motor operated 'B' valves to close. 120 VAC power - Required for weight measurement channels (A & B) to provide instrument signal outputs for comparison to trip limit settings. 24 VDC power - Required for control relay contacts to initiate 480 VAC power to be supplied to motor operated 'B' valve close contactor coil. Plant Air - Required for repositioning of various valves.
Motor Load Indicators (Section 3.15.3.6, and 3.15.4.4)	C-315 C-331 C-333 C-335 C-337	1. Motor load indicators (ammeters) for each enrichment cascade compressor motor in the ACR 2. Total cell motor load indicators for each enrichment cascade cell in the CCF 3. C-315 tails withdrawal high speed compressor motor load indicators (ammeters) in the C-315 and C-331 ACR 4. Associated current transformers 5. Cabling connecting ACR and CCF indicators to compressor motor AC power buses	No support systems are required.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Low Pressure Datum System (Section 3.15.3.7)	C-310 C-331 C-333 C-335 C-337	1. The low datum pressure Transmitter 2. Pressure indicator 3. Controller 4. Plant air back to the accumulator 5. 480 VAC power back to the first breaker 6. 120 VAC power back to the first breaker 7. Alarm in the ACR [C-310 only]	Plant air is reduced at the Datum Station. This air supply pressure level is monitored. If the air pressure decreases below a specific value, the alarm is sounded in the ACR and the Datum is isolated. 480 VAC power supplies the Datum Exhaust Pumps. If exhaust pressure increases above 0.5 psia, an alarm is received in the ACR and the Datum is isolated. 120 VAC power is provided to Datum pressure transmitters in the “00” buildings.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
High Pressure Datum System (Section 3.15.3.7)	C-310 C-331 C-333 C-335 C-337	1. Cell datum pressure indicators at the cell panel 2. Unit datum pressure indicators in the datum system 3. Air-to-open emergency block valve which blocks the datum header off the control loop 4. Alarm in the ACR 5. Hi/lo datum pressure switch and alarm 6. Pressure indicators at the Freezer/Sublimer datum panel 7. Air regulator, solenoids, the electronic controller, and the Freezer/Sublimer spare datum pressure indicators at the F/S datum panel 8. Plant air back to the accumulator 9. 480 VAC power back to the first breaker 10. 120 VAC power back to the first breaker	Plant air is reduced at the Datum Station. This air supply pressure level is monitored. If the air pressure decreases below a specific value, the alarm is sounded in the ACR and the Datum is isolated. 480 VAC power supplies the Datum Exhaust Pumps. If exhaust pressure increases above 0.5 psia, an alarm is received in the ACR and the Datum is isolated. 120 VAC power is provided to Datum pressure transmitters in the “00” buildings, or if air pressure varies by 0.1 psia from its set-point the solenoid is de-energized and closes.
Surge Drum Pressure/Room Temperature Instrumentation (Section 3.15.7.8)	C-331 C-333 C-335 C-337 C-360 C-315	1. Pressure transmitters or transducers 2. Pressure indicators 3. Temperature indicators for the surge drum rooms 4. 120 VAC power back to the first breaker	Instrument air supplies pneumatic pressure transmitters whose normal output would drop to 0 psig if lost. This would cause the Recorder to indicate less than zero. This would indicate a problem with the instrumentation. 120 VAC power to instrumentation if lost would cause drum instrumentation to be affected indicating the presence of a problem.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Freezer/Sublimers R-114 High Pressure Relief System (Section 3.15.3.8)	C-331 C-333 C-335 C-337	1. Rupture disks 2. Manual block valve between the equipment being protected and the rupture disc 3. Piping from the rupture disc either back to the equipment being protected or to a transition to a larger pipe.	No support systems are required.
Compressor Motor Manual Trip for the Withdrawal Compressor Motors in C-315 and DC power Distribution System (Section 3.15.4.2)	C-315	1. Manual shutdown buttons or switches in the ACR and C-331 for the high-speed centrifugal motors in C-315. 2. Associated breaker, trip coils, and circuitry. 3. Associated relays, switches and control wiring 4. Associated 125 VDC power supplies - 125 VDC battery banks associated with the ACR trip circuits - Associated 125 VDC control and alarm power breakers in distribution cabinets - DC circuit breakers in switchgear and substation supply - The associated wiring circuits to connect the relays and trip coils.	125-VDC Control Power (Section 3.15.4.2.2)
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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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UF_6 Cylinders (Section 3.15.6.1)	C-310 C-310-A C-315 C-333-A C-337-A C-360 C-400 C-409 C-745-A C-745-B C-745-E C-745-H C-745-Q C-745-R C745-U C-745V	1. Cylinders with the capacity of holding no more than 500 lb [227 kg] of UF_6) 2. Cylinder valves; and 3. Cylinder plugs. 4. Valve protector for Q and AQ cylinders.	No support systems are required (Section 3.15.6.1.3).

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Cylinder Weighing System (Section 3.15.6.4)	C-310 C-315 C-333-A C-337-A C-360	System boundary includes the scales that are used to provide a means for identifying cylinders with weights that exceed allowable limits. The specific scales used for this activity are identified in applicable TSRs. The boundary for individual scales includes those components that are used to determine a cylinder's weight.	No support systems are required.
Criticality Accident Alarm System (Section 3.15.7.1)	C-310 C-310-A C-331 C-333 C-333-A C-335 C-337 C-337-A C-360 C-400 C-409	The Criticality Accident Alarm System boundary includes the following: 1. Radiation detector cluster units consisting of a. Three gamma detector modules, b. Cluster logic module, c. Cluster housing, d. Backup battery for the cluster, e. Associated wiring between the clusters and alarms, and; f. 120 VAC power to and including the supply breaker	CAAS Air accumulator system 120 VAC power - Required for the cluster's power and the portable CAAS to function. The cluster upon loss of 120 VAC power is provided with battery backup and is therefore fail-safe. There is a backup battery for the portable CAAS cluster and electric horn and is therefore considered failsafe. An uninterruptible power supply is provided as backup power for buildings with horn solenoid valves (C-333-A, C-360, C-400, and C-409) and electronic horns (C-360, C-400, C-409) powered from 120 VAC.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		2. Alarm horn unit (local and building evacuation including slaved buildings) a. Building horns including: • solenoid, • air pressure regulator, • air horn, • piping between solenoid and building air horns, • 125 VDC power to and including the supply breaker, • Compressed air system from the horn to and including the isolation valve from the building plant air header, • elecrtonic horns b. CAAS Air Accumulator System: • air accumulators and relief valves, • air piping from accumulators to pressure regulators and from regulators to solenoids, • accumulator low pressure switch, pressure indicator, and alarm, • isolation and check valves in flow path between accumulators and air horn solenoids	125 VDC power - for building horn solenoid operated air valves; power to open and power to close. The solenoid valve fails-as-is “normally closed” on loss of power and is therefore not fail-safe. 48 VDC power - Required to support the actuation of the building horns and is powered by the C-300 48 VDC circuit.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		3. Radiation Alarm Cabinet and Building Horn Relay Cabinet in each building consisting of a. Relay from the clusters, and; b. Relay to actuate the building/slave horns 4. C-300 annunciation system including a. 48 volt power supply from the radiation alarm annunciator cabinets to the first breaker, b. Loss of power relays, c. Loss of power indication on the C-300 console, and; d. Building horn control switch 5. Portable CAAS consisting of a. Gamma detector channel, b. Cluster logic module, c. Cluster housing, d. Associated circuitry, e. Local electric horn, f. Backup battery for the cluster and horn, and; g. Connecting cable to connect to the building system.	

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1)	C-710	The Criticality Accident Alarm System boundary includes the following: 1. Radiation detector cluster units consisting of a. Three gamma detector modules, b. Cluster logic module, c. Cluster housing, d. Backup battery for the cluster, e. Associated wiring between the clusters and alarm horns, and; f. 120 VAC power to and including the supply breaker	120 VAC power - Required for the cluster's power, the CAAS horns, and the portable CAAS to function. The cluster upon loss of 120 VAC power is provided with battery backup and is therefore fail-safe. There is a battery backup for the portable CAAS cluster and electric horn and is therefore considered fail-safe. Also required for the C-709 and C-710 building horns power. Power is provided by an uninterruptible power supply and is therefore considered fail-safe.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		2. Alarm horn unit (building evacuation including slaved buildings) a. Building horns including: • electronic horns, • 24 VDC power to and including the supply breaker, • 120 VAC power for the horns including the supply breaker, and; • uninterruptible power supply for the alarm horns 3. Radiation Alarm Cabinet in each building consisting of a. Relay from the clusters, and; b. Relay to actuate the building/slave horns 4. C-300 annunciation system including a. 48 volt power supply from the radiation alarm annunciator cabinets to the first breaker, b. Loss of power relays, c. Loss of power indication on the C-300 console, and; d. Building horn control switch	48 VDC power - for supervisory circuits monitoring CAAS status and powered by the C-300 48 VDC circuit. 24 VDC power - Required as backup support for actuation of the building horns. Loss of 24 VDC power is annunciated in C-300 CAAS console.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		5. Portable CAAS consisting of a. Gamma detector channel, b. Cluster logic module, c. Cluster housing, d. Associated circuitry, e. Local electric horn, f. Backup battery for the cluster and horn, and; g. Connecting cable to connect to the building system.	
Criticality Accident Alarm System (Section 3.15.7.1)	C-720	1. Radiation detector cluster units consisting of a. Three gamma detector modules, b. Cluster logic module, c. Cluster housing, d. Backup battery for the clusters, e. Associated wiring between the clusters and alarms, and; f. 120 VAC power to and including the supply breaker 2. Alarm horn unit (local and building evacuation including slaved buildings) a. Building horns including: • electronic horn, and; • 120 VAC power to the horns including the supply breaker	120 VAC power - Required for the cluster's power and the portable CAAS to function. The cluster upon loss of 120 VAC is provided with battery backup and is therefore fail-safe. There is a backup battery for the portable CAAS cluster and electric horn and is therefore considered fail-safe. Also required for the building horns power. Power is provided by an uninterruptible power supply and is therefore considered fail-safe.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		3. Radiation Alarm Cabinet in each building consisting of a. Relay from the clusters, and; b. Relay to actuate the building/slave horns 4. C-300 annunciation system including a. 48 volt power supply from the radiation alarm annunciator cabinets to the first breaker, b. Loss of power relays, c. Loss of power indication on the C-300 console, and; d. Building horn control switch 5. Portable CAAS consisting of a. Gamma detector channel, b. Cluster logic module, c. Cluster housing, d. Associated circuitry, e. Local electric horn, f. Backup battery for the cluster and horn, and; g. Connecting cable to connect to the building system.	48 VDC power - Required to support the actuation of the building horns and is powered by the C-300 48 VDC circuit.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1)	C-746-Q1	The Criticality Accident Alarm System boundary includes the following: 1. Radiation detector cluster units consisting of a. Three gamma detector modules, b. Cluster logic module, c. Cluster housing, d. Backup battery for the cluster, e. Associated wiring between the clusters and alarms, and; f. 120 VAC power to and including the supply breaker 2. Alarm horn unit a. Building electronic horns 3. Radiation Alarm Cabinet and Building Horn Relay Cabinet in each building consisting of a. Relay from the clusters, and; b. Relay to actuate the building/slave horns	120 VAC power - Required for electronic horns. Also required for the cluster's power and the portable CAAS to function. The cluster upon loss of 120 VAC power is provided with battery backup and are therefore fail-safe. There is a backup battery for the portable CAAS cluster and electric horn and is therefore considered fail-safe. 48 VDC power - Required to support the actuation of the building horns and is powered by the C-300 48 VDC circuit.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Criticality Accident Alarm System (Section 3.15.7.1) (Continued)		4. C-300 annunciation system including a. 48 volt power supply from the radiation alarm annunciator cabinets to the first breaker, b. Loss of power relays, c. Loss of power indication on the C-300 console, and; d. Building horn control switch 5. Portable CAAS consisting of a. Gamma detector channel, b. Cluster logic module, c. Cluster housing, d. Associated circuitry, e. Local electric horn, f. Backup battery for the cluster and horn, and; g. Connecting cable to connect to the building system.	
High Pressure Fire Water System (Section 3.15.7.2)	C-310 C-310A C-315 C-331 C-333 C-335 C-337 C-631-1 C-631-2 C-631-3 C-611-R	The following defines the AQ boundary for the High Pressure Fire Water System from the C-631-2 cooling tower basin up to and including the sprinkler heads in the process buildings. The boundary includes: 1. Cooling tower basin 2. Four fire water pumps 3. 300,000 gallon elevated steel storage tank 4. Piping comprising water distribution (to the process buildings, C-310, and C-315) 5. Sectional valves in the water distribution loops 6. Lead-ins to sprinkler systems and their post indicator valves (PIVs) 7. Automatic wet pipe sprinkler system in the process buildings except the antifreeze and the dry pipe sprinkler systems in C-310 (canopy area for product withdrawal).	The elevated storage tank provides a gravity-fed supply to the fire sprinkler system that meets the functional requirements for flow rates, pressures, and duration. The systems are actuated automatically by the heat of the fire actuating sprinkler heads, thus initiating flow of water through the system. No support systems are needed to accomplish the safety function of the fire protection system. Use of the fire water pumps would necessitate the availability of the electrical power used to run the pump motors. Use of the diesel-driven pump would require those systems needed to start and run the diesel engine.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
High Pressure Fire Water System (Section 3.15.7.2) (Continued)		8. One pump is diesel driven. The following items must be controlled for the operation of the diesel pump: a. the diesel engine, b. the fuel oil, c. the fuel oil supply tank, d. and the fuel supply system. e. the pump electric starting mechanism is also bounded including the starting batteries. 9. For the electric driven pumps, the electric power supply is bounded from the pumps back to the 13.8 kV→4160 V transformers (2PH3, 2PH4A, and 2PH4B) that supply the 4160 V switchgear in C-631-1. The boundary includes: a. the switchgear main bus, b. bus supply circuit breaker, c. the bus tie breaker, d. and the protective relays for all circuit breakers in the switchgear. 10. Controls for manual and automatic start-up of the pumps. 11. Associated circuitry.	

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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UF_6 Release Detection System (Section 3.15.7.3)	C-310 C-310-A C-315 C-333-A C-337-A C-360	This system only includes those systems that detect UF_6 releases and provide an alarm to alert personnel to immediately evacuate the facility. Other systems that perform alarm and mitigation functions are discussed in other sections (see Sections 3.15.4.1, and 3.15.5.2). The AQ system boundary for the feed facilities, toll transfer and sampling facility (zones 5 through 8), and the withdrawal facilities include the following: 1. UF_6 detector heads; 2. PLC (including input and output modules); and 3. Associated alarms and alarm circuitry. 4. 120-VAC, 200-VDC and 24-VDC power back to the first breaker. See Table 3.15-3 for the toll transfer and sampling facility (zones 2 and 3). In addition, the AQ system boundary includes associated alarms and alarm circuitry.	In the feed facilities, 120-VAC electrical power and 24-VDC electrical power are required to perform the safety function. In the toll transfer and sampling facility (zones 5-8 only), 120-VAC electrical power and 24-VDC electrical power are required for this system to perform its required safety function. See Table 3.15-3 for the toll transfer and sampling facility (zones 2 and 3). In the withdrawal facilities, the high voltage systems require 120-VAC and 200-VDC to perform their safety function. The low voltage systems in the withdrawal facilities require 120-VAC and 24-VDC to perform their safety function.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Inventory Instrumentation Required for Nuclear Material Accountability (Section 3.15.7.4)	Plant-Wide	1. Inventory instruments used to demonstrate compliance with the nuclear material accountability requirements a. This is limited to freezer/sublimer weight instrumentation which is addressed in Section 3.15.3.5. b. The high and low pressure datum systems pressure instrumentation for cascade pressure control (controlled as separate AQ systems). c. The cell stage high side pressure transmitters and pressure indicating controllers. d. The cell "A" suction pressure transmitter and indicator. e. The cell UF_6 temperature thermocouples and temperature indicator. f. The surge drum pressure instrumentation and temperature instrumentation. g. The Hortonspheres' pressure instrumentation. 2. Scales controlled by the NMC&A program. 3. Waste drum monitors 4. Flow meters and associated instrumentation which are used while taking inventory to estimate the amount of material in a partially filled cylinder during the feeding process. 5. Flow transmitter 6. Flow indicating totalizer	120 VAC power to flow transmitters. 120 VAC power to instrumentation Instrument air to pneumatic pressure transmitter.
Public Warning System (Section 3.15.7.5)		The public warning system boundary includes: 1. Sirens 2. Towers 3. Control stations necessary to operate the public warning system 4. 120 VAC power back to the first breaker 5. 24 VDC supply back to the first breaker	120 VAC power for charging the batteries 24 VDC Battery power for the siren The 120 VAC and 24 VDC power supplies are monitored and status reported regularly over the Radio Data Link.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Onsite Warning/Evacuation Systems (Section 3.15.7.6)		The plant PA system boundary includes: 1. Speakers 2. Control consoles 3. Amplifiers 4. Power sources 5. Wiring included in the plant wide PA system 6. 120 VAC power supply back to the first breaker 7. 24 VDC supply back to the first breaker The building evacuation alarm system boundary includes 1. Horns (may be air or electrically operated. Non-cascade buildings that do not have evacuation horns use fire evacuation horn: C-100, C-300, C-400, C-409, C-410, C-600, C-611, C-710, C-720, and C-750) 2. Control cabinets 3. Control consoles 4. Power and utility supplies and wiring necessary to provide an evacuation alarm to the cascade buildings and other facilities where the PA system is not effective. 5. 125 VDC supply back to the first breaker 6. Plant air back to the accumulator 7. 48 VDC supply back to the first breaker 8. Howlers (used in cascade buildings)	120 VAC supplies the internal PA amplifiers, the external pole-mounted PA systems battery charging circuit, the non-process building evacuation horns, associated control circuitry, and cascade building howlers. Loss of 120 VAC power renders the internal PA system and the non-process building evacuation horns inoperable and prevents charging the external PA system batteries. Cascade building air-powered horns can be operated locally on loss of 120 VAC power. 125 VDC power supplies power for the building horn solenoid valves for the process buildings, activating relays for the howlers, and associated circuitry. Loss of 125 VDC renders the system inoperable. Plant air supplies the air-powered building evacuation horns. Loss of air renders the system inoperable. The air system is supplied from a plant air header with multiple compressors. 24 VDC power from the batteries supplies power for the external PA system amplifiers, circuits and speakers. If the batteries fail, there is no power for the external PA system. 48 VDC power is required by control circuitry used from C-300. Loss of 48 VDC power would render the fire evacuation horns used by non-process buildings inoperable.
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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Mass Spectrometers (Section 3.15.7.9)	C-310, C-331, C-333, C-335, C-337	Mass spectrometers and associated circuitry.	120 VAC power supports the assay machine instrumentation, computer, and the solenoid isolation valves. Upon loss of power the assay machine has no indication, no power available lights, the computer screen is blank, indicating to the operators that a problem exists, and the block valves fail shut. The system is therefore fail-safe.
Chlorine System (Section 3.15.8)	C-611-B, C-611-S, C-615, C-631-1, C-633-1, C-635-1, and C-637-1	The vacuum regulator and chlorine leak detectors and associated alarms. 120 VAC power for the chlorine release detection and alarm system back to the first breaker.	120 VAC power for the chlorine release detection and alarm system.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
ClF_3 System (Section 3.15.8)	C-350	The ClF_3, F_2, and Mixed Gas distribution piping including the flexible connections, piping, and valves, and tanks. The instrumentation that controls the tank pressures to less than atmospheric pressure. The HF detectors and associated alarms. 120 VAC and 24 VDC power from the HF detection and alarm system back to the first breaker.	120 VAC and 24 VDC power for the HF detection and alarm system
F_2 System (Section 3.15.8)	C-310 C-331 C-333 C-335 C-337 C-350 C-410-D C-410-K C-745-A C-745-B	The F_2 system boundary includes the following: 1. The primary system integrity of distribution equipment that operates at above atmospheric pressure a. storage tanks b. flexible pigtail connecting the multi-tube trailer to the C-410-K pressure reducing station c. manifold d. valves e. piping and tubing f. rupture discs g. relief valve 2. Fluorine leak detectors and associated alarms for the: a. C-410-D and C-410-K ambient areas b. C-410-D and C-410-K pressure reducing manifolds 3. 120 VAC and 24 VDC power for the fluorine release detection and alarm system back to the first breaker.	120 VAC and 24 VDC power for the fluorine release detection and alarm systems

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Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Enrichment and Purge Cascade, interbuilding tie-line, and Product and Tails Withdrawal Facility Structures (Section 3.15.9.1)	C-310 C-310-A C-315 C-331 C-333 C-335 C-337	1. Foundations 2. Base plates 3. Building frames 4. Column anchorage 5. Load bearing walls 6. Reinforcing tees 7. Bracing 8. Seismic expansion joints (gaps between floor sections) 9. Connections 10. Supports for important to safety piping 11. Siding at the cell floor and above 12. Roof	No support systems are required.
Feed and Toll Transfer and Sampling Facility Structures (Section 3.15.9.1)	C-333-A C-337-A C-360	1. Foundations 2. Base plates 3. Building frames 4. Column anchorage 5. Load bearing walls 6. Reinforcing tees 7. Bracing 8. Supports for important to safety piping	No support systems are required.
Process Building Cranes (Section 3.15.9.2)	C-333 C-337	1. Bridge crane rails, crane structure and structural supports for the C-333 and C-337 cranes parked over unit bypass piping.	No support systems are required.
Cascade Equipment Housings (Section 3.15.9.3)	C-331 C-333 C-335 C-337	For housings over UF_6 primary system piping and equipment, defined in 3.15.3.3, intended to be operated above atmospheric pressure: 1. Steel frame surrounding UF_6 primary systems. 2. Non-metallic or sheet metal panels attached to the framing.	No support systems are required.

Table 3.15-2. Boundary Definition for AQ Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
Miscellaneous Waste Storage & Handling and Support Structures (Section 3.15.9.4)	C-300 C-400 C-409 C-710 C-720 C-720-A C-720-B C-720-C C-720-K C-746-Q1	1. Foundations 2. Base plates 3. Building frames 4. Column anchorage 5. Load bearing walls 6. Reinforcing tees 7. Bracing 8. Seismic expansion joints (gaps between floor sections) 9. Connections	No support systems are required.

Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components.

System	Facility	Boundary Definition	Support Systems
Autoclave Water Inventory Control System (Sections 3.15.2.5, 3.15.5.5, 3.15.10.2.1, and 3.15.10.5.1)	C-333-A C-337-A C-360	1. Level probes and level switches (2) 2. Steam block valves, thermovent block valve 3. Solenoid valve and piping to block valves (operates the steam block valve) 4. Programmable logic controller in C-333-A and C-337-A (includes input/output modules) 5. Connecting electrical signal and pneumatic lines	No support systems are required
Autoclave Steam Pressure Control System (Sections 3.15.2.7, 3.15.5.7, 3.15.10.2.3, and 3.15.10.5.3)	C-333-A C-337-A C-360	See Table 3.15-1	No support systems are required
Freezer/Sublimers (F/S) High-High Weight Trip (Section 3.15.10.1.4)	C-331 C-333 C-335 C-337	The boundary applies to all the F/Ss exposed to greater than or equal to 1.0 wt.% ^{235}U. The F/S High-High Weight Trip System boundary includes: 1. Weight monitoring instumentation 2. Interconnecting circuitry 3. Motor operated UF_6 inlet "B" line valve 4. 480 VAC breaker for the inlet "B" line valve 5. 24 VDC power supply to control relay for inlet "B" line valve close contactor coil 6. 120 VAC power supply back to the first breaker	480 VAC power - Required for inlet "B" line valve to close 120 VAC power - Required for weight measurement channel to provide an output. 24 VDC power - Required for control relay contacts to close thereby allowing 480 VAC power to be supplied to inlet "B" line valve close contactor coil.
Autoclave High Pressure Isolation System (Sections 3.15.2.1, 3.15.5.1, 3.15.10.2.2, 3.15.10.5.2)	C-337-A C-360	See Table 3.15-1	See Table 3.15-1
High Cylinder Pressure System (Section 3.15.2.6, 3.15.10.5.5)	C-337-A (A/C's 5E & 5W only)	See Table 3.15-2	No support system is required.

Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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Spray Booth Key Interlock for Solution Transfer (Section 3.15.10.3.1)	C-400	1.Two selector switches.	No support systems are required
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C-310 Normetex Pumps High Oil Pressure Trip (Section 3.15.10.4.2)	C-310	1. High Oil Pressure Sensor upstream of the Filter, 2. Associated valves, and 3. High Oil Pressure Trip Circuit Including a. oil pump circuit relay for the east and west vacuum pumps, and b. 911 relay for the side withdrawal vacuum pump. 4. Electric power back to first breaker	Electric power, 48 VAC for pump control and shutdown.

Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
C-310 Normetex Pumps Low Oil Flow Trip (Section 3.15.10.4.3)	C-310	1. Low Oil Flow Switch, 2. Associated valves, and 3. Oil Circuit Relay. 4. Electric power back to first breaker	Electric power, 48 VAC for pump control and shutdown, 120 VAC for Pump Discharge Block Valve Control.
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Cylinder Roll Interlock System (Section 3.15.10.2.5)	C-360	1. Pressure element 2. Pressure transmitter 3. Trip devices 4. Pigtail selection switch 5. Associated electrical circuitry and interlocks 6. Platform limit switches	Electric power

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Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
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C-310 UF_6 Release Detection System - Normetex Pumps (Section 3.15.4.8 and 3.15.10.4.9)	C-310	See Table 3.15-1	See Table 3.15-1
C-310 Normetex Pump Discharge Block Valve Closure on Pump Trip (Section 3.15.10.4.12)	C-310	1. Discharge block valve 2. Pump discharge valve air-control solenoids 3. Associated circuitry to trip pump and close discharge valve 4. Normetex pump discharge block valve interlock logic to close valve on pump trip shutdown sequence 5. Electric power back to first breaker	Electric power, 48 VAC for pump control and shutdown, 120 VAC for pump discharge block valve control.
Scale Cart Movement Prevention System (Section 3.15.6.5)	C-310	See Table 3.15-1	See Table 3.15-1
UF_6 Release Detection and Isolation System - Low Voltage (“New”) system at the withdrawal stations (Section 3.15.4.1 and Section 3.15.10.4.10)	C-310	See Table 3.15-1	See Table 3.15-1
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Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

System	Facility	Boundary Definition	Support Systems
UF_6 Release Detection System - Zone 4 (Section 3.15.5.2 and Section 3.15.10.2.7)	C-360	See Table 3.15-1, In addition, the boundary includes associated circuitry to trip the elevator pit sump pump.	See Table 3.15-1
UF_6 Release Detection System - Zones 2 and 3 (Section 3.15.7.3 and Section 3.15.10.2.7)	C-360	1. UF_6 detector heads (AQ) 2. 120-VAC, and 200-VDC power back to the first breaker (AQ) 3. Associated circuitry to trip elevator pit sump pump	120-VAC electrical power and 200-VDC electrical power are required for this system to perform its safety function.
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UF_6 Release Detection System - Zone 1 (Section 3.15.10.2.4)	C-360	See Table 3.15-1	See Table 3.15-1
Cylinder Scale Cart Movement Prevention System (Section 3.15.6.5 and 3.15.10.2.8)	C-360	Associated interlocks on the air supply to the scale cart	The scale carts fail in a safe condition upon loss of air
Liquid UF_6 Cylinder Handling Equipment (Section 3.15.6.3, 3.15.10.2.6, and 3.15.10.2.9)	C-360	1. Interlock switch (prevents scale cart motion when C-360 levelator is not in its fully raised position) 2. Elevator key lock, interlock on the C-360 elevator door to prevent opening when elevator floor is not level with the floor	No support systems are required

Table 3.15-3. Boundary Definition for NCS AEF Structures, Systems, and Components (continued).

C-409 Uranium Precipitation System Filtrate Receiver High-Level Actuation System for Filtrate Pump	C-409	1. High-Level Probe/Switch and Controls 2. Electric power back to first breaker 3. Electric power to filtrate pump	Electric power
C-409 Uranium Precipitation System Filtrate Receiver High-Level Shutoff System for Vacuum Pump	C-409	1. High-Level Probe/Switch and Controls 2. Electric power back to first breaker 3. Associated circuitry to trip the pump	Electric power
C-409 Cylinder Wash HF Scrubber Recycle Pump Shutdown	C-409	1. Flow indicator 2. Vacuum switch 3. Associated circuitry to trip the pump	No support systems required. The loss of electrical power will automatically shutdown the pump.
UF_6 Release Detection System - C-337A (Section 3.15.10.5.4)	C-337A	1. All UF_6 detector heads located in C-337A. 2. UF_6 detector control panel. 3. Alarms and associated alarm circuitry. Note: This system initiates the Autoclave Manual Isolation System. See Table 3.15-1.	Detector power is provided by 120 VAC and 24 VDC distribution. This power is required to perform the safety function of UF_6 isolation. 120 VAC power to the controlling PLC is fail safe and not required to meet the intended AQ-NCS safety function. The UF_6 detection system does not rely on any other support systems to perform its safety function.

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Table 3.15-4. Seismic Capacities of Process Building C-331 Piping and Equipment

Equipment and Piping	Seismic Capacity, g	Annual Probability of Failure	Location	Comments
			A-stream	
Pipe support (type 184)	<0.05	>3.8 x 10^{-3}	Unit bypass near unit 4	30-in. expansion joint at the end of pipe segment may tear. (Only one such support in the building.)
Pipe support (types 121 & 139)	0.07	3.1 x 10^{-3}	Unit bypass near tie line to C-333	Two 30-in. expansion joints in vicinity may tear. (Only one place in the building.)
Pipe Support (type 106)	0.10	2.2 x 10^{-3}	Unit bypass at cell bypass to unit 1	One 30-in. expansion joint may tear. (Only one place in building)
Tie rod (type 104)	0.12	1.8 x 10^{-3}	Unit bypass at cell bypass	One adjacent 30-in. expansion joint may tear. (Six places in building)
			B- or A-/B-streams	
Pipe support (type 184)	<0.05	>3.8 x 10^{-3}	Unit bypass near unit 4	30-in. expansion joint at the end of pipe segment may tear. (Only one such support in the building.)
Expansion joint	<0.05	>3.8 x 10^{-3}	Unit 4, cell 3, stage 5	Cut hinge, 24-in. expansion joint may tear. (Only one cut hinge in building)
Pipe support (types 121 & 139)	0.08	2.8 x 10^{-3}	Unit bypass near tie line to C-333	One 30-in. expansion joint in vicinity may tear. (Only one place in the building.)
Piping*	0.14	1.5 x 10^{-3}	Stage 1 of all cells in units 2 and 3	Unanchored recycle cooler slides and may tear 16-in. piping. (Twenty places in building)
Pipe supports*	0.15	1.3 x 10^{-3}	Cell bypass	24-in. expansion joints at each end of the pipe may tear. (One location per cell)

* Pressure boundary is not likely to be adversely affected.

All other equipment, piping and components with A-, B-, and A-/B-streams had capacities equal to or greater than the EBE (0.165g).

Table 3.15-5. Seismic Capacities of Process Building C-335 Piping and Equipment.

Equipment and piping	Seismic capacity, g	Annual probability of failure	Location	Comments
			A-stream	
Expansion joints	<0.05	>3.8 x 10^{-3}	Cell bypass near cell 9	Two 24-in. expansion joints type X-9 at each end of loop in A-stream may tear. (Two in each unit)
Pipe support (type 30)	0.07	3.1 x 10^{-3}	Cell bypass	One 24-in. expansion joint at each end of the pipe segment may tear. (One support at each cell)
Pipe support* (type 106)	0.07	3.1 x 10^{-3}	Unit bypass at cell bypass	Adjacent 30-in. expansion joint may tear. (Only one place in the building)
Pipe supports (type 120 and 121)	0.09	2.5 x 10^{-3}	Unit bypass	30-in. expansion joints may fail (One at each unit)
Pipe flange*	0.12	1.8 x 10^{-3}	Cell bypass near cell 9	Hole develops at pipe flange weld. (One at each unit)
Pipe support (type 20)	0.11	2.0 x 10^{-3}	Cell bypass	24-in. expansion joints at each end of the pipe segment tear. (One support at each cell)
Tie rod (type 105)	0.11	2.0 x 10^{-3}	Unit bypass at unit 1	Adjacent 30-in. expansion joint may tear. (Only one place in the building)
Tie rod (type 104)	0.14	1.5 x 10^{-3}	Unit bypass	Adjacent 30-in. expansion joint may tear. (Six places in the building)
			B- or A-/B-streams	
Pipe support (types 120 and 121	0.09	2.5 x 10^{-3}	Unit bypass at cell bypass, units 1, 2 and 3	30-in expansion joint may tear.(One each in units 1, 2, and 3)
Pipe support* (type 20)	0.14	1.5 x 10^{-3}	Cell bypass	24-in. expansion joints at each end of the pipe segment may tear. (One support at each cell)
Expansion joint*	0.14	1.5 x 10^{-3}	Cell bypass	Two X-9 expansion joints near cells 9 and 10 may tear. (One pair in each unit)
Piping*	0.14	1.5 x 10^{-3}	Stage 1 of all cells in units 2 and 3	Unanchored recycle cooler slides and may tear 16-in. piping. (Twenty places in building)

* Pressure boundary is not likely to be adversely affected.

All other equipment, piping and components with A-, B-, and A-/B-streams had capacities equal to or greater than the EBE (0.165g).

Table 3.15-6. Seismic Capacities of Process Building C-333 Piping and Equipment.

Equipment and piping	Seismic capacity, g	Annual probability of failure	Location	Comments
			A-stream	
Expansion joint (X-10/10A)	<0.05	>3.8 x 10^{-3}	Unit bypass	Pressure balanced expansion joint on the A-stream may tear due to unrestrained piping. (This condition occurs only at one location in the building)
Pipe support (type 86)	0.07	3.1 x 10^{-3}	Unit bypass	Anchor failure may cause tear in the adjacent A-stream bellows. (This condition occurs only at one location in the building)
			B- or A-/B-streams	
Coolers	<0.05	>3.8 x 10^{-3}	B booster	B booster station coolers are unanchored. Inertial effects may tear all bellows in the booster station. (Three coolers affecting three bellows each)
Pipe support (types 2, 3, 4, 4a, 5)	<0.05	>3.8 x 10^{-3}	B booster	B-stream pipe supports failures may tear all the bellows in the booster station. (These are the same bellows as the above)
Expansion joint (X-11/11A)	<0.05	>3.8 x 10^{-3}	Unit bypass	Pressure balanced expansion joint on the B-stream may tear due to unrestrained piping. (This condition occurs only at one location in the building)

All other equipment, piping and components in A-, B-, and A-/B-streams had capacities equal to or greater than the EBE (0.165g).

Table 3.15-7. Seismic Capacities of Process Building C-337 Piping and Equipment.

Equipment and piping	Seismic capacity, g	Annual probability of failure	Location	Comments
			A-stream	
Expansion joint (X-10/10A)	<0.05	>3.8 x 10^{-3}	Unit bypass	Pressure balanced expansion joint on the A-stream may tear due to unrestrained piping. (This condition occurs only at one location in the building)
			B- or A-/B-streams	
Expansion joint (X-11/11A)	<0.05	>3.8 x 10^{-3}	Unit Bypass	Pressure balanced expansion joint on the B-stream may tear due to unrestrained piping. (This condition occurs only at one location in the building)

All other equipment, piping and components in A-, B-, and A-/B-streams had capacities equal to or greater than the EBE (0.165g).

Table 3.15-8. Seismic Capacities of Buildings C-310/C-310-A Piping, Equipment and Components.

Equipment, piping and components	Seismic capacity, g	Annual probability of failure	Location	Comments
Piping between cells	<0.05	>3.8 x 10^{-3}	C-310 cell	Weak or missing support
Cell bellows	<0.05	>3.8 x 10^{-3}	C-310 cell	Building relative movements may tear bellows
Bellows SX-5/9/10/12	<0.05	>3.8 x 10^{-3}	C-310 bypass	Bellows may tear due to unrestrained piping
Bellows SX-6*	0.13	1.6 x 10^{-3}	C-310 bypass	Same as above
Bellows OX-2/4/5/6	<0.05	>3.8 x 10^{-3}	C-310 bypass	Same as above
Bellows SX-11	0.08	2.8 x 10^{-3}	C-310 bypass	Building relative movements may tear bellows
Anchor types 90 & 96	<0.05	>3.8 x 10^{-3}	C-310 bypass	Weld deficiency

* Pressure boundary is not likely to be adversely affected.

All other equipment, piping, and components had capacities equal to or greater than the EBE (0.165g).

Table 3.15-9. Seismic Capacities of Building C-315 Piping, Equipment and Components

Equipment, piping, and components	Location	Seismic capacity, g	Annual probability of failure	Comments
Process piping	Hortonspheres	0.10g	2.2×10^{-3}	Hortonsphere rod fails and attached piping breaks or sphere ruptures

All other equipment, piping, and components had capacities equal to or greater than the EBE (0.165g).

Table 3.15-10. Natural Phenomena Capacities of Buildings.

Structure	Seismic (note 1) OK>0.165g	Wind OK>70 mph (113 km/hr)		Flood
		Structure	Components	
C-300	OK	OK	OK	OK
C-310/310-A	0.1 → 0.165	OK	50	OK
C-315	0.06 →0.165	65	50	OK
C-331/335	OK	OK	50 (note 3)	Inleakage (note 4)
C-333/337	0.1 →0.165	OK	50	Inleakage (note 4)
C-333-A/337-A	0.1 →0.165	OK	50	OK
C-360	OK	OK	45 (note 5)	OK
C-400	0.05 →0.165	OK	OK	OK
C-409	OK	OK	OK	OK
C-710	OK	OK	OK	OK
C-720	0.12 →0.165	OK	OK	OK
C-746-Q	OK	OK	OK	OK
Tie lines	0.12 →0.165(note 6)	OK	OK	OK

Notes

1. Range indicates onset of yield with structural integrity to at least the high value
2. Text deleted
3. Siding pulled off
4. Roof ponding
5. Roof decking pulled off
6. Structural deficiencies have potentially compromised the support capabilities of sections of the interbuilding tie-line support structures. The structural failure of the tie-line support structures is possible at loadings below 0.165g. Administrative controls require that the interbuilding process piping in all interbuilding tie-lines that have structural deficiencies and that contain UF_6 be maintained below atmospheric pressure. Implementation of these administrative controls ensures that any tie-line structural failure due to a seismic event will not result in an unanalyzed UF_6 release. The interbuilding process piping in the C-331/C-333 tie-line is exempt from this administrative requirement since the deficiencies in the C-331/C-333 tie-line support structure have been corrected such that the tie-line structure is adequate to resist service level and natural phenomena loading as described in the SAR for above atmospheric conditions.

Table 3.15-11. Seismic Capacities of Building C-360 Piping and Equipment.

Equipment, piping and components	Seismic capacity, g	Annual Probability of failure	Comments
Lift unanchored	0.05	3.8×10^{-3}	Movement may break hydraulic lines

All other equipment, piping and components had capacities equal to or greater than the EBE (0.165g).

4.0 HAZARD AND ACCIDENT ANALYSIS

4.1 INTRODUCTION

This chapter describes the hazard and accident analysis performed for the Paducah Gaseous Diffusion Plant (PGDP).

The hazard analysis methodology consists of the identification and evaluation of facility hazards. Hazard identification is a comprehensive assessment of process-related, natural phenomena and external hazards that may result in onsite or offsite consequences of interest if an accident occurs. Hazard evaluation generates the largely qualitative consequence and likelihood estimates used to characterize hazards in the context of potential accidents. This method provides a thorough, predominantly qualitative evaluation of the spectrum of risks to the public, onsite personnel, and the environment resulting from potential accidents involving the identified hazards. The results of the hazard analysis include the identification of a reasonable spectrum of initiating events for evaluation in the accident analysis.

The initiating events that are chosen for evaluation in the accident analysis are defined as limiting initiating events. Limiting initiating events are those initiating events that can result in the most severe accident in a given frequency category (see Section 4.2.5.3). All limiting initiating events are compared with Evaluation Guidelines (EGs) to identify and assess the adequacy of existing SSCs.

Selection criteria are applied to the results of the hazard and accident analyses to derive the Technical Safety Requirements (TSRs).[1]

The hazard and accident analysis uses a graded approach to determine the level of analysis applied to each identified hazard. This approach requires that the level of analysis and documentation for each facility be commensurate with the following:

- The magnitude of the hazards being addressed.
- The stage or stages of the facility life cycle.
- The complexity of the facility and/or systems being relied on to maintain an acceptable level of risk.

In general, because grading is a function of both hazard potential and complexity, a graded approach dictates an assessment of complex, higher-hazard facilities that is more thoroughly documented than assessments of simple, lower-hazard facilities. If a hazard poses a more significant threat for the facility (i.e., health consequences), a more detailed analysis is performed. Note that

[1]Certain TSR Limiting Conditions for Operations were not derived from the hazard and accident analysis and may not satisfy the TSR selection criteria described in Section 4.3.2. These “legacy” TSRs are a carryover from previous OSR/TSR documents (i.e., prior to SARUP).

standard industrial hazards for which national consensus codes and/or standards [e.g., Occupational Safety and Health Administration (OSHA) regulations] exist are not in the scope of this SAR except where these hazards are identified as initiators or contributors to accidents in the facility.

Grading was also applied at each of the four major steps of the analysis process:

- Hazard identification and screening.
- Hazard classification.
- Hazard analysis.
- Accident analysis and development of safety controls.

Hazard identification and screening was used to review facility hazards to determine whether any safety analysis was required. This was accomplished by comparing the hazards with a screening value as described in Section 4.2.4. If the identified hazards remained below the screening values, the results were documented, and no additional analysis was required for the facility. The second step of the process involved classifying the facility in accordance with DOE-STD-1027-92 (Reference 1). The third step required analysis of the hazards associated with the facility. One of the elements of the graded approach for hazard analysis is a function of selecting techniques for hazard evaluation depending on the complexity of the process and the significance of the hazard. The techniques used for hazard evaluation can range from simple checklists or "What If" analyses to systematic parameter examinations. The technique selected need not be more sophisticated or detailed than is necessary to provide a comprehensive examination of the hazards associated with the facility operations. For example, a simple storage operation may be adequately evaluated by a preliminary hazard analysis or a structured "What If" analysis. The final step of the overall process involved taking the most significant hazards within the facility, determining specific accident scenarios, identifying safety controls that can minimize the frequency of the event, and identifying safety controls that can be used to mitigate the consequences should the event occur.

The hazard analysis methodology and results, presented in Section 4.2, include the hazard identification, classification, and evaluation tasks, including limiting initiating event selection. Section 4.3 describes the accident analysis methodology and results for each of the limiting initiating events identified in Section 4.2. The discussion summarizes the accident scenario development, source-term analysis, and consequence analysis, provides a comparison with guidelines, and summarizes SSCs and TSR controls.

4.2 HAZARD ANALYSIS

This section describes the hazard analysis methodology and results. The overall methodology integrated the hazard analysis, accident analysis, system classification, and TSR selection to ensure consistency throughout the analysis process. The methodology description also addresses the generic parts of the analysis and the specific portions that relate to hazard analysis.

Section 4.2.1 provides a discussion of the Evaluation Guidelines established for the hazard and accident analysis. The Evaluation Guidelines are used to identify and assess the adequacy of existing structures, systems, and components (SSCs). Section 4.2.2 establishes SSC classification criteria. These criteria are applied to the results of the hazard and accident analyses to establish the level of quality to be applied to SSCs based on their relative importance to safety. Section 4.2.3 identifies the selection criteria for deriving the Technical Safety Requirements (TSRs). Section 4.2.4 provides a discussion of the screening thresholds established as part of the hazard analysis. Sections 4.2.5 and 4.2.6 present the hazard analysis methodology and hazard analysis results, respectively.

4.2.1 Evaluation Guidelines

A key element of the analysis methodology is the establishment of Evaluation Guidelines (EGs) to ensure a consistent and systematic approach in all steps of the analysis process. The overall objective of establishing EGs is to limit consequences to smaller values for initiating events of higher frequency. This approach provides a logical response to different levels of risk by providing greater protection as the potential consequences increase. To accomplish this objective, plant Operating Conditions (OCs) and consequence guidelines for each plant operating condition were established. Together, this information forms the EGs for the hazard and accident analysis process.

It is important to note that because PGDP is an existing, operating facility, these Evaluation Guidelines may *not* be achievable for all accident sequences. Design conditions were not applied to PGDP specifically for the protection of the public. This analysis has identified and addressed those situations.

4.2.1.1 Initiating Event Frequency Categories

Consistent with the objective of providing protection commensurate with risk (i.e., potential consequences over the full range of plant Operating Conditions), initiating event frequency categories were first defined. 10 CFR 76.85 requires an assessment of accidents be performed by reviewing the full range of operation using an expected release rate resulting from anticipated operational occurrences and accidents. This statement implies three basic frequency categories or Operating Conditions that have been established for the accident analysis as shown in Table 4.2-1: Normal Operation, Anticipated Events (AEs), and Evaluation Basis Events (EBEs). The bases for these categories are provided as follows:

Normal Operation (OC-1)

The Normal Operation frequency category is based on normal operations that are planned for plant facilities. Normal operation of the facility was evaluated to determine initial conditions assumed

in the accident analysis as well as any normal operational safety programs (e.g., radiation protection) and administrative controls used to prevent an initiating event.

Anticipated Events (OC-2)

The Anticipated Event frequency category addresses deviations from normal operation that are anticipated to occur during the life of the facility. This category ranges from normal operation to those that have an initiating event frequency of greater than or equal to 10^{-2} per year or consistent with an event expected to occur in the life of a new facility. The AE frequency category was established with a 10^{-2} per year lower bound to provide a conservative margin based on the qualititative definition. Based on the relatively short remaining life of the plant, this category provides a conservative binning of initiating events estimated to occur more frequently than 10^{-2} per year.

Evaluation Basis Events (OC-3)

These initiating events address the remaining events for the GDPs considered credible.

4.2.1.2 Evaluation Guidelines

Evaluation Guidelines (EGs 1 through 6) were established for each initiating event frequency category to ensure operational requirements are met during all plant conditions. The EGs used in the GDP accident analysis methodology were adapted from the commercial reactor industry (Reference 1) and are provided in Table 4.2-2. Limiting initiating events (see Section 4.2.5.3) are compared with the Evaluation Guidelines to identify and assess the adequacy of existing SSCs. The basis for each of the EGs is as follows:

Evaluation Guideline 1 (EG 1)

The purpose of EG 1 is to establish radiological dose guidelines for members of the offsite public and onsite personnel.

The following radiological dose guidelines were established for the offsite public:

- For Normal Operation (OC-1), 10 CFR 20.1301 identifies dose limits for individual members of the public.

- For Anticipated Events (OC-2), the value of 5 rem TEDE/event was established for the offsite public based on onsite requirements for adult occupational dose limits defined in 10 CFR 20.1201(a)(1)(i). This limit was conservatively applied to the offsite public for Anticipated Events.

- For Evaluation Basis Events (OC-3), the value of 25 rem TEDE/event was established based on 10 CFR 100 and the Statements of Consideration for the 10 CFR 76 final rule

which references this value in Part C of the "Summary of Requirements and Analysis of Public Comments" (Federal Register, Vol. 59, No. 184, 9/23/94, page 48954).

The following radiological dose guidelines were established for onsite personnel:

- For Normal Operation (OC-1), 10 CFR 20.1201 identifies occupational dose limits for adults.

- For Anticipated Events (OC-2) and Evaluation Basis Events (OC-3), the guideline established was to ensure that onsite personnel are not exposed to life-threatening or serious health effects from the release of radioactive materials.

Because NRC regulations do not specify limits (or evaluation guidelines) for accident exposures to onsite personnel, specific radiological exposure values for AEs and EBEs were not established for onsite personnel as part of EG 1. For releases of UF_6, HF, and other corrosive gases, the "see and flee" policy trains employees to flee an area immediately upon detection by sight or smell of releases of UF_6 or other corrosive gases. Operating experience at the plants has demonstrated the effectiveness of the see and flee policy because no individual has been significantly injured by a UF_6 release. This policy, coupled with the requirements of the programmatic TSR on worker protection from UF_6 process hazards and the characteristics of UF_6, HF, and other toxic gases, adequately controls potential onsite toxic consequences. Qualitiative evaluations have been performed as part of the hazard and accident analyses to assess the potential for life-threatening or serious health effects to onsite personnel from the release of radioactive materials.

Evaluation Guideline 2 (EG 2)

The purpose of EG 2 is to establish nonradiological dose guidelines for members of the offsite public and onsite personnel due to a release of radioactive materials.

The following nonradiological dose guidelines were established for the offsite public:

- For Normal Operation (OC-1), 10 CFR 20.1301 identifies uranium dose limits for individual members of the public.

- For Anticipated Events (OC-2), the value of 10 mg soluble uranium intake/event is based on 10 CFR 20.1201(e), which uses this value for onsite workers for a period of 1 week. This limit was conservatively applied to the offsite public for Anticipated Events.

- For Evaluation Basis Events (OC-3), the value of 30 mg soluble uranium intake/event was established based on the Statements of Consideration for the 10 CFR 76 final rule which references this value in Part C of the "Summary of Requirements and Analysis of Public Comments" (Federal Register, Vol. 59, No. 184, 9/23/94, page 48954).

The following nonradiological dose guidelines were established for onsite personnel:

- For Normal Operation (OC-1), 10 CFR 20.1201 identifies occupational uranium dose limits for adults.

- For Anticipated Events (OC-2) and Evaluation Basis Events (OC-3), the guideline established was to ensure that onsite personnel are not exposed to life-threatening or serious health effects from the release of radioactive materials.

For the same reasons discussed above for EG 1, specific nonradiological exposure values for AEs and EBEs were not established for onsite personnel as part of EG 2. Qualitiative evaluations have been performed as part of the hazard and accident analyses to assess the potential for life-threatening or serious health effects to onsite personnel from the release of radioactive materials.

In addition to the radiological and uranium toxicity concerns, the by-product of a UF_6-moisture reaction [i.e., hydrogen fluoride (HF)] could result in potential health effects. Because HF is produced in direct proportion to the amount of UO_2F_2 produced, the AE and EBE guideline values for soluble uranium provide adequate control of HF. Consequently, consistent with the Statements of Consideration for the 10 CFR 76 final rule, no specific criterion for HF exposure was established. However, potential HF concentrations have been calculated and characterized as part of the consequence analyses.

Evaluation Guideline 3 (EG 3)

The purpose of EG 3 is to establish pressure and temperature guidelines.

EG 3 requires that system pressure and temperature be controlled to minimize the potential for a loss of primary system integrity. This guideline only applies when a postulated failure of the primary system could exceed EGs 1 or 2 (i.e., if a failure of the primary system would not exceed EG 1 or 2, then EG 3 is not applicable). Additionally, EG 3 would not apply if the event is a loss of primary system integrity since the intent of EG 3 is to prevent failure.

For Normal Operation (OC-1), temperatures should be maintained within the design rating for the equipment. Primary system pressure should be maintained below the Maximum Allowable Working Pressure (MAWP), or design pressure rating if the MAWP is not available during normal operation.

For Anticipated Events (OC-2), primary system pressure should be maintained below the MAWP (or design rating) plus the ASME code allowable stresses for overpressure protection. (Refer to Appendix A of Chapter 1 for a discussion of ASME code applicability.)

For Evaluation Basis Events (OC-3), primary containment system pressure (when a containment system is present to contain hazardous releases) should not exceed the system's hydrostatic test pressure.

Evaluation Guideline 4 (EG 4)

The purpose of EG 4 is to require that the normal operation or initiating event be controlled within the guidelines of the double contingency principle for nuclear criticality safety.

For Normal Operation (OC-1), EG 4 is satisfied when the process is provided with two independent criticality safety controls.

For Anticipated Events (OC-2), one of the two independent criticality safety controls is assumed to fail. Therefore, one criticality safety control is required to be available for an AE.

For Evaluation Basis Events (OC-3), EG 4 does not apply because an EBE postulates the loss of controls resulting in a criticality accident.

The Nuclear Criticality Safety (NCS) program described in Section 5.2 documents the required NCS controls. Any exceptions to the double contingency principle are identified and discussed in Section 5.2.

Evaluation Guideline 5 (EG 5)

The purpose of EG 5 is to identify controls required to ensure normal operations are conducted within the assumptions and initial conditions of the accident analysis.

Evaluation Guideline 6 (EG 6)

The purpose of EG 6 is to ensure a habitable environment for operations personnel to perform required manual safety actions in response to an initiating event. In accordance with the see and flee policy, operator actions are only assumed to reliably occur if they can be accomplished during evacuation of the area or if the operator is provided with personal protective equipment (PPE) such as breathing apparatus. As a result, the accident analysis evaluated "evacuation of the area" as a potential initiating event for all nuclear operations.

The safety of operations involving toxic (but non-nuclear) chemicals is provided through compliance with OSHA Process Safety Management (PSM) requirements. Therefore, Evaluation Guidelines for postulated chemical releases (e.g., flourine, chlorine) have not been established as part of EGs 1 through 6. In addition, specific controls for these operations are not specified through the accident analysis or facility-specific TSRs. The programmatic TSR on the chemical safety program requires that a chemical safety program be established, implemented, and maintained as described in Section 5.6. Section 5.6 includes a commitment to implementing the OSHA PSM requirements. A summary of the process for how potential hazards from chemical releases are evaluated and controlled is as follows:

1. Determine which chemicals exceed the process safety management (PSM) threshold values as defined in 29 CFR 1910.119.

2. For those chemicals that have values greater than the threshold values, evaluate and control the process in accordance with the 29 CFR 1910.119 requirements and determine the potential impact of releases on nuclear-related operations (see EG 6 for how this is evaluated).

3. For those chemicals that have values less than the threshold values, treat the hazard as a standard industrial hazard and determine the potential impact of releases on nuclear-related operations (see EG 6 for how this is evaluated).

4.2.2 Criteria for the Classification of Structures, Systems, and Components

Structures, systems, and components are either (1) important to safety or (2) non-safety. Important to safety SSCs are classified as either Q or AQ. Non-safety SSCs are identified as NS.

SSCs will be classified in accordance with the following criteria based on the initiating events analyzed. These criteria are applied to the results of the hazard and accident analyses to establish the level of quality to be applied to SSCs based on their relative importance to safety.

Category Q

Category Q structures, systems, and components are those important to safety SSCs that are necessary to prevent or mitigate the consequences of postulated accidents that could result in a member of the general public located offsite being exposed to:

- More than 25 rem total effective dose equivalent (TEDE) over the course of the event
- Inhalation of more than 30 mg of soluble uranium over the course of the event

These limits correspond to the guideline values established in EGs 1 and 2 for Evaluation Basis Events. See the discussion in Section 4.2.1.2.

Category AQ

Category AQ structures, systems, and components are those important to safety SSCs that:

- Are necessary to maintain an initial condition required to support the accident analysis
- Are necessary to prevent or mitigate the consequences of events that could result in life-threatening or serious health effects to onsite personnel from the release of radioactive materials
- Are necessary to meet the double contingency principle for the prevention of an accidental nuclear criticality
- Represent the single contingent control to prevent an accidental nuclear criticality where the double contingency principle is not met
- Are necessary to detect and alarm an accidental nuclear criticality
- Are necessary to mitigate the consequences of a fire (fixed fire suppression systems only)

- Are part of the cascade piping and equipment including UF6 process piping 2 inches and larger, expansion joints, valves, and process equipment that provide the UF_6 containment pressure boundary

- Are structures or portions of enrichment process facilities necessary to physically support process piping, equipment, and their support systems

Category NS

Category NS includes non-safety structures, systems, and components.

Refer to Section 3.15 for an identification of Q and AQ SSCs. Refer to the Quality Assurance Program Description in Volume 3 for the quality assurance requirements applied to Q and AQ SSCs.

4.2.3 Criteria for Technical Safety Requirement Selection

Technical Safety Requirements (TSRs) will be established as required by 10 CFR 76.87 to include safety limits, limiting control settings, limiting conditions for operation, design features, surveillance requirements, and administrative controls.

Based on the limiting initiating events analyzed in Section 4.3.2, a TSR limiting condition for operation will be established for each item meeting one or more of the following criteria:

1. An active structure, system, or component that prevents exceeding the EG 1 or EG 2 offsite evaluation guidelines for Anticipated Events and Evaluation Basis Events (see Table 4.2-2).

2. A process variable or operating restriction that preserves an initial condition for the analysis of an Anticipated Event or Evaluation Basis Event that could otherwise exceed the EG 1 or EG 2 offsite evaluation guidelines.

3. An active structure, system, or component that prevents or mitigates an event that could result in life-threatening or serious health effects to onsite personnel from the release of radioactive materials.

4. A single contingent control to prevent an accidental nuclear criticality where the double contingency principle is not met.

5. Installed instrumentation that is used to detect and alarm an accidental nuclear criticality.

Refer to the individual accident scenarios in Section 4.3.2 for an identification of essential controls that require TSRs.

4.2.4 Hazard Screening and Threshold Analysis

In addition to the Evaluation Guidelines, screening thresholds were established as part of the hazard analysis to distinguish the different levels of analysis and the level of documentation necessary to support a graded approach. Table 4.2-3 summarizes the screening thresholds and the level of documentation used for the hazard analysis. The consequences listed in Table 4.2-3 assume that no mitigation is provided. The basis for each of the thresholds is provided below.

Preliminary hazard screening (PHS) threshold. The PHS threshold uses the reportable quantity values in 40 CFR 302, Table 302.4, plus those in Appendix B of 40 CFR 302. These values establish the lowest threshold of concern for the hazard analysis process.

Process hazard analysis (PrHA) threshold. The PrHA radiological threshold uses the inventory of radiological materials specified in Appendix A of DOE-STD-1027-92 (Reference 2) for Category 3 facilities. For nonradiological hazards, the PrHA screening threshold is not easily based on a threshold quantity of material because of the different types of hazards that could be present and the different consequences that could result. Therefore, the nonradiological PrHA screening threshold is considered exceeded when a release of the applicable nonstandard hazard could result in life-threatening or serious health effects in the vicinity of the event. This threshold limits the hazard and unmitigated consequences to a value at which operating personnel are capable of evacuating the area and minimizes the risk of serious health effects caused by a release of the hazard. This threshold also considers that operating personnel are trained in the type of operation they are asked to perform and the hazards involved in accordance with OSHA standards and regulations and the plant procedure and training program.

Plant safety operational analysis (PSOA) threshold. The PSOA threshold is established to ensure that any hazard that can result in potentially significant onsite consequences (i.e., significant consequences beyond the immediate area) or offsite consequences is evaluated in detail to establish controls that may prevent exceeding the EGs. The PSOA radiological and nonradiological thresholds for offsite consequences are the same as the EGs for the Anticipated Event frequency category. The PSOA onsite radiological threshold was established by using the inventory of radiological materials specified in Appendix A of DOE-STD-1027-92 for Category 2 facilities as well as the EG for the Anticipated Event frequency category. Nonradiological health effects were established to ensure that a detailed analysis is performed of initiating events and hazards that could result in life-threatening or serious health effects beyond the immediate area of the facility.

These thresholds, in combination with the EGs, aided in ensuring that a consistent level of analysis was applied to various types of hazards and that a graded approach was used based on the potential unmitigated consequences associated with the hazards of concern. Different levels of analysis are provided depending on which thresholds are exceeded. The different levels of analysis, methods for performing the analysis, and documentation requirements are described in Section 4.2.5.1.

4.2.5 Hazard Analysis Methodology

Hazard analysis is the process of identifying facility hazards and evaluating potential initiating events, consequences that may result from accidents involving these hazards, and controls that can be

used to prevent or mitigate the consequences. The hazard analysis was divided into two parts: hazard identification and hazard evaluation.

Hazard identification involved selecting those facilities that possess nonstandard industrial hazards that present a threat to the health and safety of on-site workers or the general public. Hazard identification also involved determining which hazards require more detailed analysis based on the consequence screening criteria. Hazards that were not "screened out" in this process were subject to hazard evaluation.

Hazard evaluation involved qualitatively determining the unmitigated consequences of potential accidents involving a given hazard, the initiating events for the accident, the frequency of the initiating events, and controls that can be used to prevent or mitigate the initiating events. The unmitigated consequences were compared with threshold consequence values to determine whether more detailed accident analysis may be required. The hazard analysis (1) documented the hazards of concern, (2) determined the initiating events and consequences, (3) identified controls to minimize potential consequences, (4) identified limiting initiating events that require more detailed analysis, and (5) selected controls that were determined to be AQ because of their importance in the event scenario for protecting onsite workers.

4.2.5.1 Hazard Identification

PGDP consists of many facilities and processes. The first step of the hazard analysis was to identify the plant facilities and track each facility for evaluation. Figure 4.2-1 outlines the steps in the hazard identification task.

The hazard analysis involved identifying facilities with nonstandard industrial hazards that may threaten onsite workers or the offsite public. Because many facilities have only standard industrial hazards encountered elsewhere in industry, a screening process was used to focus on the nonstandard industrial hazards. The Preliminary Hazard Screening (PHS) was this initial screening process. In the PHS process, the PHS screening threshold from Table 4.2-3 was used to determine whether a facility "screens in" or "screens out." The first step of the PHS was a brief examination of the facilities to identify those that obviously exceed the PHS threshold. These facilities were automatically screened in to the next level of analysis without any additional review or screening. The remaining facilities were evaluated using the PHS thresholds listed in Table 4.2-3. If the threshold values associated with the various hazards were not exceeded, no additional analysis was required. If one or more of the hazards in a facility exceeded a threshold value, then the facility required additional review, and completion of the PHS form was not required. The PHS process provides the safety analysis documentation for the facilities that screen out.

The next step of the hazard identification process was to establish a hazard category for the facility in accordance with DOE-STD-1027-92. This standard provides a categorization of nuclear facilities (Categories 1, 2, and 3; Category 1 is the highest-hazard category) based on inventory of radiological material. Hazard categorization was also used as input to applying the graded approach. If the facility did not exceed the Category 3 threshold quantities listed in DOE-STD-1027-92 and if it

exceeded the PHS threshold for radiological material, the facility was categorized as a "radiological" facility.

The final step of the hazard identification task was to determine the facilities that exceeded the PrHA threshold. The analysis statement level of documentation indicated in Table 4.2-3 was applied to the facilities that exceeded the PHS threshold but did not exceed the PrHA threshold. This level of documentation was typically used for facilities that exceeded the low PHS threshold but have no release mechanisms that could cause any significant health effects to onsite or offsite personnel. Typically, these facilities were reviewed to determine whether the hazard was controlled by existing facility safety management programs. If the hazard was controlled, a statement was provided to document this decision in the PrHA for the facility, and no additional analysis was required for the facility. If the hazard was not controlled, the facility progressed to the hazard evaluation task described in Section 4.2.5.2.

To summarize, the final product of the hazard identification task was a listing of facilities that contain hazards exceeding the PrHA threshold and that have a radiological hazards categorization. Nonstandard industrial hazards that required additional analysis were identified by comparing their potential unmitigated consequences with PHS and PrHA threshold values (Table 4.2-3). This set of facilities was analyzed in the hazard evaluation task described in Section 4.2.5.2.

4.2.5.2 Hazard Evaluation

Hazard evaluation is the process of identifying initiating events that can lead to accidents involving the hazards screened in from the hazard identification process (Section 4.2.5.1), qualitatively determining the consequences of such accidents, estimating the initiating event frequencies, comparing the consequences with threshold values, and identifying the controls needed to prevent such accidents or to mitigate their consequences. The objective of this process was to identify AQ SSCs and the limiting initiating events that could exceed EGs. Because of its importance to the accident analysis, the selection of limiting initiating events is presented separately (Section 4.2.5.3). The process used for the hazard evaluation was called Process Hazard Analysis (PrHA) and is outlined in Figure 4.2-2. The PrHA was a largely qualitative process for evaluating hazards that exceed the PrHA threshold as determined during the hazard identification process. One of several evaluation techniques were used for the PrHA, depending on the complexity of the process. The evaluation technique includes justification. The PrHA identified the initiating events and hazard combinations that could result in consequences that exceed the PSOA thresholds listed in Table 4.2-3.

In the first step of the hazard evaluation process, an appropriate analysis technique was determined and applied to the facility and its associated hazards. Several standard techniques are well documented in the industry and provide acceptable methods for performing a PrHA. Some of these analysis techniques include What If, Checklist, Hazard and Operability Analysis (HAZOP), Fault Trees, and Failure Modes and Effects Analysis. The type of analysis selected depended on the hazards present and the complexity of the facility.

The second step of the PrHA process was to evaluate the hazards present that, if released, could exceed the PrHA threshold. Any facility operations and/or controls that could be used to prevent or mitigate an initiating event were also identified. Facility safety programs were also considered and

included as potential controls for prevention and mitigation. For hazards related to nuclear criticality, the PrHA identified criticality as a hazard of concern and relied on the Nuclear Criticality Safety (NCS) Program (see Section 5.2) to evaluate the hazards related to accidental criticality. The NCS Program is responsible for identifying the controls necessary to address the double-contingency principle for criticality safety. For fire-related hazards associated with the facility or process, the PrHA identified any specific controls deemed necessary to prevent a fire from causing a significant release of the hazard(s). The Fire Protection Program [which includes an on-site fire department (see Section 5.4)] is responsible for ensuring that sufficient preventive and mitigative controls are in place to minimize the risk of a fire-related event. In addition, for areas with a criticality concern, fire-fighting techniques in these facilities are coordinated with the NCS Program.

The next step of the hazard evaluation process was to develop the following information for each hazard that, if released, could result in unmitigated consequences exceeding the PrHA threshold:

- Process parameter of interest
- Initiating events
- Initiating event frequencies (Table 4.2-1)
- Qualitative consequence categories (Table 4.2-4)
- Preventive and mitigative controls
- Threshold analysis

Providing this information for all PrHAs provided consistency in the analysis results independent of the analysis method (e.g., What If, HAZOP) chosen.

The preventive and mitigative controls identified in the PrHA provide an indication of the defense-in-depth provided by the facility for potential accidents. Programs and plans were also used in the PrHA process to provide preventive and mitigative functions in addition to the facility SSCs. These programs and plans include the Nuclear Criticality Safety Program, Radiation Protection Program, Chemical Safety Program, Fire Protection Program, Emergency Plan, Quality Assurance Program Description, etc. They may apply to any facility in which a relevant hazard is identified, and they provide administrative controls to support defense-in-depth. The programs and plans and their purposes are described in SAR Chapter 5 and Volume 3 of the Certification Application.

To summarize, hazard evaluation resulted in the identification of controls that can help prevent and/or mitigate the consequences of the postulated initiating events. These controls were then reviewed and a summary of their importance to the hazard analysis is presented in Section 4.2.6. Next, the criteria outlined in Section 4.2.2 were used to determine which controls should be classified as AQ. Those

controls that require coverage in the TSRs were then determined using the criteria outlined in Section 4.2.3. Initiating events that resulted in accidents that could exceed a PSOA threshold are also identified as possible limiting initiating events and are evaluated as described in Section 4.2.5.3.

4.2.5.3 Accident Selection

The objective of the accident selection portion of the hazard evaluation was to identify a representative set of events for accident analysis. This representative set of events is termed "limiting initiating events" in the remainder of this analysis. Defining the limiting events required consideration of all actions made in response to each initiating event without any mitigative action. If an initiating event could result in a parameter change that might lead to an accident scenario which exceeds any EG, this initiating event is a candidate for a limiting event. For each unmitigated initiating event that could lead to exceeding an EG, the following guidelines were used to determine the set of limiting events:

- The initiating events which result in the most limiting change in a process parameter of interest for each frequency category were selected.

- If different facility protection methods were provided for the same process parameter of interest, a limiting event for each frequency category, each parameter of interest, and each facility protection method was selected.

The process for determining the limiting initiating events consisted of five steps (Figure 4.2-3):

1. Develop facility operating modes

2. Identify specific hazard states for each hazard

3. Develop operating mode-hazard-hazard state matrix

4. Develop initiating event-operating mode-hazard-hazard state matrix

5. Select and define limiting initiating events

The development of specific facility operating modes was key to accomplishing this part of the analysis. These operating modes are also used in the TSRs. These modes were used to ensure that all combinations of operations, hazards, and equipment configurations were considered.

The next step of the process was to define the hazard states for each of the hazards that could result in the PSOA threshold being exceeded. For some hazardous materials, the physical state (e.g., solid, liquid, gas) has a direct bearing on the potential consequences should a release occur. Therefore, identification of the hazard state(s) of interest was required. UF_6 is a primary hazard of interest for the GDPs, and its physical state has a significant impact on potential consequences. The quantity of material at risk was determined by the normal operating mode and the initial conditions at the time of the event.

Once the operating modes and hazard states were identified, a matrix was defined that identified the hazard and hazard state(s) applicable to each operating mode. This matrix was based on facility operations and discussions with facility personnel. This matrix was used to ensure that each initiating event considered the hazard condition and operating condition that could be applicable.

Initiating events from the PrHA that could exceed the PSOA consequence thresholds (Table 4.2-3) were considered with each operating mode and hazard state for which they were applicable. This information was used to develop the combinations as illustrated in the example in Table 4.2-5. This matrix, which includes the operating modes, hazard states, and initiating events along with the process parameters of interest, provides a systematic method of identifying the complete spectrum of hazards,

hazard states, operating modes, and initiating events that may result in accidents with consequences of interest. The hazard matrix provides the foundation for detailed analysis to determine the TSRs, system classifications, and accident analyses. Each specific combination required analysis to determine whether protective action is required to prevent exceeding an Evaluation Guideline. An example of one combination taken from Table 4.2-5 follows:

- Process parameter of interest—pressure increase.
- Initiating event—steam control valve fails to open.
- Operating modes—open/out of service, containment, autoclave closed, and heating/feeding/ heeling.
- Hazard state for each mode—all states for each operating mode.

The matrix combinations were evaluated to determine the minimum set of controls that could prevent exceeding the Evaluation Guidelines should the event occur. The combination that results in the most severe consequences (i.e., bounds all other initiating events by consequence) is identified as the limiting initiating event for that combination.

Each combination of initiating event, hazard state, and operating mode was reviewed as described for the operational analysis task (Section 4.3.1.1). Defining the limiting initiating events for a facility required consideration of the integrated response of the facility to each initiating event without any mitigative action. If the initiating event could result in a parameter change with unmitigated consequences that exceed any Evaluation Guideline for the applicable frequency category, the initiating event was a candidate for a limiting initiating event. The definition of a limiting initiating event described above was used to finalize the set of limiting initiating events. The resulting set of limiting initiating events was subjected to the detailed accident analysis described in Section 4.3.2. Initiating events that exceed the PSOA thresholds and are not limiting initiating events are documented in the analysis for the facility with justification provided for them—being bounded by the limiting events along with the controls necessary to support meeting the Evaluation Guidelines.

4.2.6 Hazard Analysis Results

This section presents the results of the hazard analysis. Most of the results are given in summary form. Details of the analyses are provided in the PrHA reports for the respective facilities.

One of the key elements of the hazard analysis was to identify historical events that resulted in accidents of interest. Table 4.2-6 identifies historical release events from 1961 through 1993 at all three GDP sites. Historical release events as well as discussions with operational personnel were a key input to all of the hazard analyses.

A comprehensive listing of all facilities that were included in the hazard analysis is presented in Table 4.2-7. The table shows the level of analysis that was applied to each facility based on the graded approach. It indicates whether a facility required a PHS, PrHA, and/or PSOA review. The hazard categorization based on DOE-STD-1027-92 is also presented. Facilities that were screened out by the PHS did not receive any additional review and are not addressed in the following sections. Facilities that exceeded PHS thresholds but did not exceed PrHA thresholds are documented by an analysis statement (Table 4.2-8). The analysis statement serves as the safety analysis for these facilities, and they are not

analyzed any further in the hazard evaluation. All facilities that exceeded PrHA thresholds are reviewed in detail in the hazard evaluation.

4.2.6.1 Hazard Identification

The hazard identification task involved reviewing the facilities listed in Table 4.2-7 and comparing them against the PHS threshold values in Table 4.2-3. The facilities identified by a "Yes" in the "PHS screen in?" column, exceeded the PHS screening threshold. Facilities that exceeded the PHS threshold but did not exceed the PrHA thresholds in Table 4.2-3 were documented by analysis statement. The remaining facilities, identified by a "Yes" in the "PrHA required?" column of Table 4.2-7, contained hazards that exceeded the PrHA thresholds and were examined in the PrHA review.

Table 4.2-9 presents the facilities and their associated processes that contain hazards that exceeded the PrHA threshold values. The facilities are grouped together by process and by the types of hazards identified for those facilities. The Cascade Facilities Group includes facilities involved with the main cascade process and supporting systems. The principal hazards identified for these processes are uranium hexafluoride (UF_6), fluorine (F_2), chlorine trifluoride (ClF_3), and light cascade gases (e.g., combinations of coolant, ClF_3, F_2). Some waste storage areas may also be located in the process buildings in addition to the cascade processes. The UF_6 Handling and Storage Facilities Group includes facilities involved with the autoclave, withdrawal, and cylinder handling and storage operations. The principal hazard here is UF_6. The Toxic Gas Storage and Distribution Group involves processes that store and/or distribute F_2, chlorine (Cl_2), or ClF_3. The Miscellaneous Waste Storage and Handling Facilities Group includes facilities involved with radioactive waste (radwaste) and uranium-bearing compounds. These facilities may also contain mixed wastes, Resource Conservation and Recovery Act of 1976 (RCRA) waste, and Toxic Substances Control Act of 1976 (TSCA) waste. The Miscellaneous Support Facilities Group includes facilities that do not fall into the other groups. Hazardous chemicals in this group include nitric acid, sulfuric acid, hydrochloric acid, and hydrofluoric acid. Note that other types of industrial hazards may be present in these facilities, but they do not exceed the PrHA threshold values in Table 4.2-3 and are therefore not considered in this analysis except as potential initiators.

4.2.6.2 Hazard Categorization

Hazard categorization in accordance with DOE-STD-1027-92 was performed during the PHS (i.e., hazard identification) portion of the hazard analysis. The facility hazard categories are indicated in Table 4.2-7. The breakdown of facilities by hazard categorization is presented in Table 4.2-10.

4.2.6.3 Hazard Evaluation

The detailed results of the hazard evaluation for the hazards identified in Table 4.2-9 are documented in the PrHA reports for the respective facilities. A summary of the results is presented in the following subsections for facility groupings listed in the table. The evaluation of processes that present a potential nuclear criticality safety hazard is provided in Section 5.2, Appendix A.

4.2.6.3.1 Initiating Events

Table 4.2-11 summarizes the initiating events identified in the hazard analyses for each of the groups identified in Table 4.2-9. The initiating events are arranged according to the affected parameter of interest (e.g., criticality control, external event, pressure increase, primary system integrity). Table 4.2-11 provides a summary of the accidents postulated in the PrHA. For example, the event "autoclave steam control valve fails open" can result in a pressure increase in a UF_6 cylinder located in an autoclave. This event is an anticipated event (AE) that could result in significant off-site radiological and nonradiological consequences if no mitigation is provided. Because this event could result in the PSOA threshold being exceeded, a PSOA is required to provide additional analysis of this specific event. The initiating events that can exceed PSOA thresholds are indicated in Table 4.2-11. These events were evaluated to determine which ones result in the most limiting accidents as described in the applicable sections below. The table shows the initiating events and frequency category, indicates whether the PSOA threshold could be exceeded, and identifies which events are limiting events.

4.2.6.3.2 Threshold Analysis

Based on the initiating events identified, a set of release scenarios was developed for the different types of facilities to bound the range of possible releases. Some of these events were not considered credible but were evaluated to provide input to the hazard analysis consequence categorization. These scenarios were used, along with operational experience and engineering judgment, to assign consequence categories (Table 4.2-4) for the various events. The threshold analysis scenarios delineated here may not reflect the exact, more specific, scenarios and supporting analyses that were developed for the accident analyses presented in SAR Section 4.3. A brief description of the scenarios is provided here; a summary of the threshold analysis results is provided in Table 4.2-12.

Open valve on a solid cylinder. The scenario of an open valve on a solid cylinder involves a cylinder containing solid UF_6 at its triple point. This consideration maximizes the amount of UF_6 released from a cylinder in the solid state. It was conservatively assumed that all of the gaseous UF_6 present in the cylinder [about 60 lb (27 kg)] would be released. However, only about 20 lbs (9.5 kg) of gaseous UF_6 would be released prior to the cylinder reaching atmospheric pressure. Because this conservative amount is small relative to all of the other cases, this release was judged not to have any off-site impact, and no dispersion study was performed for this case.

Open valve on a liquid-filled cylinder, 6 o'clock position. In the scenario of an open valve on a liquid-filled cylinder, 6 o'clock position, the cylinder is in a horizontal position with the valve pointing down. The UF_6 is released as a liquid that flashes to a mixture of vapor and solid at atmospheric pressure.

Open valve on a liquid-filled cylinder, 12 o'clock position. In the scenario of an open valve on a liquid-filled cylinder, 12 o'clock position, the cylinder is in a horizontal position with the valve pointing up. Two scenarios were analyzed: (1) the liquid level is above the valve location, resulting in an initial

release of liquid UF_6 that flashes to a vapor and solid mixture at atmospheric pressure followed by a pure vapor release and (2) the liquid level is below the valve location, resulting in a release of only vapor.

Broken pigtail during parent-daughter transfer. The scenario of a broken pigtail during parent-daughter transfer occurs during a transfer of liquid UF_6 from a 48X parent cylinder to a 30B daughter cylinder. Both cylinders are horizontal and contain UF_6 at 235°F. The parent cylinder valve is in the 6 o'clock position and the daughter cylinder valve in the 12 o'clock position. The liquid level in the daughter cylinder is assumed to be below the valve opening. Therefore, the release from the parent cylinder consists of a mixture of vapor and solid UF_6 flashing, whereas the release from the daughter cylinder is only pure vapor.

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Broken pigtail during withdrawal. The scenario of a broken pigtail during withdrawal involves a broken pigtail in the line from the accumulator to the cylinder. Liquid UF_6 from the accumulator escapes through the broken pigtail, flashing to a mixture of vapor and solid at atmospheric pressure. Simultaneously, there is a vapor release from the cylinder, which has a liquid level below the break. Two scenarios are assumed: (1) both vessels remain open to the ruptured pigtail for the full duration of the release and (2) the accumulator valve is closed after 1 min of liquid release. The vapor from these releases is assumed to exit the process building through open bay doors.

Broken withdrawal compressor discharge. The scenario of broken withdrawal compressor discharge involves a continuous vapor flow from the compressor and a flashing liquid release from the condenser/accumulator until it is empty. The compressor discharge is located in the process building; therefore, the vapor must pass through the building ventilation system. This provides some holdup time, some dilution, and some uranyl fluoride (UO_2F_2) deposition. The UF_6 completely reacts within the building, and the undeposited material is vented at the process building roof.

B-line failure at maximum power. The scenario of B-line failure at maximum power assumes a circumferential break of the B-line with the highest flow rate in the process buildings. The UF_6 reacts with the moist air and forms UO_2F_2 and hydrogen fluoride (HF). The analysis modeled the release from the building and subsequent dispersion. The analysis of the flow from the line continues until the guideline values are reached at the site boundary.

Release from an isolated cell. The scenario of release from an isolated cell involves an isolated cascade cell with the maximum inventory of UF_6. The evaluation for this case assumed that the cell coolant system ruptured into the primary system and caused an overpressurization, resulting in a release of the cell contents into the process building. The UF_6 reacts with the moist air and forms UO_2F_2 and HF. The analysis modeled the release from the building and subsequent dispersion.

Tie-line failure at maximum power. The scenario of tie-line failure at maximum power assumes a circumferential break of the tie-line with the highest flow rate from the process buildings. The consequences were evaluated to determine whether this type of failure could have off-site impact. The UF_6 reacts with the moist air and forms UO_2F_2 and HF. The analysis modeled the release from the line and subsequent dispersion. The analysis of the flow from the line was conservatively assumed to continue until the guideline values are reached at the site boundary.

The analysis did not identify any initiator other than natural pheonomena related events for the failure of the tie lines outside the process buildings. For a tie line failure due to natural phenomena, see the external events analysis in Section 4.3.2.5. All other process related gaseous releases were considered bounded by the large release of gaseous UF_6 to atmosphere evaluated in Section 4.3.2.1.7. Therefore, this event type was not considered further.

Source terms for these release scenarios were calculated. Dispersion analyses were performed to estimate the duration of an unmitigated release necessary to exceed EGs. The resulting release durations from the threshold analysis are summarized in Table 4.2-12.

4.2.6.3.3 Preventive/Mitigative Controls

The PrHA also identified the facility controls (procedural and equipment) that can be used to prevent and/or mitigate the initiating events or minimize the consequences of the resulting accidents. The only safety classification that could be made as a result of the PrHA is AQ. The remaining classifications are based on the results of the accident analysis described in Section 4.3. Detailed technical bases for the safety classifications are presented in Section 3.15. In addition to process-specific controls, programs and plans are identified in the PrHA and play an important role in providing worker safety for many of the events evaluated. These programs and plans are described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.3.4 Accident Selection

Accidents selected for the accident analysis are defined by the set of limiting initiating events determined in the hazard evaluation. The limiting initiating events were selected from the events that exceed the PSOA threshold as indicated in Table 4.2-11. The process for selecting the limiting initiating events is described in Section 4.2.5.3.

Operating modes. A review of operations identified normal operating modes for the various processes that had events exceeding the PSOA threshold. These operating modes, described in the TSRs, are used to address potential operations for the defined processes and to develop the limiting initiating events. The modes are not mutually exclusive; operations within a facility may simultaneously involve more than one mode. For example, when one cell is in *above atmospheric pressure operating* mode, another cell may be in *below atmospheric pressure operating* mode.

Hazard states. The analysis of normal operation and initiating events must include evaluation of each mode of operation in combination with the hazard states that may be present during that mode. Hazard states for all hazards were identified as solid, liquid, and gas. Where one hazard state is present with another (e.g., gaseous UF_6 is always present with both liquid and solid UF_6), only one of the hazard states is associated with the analysis, but both conditions are considered in establishing the consequences.

Operating mode-initiating event-hazard state matrix. The consequences of unmitigated initiating events were compared with the PSOA screening thresholds to determine whether an event is carried forward to the PSOA. The comparison of the consequences with the PSOA screening thresholds (Table 4.2-3) is provided in the PrHA reports. The evaluation resulted in the set of initiating events indicated in Table 4.2-11.

Limiting initiating events. The set of the initiating events in Table 4.2-11 that were carried forward to the PSOA were evaluated to determine which of these events place the most demand on an essential mitigative system in each initiating event frequency category. Table 4.2-11 indicates the limiting

initiating events that are evaluated in detail in Section 4.3.2. The evaluation resulted in a set of limiting events, denoted by a "Yes" under "Limiting event?" in Table 4.2-11.

Detailed descriptions of the accident scenarios associated with these limiting initiating events are presented in Section 4.3.2. Sections 4.2.6.4 through 4.2.6.8 present an overall summary and characterization of the hazard evaluation results for the facility groupings given in Table 4.2-9.

4.2.6.4 Cascade Facilities Group

The Cascade Facilities Group consists of the process buildings (C-331, C-333, C-335, C-337, C-310, and C-315) and the associated tie lines (C-310-331, C-310-410, C-315-331, C-331-333, C-331-335, C-331-410, and C-335-337). The principal hazards identified for this group are UF_6 and its reaction products, toxic gases (ClF_3 and F_2), light cascade gases (e.g., combinations of coolant, ClF_3, F_2), and miscellaneous waste storage areas. The miscellaneous waste storage areas are addressed in the group for waste storage (Section 4.2.6.7). Because these are complex facilities that contain a significant hazard, the principle hazard evaluation performed for the cascade facilities involved a more detailed analysis method. This hazard evaluation combined an operational review, the What If method, and the PSOA approach to evaluate potential initiating events and consequences. A separate hazard evaluation was performed for the cascade facilities to focus on shutdown scenarios. This hazard evaluation combined a failure modes and effects analysis and event tree sequence analysis to identify potential accident sequences and consequences. The following discussion summarizes the results of these hazard evaluations for UF_6 in these facilities.

4.2.6.4.1 Process Definitions

The enrichment and purge cascades include the cascade auxiliary equipment (e.g., booster systems, surge systems, coolant systems, seal systems, seal exhaust systems, wet air evacuation systems, datum systems) that supports the operation of the cascades. In addition to the cascades, the enrichment and purge cascade facilities also include the following processes that provide support for the operation of the main cascades:

- Freezer/Sublimer (F/S) Process.
- 5.5 wt.% UF_6/R-114 Separation Process.
- Toxic Gas Distribution Process.

The F/S Process consists of F/S vessels and associated support equipment. These vessels are installed in various locations within C-333 and C-337 to allow excess UF_6 inventory to be rapidly removed from the cascade by freezing it in storage vessels and then returning it to the cascade by sublimation when required. Cascade inventory adjustments may periodically be required to accommodate changes in the available power. F/Ss are strategically located where they can be independently or jointly

operated to remove excess UF_6 inventory, to conduct emergency power drops, or to adjust the power load to maximize production.

The 5.5 wt.% UF_6/R-114 Separation Process in C-335 removes UF_6 from process gas that has been contaminated with coolant. The gas is evacuated from the cascade to the surge drums. The UF_6 is then

separated out in a cold trap and in chemical traps (sodium fluoride and alumina) while the coolant is either vented to the atmosphere or reclaimed for re-use. The UF_6 is then sublimed to surge drums and returned to the cascade.

The Toxic Gas Distribution Process includes the distribution of ClF_3 and F_2/N_2 mixture within the C-310, C-331, C-333, C-337 and C-335 process buildings.

4.2.6.4.2 Hazards

The hazardous materials in the Cascade Facilities Group were reviewed to determine which needed to be evaluated in the PrHA and PSOA. The results of this review are indicated in Table 4.2-9. All the hazardous materials, except those indicated in the table, were characterized as being standard industrial hazards that are commonly found in industrial facilities. These were screened out from further analysis in the PrHA because the amounts of the material are insufficient to cause any significant local health effects. These hazards are adequately controlled by site administrative programs and plans, and no additional analysis was required.

The energy sources identified in the hazards analysis that have the potential for causing releases of hazardous materials are (1) steam energy used to heat the building, (2) electrical energy, (3) chemical energy from the reaction between UF_6 and a coolant/oxidant, (4) potential energy associated with the process building cranes and the lifting of heavy equipment, (5) kinetic energy associated with the process gas compressors and the various types of vehicles, (6) flammable materials (7) combustible materials (e.g., lube, hydraulic oil), and (8) compressed gases (e.g., coolant, nitrogen).

The Enrichment and Purge Cascade Facilities were categorized as Hazard Category 2 nuclear facilities because they contain quantities of the ^{235}U component of the UF_6 sufficient to exceed the threshold quantity for Hazard Category 2 in Table A.1 of DOE-STD-1027-92.

4.2.6.4.3 Parameters of Concern

The first step of the principle hazard evaluation was to identify potential initiating events associated with the Cascade Facilities Group to identify the process parameters that, if changed, could result in a release of the hazard that could exceed the screening thresholds for either PrHA or PSOA. The process parameter changes that could lead to a release of the hazards are (1) a temperature change in the primary system that exceeds the primary system temperature limits, (2) a pressure change in the primary system that exceeds the primary system pressure limits, (3) a failure in the primary system integrity, and (4) a loss of criticality safety controls.

Based on the groupings described, four process parameters should be addressed for each operating condition to ensure that potential types of events are considered in the hazard analysis. The potential ways of releasing hazardous materials that are caused by things such as energy sources and natural phenomena were evaluated for each operating mode to determine whether they might cause a

change in one of the four process parameters. Table 4.2-11 summarizes the different initiating events by parameter. These events were developed by considering operational history, operator input, and systematic evaluations.

The first step of the hazard evaluation associated with the shutdown scenarios was to identify the specific scenarios to be evaluated. The scenarios chosen for the evaluation included:

- Prompt total shutdown of a cell or multiple cells, a unit or multiple units, a partial building or complete building or multiple buildings with UF_6 inventory.
- Controlled shutdown of multiple cells, a unit or multiple units, a partial building or complete building or multiple buildings with UF_6 inventory.
- Controlled shutdown of multiple cells, a unit or multiple units, a partial building or complete building or multiple buildings following UF_6 evacuation.
- Shutdown of C-310 purge gas removal capability

The evaluation developed failure modes and effects analyses to identify failures that could initiate these scenarios and then analyzed the bounding initiating events via event trees to identify the range of potential scenario outcomes.

4.2.6.4.4 Summary of Results

As indicated in Table 4.2-11, the events considered for the Cascade Facilities Group included a wide range of process-related events, external events, shutdown scenarios, and controls for minimizing the potential risks. A brief summary of the hazard analyses are presented below for each process.

4.2.6.4.4.1. Enrichment Cascade

Table 4.2-11 identifies all of the events associated with the Enrichment Cascade Process that were considered in the hazard analyses. Thirteen of these events were identified as having the potential to exceed the PSOA threshold, with only one of these (stage control valve closure) not being a limiting event (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The primary administrative control identified for this process is to limit operating pressures for the cascade auxiliary equipment that processes UF_6 not including B Booster pumps. This equipment is maintained below atmospheric pressure to minimize releases of UF_6 should a failure in the primary system occur. In addition to the auxiliary equipment, a large portion of the Enrichment Cascade Process is also operated below atmospheric pressure. These portions of the cascade were not considered to have the potential to exceed the PSOA threshold except where the stage control valve closure event or the B-stream block valve closure event could still cause the pressures to increase above atmospheric pressure. In these cases, the PrHA does not postulate that a catastrophic rupture will occur due to the extended period of time to detect and mitigate the event. However, limited UF_6 releases (see Section 4.3.2.1.4) are possible during the transient due to the pressure increase. The remaining controls identified for the enrichment cascade

process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.4.4.2. Purge Cascade

The Purge Cascade Process is similar to the Enrichment Cascade Process (i.e., same type of equipment and initiators) but does not have any significant inventory of hazardous material that could

exceed the PSOA threshold except for criticality. Therefore, the analyses were very similar to that for the Enrichment Cascade Process where pressures remain below atmosphere.

4.2.6.4.4.3 Freezer/Sublimers

Table 4.2-11 identifies all of the events associated with the Freezer/Sublimer (F/S) Process that were considered in the hazard analyses. Seven were identified as having the potential to exceed the PSOA threshold, and all seven events were limiting events (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). During the freeze mode of operation, the primary concerns are to prevent overfilling and then applying heat to the vessel with excess UF_6 (overfilling could result in failure of the primary system due to heating during a subsequent sublime mode). Expansion of UF_6 from a solid to gas in the sublime mode could result in stress failure of the coolant tubes. This event was evaluated in the hazard analysis and was determined to cause only local effects. The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.4.4.4 5.5 Wt.% UF6/R-114 Separation

Table 4.2-11 identifies all of the events associated with the 5.5 wt.% UF_6/R-114 Separation Process that were considered in the hazard analyses. Only two of these events (criticality and evacuation) were identified as having the potential to exceed the PSOA threshold (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The primary administrative control identified for this process is to limit operating pressures to below atmospheric pressure to minimize releases of UF_6 should a failure in the primary system occur. The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.4.4.5 Toxic Gas Distribution

Table 4.2-11 identifies all of the events associated with the Toxic Gas Distribution Process that were considered in the hazard analyses. Only one of these events (evacuation) was identified as having the potential to exceed the PSOA threshold (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.5 UF_6 Handling and Storage Facilities Group

The UF_6 Handling and Storage Facilities Group consists of the feed vaporization buildings (C-333-A and C-337-A), the toll transfer and sampling facility and annex (C-360, 360-A), the withdrawal facilities (located in C-310 and C-315), and the cylinder storage yards (C-745-A, -B, -B1, -E, -H, -R, -Q, -U, and -V), and the cylinder changeout building located in the C-745-R yard. The principal hazard identified for this group is UF_6 and its reaction products. Because these are complex facilities that contain a significant hazard, the principle hazard evaluation performed for the liquid UF_6 facilities (i.e., C-333-A, C-337-A, withdrawal, C-360) involved a more detailed analysis method. This hazard evaluation combined an operational review, the What If method, and the PSOA approach to evaluate potential initiating events and consequences. A separate hazard evaluation was performed for the withdrawal facilities to focus on shutdown scenarios. This hazard evaluation combined a failure modes and effects analysis and event tree sequence analysis to identify potential accident sequences and consequences. The following discussion summarizes the results of these hazard evaluations for UF_6 in these facilities.

4.2.6.5.1 Process Definitions

The UF_6 Handling and Storage Facilities Group consists of liquid UF_6 handling facilities and large UF_6 cylinder storage and handling operations. These operations consist of equipment such as autoclaves, cranes, UF_6 compression equipment, condensers, piping, and other support equipment.

The C-360 toll transfer and sampling facility provides systems for the receiving, sampling, transferring, and shipping of cylinders containing UF_6. This facility provides all operations necessary for the fulfillment of enrichment service contracts with private industry. Toll product is withdrawn from the enrichment cascade into cylinders. Before the material can be shipped, it must be sampled on a statistical basis and/or transferred into cylinders approved for transport over highways and railways. Special shipping packages are used to protect the full product cylinders during shipment. In addition, feed material is received at this facility and must be determined on a statistical basis to meet feed composition and weight specifications. The C-360-A annex facility provides an area for handling and staging solid or empty 30B cylinders upon receipt or prior to shipping.

The feed facilities are used to supply UF_6 to the cascade. The C-333-A feed vaporization facility has eight feed-only autoclaves arranged in pairs. The C-337-A feed vaporization facility has 10 feed-only autoclaves arranged in pairs. Each facility has two overhead cranes that are used to transfer cylinders to and from the autoclaves.

The withdrawal facilities are used for withdrawing UF_6 from the cascade into cylinders. UF_6 is withdrawn from the cascade using the Normetex pumps. After being compressed, the UF_6 passes through the condensers and collects in the accumulators or drains into cylinders at the withdrawal stations. After the cylinders have been filled, an air-operated scale cart is used to move the cylinders from the withdrawal stations to a cooldown area. Cylinders remain at this facility until the UF_6 inside the cylinders solidifies. The cylinders are allowed to solidify on the scale cart, or they are moved by an overhead crane to a cooldown area.

The cylinder storage yards are open facilities for storing various sizes of cylinders mostly containing depleted UF_6. Also, in the C-745-R yard, a cylinder changout building provides a covered area for handling and staging empty/solid cylinders and overpacks upon receipt, prior to shipping, or during periods of inclement weather.

4.2.6.5.2 Hazards

The hazardous materials in the UF_6 Handling and Storage Facilities Group were reviewed to determine which needed to be evaluated in the PrHA and PSOA. The results of this review are indicated in Table 4.2-9. All the hazardous materials, except those indicated in the table, were characterized as being standard industrial hazards that are commonly found in industrial facilities. These were screened out from further analysis in the PrHA because the amounts of the material are insufficient to cause any significant local health effects. These hazards are adequately controlled by site administrative programs and plans, and no additional analysis was required.

The energy sources associated with the facility that have the potential for causing releases of the hazardous materials are (1) steam used to heat the autoclaves; (2) electrical energy used in heat tracing; (3) chemical energy from the reactivity of the UF_6; (4) potential energy associated with the lifting of cylinders; (5) kinetic energy associated with the various types of vehicles; (6) flammable material present during lube oil transfer operations (feed facilities only); (7) thermal energy associated with the steam used to heat the equipment enclosures for the compressors, coolers, accumulators, manifolds, and associated piping; and (8) kinetic energy associated with the compressors and Normetex pumps.

All facilities in this group were categorized as Hazard Category 2 nuclear facilities because they contain quantities of the ^{235}U component of the UF_6 sufficient to exceed the threshold quantity for Hazard Category 2 in Table A.1 of DOE-STD-1027-92.

4.2.6.5.3 Parameters of Concern

The first step of the principle hazard evaluation was to identify potential initiating events associated with the UF_6 Handling and Storage Facilities Group to identify the process parameters that, if changed, could result in a release of the hazard that could exceed the screening thresholds for either the PrHA or PSOA. The process parameter changes that could lead to a release of UF_6 are (1) a temperature change in the primary system that exceeds the primary system temperature limits, (2) a pressure change in the primary system that exceeds the primary system pressure limits, (3) a failure in the primary system integrity, and (4) a loss of criticality safety controls.

Based on the groupings described, four process parameters should be addressed for each operating condition to ensure that potential types of events are considered in the hazard analysis. The potential ways of releasing hazardous materials that are caused by things such as energy sources and natural phenomena were evaluated for each operating mode to determine whether they might cause a change in one of the four process parameters. Table 4.2-11 summarizes the different initiating events by parameter. These events were developed by considering operational history, operator input, and systematic evaluations.

The first step of the hazard evaluation associated with the withdrawal shutdown scenarios was to identify the specific scenarios to be evaluated. The scenarios chosen for evaluation included:

- Shutdown of C-310 product withdrawal capability
- Shutdown of C-315 tails withdrawal capability

The evaluation developed failure modes and effects analyses to identify failures that could initiate these scenarios, and then analyzed the bounding initiating events via event trees to identify the range of potential scenario outcomes.

4.2.6.5.4 Summary of Results

As indicated in Table 4.2-11, the events considered for UF_6 Handling and Storage Facilities Group included a wide range of process-related events, external events, shutdown scenarios, and controls for minimizing the potential risks. A brief summary of the hazard analysis is presented below for each process.

4.2.6.5.4.1 Toll Transfer and Sampling

Table 4.2-11 identifies all of the events associated with the Toll Transfer and Sampling Process that were considered in the hazard analyses. Fifteen were identified as having the potential to exceed the PSOA threshold, with only one of these (pigtail line failure inside autoclave) not being a limiting event (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure to on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The primary administrative controls identified for this process are associated with preventing a release of liquid UF_6 resulting from a cylinder or primary system failure. These controls are also addressed in the accident analysis. The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.5.4.2 Feed Facilities

The Feed Facilities Process is similar to the Toll Transfer and Sampling Process (i.e., same type of equipment and initiators). Table 4.2-11 identifies all of the events associated with the Feed Facilities Process that were considered in the hazard analyses. Fifteen of these events are identified as having the potential to exceed the PSOA threshold (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2).

4.2.6.5.4.3 Withdrawal Facilities

Table 4.2-11 identifies all of the events associated with the Withdrawal Facilities Process that were considered in the hazard analyses. Thirteen were identified as having the potential to exceed the PSOA threshold, with all these being limiting events (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Sec 4.3.2). The administrative controls for this facility were similar to those for the facilities

with autoclaves. The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.5.4.4 Cylinder Storage and Handling

Table 4.2-11 identifies all of the events associated with the Cylinder Storage and Handling Process that were considered in the hazard analyses. Only three were identified as having the potential to exceed the PSOA threshold, with all three (criticality, fire, and release of solid/gaseous UF_6 to atmosphere) being considered limiting events (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The primary administrative control for these facilities is not allowing any liquid UF_6 (in 2.5-ton cylinders and larger) to be handled outside the feed, withdrawal, and cylinder storage and handling processes described above. Other administrative controls for the Cylinder Storage and Handling Process include controls for the prevention of criticality so that no alarm coverage can be justified. These controls include the following requirements in addition to any controls described in Section 5.2:

- Cylinders containing $UF_6 \geq$ 1 wt % ^{235}U are inspected within one week of movement.
- Cylinders containing $UF_6 \geq$ 1 wt % ^{235}U are inspected every 4-years for abnormal corrosion products on the cylinder valve, cylinder plug, or cylinder wall.
- Cylinders containing $UF_6 \geq$ 1 wt % ^{235}U are spaced such that inspection can detect degradation of the integrity of the cylinder wall, valve, or plug.
- Cylinders containing $UF_6 \geq$ 1 wt % ^{235}U are stored off the ground in saddles that preclude rolling of the stored cylinders.
- Cylinders containing $UF_6 \geq$ 1 wt % ^{235}U are inspected for damage following occurrence of an evaluation basis earthquake at the site.
- Cylinders, which are discovered not to meet the inspection criteria, are handled commensurate with the observed damage.

In addition, the following administrative controls were identified for minimizing the potential for release of UF_6 during cylinder handling operations:

- Only approved cylinder handling equipment with qualified operators shall be used for the purpose of maneuvering UF_6 cylinders or other heavy loads.
- Cylinder handling equipment will be inspected (once per day when the equipment is used) to detect visible defects before it is used for lifting heavy loads.

If a breached cylinder containing UF_6 enriched to $\geq$ 1.0 wt. % ^{235}U is discovered during handling or inspection, the plant shift superintendent will be notified immediately so that appropriate action can be initiated. The cylinder will be covered within 2 hours to prevent entry of precipitation or water from any

source, and repairs will be affected in accordance with directions from nuclear criticality safety. Water will not be sprayed on a cylinder, which has been breached; however, CO_2 may be sprayed on the area of the breach to allow for patching. Personnel involved in the handling or repair of breached cylinders will be equipped with personal alarming dosimeters while working in close proximity to the affected cylinder (if the cylinder is not in an area with CAAS coverage).

The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.6 Toxic Gas Storage and Distribution Group

The Toxic Gas Storage and Distribution Group consists of facilities with large storage volumes and/or distribution lines containing the following toxic chemicals:

- Fluorine.
- Chlorine.
- Chlorine trifluoride.

The facilities and the applicable hazards that are associated with this group are indicated in Table 4.2-9. These facilities were not considered to be complex in their operation and control systems. Therefore the primary method of performing the hazard analysis was an operational review combined

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with the What If method to evaluate potential initiating events and consequences. The following discussion summarizes the results of the hazard evaluation for the hazards in these facilities.

4.2.6.6.1 Processes Definitions

As indicated above, the Toxic Gas Storage and Distribution Group is limited to the processes on the site that contain significant quantities of the hazards listed. These processes are located in various facilities. However, this analysis is limited to the primary storage locations and the distribution systems not associated with another facility. Table 4.2-9 lists the facilities associated with this group.

4.2.6.6.2 Hazards

As indicated above, analysis of the Toxic Gas Storage and Distribution Group is limited to the hazards listed. Other hazards located in these facilities (e.g., sulfuric acid) were evaluated with these processes, but any hazards identified were considered standard industrial hazards.

The energy sources that could be associated with these processes that have the potential for causing releases of the hazardous materials are (1) electrical energy, (2) chemical energy from the reactivity of the potential hazards, (3) potential energy associated with the cranes and the lifting of heavy equipment (e.g., cylinders, containers), (4) kinetic energy associated with the various types of vehicles, (5) flammable materials, (6) combustible materials, and (7) compressed gases (e.g., ClF_3).

These facilities did not contain any radiological material and therefore were not categorized according to DOE-STD-1027-92.

4.2.6.6.3 Parameters of Concern

The first step in identifying potential initiating events associated with the Toxic Gas Storage and Distribution Group was to identify the process parameters that, if changed, could result in a release of the hazard that could exceed the screening thresholds for either the PrHA or PSOA. The process parameter changes that could lead to a release of toxic material are (1) a concentration increase, (2) external event, (3) a flow increase, (4) pressure decrease, (5) pressure increase that exceeds primary system pressure limits, and (6) a failure of the primary system integrity.

Based on the groupings described, six process parameters should be addressed for each operating condition to ensure that potential types of events are considered in the hazard analysis. The potential ways of releasing hazardous materials that are caused by things such as energy sources and natural phenomena were evaluated for each operating mode to determine whether they might cause a change in one of the five process parameters. Table 4.2-11 summarizes the different initiating events by parameter. These events were developed by considering operational history, operator input, and systematic evaluations.

4.2.6.6.4 Summary of Results

As indicated in Table 4.2-11, the events considered for the Toxic Gas Storage and Distribution Group included a wide range of process-related events, external events, and controls for minimizing potential risks.

The six different parameter changes were reviewed for this hazard analysis. Table 4.2-11 identifies all of the events associated with the Toxic Gas Distribution Process that were considered in the hazard analyses. Twelve were identified as having the potential to exceed the PSOA threshold, with five of these being considered limiting events (Table 4.2-11). However, consistent with 10CFR76.85, because these events do not cause a release of radioactive materials, no further discussion is provided in this SAR. The administrative controls for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application, with special emphasis on the Chemical Safety Program [which includes the Process Safety Management (PSM) Program]. The controls identified as being AQ are described in Section 3.15. Application of the PSM is based on the requirements and is not necessarily applicable to all of these processes.

4.2.6.7 Miscellaneous Waste Storage and Handling Facilities Group

The facilities and the applicable hazards that are associated with the Miscellaneous Waste Storage and Handling Facilities Group are indicated in Table 4.2-9. In addition to the facilities that are presently dedicated to storing waste materials, several staging, temporary, and long-term storage areas are also located in different facilities. Therefore, this section addresses typical waste storage and handling operations for different waste classifications. Specific analyses were performed for each facility and are documented in the PrHAs. However, the analyses were considered to be generic in their application regardless of where the waste is stored. Therefore, specific facilities will not be addressed in this section. These facilities were not considered to be complex in their operation and control systems. Therefore, the primary method of performing the hazard analysis was an operational review combined with the What If method to evaluate potential initiating events and consequences. The following discussion summarizes the results of the hazard evaluation for the hazards in these facilities.

4.2.6.7.1 Processes Definitions

As indicated above, the Miscellaneous Waste Storage and Handling Facilities Group is limited to the processes on the site that are used for the storage and handling of waste. These processes are located in various facilities. However, this analysis is limited to the primary storage locations. Table 4.2-9 lists the facilities associated with this group.

4.2.6.7.2 Hazards

The hazardous materials in the Miscellaneous Waste Storage and Handling Facilities Group were reviewed to determine which needed to be evaluated in the PrHA and PSOA. The results of this review

are indicated in Table 4.2-9. All the hazardous materials, except those indicated in the table, were characterized as being standard industrial hazards that are commonly found in industrial facilities. These were screened out from further analysis in the PrHA because the amounts of the material are insufficient

to cause any significant local health effects. These hazards are adequately controlled by site administrative programs and plans, and no additional analysis was required.

The energy sources that could be associated with these processes that have the potential for causing releases of the hazardous materials are (1) electrical energy, (2) chemical energy from the reactivity of the potential hazards, (3) potential energy associated with the cranes and the lifting of heavy equipment (e.g., containers), (4) kinetic energy associated with the various types of vehicles, (5) flammable materials, and (6) combustible materials.

Facilities in this group were categorized as Hazard Category 2 nuclear facilities if they contained more than 700 g of fissionable material and if the following conditions were met:

- A nuclear criticality safety approval [NCSA (see Section 5.2)] is required for the facility in accordance with plant procedures.
- The NCSA establishes essential restrictions to control the fissionable material within the facility (i.e., controls to prevent entry of material into the facility do not meet this restriction) based on the operations to be performed in the facility.
- The restrictions established by the NCSA are not surveillance items associated with ensuring that the facility never exceeds the allowable limits (e.g., so many grams of ^{235}U per container) that need no controls within the facility.
- There is no documented exemption for requiring criticality accident alarm system (CAAS) coverage to the area.

Fissionable material is defined as any material in which a self-sustaining, neutron-induced fission chain reaction can occur. Nearly all the fissions in such a chain reaction are of the fissionable nuclides (e.g., ^{233}U, ^{235}U, or ^{239}Pu) contained in the fissionable material. The remaining facilities containing contaminated waste were categorized as indicated in Table 4.2-7. All categorization was performed in accordance with DOE-STD-1027-92.

4.2.6.7.3 Parameters of Concern

The first step in identifying potential initiating events associated with the Miscellaneous Waste Storage and Handling Facilities Group was to identify the process parameters that, if changed, could result in a release of the hazard that could exceed the screening thresholds for either the PrHA or PSOA. The process parameter changes that could lead to a release of the hazards are (1) a failure in the primary system integrity, (2) exposure to radionuclides, and (3) loss of criticality safety controls.

Based on the groupings described, three process parameters should be addressed for each operating condition to ensure that potential types of events are considered in the hazard analysis. The

potential ways of releasing hazardous materials that are caused by things such as energy sources and natural phenomena were evaluated for each operating mode to determine whether they might cause a change in one of the three process parameters. Table 4.2-11 summarizes the different initiating events by parameter. These events were developed by considering operational history, operator input, and systematic evaluations.

4.2.6.7.4 Summary of Results

As indicated in Table 4.2-11, the events considered for the Miscellaneous Waste Storage and Handling Facilities Group included a wide range of process-related events, external events, and controls for minimizing the potential risks. The three different parameter changes were reviewed for this hazard analysis. Two of the evaluated events were identified as having the potential to exceed the PSOA threshold, with both of these being considered limiting events (Table 4.2-11). No controls were identified for inclusion into Section 3.15. Administrative controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The administrative controls for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application with special emphasis on the NCS, Radiation Protection, Chemical Safety, Fire Protection, and Radioactive Waste Management Programs.

4.2.6.8 Miscellaneous Support Facilities Group

The facilities and the applicable hazards that are associated with the Miscellaneous Support Facilities Group are indicated in Table 4.2-9. These facilities were not considered to be complex in their operation and control systems. Therefore, the primary method of performing the hazard analysis was an operational review combined with the What If method to evaluate potential initiating events and consequences. The following discussion summarizes the results of the hazard evaluation for the hazards in these facilities.

4.2.6.8.1 Process Definitions

The Miscellaneous Support Facilities Group of facilities includes the C-400, C-409, C-720, C-709, C-710 buildings, the C-745-X equipment storage yard, and their various processes that required analysis in the PrHA. The processes are defined in Table 4.2-9. These facilities had various operations containing hazards exceeding the PrHA threshold being reviewed.

4.2.6.8.2 Hazards

The hazardous materials in the Miscellaneous Support Facilities Group were reviewed to determine which needed to be evaluated in the PrHA and PSOA. The results of this review are indicated in Table 4.2-9. All the hazardous materials, except those indicated in the table, were characterized as being standard industrial hazards that are commonly found in industrial facilities. These were screened out from further analysis in the PrHA because the amounts of the material are insufficient to cause any significant local health effects. These hazards are adequately controlled by site administrative programs and plans, and no additional analysis was required.

The energy sources associated with the facility that have the potential for causing releases of the hazardous materials are various because of the different facilities and missions. However, the primary energy sources are (1) chemical energy from the reactivity of the various hazards, (2) potential energy,

(3) kinetic energy associated with the various types of vehicles, (4) flammable and combustible material, and (5) heat associated with heating of process systems.

All facilities in this group except C-100 and C-709 were categorized as Hazard Category 2 nuclear facilities because they may contain quantities of the ^{235}U component of the UF_6 sufficient to exceed the threshold quantity for Hazard Category 2 in Table A.1 of DOE-STD-1027-92. Building C-100 did not contain any radiological material, and C-709 contains less than the category 3 threshold quantities.

4.2.6.8.3 Parameters of Concern

The first step in identifying potential initiating events associated with the Miscellaneous Support Facilities Group was to identify the process parameters that, if changed, could result in a release of the hazard that could exceed the screening thresholds for either the PrHA or PSOA. The process parameter changes that could lead to an accident of interest are (1) a failure in the primary system integrity, (2) exposure to radionuclides, (3) loss of criticality safety controls, (4) pressure increase, (5) flow increase, (6) level increase, and (7) concentration increase.

Based on the groupings described, seven process parameters should be addressed for each operating condition to ensure that potential types of events are considered in the hazard analysis. The potential ways of releasing hazardous materials that are caused by things such as energy sources and natural phenomena were evaluated for each operating mode to determine whether they might cause a change in one of the seven process parameters. Table 4.2-11 summarizes the different initiating events by parameter. These events were developed by considering operational history, operator input, and systematic evaluations.

4.2.6.8.4 Summary of Results

As indicated in Table 4.2-11, the events considered for the Miscellaneous Support Facilities Group included a wide range of process-related events, external events, and controls for minimizing the potential risks. A brief summary of the hazard analysis is presented below for each process.

4.2.6.8.4.1 Building C-400 Process

Table 4.2-11 identifies all of the events associated with the Building C-400 Process that were considered in the hazard analyses. Two were identified as having the potential to exceed the PSOA threshold, with both (fire and criticality) being considered limiting events (Table 4.2-11). No controls were identified for inclusion into Section 3.15. Administrative controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.2 Building C-409 Process

Table 4.2-11 identifies all of the events associated with the Building C-409 Process that were considered in the hazard analyses. One (criticality) was identified as having the potential to exceed the PSOA threshold (Table 4.2-11). No controls were identified for inclusion into Section 3.15. Administrative controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.3 Building C-710 Process

Table 4.2-11 identifies all of the events associated with the Building C-710 Process that were considered in the hazard analyses. Five were identified as having the potential to exceed the PSOA threshold, with only two (criticality and fire) being limiting events (Table 4.2-11). The controls identified as being AQ are described in Section 3.15. These controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.4 Building C-720 Process

Table 4.2-11 identifies all of the events associated with the Building C-720 Process that were considered in the hazard analyses. One (criticality) was identified as having the potential to exceed the PSOA threshold, and it is a limiting event (Table 4.2-11).The controls identified as being AQ are listed in Section 3.15. The controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.5 Building C-100 Process

Table 4.2-11 identifies all of the events associated with the Building C-100 Process that were considered in the hazard analyses. None were identified as having the potential to exceed the PSOA threshold. No controls were identified for inclusion into Section 3.15. Administrative controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.6 Building C-709 Process

Table 4.2-11 identifies all of the events associated with the Building C-709 Process that were considered in the hazard analyses. None were identified as having the potential to exceed the PSOA threshold. No controls were identified for inclusion into Section 3.15. Administrative controls were

identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

4.2.6.8.4.7 Equipment Storage Process

Table 4.2-11 identifies all of the events associated with the Equipment Storage Process that were considered in the hazard analysis. One (criticality) was identified as having the potential to exceed the PSOA threshold (Table 4.2-11). No new controls were identified for inclusion into Section 3.15. Administrative controls were identified as playing an important role in minimizing the potential exposure for on-site personnel, but none were identified as being required to protect the off-site public (Section 4.3.2.6). The remaining controls identified for this process are adequately addressed by the programs and plans described in SAR Chapters 5 and 6 and Volume 3 of the Application.

Table 4.2-1. Initiating Event Frequency Categories.

Operating Condition	Description	Annual Frequency (*f*)
Normal Operation (OC-1)	Operations that are planned to occur regularly in the course of facility operation (i.e., operating modes).	$f \geq 1/\text{yr}$
Anticipated Event (OC-2)	Initiating events of moderate frequency that may occur one or more times during the life of the facility.	$10^{-2}/\text{yr} \leq f < 1/\text{yr}$
Evaluation Basis Event (OC-3)	Initiating events which are not expected to occur during the life of the facility but that are postulated because their consequences would include the potential for the release of significant amounts of radioactive material and because they represent upper bounds on failures or accidents with a probability of occurrence sufficiently high to require consideration.	$10^{-6}/\text{yr} < f < 10^{-2}/\text{yr}$

Table 4.2-2. Evaluation Guidelines.

Plant Evaluation Guidelines	**Operating Condition**		
	Normal Operation (OC-1)	**Anticipated Events (OC-2)**	**Evaluation Basis Events (OC-3)**
EG 1: Radiological Dose			
For the Offsite Public, the normal operation or initiating event shall be controlled such that the radiological dose is within 10 CFR 20 limits for OC-1 and within the guideline values identified for OC-2 and OC-3.	10 CFR 20.1301	5 rem TEDE	25 rem TEDE
For Onsite Personnel, the normal operation or initiating event shall be controlled such that the radiological dose is within 10 CFR 20 limits for OC-1 and does not result in life-threatening or serious health effects for OC-2 and OC-3.	10 CFR 20.1201	No life-threatening or serious health effects to onsite personnel from the release of radioactive materials	No life-threatening or serious health effects to onsite personnel from the release of radioactive materials

Plant Evaluation Guidelines	Operating Condition		
	Normal Operation (OC-1)	**Anticipated Events (OC-2)**	**Evaluation Basis Events (OC-3)**
EG 2: Nonradiological Dose			
For the Offsite Public, the normal operation or initiating event shall be controlled such that the nonradiological dose is within 10 CFR 20 lmits for OC-1 and within the guideline values identified for OC-2 and OC-3.	10 CFR 20.1301	10 mg U	30 mg U
For Onsite Personnel, the normal operation or initiating event shall be controlled such that the nonradiological dose is within 10 CFR 20 limits for OC-1 and does not result in life-threatening or serious health effects for OC-2 and OC-3.	10 CFR 20.1201	No life-threatening or serious health effects to onsite personnel from the release of radioactive materials	No life-threatening or serious health effects to onsite personnel from the release of radioactive materials

Table 4.2-2. Evaluation Guidelines. (continued)

Plant Evaluation Guidelines	Operating Condition		
	Normal Operation (OC-1)	**Anticipated Events (OC-2)**	**Evaluation Basis Events (OC-3)**
EG 3: Pressure/Temperature The normal operation or initiating event shall be controlled within the pressure and temperature limits identified.	Maintain temperature within the design rating. Maintain pressure below MAWP or design pressure rating (if MAWP is not available during normal operation)	Maintain pressure below MAWP (or design rating) plus the ASME code allowable stresses for overpressure protection	Primary containment system pressure less than or equal to system hydrostatic test pressure
EG 4: Double Contingency Principle The normal operation or initiating event shall be controlled within the guidelines of the double contingency principle.	Applies	Applies	EG 4 does not apply to OC-3
EG 5: Initial Conditions The normal operation shall be controlled so that there is not a condition outside the accident analysis (i.e., maintain initial conditions).	Applies	EG 5 does not apply to OC-2	EG 5 does not apply to OC-3
EG 6: Control Area Habitability The initiating event shall be controlled to ensure habitability of a required control area is sufficiently maintained to accomplish the required operator action.	EG 6 does not apply to OC-1	Applies	Applies

Table 4.2-3. Screening Thresholds.

	Onsite		Offsite	
Document Type	**Radiological**	**Nonradiological**	**Radiological**	**Nonradiological**
Preliminary Hazard Screening	≤ 40 CFR 302.4	≤ 40 CFR 302.4	N/A	N/A
Analysis Statement	> 40 CFR 302.4 and < DOE-STD-1027-92 and Category 3 limits	> 40 CFR 302.4 and qualitative consequences would not result in life-threatening health effects close to the event	N/A	N/A
Process Hazards Analysis	≥ DOE-STD-1027-92 Category 3 limits	Qualititative consequences that could result in life-threatening health effects close to the event	N/A	N/A
Plant Safety Operational Analysis	≥ 25 rem anywhere onsite or ≥ DOE-STD-1027-92 Category 2 limits	Qualitative consequences that could result in life-threatening health effects beyond the immediate facility area	≥ 5 rem	Qualitative consequences that could result in irreversible or other serious health effects that could impair ability to take protective action

Table 4.2-4. Qualitative Consequence Categories.

Consequence code	Description	Screening threshold exceeded
NONE	There are no radiological or nonradiological effects for this event (i.e., no release of the hazard will occur).	None
MINR	Radiological effects are minor (e.g., release of material from contaminated equipment). Radiation Protection Program is sufficient to control the hazard.	PHS - radiological
MINT	Nonradiological effects are minor (e.g., reversible health effects). Chemical Safety Program is sufficient to control the hazard.	PHS - nonradiological
MINRT	Radiological and nonradiological effects are minor. Administrative control programs (Radiation Protection and Chemical Safety) are sufficient to control the hazard.	PHS - radiological & nonradiological
LOWOR	Radiological quantities could exceed DOE-STD-1027-92 Category 3 levels, but off-site radiological effects are negligible.	PrHA - radiological
LOWOT	On-site nonradiological effects could result in life-threatening health effects in area operating personnel. Beyond the immediate area, only reversible health effects are credible.	PrHA - nonradiological
LOWRT	Radiological quantities could exceed DOE-STD-1027-92 Category 3 levels, but off-site radiological effects are negligible. On-site nonradiological effects could result in life-threatening health effects in area operating personnel. Beyond the immediate area, only reversible health effects are credible.	PrHA - radiological & nonradiological

MODOR	On-site radiological effects could exceed 25 rem at the facility.	PSOA - on-site radiological
MODOT	On-site nonradiological effects could result in life-threatening health effects beyond the immediate area.	PSOA - on-site nonradiological
MODRT	On-site radiological effects could exceed 25 rem at the facility and on-site nonradiological effects could result in life-threatening health effects beyond the immediate area.	PSOA - on-site radiological & nonradiological
OFFR2	Off-site radiological exposure could exceed 5 rem.	PSOA - off-site radiological
OFFT2	Off-site nonradiological effects could result in irreversible health effects.	PSOA - off-site nonradiological
SIGRT	Off-site radiological exposure could exceed 5 rem and off-site nonradiological effects could result in irreversible health effects.	PSOA - off-site radiological & nonradiological

Notes: PHS = Preliminary Hazard Screening; PrHA = Process Hazards Analysis; PSOA = Plant Safety Operational Analysis

Table 4.2-5. Example Initiating Event-Operating Mode-Hazard State Matrix.[1]

Anticipated Initiating Event	Cylinder Handling	Autoclave Open/Out of Service	Containment	Autoclave Closed	Heating/ Feeding/ Heeling	Controlled Feeding	Cold Feeding
	Hazard state						
Pressure increase							
Autoclave steam control valve fails open	---	All states	All states	All states	All states	Gas/Solid	Gas/Solid
Primary system integrity							
Minor leaks of UF_6 inside autoclave	---	---	---	All states	All states	Gas/Solid	Gas/Solid
Minor leaks of UF_6 to atmosphere	All states	All states	All states	---	All states	Gas/Solid	Gas/Solid

[1] Note this table is representative for the feed facilities (C-333-A and C-337-A).

Table 4.2-6. Historical UF_6 Releases—1956-93.

Site and incident	Location	Date	Description	kg U
Oak Ridge Gaseous Diffusion Plant				
1	Laboratory Development Feed Vaporization	11/61	Cylinder valve failure	193 [a]
2	Liquid Feed Sample	5/69	Pigtail evacuation with cylinder valve open	7 [a]
3	Feed Vaporization	12/70	Pigtail connection leak	153 [a]
4	Test Loop Feed Vaporization	4/71	Pigtail connection failed	11 [a]
5	Liquid Product Transfer	9/75	Cylinder failure resulting from explosive UF_6 oil reaction	6
Paducah Gaseous Diffusion Plant				
1	Product Withdrawal	11/56	Lube oil fire	No estimate
2	Feed Vaporization	11/60	Hydraulic rupture of cylinder	2100
3	Process Building (C-337)	12/62	Exothermic reaction	1000
4	Tails Storage	3/66	Liquid cylinder dropped and ruptured cylinder wall	8
5	Sampling	1/71	Broken pigtail	15 [a]
6	Tails Withdrawal	1/78	Rubbing compressor, UF_6/R-114 reaction	9
7	Process Buildilng (C-337)	12/93	Coupling failure	1
Portsmouth Gaseous Diffusion Plant				
1	Tails Withdrawal	11/60	Pigtail failure	92
2	Feed Vaporization	7/65	Pigtail rupture	14 [a]
3	Tails Withdrawal	7/69	Cylinder valve would not close	460
4	Feed Vaporization	12/70	Pigtail leak	12 [a]
5	Sampling	5/73	Cylinder valve would not close	45 [a]
6	High Assay Sampling	11/75	Pigtail connection leak	11
7	Transfer Bay	9/76	Pigtail connection leak	65 [a]
8	Transfer Autoclave	12/77	Cylinder valve thread leak	6 [a]
9	Feed Vaporization	12/77	Pigtail connection leak	8 [a]
10	Sampling	3/78	Cylinder connection leak, operator error	6 [a]
11	Liquid Cylinder Storage	3/78	Cylinder rupture from straddle error	5926

12	Tails Withdrawal	10/78	Cylinder valve broke as result of transport while connected	561

[a] Autoclave incidents

Table 4.2-7. Facilities Included in the SAR Review.

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-100	Administration Building	Yes	N/A	Yes	No
C-100-A	Engineering Trailer	No	N/A	No	No
C-100-T-04	Temporary Office	No	N/A`	No	No
C-100-T-05	Temporary Office	No	N/A	No	No
C-100-T-06	Temporary Office	No	N/A	No	No
C-100-T-07	Temporary Office	No	N/A	No	No
C-101	Cafeteria	No	N/A	No	No
C-102	Hospital	No	N/A	No	No
C-102-T-01	Temporary Office	No	N/A	No	No
C-102-T-02	Temporary Office	No	N/A	No	No
C-102-T-03	Temporary Office	No	N/A	No	No
C-102-T-04	Temporary Office	No	N/A	No	No
C-102-T-05	Temporary Office	No	N/A	No	No
C-102-T-06	Temporary Office	No	N/A	No	No
C-102-T-07	Temporary Office	No	N/A	No	No
C-200	Guard & Fire Headquarters	Yes	N/A	No	No
C-201	Emergency Equipment Storage Building	No	N/A	No	No
C-201-A	Emergency Equipment Storage Building	No	N/A	No	No
C-201-B	Emergency Equipment Storage Building	No	N/A	No	No
C-201-C	Emergency Equipment Storage Building	No	N/A	No	No
C-202	Guard Training Building	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-203	Emergency Vehicle Shelter	No	N/A	No	No
C-205	Respirator Issue Building	No	N/A	No	No
C-206	Pump Draftor Pit	No	N/A	No	No
C-206-A	Storage Trailer	No	N/A	No	No
C-206-B	Smoke Training Facility	No	N/A	No	No
C-207	Fire Training Facility	No	N/A	No	No
C-212	Office Building	No	N/A	No	No
C-212-A	Main Guard Post (Gate 15)	No	N/A	No	No
C-215	Portals 18 & 19	No	N/A	No	No
C-216	Post 47	No	N/A	No	No
	Text deleted				
C-229	Guard Post	No	N/A	No	No
C-300	Central Control Building	No	N/A	No	No
C-300-531	Instrumentation Tunnel	Yes	Radiological	No	No
C-300-533	Instrumentation Tunnel	Yes	Radiological	No	No
C-300-535	Instrumentation Tunnel	Yes	Radiological	No	No
C-300-537	Instrumentation Tunnel	Yes	Radiological	No	No
C-302	Cascade Operations Data Center	No	N/A	No	No
C-303	Supervisory Control and Data Acquisition Systems Building	No	N/A	No	No
C-304	Training and Cascade Office Building	No	N/A	No	No
C-304-T-01	Temporary Office	No	N/A	No	No
C-310	Purge & Product Building	Yes	Category 2	Yes	Yes
C-310-331	Enclosed Bridge	Yes	Radiological	No	No
C-310-331	Tie Line	Yes	Category 2	Yes	Yes
C-310-410	Tie Line	Yes	Category 2	Yes	Yes

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued).

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-310-A	Product Withdrawal Building	Yes	Category 2	Yes	Yes
C-310-B	Mobile Office	No	N/A	No	No
C-315	Surge & Waste Building (Tails Withdrawal)	Yes	Category 2	Yes	Yes
C-315-331	Tie Line	Yes	Category 2	Yes	Yes
C-320	Communication Building	No	N/A	No	No
C-320-A	Temporary Storage	No	N/A	No	No
C-331	Process Building	Yes	Category 2	Yes	Yes
C-331-333	Enclosed Bridge	Yes	Radiological	No	No
C-331-333	Tie Line	Yes	Category 2	Yes	Yes
C-331-335	Tie Line	Yes	Category 2	Yes	Yes
C-331-410	Tie Line	Yes	Category 2	Yes	Yes
C-333	Process Building	Yes	Category 2	Yes	Yes
C-333-A	Feed Vaporization Facility	Yes	Category 2	Yes	Yes
C-335	Process Building	Yes	Category 2	Yes	Yes
C-335-337	Enclosed Bridge	Yes	Radiological	No	No
C-335-337	Tie Line	Yes	Category 2	Yes	Yes
C-337	Process Building	Yes	Category 2	Yes	Yes
C-337-A	Feed Vaporization Facility	Yes	Category 2	Yes	Yes
C-350	Drying Agent Storage Building	Yes	N/A	Yes	Yes
C-360	Toll Transfer & Sampling Facility	Yes	Category 2	Yes	Yes
C-360-A	Toll Transfer & Sampling Facility Annex	Yes	Category 2	Yes	Yes
C-375-E2	Oil Control Dam (East Drainage Ditch First from North)	Yes	Radiological	No	No
C-375-E3	Oil Control Dam (East Drainage Ditch Second from North)	Yes	Radiological	No	No

Table 4.2-7. Facilities Included in the SAR Review. (continued).

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-375-E4	Oil Control Dam (East Drainage Ditch Third from North)	Yes	Radiological	No	No
C-375-E5	Oil Control Dam (East Drainage Ditch Fourth from North)	Yes	Radiological	No	No
C-375-E6	Oil Control Dam (East Drainage Ditch Fifth from North)	Yes	Radiological	No	No
C-375-N1	Oil Control Dam (North Drainage Ditch)	Yes	Radiological	No	No
C-375-S6	Oil Control Dam (South Drainage Ditch)	Yes	Radiological	No	No
C-375-W7	Oil Control Dam (West Drainage Ditch First from South)	Yes	Radiological	No	No
C-400	Cleaning Building and Appurtenant Structures	Yes	Category 2	Yes	Yes
C-400-A	Emergency Power for Critical Alarms	No	N/A	No	No
C-404-A	Pump House	Yes	Radiological	No	No
	Text deleted				
C-407	Nitric Acid Storage Tank	Yes	N/A	Yes	No
C-408	50-Ton Truck Scale	No	N/A	No	No
C-409	Stabilization Building	Yes	Category 2	Yes	Yes
C-409-A	Storage Trailer	No	N/A	No	No
C-409-B	Storage Trailer	No	N/A	No	No
C-409-C	Storage Trailer	No	N/A	No	No
C-410-D	F2 Storage Building	Yes	N/A	Yes	Yes
C-410-K	Fluorine Building	Yes	N/A	Yes	Yes
C-531	Switch House and Appurtenant Structures	No	N/A	No	No
C-531-1	Switch House	No	N/A	No	No
C-531-2	Switchyard	No	N/A	No	No

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-531-3A	Fire Valve House No. 1	No	N/A	No	No
C-531-3B	Fire Valve House No. 2	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-532	Relay House	No	N/A	No	No
C-533	Switch House and Appurtenant Structures	No	N/A	No	No
C-533-1	Switch House	No	N/A	No	No
C-533-2	Switchyard	No	N/A	No	No
C-533-3A	Fire Valve House No. 1	No	N/A	No	No
C-533-3B	Fire Valve House No. 2	No	N/A	No	No
C-533-3C	Fire Valve House No. 3	No	N/A	No	No
C-533-3D	Fire Valve House No. 4	No	N/A	No	No
C-535	Switch House and Appurtenant Structures	No	N/A	No	No
C-535-1	Switch House	No	N/A	No	No
C-535-2	Switchyard	No	N/A	No	No
C-535-3A	Fire Valve House No. 1	No	N/A	No	No
C-535-3B	Fire Valve House No. 2	No	N/A	No	No
C-535-4	Test Shop	No	N/A	No	No
C-536	Relay House	No	N/A	No	No
C-537	Switch House and Appurtenant Structures	No	N/A	No	No
C-537-1	Switch House	No	N/A	No	No
C-537-2	Switchyard	No	N/A	No	No
C-537-3A	Fire Valve House No. 1	No	N/A	No	No
C-537-3B	Fire Valve House No. 2	No	N/A	No	No
C-537-3C	Fire Valve House No. 3	No	N/A	No	No
C-537-3D	Fire Valve House No. 4	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-537-4	Test Shop	No	N/A	No	No
C-540	Oil Pump House and Appurtenant Structures	No	N/A	No	No
C-540-A	Oil Pump House	No	N/A	No	No
C-540-B	Oil Storage Tank (Northwest)	No	N/A	No	No
C-540-C	Oil Storage Tank (Southwest)	No	N/A	No	No
C-540-D	Oil Storage Tank (Northeast)	No	N/A	No	No
C-540-E	Oil Storage Tank (Southeast)	No	N/A	No	No
C-541	Oil Pump House and Appurtenant Structures	No	N/A	No	No
C-541-A	Oil Pump House	No	N/A	No	No
C-541-B	Oil Storage Tank (Northwest)	No	N/A	No	No
C-541-C	Oil Storage Tank (Southwest)	No	N/A	No	No
C-541-D	Oil Storage Tank (Northeast)	No	N/A	No	No
C-541-E	Oil Storage Tank (Southeast)	No	N/A	No	No
C-600	Steam Plant and Associated Utility Appurtenant	No	N/A	No	No
C-601	Nitrogen Generator Building Addition	No	N/A	No	No
C-601-A	Steam Plant Fuel-Storage Tank (Center)	No	N/A	No	No
C-601-B	Steam Plant Fuel-Storage Tank (South)	No	N/A	No	No
C-601-C	Steam Plan Fuel Oil Pump House	No	N/A	No	No
C-601-D	Fuel Oil Storage Tank (North)	No	N/A	No	No
C-602	Coal Storage Yard	No	N/A	No	No
C-603-E	Nitrogen Storage Tank (East)	No	N/A	No	No
C-603-F	Nitrogen Storage Tank (Center)	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-603-G	Nitrogen Storage Tank (West)	No	N/A	No	No
C-604	Utilities Maintenance Building	No	N/A	No	No
C-604-A	Utilities Storage Building	No	N/A	No	No
C-605	Substation Building	No	N/A	No	No
C-606	Coal Crusher Building	No	N/A	No	No
C-607	Emergency Air Compressor Generator Building	No	N/A	No	No
C-611	Water Treatment Plant Distribution System and Appurtenant Structures	Yes	N/A	Yes	Yes
C-611-A	Building and Shop Storage	No	N/A	No	No
C-611-A1	Activated Carbon Storage	No	N/A	No	No
C-611-B	Head House	Yes	N/A	Yes	Yes
C-611-B1	Polymer Feed System Enclosures	No	N/A	No	No
C-611-C	Flocculator Basin	No	N/A	No	No
C-611-D	Settling Basin (Northeast)	No	N/A	No	No
C-611-E	Settling Basin (Northwest)	No	N/A	No	No
C-611-F	Settling Basin (Southeast)	No	N/A	No	No
C-611-F1	Secondary Coagulation Basin	No	N/A	No	No
C-611-F2	Chemical Feed Building for C-611-F1	No	N/A	No	No
C-611-F3	Activated Carbon Feed Building	No	N/A	No	No
C-611-G	Settling Basin (Southwest)	No	N/A	No	No
C-611-H	Filter Building and Pump Station	No	N/A	No	No

Continued.

NOTE: Status of implementation/plant modification associated with RACs identified on this page can be determined through the subject matter expert or Nuclear Regulatory Affairs. Both deleted and added text require consideration in PCR 10CFR76.68 process.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-611-I	Clear Well	No	N/A	No	No
C-611-K	Number 4 Lagoon	No	N/A	No	No
C-611-O	Sanitary Water Storage Tank	No	N/A	No	No
C-611-P	Pump House	No	N/A	No	No
C-611-Q	Booster Station 36” Raw Water Line	No	N/A	No	No
C-611-R	Water Tank—RCW Fire Water (High Press.)	No	N/A	No	No
C-611-S	Corrosion Inhibitor Building	Yes	N/A	Yes	Yes
C-611-T	Booster Pump Station (Plant Water)	No	N/A	No	No
C-611-T-01	Temporary Office	No	N/A	No	No
C-611-U	Softening Facility (West)	No	N/A	No	No
C-611-V	Sludge Lagoon	Yes	N/A	No	No
C-611-W	Sludge Lagoon (Abandoned)	Yes	N/A	No	No
C-611-X	Softening Facility (East)	No	N/A	No	No
C-611-Y	Recycle Lagoon	Yes	N/A	No	No
C-611-Z	Flocculator Basin	No	N/A	No	No
C-615	Sewage Disposal Plant, Collection System, and Appurtenant Structures	Yes	Radiological	No	No
C-615-A	Primary Settling Tank	Yes	Radiological	No	No
C-615-B	Final Settling Tank	Yes	Radiological	No	No
C-615-C	Control Building	Yes	Radiological	Yes	Yes
C-615-D	Digestor	Yes	Radiological	No	No
C-615-E	Trickling Filter	Yes	Radiological	No	No
C-615-F	Sludge Beds	Yes	Radiological	No	No

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-615-G	Sewage Lift Station	No	N/A	No	No
C-615-H	Sewage Lift Station	No	N/A	No	No
C-615-H1	Sewage Lift Station	No	N/A	No	No
C-615-H2	Sewage Lift Station	No	N/A	No	No
C-615-H7	Sewage Lift Station	No	N/A	No	No
C-615-H8	Sewage Lift Station	No	N/A	No	No
C-615-J	Chromate Lift Station (Abandoned)	No	N/A	No	No
C-615-K	Chromate Lift Station (Abandoned)	No	N/A	No	No
C-615-L	Oil Control Monitoring Station	No	N/A	No	No
C-615-M	Oil Control Structure	No	N/A	No	No
C-615-N	Oil Contaminated Lagoon	No	N/A	No	No
C-615-O	Oil Control Building	No	N/A	No	No
C-616	Liquid Pollution Abatement and Appurtenant Structures	Yes	N/A	No	No
C-616-A	Chemical Feed Building	Yes	N/A	No	No
C-616-B	Clarifier	Yes	N/A	No	No
C-616-C	Lift Station	Yes	N/A	No	No
C-616-D	Sludge Lagoon and Valve Pit	Yes	Radiological	No	No
C-616-F	Full Flow Lagoon	Yes	N/A	No	No
C-616-G	Sulfuric Acid Tank	Yes	N/A	Yes	Yes
C-616-H1	FeSO4 Storage Tank (East)	Yes	N/A	No	No
C-616-H2	FeSO4 Storage Tank (West)	Yes	N/A	No	No

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-616-J	Reduction Tank	Yes	N/A	No	No
C-616-K	Service Building	Yes	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-616-L	Effluent Control Vault	Yes	N/A	No	No
C-616-M	Clarifier-West	Yes	N/A	No	No
C-616-N	Reduction Tank-West	Yes	N/A	No	No
C-616-P	Sludge Vault and Valve Pit	Yes	Radiological	No	No
C-617-A	Effluent Control Station	No	N/A	No	No
C-617-B	Lagoon	Yes	N/A	No	No
C-620	Air Compressor Room	Yes	Radiological	No	No
C-631	RCW Pump House and Appurtenant Structures	No	N/A	No	No
C-631-01	Pump House	Yes	N/A	Yes	Yes
C-631-02	Cooling Tower	No	N/A	No	No
C-631-03	Pump House (Firewater)	No	N/A	No	No
C-631-04	Blending Pump House	No	N/A	No	No
C-631-05	Blending Cooling Tower (West)	No	N/A	No	No
C-631-06	Blending Cooling Tower (East)	No	N/A	No	No
C-631-07	Maintenance Shop	No	N/A	No	No
C-631-08	Change House	No	N/A	No	No
C-631-09	Asbestos Crew Breakroom	No	N/A	No	No
C-631-10	Asbestos Crew Storage	No	N/A	No	No
C-633	RCW Pump House and Appurtenant Structures	No	N/A	No	No
C-633-1	Pump House	Yes	N/A	Yes	Yes
C-633-2A	Cooling Tower (South)	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-633-2B	Cooling Tower (North)	No	N/A	No	No
C-633-3	Blending Pump House	No	N/A	No	No
C-633-4	Blending Cooling Tower (North)	No	N/A	No	No
C-633-5	Blending Cooling Tower (South)	No	N/A	No	No
C-633-6	Sand Filter Building	No	N/A	No	No
C-635	RCW Pump House and Appurtenant Structures	No	N/A	No	No
C-635-1	Pump House and Piping	Yes	N/A	Yes	Yes
C-635-2	Cooling Tower	No	N/A	No	No
C-635-3	Blending Pump House	No	N/A	No	No
C-635-4	Blending Cooling Tower (North)	No	N/A	No	No
C-635-5	Blending Cooling Tower (South)	No	N/A	No	No
C-635-6	Process Waste Heat Utilization Pump House	No	N/A	No	No
C-637	RCW Pump House and Appurtenant Structures	No	N/A	No	No
C-637-1	Pump House	Yes	N/A	Yes	Yes
C-637-2A	Cooling Tower (South)	No	N/A	No	No
C-637-2B	Cooling Tower (North)	No	N/A	No	No
C-637-3	Blending Pump House	No	N/A	No	No
C-637-4	Blending Cooling Tower (North)	No	N/A	No	No
C-637-5	Blending Cooling Tower (South)	No	N/A	No	No
C-637-6	Sand Filter Building	No	N/A	No	No
C-709	Laboratory Annex	Yes	Radiological	Yes	Yes
C-710	Technical Services Building and Appurtenant	Yes	Category 2	Yes	Yes

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-710-A	Gas Cylinder Storage Building	Yes	N/A	Yes	Yes
C-710-B	Storage Facility	No	N/A	No	No
C-711	Gas Manifold	No	N/A	No	No
C-712	Acid Neutralization Pit	No	N/A	No	No
C-720	Maintenance and Stores Building and Appurtenant Structures	Yes	Category 2	Yes	Yes
C-720-A	Compressor Shop	Yes	Category 2	Yes	Yes
C-720-B	Machine Shop Addition	Yes	Category 2	Yes	Yes
C-720-C	Converter Shop Addition	Yes	Category 2	Yes	Yes
C-720-C1	Barrier Storage	No	N/A	No	No
C-720-D	Transformer Building	No	N/A	No	No
C-720-E	Change House Addition	No	N/A	No	No
C-720-F	Engineering Trailer	No	N/A	No	No
C-720-G	Warehouse	No	N/A	No	No
C-720-H	Warehouse	No	N/A	No	No
C-720-J	Air Lock	No	N/A	No	No
C-720-K	Instrument Shop Addition	Yes	Category 2	Yes	Yes
C-720-L	Oxygen Facility	No	N/A	No	No
C-720-M	Engineering Trailer	No	N/A	No	No
C-720-P	Instrument Maintenance Trailer	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-720-Q	Instrument Maintenance Storage Trailer	No	N/A	No	No
C-720-R	Instrument Training Trailer	No	N/A	No	No
C-720-S	MSA Mask Repair Trailer	No	N/A	No	No
C-721	Gas Manifold Storage	No	N/A	No	No
C-722	Acid Neutralization Pit	No	N/A	No	No
C-724-A	Carpenter Shop Annex	No	N/A	No	No
C-724-B	Carpenter Shop	No	N/A	No	No
C-724-C	Sandblast Facility	No	N/A	No	No
C-724-D	Lumber Storage Building	No	N/A	No	No
C-725	Sandblast Building	No	N/A	No	No
C-726	Sandblast Building	Yes	Radiological	No	No
C-727	90-day Accumulation Area for Hazardous and Mixed Waste	Yes	Radiological	Yes	Yes
C-729	Acetylene Building	No	N/A	No	No
C-730	Maintenance Service Building and Adjacent Parking Lot	No	N/A	No	No
C-731	Railroad Repair Equipment Storage Building	No	N/A	No	No
C-732	Maintenance Materials Storage Building	No	N/A	No	No
C-740	Material Yard	No	N/A	No	No
C-740-A	Semitrailer Unloading Facility	No	N/A	No	No
C-740-B	Oil Drum Storage Shelter	No	N/A	No	No
C-740-C	Miscellaneous Material Storage Yard	No	N/A	No	No
C-741	Mobile Equipment Shed	Yes	Radiological	No	No
C-742	Cylinder Storage Building	No	N/A	No	No

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-742-B	ClF3 Cylinder Storage	Yes	N/A	Yes	Yes
C-743	Maintenance Annex	No	N/A	No	No
C-744	Lubrication Building	No	N/A	No	No
C-745-A	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-B	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-B1	Cylinder Storage Yard Office	Yes	Category 2	Yes	Yes
C-745-E	Kellogg Storage Yard	Yes	Category 2	Yes	Yes
C-745-H	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-J	Waste Management Equipment Storage Yard	No	N/A	No	No
C-745-Q	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-R	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-R1	Cylinder Changeout Building	Yes	Category 2	Yes	Yes
C-745-U	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-V	Cylinder Storage Yard	Yes	Category 2	Yes	Yes
C-745-X	Equipment Storage Yard	Yes	Category 2	Yes	Yes
C-745-Y	Equipment Storage Yard	Yes	Radiological	No	No
C-746-G	Electric Equipment Storage	No	N/A	No	No
C-746-H1	PEM Storage Slab	No	N/A	No	No

Continued.

Table 4.2-7. Facilities Included in the SAR Review. (Continued)

Facility	Name	Screen in?	Nuclear hazard category	PrHA required?	PSOA required?
C-746-H2	PEM Storage Slab	No	N/A	No	No
C-746-L	Tractor Storage	No	N/A	No	No
C-746-Q1	High Assay Waste Storage Facility	Yes	Category 2	Yes	Yes
C-746-X	Electrical Equipment Storage	No	N/A	No	No
C-750	Garage and Appurtenant Structures	No	N/A	No	No
C-751	Fuel Dispensing Facility	No	N/A	No	No
C-754	Low Level Waste Storage	Yes	Radiological	No	No
C-754-A	Low Level Waste Storage	Yes	Radiological	No	No
C-754-B	Low Level Waste Storage	Yes	Radiological	No	No
C-757	Solid & Low Level Waste Processing Facility	Yes	Radiological	No	No
C-800	Entrance Highway Bus Shelter	No	N/A	No	No
C-801	Ohio Drive (Ave.) Bus Shelter	No	N/A	No	No
C-802	Meteorological Tower	No	N/A	No	No
C-810	Parking Area (C-100)	No	N/A	No	No
C-811	Parking Area (C-720)	No	N/A	No	No

Table 4.2-8. Facilities Documented by Analysis Statement.

Facility	Name
C-300-531	Instrumentation Tunnel
C-300-533	Instrumentation Tunnel
C-300-535	Instrumentation Tunnel
C-300-537	Instrumentation Tunnel
C-310-331-E	Enclosed Bridge
C-331-333-E	Enclosed Bridge
C-335-337-E	Enclosed Bridge
C-375-E2	Oil Control Dam (East Drainage Ditch First from North)
C-375-E3	Oil Control Dam (East Drainage Ditch Second from North)
C-375-E4	Oil Control Dam (East Drainage Ditch Third from North)
C-375-E5	Oil Control Dam (East Drainage Ditch Fourth from North)
C-375-E6	Oil Control Dam (East Drainage Ditch Fifth from North)
C-375-N1	Oil Control Dam (North Drainage Ditch)
C-375-S6	Oil Control Dam (South Drainage Ditch)
C-375-W7	Oil Control Dam (West Drainage Ditch First from South)
C-404-A	Pump House
C-611-V	Sludge Lagoon
C-611-W	Sludge Lagoon (Abandoned)
C-611-Y	Recycle Lagoon
C-615	Sewage Disposal Plant, Collection System, and Appurtenant Structures
C-615-A	Primary Settling Tank
C-615-B	Final Settling Tank
C-615-D	Digestor
C-615-E	Trickling Filter
C-615-F	Sludge Beds
C-616	Liquid Pollution Abatement and Appurtenant Structures

C-616-A	Chemical Feed Building
C-616-B	Clarifier
C-616-C	Lift Station

Continued.

Table 4.2-8. Facilities Documented by Analysis Statement. (continued)

Facility	Name
C-616-D	Sludge Lagoon and Valve Pit
C-616-F	Full Flow Lagoon
C-616-H1	$FeSO_4$ Storage Tank (East)
C-616-H2	$FeSO_4$ Storage Tank (West)
C-616-J	Reduction Tank
C-616-K	Service Building
C-616-L	Effluent Control Vault
C-616-M	Clarifier-West
C-616-N	Reduction Tank-West
C-616-P	Sludge Vault and Valve Pit
C-617-B	Lagoon
C-620	Air Compressor Room
C-726	Sandblast Building
C-741	Mobile Equipment Shed
C-745-Y	Equipment Storage Yard
C-754	Low Level Waste Storage
C-754-A	Low Level Waste Storage
C-754-B	Low Level Waste Storage
C-757	Solid & Low Level Waste Processing Facility

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds.

Facility group/processes evaluated/hazards/facilities

Cascade facilities

Enrichment cascade process

Hazards exceeding the PrHA threshold

UF_6 - Uranium hexafluoride

Light cascade gases (ClF_3, F_2, R-114, O_2, N_2)

Facilities associated with process

C-310
C-310-331-T
C-310-410
C-315
C-315-331
C-331
C-331-333-T
C-331-335
C-331-410
C-333
C-335
C-335-337-T
C-337

Freezer/Sublimer process

Hazards exceeding the PrHA threshold

UF_6 - Uranium hexafluoride

Facilities associated with process

C-331 Process Building
C-333 Process Building
C-335 Process Building
C-337 Process Building

5.5 WT.% UF_6/R-114 SEPARATION PROCESS

Hazards exceeding the PrHA threshold

UF_6 - Uranium hexafluoride

Light cascade gases (ClF3, F2, R-114, O2, N2)

Facilities associated with process

C-335 Process Building

Toxic gas distribution processes

Hazards exceeding the PrHA threshold

Fluorine (F2)

Chlorine trifluoride (ClF3)

Facilities associated with process

C-310 Purge & Product Building
C-331 Process Building
C-333 Process Building

C-335	Process Building
C-337	Process Building

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities

Purge cascade process
Hazards exceeding the PrHA threshold
UF_6 - Uranium hexafluoride
Light cascade gases (ClF3, F2, R-114, O2, N2)
Facilities associated with process

C-310	Purge & Product Building

UF6 handling and storage facilities

Withdrawal processes (Product and Tails)
Hazards exceeding the PrHA threshold
UF_6 - Uranium hexafluoride
Facilities associated with process

C-310	Purge & Product Building
C-310-A	Product Withdrawal Building
C-315	Surge & Waste Building (Tails Withdrawal)

Feed and vaporization processes (C-333-A and C-337-A)
Hazards exceeding the PrHA threshold
UF_6 - Uranium hexafluoride
Facilities associated with process

C-333-A	Feed Vaporization Facility
C-337-A	Feed Vaporization Facility

Toll sampling and transfer processes (C-360)
Hazards exceeding the PrHA threshold
UF_6 - Uranium hexafluoride
Facilities associated with process

C-360	Toll Transfer & Sampling Facility

Cylinder handling/storage processes
Hazards exceeding the PrHA threshold
UF_6 - Uranium hexafluoride
Facilities associated with process

C-360-A	Toll Transfer and Sampling Facility Annex
C-400	Cleaning Building and Appurtenant Structures
C-745-A	Cylinder Storage Yard
C-745-B	Cylinder Storage Yard
C-745-B1	Cylinder Storage Yard Office
C-745-E	Kellogg Storage Yard
C-745-H	Cylinder Storage Yard
C-745-R	Cylinder Storage Yard
C-745-R1	Cylinder Changeout Building

C-745-Q	Cylinder Storage Yard
C-745-U	Cylinder Storage Yard
C-745-V	Cylinder Storage Yard

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities

Chemical facilities

C-350 Drying agent storage processes

Hazards exceeding the PrHA threshold

Chlorine trifluoride (ClF3)

Fluorine (F2)

Facilities associated with process

C-350	Drying Agent Storage Building

C-410-D Fluorine storage building processes

Hazards exceeding the PrHA threshold

Fluorine (F2)

Facilities associated with process

C-410-D	F2 Storage Building

C-410-K Fluorine storage building processes

Hazards exceeding the PrHA threshold

Fluorine (F2)

Facilities associated with process

C-410-K	Fluorine Building

C-611 Water treatment processes

Hazards exceeding the PrHA threshold

Chlorine

Facilities associated with process

C-611-B	Head House
C-611-S	Corrosion Inhibitor Building

C-615 Sewage treatment plant processes

Hazards exceeding the PrHA threshold

Chlorine

Facilities associated with process

C-615-C	Control Building

C-616 Waste water treatment plant processes

Hazards exceeding the PrHA threshold

Sulfuric acid (Fire only)

Facilities associated with process

C-616-G	Sulfuric Acid Tank

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities

C-631, 633, 635, 637 RCW pump house processes

Hazards exceeding the PrHA threshold

Sulfuric acid (Fire only)

Chlorine

Facilities associated with process

C-631-01	Pump House
C-633-1	Pump House
C-635-1	Pump House and Piping
C-637-1	Pump House

C-742-B Storage processes

Hazards exceeding the PrHA threshold

Chlorine trifluoride (ClF3)

Facilities associated with process

C-710-A	Gas Cylinder Storage Building
C-742-B	ClF3 Cylinder Storage

C-745-A Storage processes

Hazards exceeding the PrHA threshold

Chlorine

Fluorine (F2)

Facilities associated with process

C-745-A	Cylinder Storage Yard

C-745-B Storage processes

Hazards exceeding the PrHA threshold

Fluorine (F2)

Chlorine Trifluoride (ClF3)

Facilities associated with process

C-745-B	Cylinder Storage Yard

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities

Toxic gas storage and distribution process

Hazards exceeding the PrHA threshold

Fluorine (F2)
Sufuric acid (Fire Only)
Chlorine
Chlorine trifluoride (ClF3)

Facilities associated with process

C-350	Drying Agent Storage Building
C-410-D	F2 Storage Building
C-410-K	Fluorine Building
C-611-B	Head House
C-611-S	Corrosion Inhibitor Building
C-615-C	Control Building
C-631-01	Pump House
C-633-1	Pump House
C-635-1	Pump House and Piping
C-637-1	Pump House
C-742-B	ClF3 Cylinder Storage
C-745-A	Cylinder Storage Yard
C-745-B	Cylinder Storage Yard

Miscellaneous waste storage and handling facilities

C-727 90-day Mixed waste storage processes

Hazards exceeding the PrHA threshold

RCRA hazardous waste

Facilities associated with process

C-727	90-day Accumulation Area for Hazardous and Mixed Waste

C-746-Q1 Fissile Storage Processes

Hazards exceeding the PrHA threshold

UF_6 - Uranium hexafluoride
Uranium oxide

Facilities associated with process

C-746-Q1	High Assay Waste Storage Facility

Waste storage/handling processes

Hazards exceeding the PrHA threshold

RCRA hazardous waste (from non-leased C-746-Q)
Low-level radioactive waste
Uranium-bearing waste (>1 wt % U235)
TSCA hazardous waste (from non-leased C-746-Q)
Mixed waste (from non-leased C-746-Q)

Facilities associated with process

C-746-Q1 High Assay Waste Storage Facility

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities

Miscellaneous support facilities

C-400 Cleaning building processes

Hazards exceeding the PrHA threshold

UF_6 -Uranium hexafluoride
Nitric acid
Uranium oxide
Hydrofluoric acid (as a reaction product)
Radionuclides (including technetium)

Facilities associated with process

C-400	Cleaning Building and Appurtenant Structures

C-409 Stabilization building processes

Hazards exceeding the PrHA threshold

UF_6-Uranium hexafluoride
Nitric acid
Uranium oxide
Various analytical chemicals
Hydrofluoric acid (as a reaction product)

Facilities associated with process

C-409	Stabilization Building

C-710 Technical services building processes

Hazards exceeding the PrHA threshold

UF_6 -Uranium hexafluoride
Hydrofluoric acid
Chlorine
Chlorine trifluoride (ClF3)
Uranium oxide
Fluorine (F2)
Hydrogen
Various analytical chemicals

Facilities associated with process

C-709	Laboratory Annex
C-710	Technical Services Building and Appurtenant Structures

C-720 Maintenance and stores building processes

Hazards exceeding the PrHA threshold

UF_6 - Uranium hexafluoride
Uranium oxide

Facilities associated with process

C-720	Maintenance and Stores Building and Appurtenant Structures
C-720-A	Compressor Shop
C-720-B	Machine Shop Addition
C-720-C	Converter Shop Addition

C-720-K Instrument Shop Addition

Continued.

Table 4.2-9. Hazards in Facilities Exceeding PrHA Thresholds. (continued)

Facility group/processes evaluated/hazards/facilities
Equipment storage process
Hazards exceeding the PrHA threshold
UF_6 - uranium hexafluoride
Uranium oxide
Facilities associated with process
C-745-X Equipment Storage Yard

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Table 4.2-10. Hazard Categorization of Facilities.

Facility	Name
Radiological	
C-300-531	Instrumentation Tunnel
C-300-533	Instrumentation Tunnel
C-300-535	Instrumentation Tunnel
C-300-537	Instrumentation Tunnel
C-310-331-E	Enclosed Bridge
C-331-333-E	Enclosed Bridge
C-335-337-E	Enclosed Bridge
C-375-E2	Oil Control Dam (East Drainage Ditch First from North)
C-375-E3	Oil Control Dam (East Drainage Ditch Second from North)
C-375-E4	Oil Control Dam (East Drainage Ditch Third from North)
C-375-E5	Oil Control Dam (East Drainage Ditch Fourth from North)
C-375-E6	Oil Control Dam (East Drainage Ditch Fifth from North)
C-375-N1	Oil Control Dam (North Drainage Ditch)
C-375-S6	Oil Control Dam (South Drainage Ditch)
C-375-W7	Oil Control Dam (West Drainage Ditch First from South)
C-404-A	Pump House
C-615	Sewage Disposal Plant, Collection System, and Appurtenant Structures
C-615-A	Primary Settling Tank
C-615-B	Final Settling Tank
C-615-C	Control Building
C-615-D	Digestor
C-615-E	Trickling Filter
C-615-F	Sludge Beds
C-616-D	Sludge Lagoon and Valve Pit
C-616-P	Sludge Vault and Valve Pit
C-620	Air Compressor Room
C-709	Laboratory Annex
C-726	Sandblast Building
C-727	90-day Accumulation Area for Hazardous and Mixed Waste
C-741	Mobile Equipment Shed
C-745-Y	Equipment Storage Yard
C-754	Low Level Waste Storage
C-754-A	Low Level Waste Storage

C-754-B	Low Level Waste Storage
C-757	Solid & Low Level Waste Processing Facility

Continued.

Table 4.2-10. Hazard Categorization of Facilities.

Facility	Name
Category 2	
C-310	Purge & Product Building
C-310-331-T	Tie Line
C-310-410	Tie Line
C-310-A	Product Withdrawal Building
C-315	Surge & Waste Building (Tails Withdrawal)
C-315-331	Tie Line
C-331	Process Building
C-331-333-T	Tie Line
C-331-335	Tie Line
C-331-410	Tie Line
C-333	Process Building
C-333-A	Feed Vaporization Facility
C-335	Process Building
C-335-337-T	Tie Line
C-337	Process Building
C-337-A	Feed Vaporization Facility
C-360	Toll Transfer & Sampling Facility
C-360-A	Toll Transfer & Sampling Facility Annex
C-400	Cleaning Building and Appurtenant Structures
C-409	Stabilization Building
C-710	Technical Services Building and Appurtenant Structures
C-720	Maintenance and Stores Building and Appurtenant Structures
C-720-A	Compressor Shop
C-720-B	Machine Shop Addition
C-720-C	Converter Shop Addition
C-720-K	Instrument Shop Addition
C-745-A	Cylinder Storage Yard
C-745-B	Cylinder Storage Yard
C-745-B1	Cylinder Storage Yard Office
C-745-E	Kellogg Storage Yard
C-745-H	Cylinder Storage Yard
C-745-R	Cylinder Storage Yard
C-745-R1	Cylinder Changeout Building
C-745-Q	Cylinder Storage Yard
C-745-U	Cylinder Storage Yard

Table 4.2-10. Hazard Categorization of Facilities.

Facility	Name
C-745-V	Cylinder Storage Yard
C-745-X	Equipment Storage Yard
C-746-Q1	High Assay Waste Storage Facility

Table 4.2-11. Initiating Events.

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Cascade facilities			
Criticality Control Loss			
CRITICALITY			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	Yes	Yes
Purge cascade process	Evaluation basis event	Yes	Yes
External Event			
AIRCRAFT CRASH			
Enrichment cascade process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
EARTHQUAKE			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Toxic gas distribution processes	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
EVACUATION OF CASCADE PROCESS BUILDING			
Enrichment cascade process	Anticipated event	Yes	Yes
Freezer/Sublimer process	Anticipated event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Anticipated event	Yes	Yes
Toxic gas distribution processes	Anticipated event	Yes	Yes
Purge cascade process	Anticipated event	Yes	Yes
FLOOD			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Toxic gas distribution processes	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
HIGH WIND			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Toxic gas distribution processes	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
LARGE FIRE			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Toxic gas distribution processes	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
NATURAL GAS PIPELINE EXPLOSION			
Enrichment cascade process	Evaluation basis event	Yes	No
Pressure Increase			
B-STREAM BLOCK VALVE CLOSURE			
Enrichment cascade process	Anticipated event	Yes	Yes
Purge cascade process	Anticipated event	No	No
COOLANT TUBE RUPTURE INTO PRIMARY			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	No	No
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
COOLANT/OXIDANTS - VIOLENT REACTION			
Enrichment cascade process	Evaluation basis event	No	No
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
OVERPRESSURE OF PRIMARY SYSTEM WITH			
Enrichment cascade process	Evaluation basis event	No	No
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
STAGE CONTROL VALVE CLOSURE			
Enrichment cascade process	Anticipated event	Yes	No
Purge cascade process	Anticipated event	No	No
STRESS RUPTURE OF F/S VESSEL			
Freezer/Sublimer process	Evaluation basis event	No	No
Primary System Integrity			
COMPRESSOR SEAL FAILURE			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
DISTRIBUTION SYSTEM BREACHES			
Toxic gas distribution processes	Evaluation basis event	No	No
HEAVY EQUIPMENT DROP			
Enrichment cascade process	Evaluation basis event	Yes	Yes
Freezer/Sublimer process	Evaluation basis event	Yes	Yes
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
LARGE UF_6 RELEASE TO ATMOSPHERE			
Enrichment cascade process	Evaluation basis event	Yes	Yes
LIMITED UF_6 RELEASE TO ATMOSPHERE			
Enrichment cascade process	Anticipated event	Yes	Yes

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
MINOR UF_6 RELEASE TO ATMOSPHERE			
Purge cascade process	Anticipated event	No	No
MISVALVING (OPENING PRIMARY SYSTEM TO			
Enrichment cascade process	Evaluation basis event	No	No
Freezer/Sublimer process	Evaluation basis event	No	No
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
MOTOR-COMPRESSOR COUPLING FAILURE			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
OPENING OF PRIMARY SYSTEM W/O PURGING			
Enrichment cascade process	Evaluation basis event	No	No
Freezer/Sublimer process	Evaluation basis event	No	No
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
PRIMARY SYSTEM FAILURE DUE TO VEHICLE			
Enrichment cascade process	Evaluation basis event	No	No
Freezer/Sublimer process	Evaluation basis event	No	No
Purge cascade process	Evaluation basis event	No	No
Support System Loss			
LOSS OF ELECTRICAL POWER			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
LOSS OF LUBE OIL SUPPLY			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
LOSS OF PLANT AIR			
Enrichment cascade process	Anticipated event	No	No
Freezer/Sublimer process	Anticipated event	No	No
5.5 wt.% UF_6/R-114 separation process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
Temperature Increase			
APPLYING EXCESSIVE HEAT TO A LINE PLUGGED			
5.5 wt.% UF_6/R-114 separation process	Evaluation basis event	No	No
COMPRESSOR FAILURE - STARVING FLOW IN THE			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
COMPRESSOR FAILURE - UF_6/HOT METAL			
Enrichment cascade process	Anticipated event	Yes	Yes
Purge cascade process	Anticipated event	No	No
LOSS OF COOLANT			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
LOSS OF RCW TO COOLANT SYSTEM			
Enrichment cascade process	Anticipated event	No	No
Purge cascade process	Anticipated event	No	No
LOSS OF COOLING TO F/S			
Freezer/Sublimer process	Anticipated event	No	No
RCW TEMPERATURE INCREASE			
Freezer/Sublimer process	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Prompt Shutdown of Cascade Equipment with UF_6			
LOSS OF ELECTRICAL POWER			
Enrichment cascade process	Anticipated event	No	No
LOSS OF RCW			
Enrichment cascade process	Anticipated event	No	No
LOSS OF PLANT AIR			
Enrichment cascade process	Anticipated event	No	No
LOSS OF SEAL EXHAUST			
Enrichment cascade process	Anticipated event	No	No
LOSS OF LUBE OIL			
Enrichment cascade process	Anticipated event	No	No
LOSS OF COOLANT			
Enrichment cascade process	Anticipated event	No	No
LOSS OF DATUM SYSTEM			
Enrichment cascade process	Anticipated event	No	No
Controlled Shutdown of Cascade Equipment with UF_6 Inventory			
Enrichment cascade process	Anticipated event	No	No
Controlled Shutdown of Cascade Equipment with UF_6 Inventory			
Enrichment cascade process	Anticipated event	No	No
Loss of Purge Gas Removal Capability			
LOSS OF ELECTRICAL POWER			
Purge cascade process	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
LOSS OF RCW			
Purge cascade process	Anticipated event	No	No
LOSS OF PLANT AIR			
Purge cascade process	Anticipated event	No	No
VALVE FAILURE			
Purge cascade process	Anticipated event	No	No
UF_6 handling and storage facilities			
Criticality Control Loss			
CRITICALITY			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Evaluation basis event	Yes	Yes
External Event			
EARTHQUAKE			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Evaluation basis event	No	No
EVACUATION OF FACILITY			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	Yes	Yes
Toll sampling and transfer processes (C-360)	Anticipated event	Yes	Yes

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
FLOOD			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Evaluation basis event	No	No
HIGH WIND			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Evaluation basis event	No	No
LARGE FIRE			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A) (Only applies during Cylinder Handling and Storage	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360) (Only applies during Cylinder Handling and Storage	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Evaluation basis event	Yes	Yes
Pressure Increase			
AUTOCLAVE STEAM CONTROL VALVE FAILS OPEN			
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	Yes	Yes
Toll sampling and transfer processes (C-360)	Anticipated event	Yes	Yes
COOLANT TUBE RUPTURE INTO PRIMARY SYSTEM			
Withdrawal processes (Product and Tails)	Evaluation basis event	No	No
HEATING OF A CYLINDER WITH EXCESSIVE UF_6			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes

Continued

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
HEATING OF CYLINDER WITH EXCESSIVE NONCONDENSIBLES			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
LOSS OF UF_6 QUALITY CONTROL IN UF_6 CYLINDER			
Withdrawal processes (Product and Tails)	Evaluation basis event	No	No
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	No	No
Toll sampling and transfer processes (C-360)	Evaluation basis event	No	No
PLUGGED CYLINDER VALVE/PIGTAIL			
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	No	No
Toll sampling and transfer processes (C-360)	Anticipated event	No	No
PLUGGED/BLOCKED PROCESS LINE			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	Yes
Primary System Integrity			
COMPRESSOR SEAL FAILURE			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
CYLINDER FAILURE			
Cylinder handling/storage processes for leased facilities	Evaluation basis event	No	No
CYLINDER FAILURE INSIDE AUTOCLAVE			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
CYLINDER FAILURE OUTSIDE AUTOCLAVE			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
DAMAGED CYLINDER			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
Cylinder handling/storage processes	Anticipated event	No	No
HEAVY EQUIPMENT DROP			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
LIMITED UF_6 RELEASE TO ATMOSPHERE			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	Yes
MINOR LEAKS OF UF_6 INSIDE AN AUTOCLAVE			
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	No	No
Toll sampling and transfer processes (C-360)	Anticipated event	No	No
MINOR LEAKS OF UF_6 TO ATMOSPHERE			
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	No	No
Toll sampling and transfer processes (C-360)	Anticipated event	No	No
MOTOR-COMPRESSOR COUPLING FAILURE			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
OPENING OF PRIMARY SYSTEM W/O PURGING			
Withdrawal processes (Product and Tails)	Evaluation basis event	No	No
PIGTAIL FAILURE AT WITHDRAWAL POSITION			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
PIGTAIL LINE FAILURE INSIDE AUTOCLAVE			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	No
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
PIGTAIL LINE FAILURE OUTSIDE AUTOCLAVE			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	Yes	Yes
Toll sampling and transfer processes (C-360)	Evaluation basis event	Yes	Yes
PROCESS LINE FAILURE AT COMPRESSOR			
Withdrawal processes (Product and Tails)	Evaluation basis event	Yes	Yes
RELEASES OF SOLID/GASEOUS UF_6 TO ATMOSPHERE			
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	Yes	Yes
Toll sampling and transfer processes (C-360)	Anticipated event	Yes	Yes
Cylinder handling/storage processes	Anticipated event	Yes	Yes
Support System Loss			
LOSS OF ELECTRICAL POWER			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	No	No
Toll sampling and transfer processes (C-360)	Anticipated event	No	No
LOSS OF LUBE OIL SUPPLY			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
LOSS OF PLANT AIR			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
Feed vaporization and processes (C-333-A and C-337-A)	Anticipated event	No	No
Toll sampling and transfer processes (C-360)	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Temperature Increase			
APPLYING EXCESSIVE HEAT TO A LINE PLUGGED			
Feed vaporization and processes (C-333-A and C-337-A)	Evaluation basis event	No	No
Toll sampling and transfer processes (C-360)	Evaluation basis event	No	No
COMPRESSOR FAILURE - STARVING FLOW			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
COMPRESSOR FAILURE - UF_6/HOT METAL REACTION			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	Yes
LOSS OF COOLANT			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
LOSS OF RCW TO COOLANT SYSTEM			
Withdrawal processes (Product and Tails)	Anticipated event	No	No
Loss of Product Withdrawal Capability			
LOSS OF ELECTRICAL POWER			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	No
LOSS OF PLANT AIR			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	No
LOSS OF RCW			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	No
ISOLATION OF ALL WITHDRAWAL LOOPS			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	No
UNAVAILABILITY OF ALL WITHDRAWAL CYLINDERS			
Withdrawal processes (Product and Tails)	Anticipated event	Yes	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Chemical facilities			
Concentration Increase			
WHAT IF THE GASES ARE MIXED IMPROPERLY			
C-350 Drying agent storage processes	Anticipated event	No	No
WHAT IF THERE ARE CONTAMINANTS IN THE FLUORINE SYSTEM			
C-410-D Fluorine storage building processes	Anticipated event	Yes	No
C-410-K Fluorine storage building processes	Anticipated event	Yes	No
WHAT IF THERE ARE CONTAMINANTS IN THE SULFURIC ACID TANK			
C-616 Waste water treatment plant processes	Evaluation basis event	No	No
External Event			
WHAT IF THERE IS A LARGE FIRE			
C-410-K Fluorine storage building processes	Evaluation basis event	Yes	Yes
C-611 Water treatment plant processes	Evaluation basis event	Yes	Yes
C-615 Sewage treatment plant processes	Evaluation basis event	Yes	Yes
C-616 Waste water treatment plant processes	Evaluation basis event	Yes	Yes
C-631, 633, 635, 637 RCW pump house processes	Evaluation basis event	Yes	Yes
Toxic gas storage and distribution process	Evaluation basis event	Yes	Yes
Flow Increase			
WHAT IF THERE IS MISDIRECTED FLOW OF ClF_3 AND/OR F_2/N_2			
C-350 Drying agent storage processes	Anticipated event	No	No
WHAT IF THERE IS MISDIRECTED FLOW OF F_2/N_2			
C-410-K Fluorine storage building processes	Anticipated event	No	No
Pressure Decrease			
WHAT IF THE PRESSURE IN THE MIX TANK IS TOO LOW			
C-350 Drying agent storage processes	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?

Pressure Increase			
WHAT IF THE ClF_3-F_2/N_2 MIXING TANK IS OVERPRESSURIZED			
C-350 Drying agent storage processes	Anticipated event	No	No
WHAT IF THE F_2/N_2 TANK IS OVERPRESSURIZED			
C-410-D Fluorine storage building processes	Evaluation basis event	Yes	No
Primary System Integrity			
LARGE RELEASE OF CHLORINE			
C-611 Water treatment plant processes	Evaluation basis event	Yes	Yes
C-615 Sewage treatment plant processes	Evaluation basis event	Yes	Yes
C-631, 633, 635, 637 RCW pump house processes	Evaluation basis event	Yes	Yes
Toxic gas storage and distribution process	Evaluation basis event	Yes	Yes
C-745-A Storage processes	Evaluation basis event	Yes	Yes
RELEASE OF ClF_3 AND/OR F_2/N_2 FROM A DAMAGED STORAGE TANK AT C-350			
C-350 Drying agent storage processes	Evaluation basis event	Yes	No
Toxic gas storage and distribution process	Evaluation basis event	Yes	No
C-742-B Storage processes	Evaluation basis event	Yes	No
C-745-A Storage processes	Evaluation basis event	Yes	No
C-745-B Storage processes	Evaluation basis event	Yes	No
RELEASE OF ClF_3 FROM A LINE			
C-350 Drying agent storage processes	Evaluation basis event	Yes	Yes
Toxic gas storage and distribution process	Evaluation basis event	Yes	Yes
RELEASE OF F_2 /N_2 FROM A LINE AT THE STORAGE TANK AT C-410-D			
Toxic gas storage and distribution process	Evaluation basis event	Yes	Yes
RELEASE OF F_2/N_2 FROM THE DISTRIBUTION HEADER			
C-410-D Fluorine storage building processes	Evaluation basis event	Yes	No
C-410-K Fluorine storage building processes	Evaluation basis event	Yes	No
Toxic gas storage and distribution process	Evaluation basis event	Yes	No
RELEASE OF F_2/N_2 THROUGH THE RUPTURE DISKS AT C-410-D OR C-410-K			
Toxic gas storage and distribution process	Evaluation basis event	Yes	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF A ClF_3 CYLINDER VALVE LEAKS DURING CYLINDER HANDLING AND PIGTAIL CONNECTION			
C-350 Drying agent storage processes	Anticipated event	No	No
WHAT IF AN ClF_3 CYLINDER LEAKS			
C-742-B Storage processes	Anticipated event	No	No
C-745-B Storage processes	Anticipated event	No	No
WHAT IF THERE IS A RELEASE OF F_2N_2 FROM A HIGH PRESSURE MULTITUBE TRAILER OR PIGTAIL			
C-410-K Fluorine storage building processes	Anticipated event	Yes	Yes
C-745-A Storage processes	Anticipated event	Yes	No
C-745-B Storage processes	Anticipated event	Yes	No
WHAT IF THERE IS A LEAK IN THE CHLORINE EQUIPMENT			
C-611 Water treatment plant processes	Anticipated event	No	No
C-615 Sewage treatment plant processes	Anticipated event	No	No
C-631, 633, 635, 637 RCW pump house processes	Anticipated event	No	No
WHAT IF A CHLORINE CONTAINER LEAKS			
C-611 Water treatment plant processes	Anticipated event	No	No
C-745 Storage processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN THE ClF_3 OR FLUORINE SYSTEM			
C-350 Drying agent storage processes	Anticipated event	Yes	No
WHAT IF THERE IS A LEAK IN THE FLUORINE DISTRIBUTION LINE			
C-410-D Fluorine storage building processes	Anticipated event	Yes	No
WHAT IF THERE IS A LEAK IN THE FLUORINE SYSTEM			
C-410-K Fluorine storage building processes	Anticipated event	Yes	No
WHAT IF THERE IS A LEAK IN THE F_2/N_2 STORAGE TANK OR SUPPLY SYSTEM			
C-410-D Fluorine storage building processes	Anticipated event	No	No
C-410-K Fluorine storage building processes	Anticipated event	Yes	No
WHAT IF THERE IS A LEAK IN THE SULFURIC ACID SYSTEM			
C-616 Waste water treatment plant processes	Anticipated event	No	No
C-631, 633, 635, 637 RCW pump house processes	Anticipated event	No	No

Continued

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF THERE IS A RUPTURE IN THE SULFURIC ACID SYSTEM			
C-616 Waste water treatment plant processes	Evaluation basis event	No	No
C-631, 633, 635, 637 RCW pump house processes	Evaluation basis event	No	No
WHAT IF THERE IS MOISTURE INSIDE A STORAGE TANK			
C-350 Drying agent storage processes	Anticipated event	No	No
Miscellaneous waste storage and handling facilities			
Criticality Control Loss			
WHAT IF THERE IS A CRITICALITY			
C-746-Q1 Fissile Storage Processes	Evaluation basis event	Yes	Yes
Waste storage/handling processes	Evaluation basis event	Yes	Yes
External Event			
WHAT IF THERE IS A LARGE FIRE			
C-727 90-day Mixed waste storage processes	Evaluation basis event	Yes	Yes
C-746-Q1 Fissile Storage Processes	Evaluation basis event	No	No
Waste storage/handling processes	Evaluation basis event	Yes	Yes
Excessive Exposure to Radiation			
WHAT IF THERE IS A BUILDUP OF EXCESS RADIONUCLIDES (E.G., TC-99)			
Waste storage/handling processes	Anticipated event	No	No
Primary System Integrity			
WHAT IF THERE IS A LEAK IN ONE OR MORE OF THE STORAGE			
C-727 90-day Mixed waste storage processes	Anticipated event	No	No
C-746-Q1 Fissile Storage Processes	Anticipated event	No	No
Waste storage/handling processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE OF ONE OR MORE OF THE STORAGE			
C-727 90-day Mixed waste storage processes	Anticipated event	No	No
Waste storage/handling processes	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Miscellaneous support facilities			
Criticality Control Loss			
WHAT IF THERE IS A CRITICALITY			
C-400 Cleaning building processes	Evaluation basis event	Yes	Yes
C-409 Stabilization building processes	Evaluation basis event	Yes	Yes
C-710 Technical services building processes	Evaluation basis event	Yes	Yes
C-720 Maintenance and stores building processes	Evaluation basis event	Yes	Yes
Equipment Storage Process	Evaluation basis event	Yes	Yes
Concentration Increase			
WHAT IF A LARGE QUANTITY OF PERCHLORIC ACID ACCUMULATES IN THE HOOD			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THE NITRIC ACID CONTAMINATES THE AIR SUPPLY SYSTEM			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE ARE CONTAMINANTS IN THE NITRIC ACID SYSTEM			
C-400 Cleaning building processes	Anticipated event	No	No
External Event			
WHAT IF THERE IS A LARGE FIRE			
C-100 Administration building processes	Evaluation basis event	No	No
C-400 Cleaning building processes	Evaluation basis event	Yes	Yes
C-409 Stabilization building processes	Evaluation basis event	No	No
C-709 Laboratory Annex	Evaluation basis event	No	No
C-710 Technical services building processes	Evaluation basis event	Yes	Yes
C-720 Maintenance and stores building processes	Evaluation basis event	No	No
Equipment Storage Process	Evaluation basis event	No	No
WHAT IF THERE IS AN EARTHQUAKE			
C-710 Technical services building processes	Evaluation basis event	Yes	No
Excessive Exposure to Radiation			
WHAT IF THERE IS A BUILDUP OF EXCESS RADIONUCLIDES (E.G., TECHNETIUM)			
C-400 Cleaning building processes	Evaluation basis event	No	No
C-709 Laboratory Annex	Evaluation basis event	No	No

C-710 Technical services building processes	Evaluation basis event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
Flow Increase			
WHAT IF THERE IS REVERSE FLOW FROM THE PROCESS TO THE NITRIC ACID SYSTEM			
C-400 Cleaning building processes	Anticipated event	No	No
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS REVERSE FLOW OF THE PROCESS MATERIAL INTO THE WATER SUPPLY HEADER			
C-409 Stabilization building processes	Anticipated event	No	No
Level Increase			
WHAT IF A UF_6 CYLINDER IS OVERFILLED			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS HIGH LEVEL IN THE NITRIC ACID DAY TANK			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS HIGH LEVEL IN THE NITRIC ACID STORAGE TANK			
C-400 Cleaning building processes	Anticipated event	No	No
Pressure Increase			
WHAT IF THE STEAM VALVE ON THE CYLINDER HEATING SYSTEM FAILS			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THE UF_6 CYLINDER IS OVERHEATED WHILE IT IS CONNECTED TO THE MANIFOLD			
C-710 Technical services building processes	Anticipated event	No	No
PRIMARY SYSTEM INTEGRITY			
WHAT IF A CLEANING TANK LEAKS			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF A CLEANING TANK RUPTURES			
C-400 Cleaning building processes	Evaluation basis event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF A LIQUID UF_6 CYLINDER LEAKS			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF A MANIFOLD LINE LEAKS			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF A MANIFOLD LINE RUPTURES			
C-710 Technical services building processes	Evaluation basis event	No	No
WHAT IF A SOLID UF_6 CYLINDER LEAKS OR RUPTURES			
C-710 Technical services building processes	Evaluation basis event	No	No
WHAT IF A STORAGE TANK LEAKS			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF A STORAGE TANK RUPTURES			
C-400 Cleaning building processes	Evaluation basis event	No	No
WHAT IF A UF_6 CYLINDER IS DAMAGED			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF A UF_6 CYLINDER RUPTURES			
C-710 Technical services building processes	Evaluation basis event	No	No
WHAT IF HYDROGEN LEAKS IN THE ROOM			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF ONE OR MORE CONTAINERS OF ANALYTICAL CHEMICALS IN THIS ROOM RUPTURE, (E.G. BREAK SPILL)			
C-409 Stabilization building processes	Anticipated event	No	No
C-709 Laboratory Annex	Anticipated event	No	No
C-710 Technical services building processes	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF ONE OR MORE OF THE STORAGE CONTAINERS FAIL, RELEASING THE CONTENTS			
C-400 Cleaning building processes	Anticipated event	No	No
C-409 Stabilization building processes	Anticipated event	No	No
C-709 Laboratory Annex	Anticipated event	No	No

C-710 Technical services building processes	Anticipated event	No	No
WHAT IF OPERATOR OPENS SAMPLE CONNECTION WITHOUT HAVING A SAMPLE TUBE CONNECTED TO THE MANIFOLD			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THE FLUORINE LINE OR CYLINDER OUTSIDE THE BUILDING LEAKS			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THE FLUORINE LINE OR CYLINDER OUTSIDE THE BUILDING RUPTURES			
C-710 Technical services building processes	Evaluation basis event	Yes	No
WHAT IF THE HYDROGEN LINE OR CYLINDER OUTSIDE THE BUILDING RUPTURES			
C-710 Technical services building processes	Evaluation basis event	No	No
WHAT IF THE OPERATOR DROPS THE LIQUID UF_6 CYLINDER DURING MIXING OR WHILE ATTACHING IT TO THE MANIFOLD			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN ONE OF THE DOT CYLINDERS OF CORROSIVE GAS			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN ONE OF THE PRECIPITATION SYSTEMS			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN THE ACIDIFYING TANKS			
C-400 Cleaning building processes	Anticipated event	No	No
C-409 Stabilization building processes	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF THERE IS A LEAK IN THE FLUORINE SUPPLY SYSTEM			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN THE GLOVE BOX			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN THE NITRIC ACID SYSTEM			
C-400 Cleaning building processes	Anticipated event	No	No
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK IN THE VARNISHER			
C-720 Maintenance and stores building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OF ONE OF THE CORROSIVE GAS LECTURE BOTTLES (ClF_3, HF, F_2)			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OR RUPTURE IN A BASIN			
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OR RUPTURE IN ONE OR MORE OF THE STORAGE			
C-709 Laboratory Annex	Anticipated event	No	

C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OR RUPTURE IN THE PRECIPITATION SYSTEM			
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OR RUPTURE IN THE PRESSURE TRANSMITTER CLEANING SYSTEM			
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A LEAK OR RUPTURE OF THE DRY HONER CABINET			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS A RELEASE FROM THE CYLINDER WASHING SYSTEM			
C-400 Cleaning building processes	Anticipated event	No	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF THERE IS A RUPTURE IN ONE OF THE PRECIPITATION SYSTEMS			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE IN THE ACIDIFYING TANKS			
C-400 Cleaning building processes	Anticipated event	No	No
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE IN THE FLUORINE SUPPLY SYSTEM			
C-710 Technical services building processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE IN THE NITRIC ACID STORAGE TANK			
C-400 Cleaning building processes	Evaluation basis event	No	No
WHAT IF THERE IS A RUPTURE IN THE NITRIC ACID SYSTEM			
C-409 Stabilization building processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE IN THE NITRIC ACID SYSTEM (OTHER THAN IN THE STORAGE TANK)			
C-400 Cleaning building processes	Anticipated event	No	No
WHAT IF THERE IS A RUPTURE IN THE VARNISHER			
C-720 Maintenance and stores building processes	Evaluation basis event	No	No
WHAT IF THERE IS A RUPTURE OF ONE OF THE CORROSIVE GAS LECTURE BOTTLES (ClF_3, HF, F_2)			
C-710 Technical services building processes	Evaluation basis event	No	No
WHAT IF THERE IS A RUPTURE OF ONE OF THE DOT CYLINDERS OF CORROSIVE GAS			
C-710 Technical services building processes	Evaluation basis event	Yes	No

Continued.

Table 4.2-11. Initiating Events. (continued)

Facility group/parameter/event/applicable process descriptions	Event frequency	Exceeds PSOA threshold?	Limiting event?
WHAT IF THERE IS AN HF RELEASE FROM THE CYLINDER WASHING SYSTEM			
C-409 Stabilization building processes	Anticipated event	No	No

Table 4.2-12. Threshold Analysis for PrHA.

Case no.	Description	Release duration/ quantity (s/lb)	Radiationdose (rem)	U uptake (mg)	HF exposure (ppm)
2	Open valve on a liquid-filled cylinder, 6 o'clock position	N/A 225/3304 75/1106	< 5 rem	30.2	20.0
3	Open valve on a liquid-filled cylinder, 12 o'clock position— liquid/vapor	N/A 428/2183 233/1466	Negligible	30.1	19.9
	Open valve on a liquid-filled cylinder, 12 o'clock position— vapor only	N/A 405/1544 195/779	Negligible	29.8	19.9
4	Broken pigtail during parent-daughter transfer	N/A 285/1677 120/720	Negligible	29.8	20.3
5	Broken pigtail during withdrawal—full release	N/A 1050/4163 1800/7009	Negligible	30.0	19.7

	Broken pigtail during withdrawal— accumulator isolation after 1 min	N/A 3600/3096 1800/1880	Negligible	29.4	13.5
6	Broken withdrawal compressor discharge	3120/25080	Negligible	8.6	5.3
7	B-line break at maximum power	N/A 110/32200 78/22900	Negligible	30	20
8	Release from isolated cell	150/11000	Negligible	9.7	8.5
9	Interbuilding tie-line failure	8/1151	Negligible	30	196[a]

[a] This value is derived by assuming the peak concentration throughout a 1-hr exposure. This method is a different analysis technique than that used for the other HF exposure values which are derived from a more realistic averaging technique.

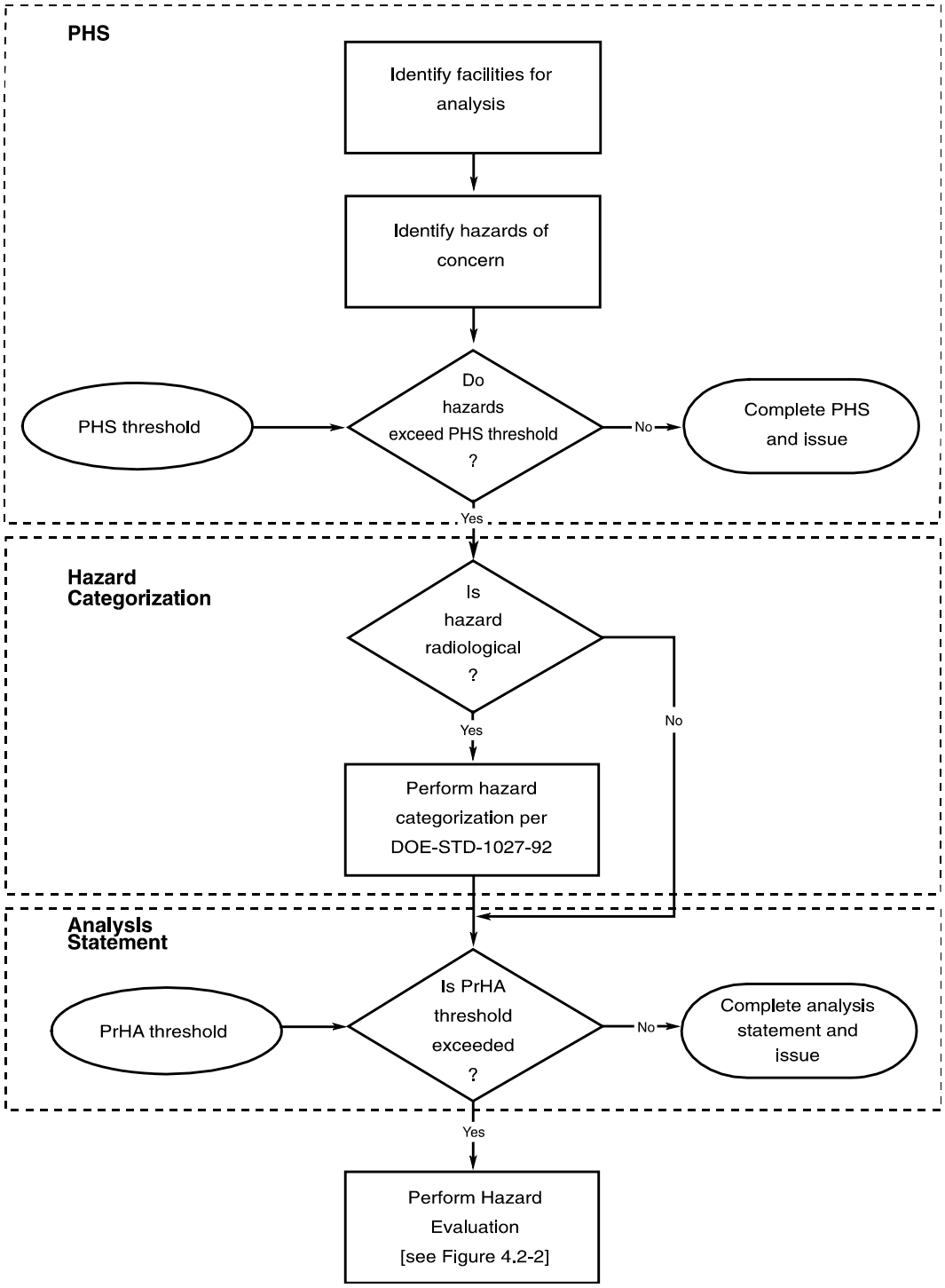
PHS
Identify facilities for analysis
Identify hazards of concern
PHS threshold
Do hazards exceed PHS threshold ?
No
Complete PHS and issue
Yes
Hazard Categorization
Is hazard radiological ?
Yes
No
Perform hazard categorization per DOE-STD-1027-92
Analysis Statement
PrHA threshold
Is PrHA threshold exceeded ?
No
Complete analysis statement and issue
Yes
Perform Hazard Evaluation [see Figure 4.2-2]

Figure 4.2-1

Hazard Identification

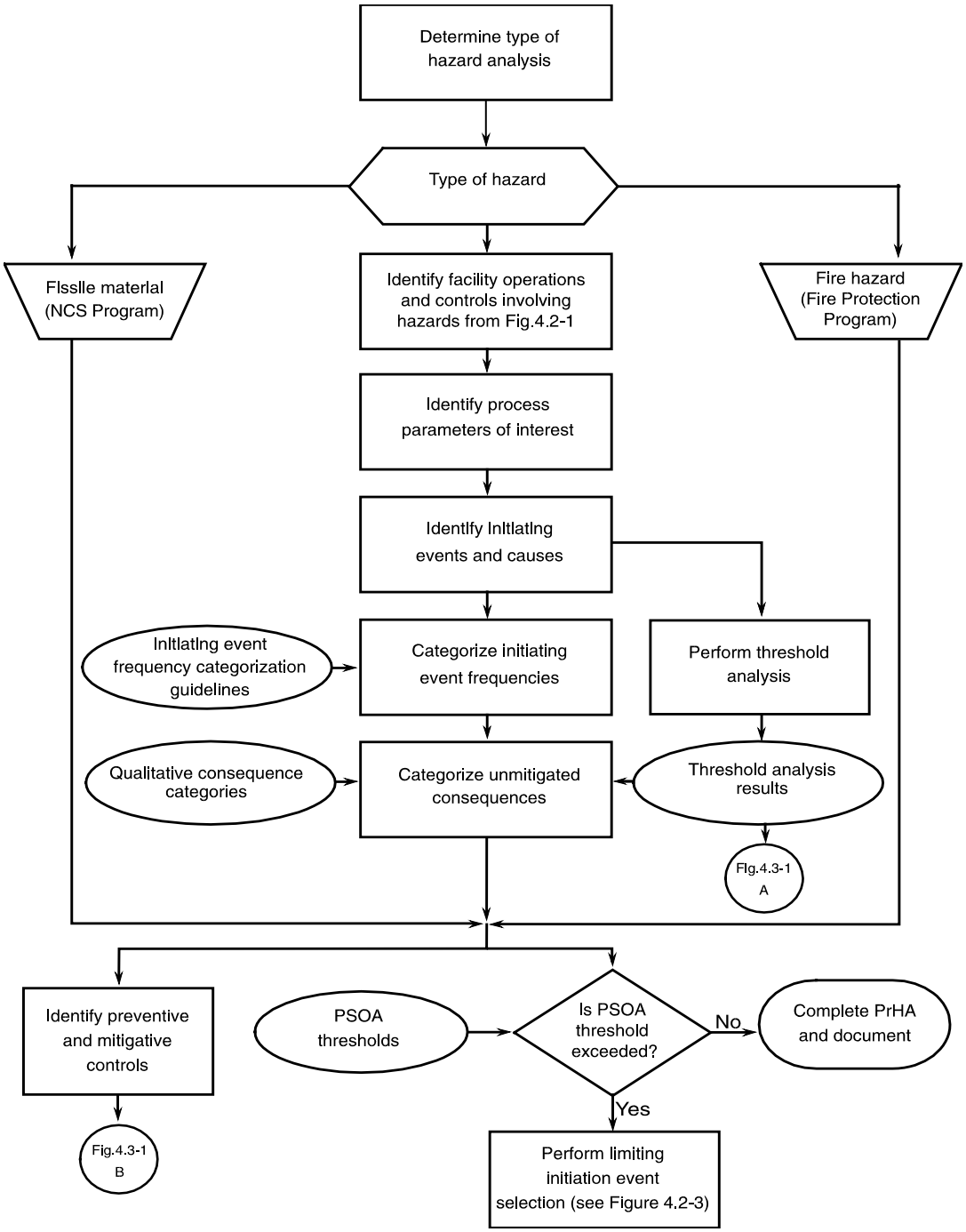
Determine type of hazard analysis
Type of hazard
Fissile material (NCS Program)
Identify facility operations and controls involving hazards from Fig.4.2-1
Fire hazard (Fire Protection Program)
Identify process parameters of interest
Identify initiating events and causes
Initiating event frequency categorization guidelines
Categorize initiating event frequencies
Perform threshold analysis
Qualitative consequence categories
Categorize unmitigated consequences
Threshold analysis results
Fig.4.3-1 A
Identify preventive and mitigative controls
PSOA thresholds
Is PSOA threshold exceeded?
No
Complete PrHA and document
Yes
Fig.4.3-1 B
Perform limiting initiation event selection (see Figure 4.2-3)

Figure 4.2-2

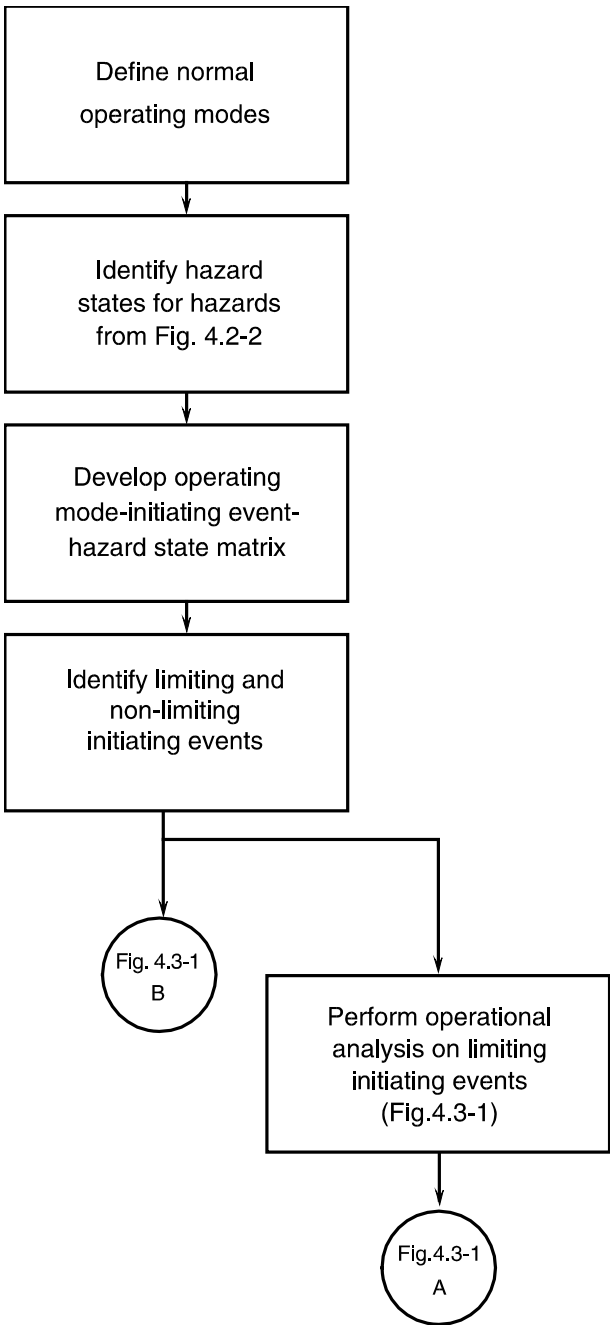
Define normal operating modes
Identify hazard states for hazards from Fig. 4.2-2
Develop operating mode-initiating event-hazard state matrix
Identify limiting and non-limiting initiating events
Fig. 4.3-1 B
Perform operational analysis on limiting initiating events (Fig.4.3-1)
Fig.4.3-1 A

Figure 4.2-3

Limiting Initiating Event Selection

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4.3 ACCIDENT ANALYSIS

This section presents the development of the potential accidents identified in the accident selection portion of Section 4.2.6. Each limiting initiating event was evaluated to identify the essential safety actions and controls to support the EGs. For the limiting initiating events identified in Section 4.2.6, the accident analysis documents the most limiting scenario associated with the initiating event, operating mode, and hazard state. Additionally, the controls that require TSRs were also identified as a result of the analysis.

4.3.1 Accident Analysis Methodology

The accident analysis methodology used the operational analysis (OA) outlined in Figure 4.3-1 to develop the scenarios presented in this section. The OA was applied to each limiting initiating event, operating mode, and hazard state as identified in Section 4.2.6 of the hazard analysis to develop the scenarios. Once the OA was accomplished, the controls selected in the PrHA and OA were classified as described in Section 4.2.2. The methods used for developing source-term modeling and consequence analysis are described in Section 4.3.1.2.

4.3.1.1 Operational Analysis

Each of the limiting initiating events was reviewed in detail to determine the required safety actions (Table 4.3-1) and controls necessary to support the Evaluation Guidelines (see Section 4.2.1). The objectives of the Operational Analysis were as follows:

- Evaluate normal operation and unmitigated initiating events to identify essential safety actions.
- Identify essential systems, structures, or components required to perform safety actions.
- Evaluate essential system capabilities and supporting system requirements (i.e., air, electrical).
- Develop operating limits [i.e., safety limits (SLs), limiting condition settings (LCSs), limiting conditions of operation (LCOs), and surveillance requirements (SRs)] and appropriate technical bases.

4.3.1.1.1 Essential Safety Actions

Safety actions are defined as the actions required to prevent exceeding the Evaluation Guidelines (EGs) for initiating events that could exceed the PSOA threshold. Table 4.3-1 lists typical safety actions used for the GDPs. Each safety action has a description of the function it provides for mitigation or prevention of a potential initiating event.

The first objective of Operational Analysis—identification of essential safety actions—involved evaluating each limiting initiating event combination identified in the hazard analysis. Only safety actions required to prevent exceeding the EGs were identified. This evaluation used the EGs given in Table 4.2-2, a consequence screening threshold analysis, and engineering judgment to determine whether a safety action is required to prevent exceeding the EGs.

Each limiting initiating event combination, along with its associated unmitigated consequences, was compared with the EGs for the same frequency category to determine whether the EG could be exceeded. If no EG could be exceeded, justification is provided, and no additional analysis is required for that particular combination. For each combination that requires a safety action to prevent exceeding an EG, a safety action was selected, and appropriate justification is provided. The combinations requiring safety actions are considered in the evaluation described in Section 4.3.1.1.2.

4.3.1.1.2 Essential Controls

The second objective of Operational Analysis—identification of essential systems, structures, or components required to perform safety actions—was accomplished by using the results of the evaluation described in Section 4.3.1.1.1. The identified set of essential controls is the minimum set of controls necessary to support meeting the EGs, and thus it provides the primary input for Technical Safety Requirement (TSR) selection. The analysis addressed each combination of safety action, initiating event, operating mode, and hazard state. For each safety action, the minimum set of controls required to accomplish it was selected. The essential controls that were selected during the evaluation were listed along with their respective safety functions. The scope of each control associated with performing the associated safety function was explicitly defined to support subsequent analyses of the system and to establish functional requirements.

4.3.1.1.3 Essential System Capabilities and Support Requirements

When a system, structure, or component was selected as essential as described in Section 4.3.1.1.2, the installed configuration of the control is typically subjected to a more detailed review to verify the capability of the control to accomplish the required safety action(s)as follows:

- Active controls selected that require TSRs were evaluated to identify the required components, their positions (e.g., valve positions), and the support systems required to accomplish the safety action (the analysis performed should be centered on the hardware only, with operator interface being the initiator for manually initiated systems).

- Controls selected that were assumed to perform a safety function during events related to natural phenomena were evaluated as described in Section 4.3.1.3.

The discussion of results for essential system capabilities and support requirements is presented in Section 3.15.

4.3.1.1.4 Operating Limits

The final objective of the Operational Analysis—development of operating limits and appropriate technical bases—was accomplished using a three-step process: (1) Limiting Conditions for Operation (LCO) development, (2) Surveillance Requirements (SR) development, and (3) Safety Limits (SL) and Limiting Control Settings (LCS) development.

LCO development. The first step, LCO development, used the identified essential controls described in Section 4.3.1.1.2. LCOs were derived by requiring essential active controls meeting the TSR selection guidelines (Section 4.2.3) to be operable in each operating mode and hazard state combination for which a safety action is required. This established the applicability statement and LCO statement for each control.

SR development. The second step, SR development, used the qualitative analyses required by Section 4.3.1.1.3 to establish SRs to verify operability of the required control. SRs include appropriate testing requirements to ensure that each portion of the control can accomplish its required safety action. Surveillance intervals are based on industry standards and on current testing intervals described for the GDPs for similar SRs. Current testing intervals are based on historical information for the type of equipment being used in the GDPs. Where historical evidence was not available, the current testing interval was used with a recommendation to trend any failures for potential changes to the testing intervals.

SL and LCS development. The final step, operating limit development, established the appropriate SLs and LCSs (if applicable) for each essential control. This step requires evaluation of each initiating event, operating mode, and hazard state to determine which combination results in the most stringent demand on the control. For systems requiring SLs and LCSs, an analysis of the limiting transient is performed and the results are used to establish the SL, LCS, and the associated technical bases. This may require specific transient response calculations to characterize system response to the initiating challenge and to provide a basis for any SL and LCS. Only controls selected to prevent an EBE, which could exceed the off-site EGs, were typically considered for establishing an SL and LCS.

Operating limits for essential systems are presented in the TSRs.

4.3.1.2 Consequence Analysis Methodology

This section summarizes the methods used to quantify the consequences of operational accidents, natural phenomena events, and external events selected in Section 4.2.6.1.3. This section discusses the development and application of computer models that provided estimates of (1) source terms (Section 4.3.1.2.1), (2) in-building transport (Section 4.3.1.2.2), and (3) outdoor atmospheric transport (Section 4.3.1.2.3).

4.3.1.2.1 Source-Term Methodology

This section discusses the source-term methodology used in the SAR. Two models are described in this section: (1) the PIPELEAK code, which was used to estimate release rates from UF_6 cylinders,

and (2) the Improved Multi-site Productivity Program (IMPP), which was used to predict pressures and interstage flow rates for each cell in the enrichment cascade.

4.3.1.2.1.1 PIPELEAK

The PIPELEAK code is a variant of the CYLIND code developed by the NRC to estimate release rates for UF_6 cylinders as detailed by NUREG/CR-4360 (Reference 1). The code simulates the release of UF_6 from a cylinder through either a breach in the cylinder itself or through a broken or misvalved transfer piping system. There have been some improvements to the original version of CYLIND. The primary modifications involve the PIPSYS subroutine, which evaluated releases through a piping system. The version of CYLIND documented in NUREG/CR-4360 would attempt to divide by zero in certain piping configurations. These errors have been corrected, and the modifications are documented in a letter from J. H. Clinton to R. W. Schmidt (Reference 2). The PIPELEAK code used for this analysis is documented in Reference 3 and overcomes the shortcomings that existed in the original CYLIND code.

Estimating releases from cylinders is complicated by UF_6 phase behavior. Two or three phases of UF_6 may be present inside the cylinder. As UF_6 moves along the release pathway (e.g., broken transfer piping or a cylinder breach), the material's phase composition is likely to change, and special considerations are needed if the flow at any point in the pathway approaches the UF_6 triple point (see Figure 3.1-1). The PIPELEAK code uses mass and energy balances around the cylinder and associated piping, along with detailed UF_6 physical property data, to track the cylinder pressure as well as the phase and temperature changes of both the UF_6 remaining in the cylinder and the UF_6 released to the atmosphere. Also, the code offers the choice of assuming isentropic (i.e., constant temperature) or isenthalpic (i.e., constant heat) flashing (i.e., rapid conversion of UF_6 liquid to the solid and vapor phases) modes.

To estimate release rates through a cylinder breach or transfer piping system, PIPELEAK first assumes a UF_6 velocity through the release path. The standard multiphase flow calculations are performed to determine the pressure drop across each segment of the release path. The UF_6 velocity is corrected until the calculated pressure drop across the release path equals the actual pressure difference between the cylinder and the ambient air. The release rates calculated by PIPELEAK are reasonably consistent with those calculated by other multiphase release models, although the pure vapor release rates generated by PIPELEAK are somewhat higher than rates calculated with standard equations for single-phase flow through an orifice.

Many of the potential releases modeled using PIPELEAK would involve cylinders with pressures above pure UF_6 vapor pressure at a specified temperature because of the presence of noncondensable gases. Because the PIPELEAK code is limited to handling pure UF_6 only, two model runs can be made to simulate the effects of noncondensable gas pressure. The first run (called the correct temperature run) is made at the scenario temperature, with the vapor pressure of liquid UF_6 at this temperature. The second run (called the correct pressure run) is made at a higher temperature, providing a pure UF_6 liquid vapor pressure at the desired scenario pressure. The correct pressure run is used to estimate the correct release rate while the liquid level in the cylinder is above the opening. Once the liquid level in the cylinder falls below the opening, the noncondensable gases would escape, and the release would continue as in the correct temperature run (the first run made). The amount of UF_6 release from a liquid source (e.g., a

source with the liquid level in the cylinder above the opening) would be taken from the correct temperature run because the higher temperature in the correct pressure case would overestimate the height of the liquid in the cylinder because of the additional thermal expansion of liquid UF_6.

4.3.1.2.1.2 Improved Multi-site Productivity Program

The Improved Multi-site Productivity Program (IMPP) is a standard productivity code for use at the GDPs. This code was used to prepare flowsheet data for PGDP operating at its nameplate power level (3040 MW). The flowsheets provide pressures and interstage flow rates for each cell in the enrichment cascade. These data were used to estimate cell inventories and potential release rates from line ruptures in a cell due to closing of a B-line block valve while the A-line valve remains open. The following equation is a curve-fit to these flowsheet data:

$$INV = MSP\left[P_N N + (P_{\max} - P_N)\frac{(N-1)}{\ln(N)}\right], \qquad (1)$$

where

INV is the mass of UF_6 in the involved stages (lb),
MSP is the mass per stage pressure equal to 65.3 lb UF_6 / stage psia,
P_N is the normal high-side pressure equal to 21.0 psia,
$P_{\max}$ is the maximum pressure at the closed block-valve (psia), and
N is the number of stages with elevated pressure.

4.3.1.2.2 In-Building Transport Methodology

This section discusses the in-building transport methodology used in the SAR. The methods described within this section are for UF_6 releases that occur inside the process buildings, specifically Building C-337 at PGDP. When UF_6 is released into the process building air, it will undergo an exothermic chemical reaction with water vapor to form UO_2F_2 and HF. The in-building transport methodology was used to estimate the amount of UO_2F_2 and HF retained in the building and, conversely, the amount of these materials released into the atmosphere that may be dispersed downwind.

4.3.1.2.2.1 Background on Previous Methods

For previous GDP safety studies, a lumped parameter model was developed by Williams (Reference 4) to evaluate in-building transport from releases of UF_6 inside a process building. The model included treatment of UF_6 in solid, liquid, and vapor phases, and treatment of HF and water in the liquid and vapor phases. Polymerization of HF was also employed in the Williams model, referred to as the cascade-summer (CSCDSM) model, because the model was developed to estimate in-building transport of UF_6 and its reaction products with summer ventilation rates in the process buildings.

The CSCDSM model solves mass and energy balance equations for a compartment with a single-volume representation. In CSCDSM, UF_6 released from process building piping is assumed to flash instantaneously to solid and vapor. The solid UF_6 is assumed to be dispersed uniformly throughout the mixing volume (i.e., the entire process building) and subjected to gravitational settling only, neglecting

other mechanisms (e.g, agglomeration). The mass of solid UF_6 particles (Δm_d,) that is removed from the in-building air over time (t) is calculated as:

$$\Delta m_d = \frac{m_c}{V} vA\Delta t \ , \qquad (2)$$

where

m_c is the particle mass (g),
V is the inside volume of the process building (m^3),
v is the aerosol settling velocity (fixed at 0.01 m/s), and
A is floor area (m^2).

The CSCDSM model assumes that process building volume is well represented by simple geometry (e.g., the process building is divided into control volumes equal to the size of one unit), thereby ignoring spatial effects of particle distribution and deposition on equipment and piping surfaces. Because of the limitations of the CSCDSM model (i.e., consideration of gravitational settling only with a constant settling velocity of 0.01 m/s and single-volume, simple-geometry representation of the process buildings), new computer modules were developed to simulate in-building transport. These new modules were linked to the MELCOR computer code (Reference 5) and are discussed in more detail in Section 4.3.1.2.2.2.

4.3.1.2.2.2 In-Building Transport Methods Used for this SAR

The MELCOR model computer code, developed by the NRC, is widely used for simulating severe accidents in nuclear reactor facilities. MELCOR is written in a highly modular fashion, in which modules may be changed or replaced, allowing the user to focus on their particular application. This modular nature facilitated the development of an in-building transport model for use for the PGDP C-337 process building. For the remainder of this section, the in-building transport model will be referred to simply as MELCOR; however, the remaining discussion will focus on the new modules incorporated into the model that deal specifically with transport of UF_6 in the C-337 process building. The following information is a summary from Kim et al. (Reference 6).

a. Development and Features of MELCOR

The MELCOR code was first used to develop a single-volume representation of the process building, and the results were used to benchmark the code with the CSCDSM. As with CSCDSM, the MELCOR model was developed for the summer ventilation configuration. During summer, the ventilation system works as a once-through system in which air is drawn into the operating floor of the process building and then forced to the cell floor by a large blower (as shown in Figure 4.3-2). The summer ventilation system results in the largest amount of material mass (e.g., UO_2F_2 and HF) to be released to the outside atmosphere after a potential accident. MELCOR estimates for the single-volume representation were found to be comparable to the CSCDSM model (Reference 6).

The next step examined the effect of finer nodalization by specifying the cell housing as a separate volume in order to observe spatial effects from multi-volume calculations on particle and vapor transport (e.g., three control volumes were used to simulate a single unit in the process building). This examination

revealed that far fewer UO_2F_2 particles were estimated to be released to the outside atmosphere than were estimated for the single-volume representation (i.e., more particles settled in the building). However, the review neglected many of the spatial effects of air flow distribution and mixing behavior that would occur in the entire process building under the summer ventilation system. For the purpose of the SAR, the entire process building was divided into a much finer nodalized system, discussed in more detail in the next section.

b. MELCOR Nodalization of the Process Building

Figure 4.3-3 shows the control volume and unit layout of the process buildings at the GDPs, specifically Building X-333 at PORTS, containing eight units, and Building C-337 at PGDP, containing six units. Each unit is combined into a single control volume, except for Unit 4. Because the fifth cell in Unit 4 (note each unit contains ten cells) is the postulated location of the pipe break, the volume of this unit is finely nodalized to capture the temporal and spatial effects of the particle and vapor dispersion in the immediate vicinity of the source. Specifically, the cell floor area of Unit 4 is divided into three-story control volumes, as seen in Figure 4.3-4. The first floor consists of 20 control volumes because each cell at this level has 2 control volumes: (1) the cell housing and (2) the cell floor volume outside the cell housing. The second story was nodalized into ten control volumes, one corresponding to each cell, and the third-story volume is treated as a single large control volume. Several other control volumes serve to model the outside atmosphere and the released source term (i.e., the material released into the environment). Also, several flow paths connect the control volumes as described in detail in Kim et al. (Reference 6).

c. Modeling of Cell Housing Wall Leakage

The cell housing wall is constructed of steel framing with siding bolted in place. Although the housing seams are tightly closed, the cell housing was not designed to provide confinement of released UF_6 in the event of a line rupture inside the housing. The air inside the housing will heat up due to heat (both convective and radiative) from equipment surfaces such as compressors. A significant temperature difference between inside and outside the housing develops buoyancy forces, convecting air naturally through the cracks in the housing, untightened seams, and other leak paths. As shown in Figure 4.3-5, three flow paths are assumed during steady-state conditions (i.e. normal operation) due to convection: (1) leak in at wall, (2) leak out at wall, and (3) leak out at ceiling. When UF_6 is released into the housing cell, a 7- by 3-ft (2.1- by 0.91-m) door is assumed to swing open to the outside because no restraint is installed to restrict the door from opening (Reference 6). Therefore, the door is assumed to stay open during the MELCOR simulations. This adds an additional flow path (Figure 4.3-5) out of the cell housing.

To obtain an appropriate size of the four cell housing flow paths, localized, three-dimensional flow simulations were performed using the Computational Fluid Dynamics (CFD) tool, CFDS-FLOW3D (a commercially available program developed by AEA Technology Engineering Software, Inc). For the CFDS-FLOW3D simulations, a single cell housing was divided into about 50,000 small control volumes (Reference 7). In the simulations, particles were uniformly sourced into the cell housing as tracers; however, particle deposition was not considered due to limitations of the code. A steady-state (i.e., normal cell operation) simulation was established, and then a transient (i.e., after a UF_6 release)

simulation was performed. Results of the CFDS-FLOW3D steady-state simulation showed that 50% of the particles released into the cell housing are exhausted through the roof vents, and the remaining 50% exit through the motor exhaust or are passed on to an adjacent cell. The transient simulation was then run using the steady-state simulation as the initial conditions, and the results showed that 70% of the released particles would escape through the roof vent due to the increased convection caused by the exothermic heat generated by the UF_6 reactions. To produce results compatible with CFDS-FLOW3D, input into the MELCOR model that specified the four cell housing leakage flow paths (Figure 4.3-5) was calibrated to match the transient simulation results from CFDS-FLOW3D.

d. Sensible Energy and Chemical Reaction of Gaseous UF_6 Releases into the Cell Housing

As gaseous UF_6 is released, the cell housing is subjected not only to exothermic energy generated from the UF_6 hydrolysis reaction, but also to sensible energy carried by the UF_6 gas. The magnitude of the UF_6 gas sensible energy is a function of the temperature of the UF_6, T_U, at the release point. The enthalpy of gaseous UF_6, H_V, is obtained from Williams (Reference 4):

$$H_V = 43.2614 + 9.21307 \times 10^{-2} T_U + 6.26265 \times 10^{-6} T_U^2 + \frac{2951.71}{T_U} + 3.0939 \times 10^{-3} T_U (Z_{p,T} - Z_{14.7,T}) \ , \quad (3)$$

where H_v is given in Btu/lb and T_U is given in °R. The compressibility factor, Z, is calculated as

$$Z = \frac{T_U^3}{T_U^3 + 4.8923 \times 10^5 p} \ , \quad (4)$$

where p is the pressure (psia).

The gaseous UF_6 is assumed to mix instantaneously with the air in the control volume and undergoes an instantaneous chemical reaction:

$$UF_6 + 2H_2O \rightarrow UO_2F_2 + 4HF + 0.33\,\text{MJ/kg of } UF_6 \text{ reacted.} \quad (5)$$

However, this chemical reaction is limited in magnitude by the availability of moisture in the air. MELCOR simulates the moisture-limited UF_6 reaction process through a series of control functions designed to monitor moisture content in each control volume atmosphere, to calculate the UF_6 reaction rate limited by the moisture content, and to determine the rate of moisture consumption in the control volume. Such amount of moisture consumption is used as input to the Control Volume Hydrodynamics (CVH) package of MELCOR as a mass sink in corresponding control volumes. Because each control volume is connected, the air flow path is updated by air being circulated into the control volume. Any unreacted UF_6 gas is subjected to convection and transport into neighboring control volumes and to chemical reactions with the moisture present in those neighboring volumes.

e. Particle Transport Model

The radionuclide package of MELCOR simulates many of the particle transport phenomena that may occur in the process buildings:

- Particle condensation, evaporation, agglomeration, deposition, and scavenging by engineering safety features (e.g., filter trapping, pool scrubbing, spray washout).
- Particle movement, as the particles grow by agglomeration, to larger-size bins through the use of multiple particle-size bins that are user-defined.
- Gravitational settling, Brownian diffusion, thermophoresis (i.e., a process causing migration of particles from higher to lower temperatures), and diffusiophoresis (i.e., deposition induced by condensation of water vapor onto structural surfaces) deposition mechanisms.

For simulations of accidental UF_6 releases, the effect of gravitational settling dominates other deposition processes (e.g., thermophoresis and diffusiophoresis) by 1 to 2 orders of magnitude (Reference 6).

For MELCOR calculations, UO_2F_2 is assumed always to be a solid, with initial particle size assumed to be a log-normal distribution between 0.4 and 2.5 µm. This particle-size range is based on guidance from the uranium particle-size distribution measurements taken at Sequoyah Nuclear Fuel Plant (Reference 8). According to these air filter measurements, most of the uranium particles fell in the size range between 0.4 and 2.5 µm, with a peak between 1.3 and 1.6 µm. Experiments by Pickrell (Reference 9) and Lux (Reference 10) corroborate the data obtained from the Sequoyah measurements.

For the deposition calculations, the surfaces of equipment and piping are included in addition to the floor surfaces. The gravitational settling model of MELCOR calculates particle mass settled on heat structure surfaces (e.g., floors, equipment, walls) based on a settling velocity that accounts for various indoor atmospheric conditions (e.g., temperature and relative humidity). However, the model does not track individual particle paths for settling. Consequently, the model does not acknowledge the relative altitude of various structures in the particle-settling calculation (i.e., particle-settling length is not factored into the calculation). Therefore, to account for the particle-settling length, equipment and piping surface measurements were increased to twice what would actually be in the cell housing. This change has the effect of uniformly distributing the surfaces throughout the different elevations in the control housing volume.

4.3.1.2.3 Atmospheric Transport Methodology

This section discusses the atmospheric transport methodology used in the SAR. Potential accidental releases of UF_6 to the atmosphere are a more likely threat to human health and safety than other potential, but unlikely, environmental transport pathways (i.e., water and soil). Four topics important in the development of the atmospheric transport methodology are summarized: (1) historical accidental atmospheric releases of UF_6, (2) reactions and dispersion of UF_6 in the atmosphere, (3) background on previous methods used to assess releases of UF_6, and (4) atmospheric transport methods used for this SAR.

4.3.1.2.3.1 Historical Accidental Atmospheric Releases of UF_6

This section discusses three historical accidental atmospheric releases of UF_6: the Comurhex plant release, the PORTS occurrence, and the Sequoyah Fuels Corporation occurrence. Because there have been virtually no controlled field data experiments for large releases of UF_6 to the atmosphere, these incidents helped provide an understanding of the potential downwind dispersion associated with an accidental release and were germane in formulating the accident analysis methodology.

4.3.1.2.3.1.1 Comurhex Plant Release

On July 1, 1977, a large release of UF_6 occurred at the Comurhex plant in Pierrelatte, France (Reference 11), in which a valve ruptured on a cylinder heated to 194-203°F (90-95°C). Liquid UF_6 was released for 10-15 min, until the liquid level in the container had fallen below the valve opening. After this, UF_6 escaped in the gas phase until the release was contained 15 min later. In the total release time of 30 min, 16,000 lb (7100 kg) of UF_6 was released into the atmosphere. The weather favored rapid dilution because the atmosphere was unstable (warm and sunny conditions), and the wind speed was 19 mph (9 m/s) (Reference 12).

Most of the uranium released was recovered within a distance of 2000 ft (600 m), suggesting that most of the solid uranium compounds settled in a relatively small area [about 0.25 acres (0.10 hectares)]. At 2000 ft (600 m) downwind of the release, ambient air monitoring showed that atmospheric concentrations of uranium were about 10 mg/m^3, and HF concentrations exceeded the French workplace limit of 2.4 mg/m^3 out to a distance of 3900 ft (1200 m) (Reference 13). About 7 percent of the uranium was not recovered and is believed to have dispersed into the atmosphere.

4.3.1.2.3.1.2 PORTS Occurrence

On March 7, 1978, a liquid-filled 14-ton UF_6 cylinder ruptured in a PORTS cylinder yard (Lot No. X-745-B) after being dropped about 9 in (23 cm). At the time of release, light snow and freezing rain were falling, and about 0.6 in (1.5 cm) of snow covered the ground in the cylinder yard. The ambient air temperature was about 32°F (0°C), with the wind blowing from the northeast at about 5 mph (2 m/s). The distance from the release point to the nearest site boundary in the direction of the wind was about 1.4 mi (2.2 km).

Within 1 h, about 21,100 lb (9500 kg) of UF_6 [14,300 lb (6400 kg) of uranium] was released from the ruptured cylinder. About 1200 lb (550 kg) of uranium was recovered from the snow in the cylinder yard. About 2500 lb (1130 kg) of uranium was carried by melted snow to the plant's west drainage ditch, of which 1500 lb (680 kg) was transported through the ditch and was released into the Scioto River and about 450 kg (1000 lb) was retained in the ditch impoundment. Therefore, 10,300 lb (4720 kg) (about 76 percent of the uranium released) left the area as an airborne plume and dispersed in the atmosphere (Reference 14).

Environmental sampling after the release showed that significant soil and water contamination were confined to distances of a few hundred meters from the release point (Reference 14). Five workers who drove through the plume on the perimeter road [about 7218 ft (2200 m) from the release point]

showed no harmful amount of uranium in their urine samples and experienced only brief discomfort (e.g., eye irritation) from HF exposure. Because on-site aquatic and terrestrial biota were exposed to elevated uranium and HF concentrations for only a short time, environmental impacts were minimal. Also, no public exposure was reported (Reference 14).

Observers of this release indicate that the visible portion of the plume (i.e., solid UF_6 and UO_2F_2) hovered over the ground for the first few hundred meters, mixing very little in the vertical. At about 980-1300 ft (300-400 m) downwind (southwest) of the release point, the plume stretched vertically, and the plume centerline lifted off the ground (Reference 14). Observations of the deposition of solid UF_6 and UO_2F_2 within the first few hundred meters from the release point agree qualitatively with these observations. The snow and freezing rain that were falling at the time may have contributed significantly to the amount of uranium deposited.

4.3.1.2.3.1.3 Sequoyah Fuels Corporation Occurrence

On January 4, 1986, at Sequoyah Fuels Corporation in Gore, Oklahoma, 30,800 lb (14,000 kg) of UF_6 was released from a 14-ton cylinder that had ruptured because of overfilling. The rupture was about 4 ft (1.2 m) long, and most of the UF_6 was released in less than 1 min (Reference 12). At the time of release, winds were from the north-northwest at about 18 mph (8 m/s) with gusts to about 30 mph (14 m/s). Atmospheric stability, not measured on site, was assumed to be neutral due to the high wind speeds (Reference 8).

Estimates of uranium recovery ranged from 35 percent to 50 percent; most of the uranium was found on the ground near the release point as solid UF_6 and UO_2F_2. The amount of uranium that was transported offsite [i.e., at distances greater than about 980 ft (300 m)] in an atmospheric plume was between about 7300 and 10,000 lb (3300 and 4700 kg).

One worker died from HF exposure as a result of the release. Several other workers experienced reversible effects of acute HF exposure, including skin burns and irritation to the eyes, mucous membranes, and respiratory tract. No symptoms of kidney injury occurred from chemical exposure to uranium, although nine workers exceeded NRC's regulatory limit for uranium inhalation (10.0 mg over a 1-wk period) (Reference 12). An air monitor at the site boundary directly downwind of the release [about 984 ft (300 m) from the release] measured a maximum ground-level uranium concentration of 120 mg/m^3 (averaged over a 10-min period) (Reference 8). Another monitor, located about 5250 ft (1600 m) downwind of the release, recorded a maximum uranium concentration over the same averaging time of 12 mg/m^3 (Reference 8). This monitor was located about 1300 ft (400 m) from the projected plume centerline (Reference 8). Computer modeling performed by Lawrence Livermore National Laboratory estimated that maximum HF concentrations at receptors located off site were about 15 mg/m^3 (averaged over a 20-min period) (Reference 8).

The worker killed during this release was on a scrubbing tower 165 ft (50 m) from the release point. Observations of the plume indicated that he was quickly enveloped in a dense, white cloud. The process building (the largest structure at the Sequoyah plant), positioned just downwind of the release point, was also engulfed by the white plume (Reference 8).

4.3.1.2.3.2 Reactions and Dispersion of UF_6 in the Atmosphere

The following information on UF_6 reactions and dispersion in the atmosphere is summarized from References 15, 16, and 17. For more details, the reader is directed to these references, particularly Chapter 5 in Reference 17 and Chapter 2 in Reference 15.

At normal atmospheric temperatures and pressures, UF_6 exists only as a gas or solid (see Figure 3.1-1, UF_6 phase diagram). Liquid UF_6 exists at pressures exceeding about 1.6 atm (160 kPa) and temperatures exceeding 147°F (64°C). If exposed directly to atmospheric temperatures and pressures (e.g., during a breach of a heated 14-ton storage cylinder), liquid UF_6 will flash (i.e., immediately partition) to a mixture of vapor and solid particles. The solid UF_6 will sublimate to the vapor form within a few minutes after release. The UF_6 vapor, which is much denser than ambient air, reacts exothermically with atmospheric water vapor entrained into the plume, forming HF vapor and solid UO_2F_2:

$$UF_6(g) + 2\,H_2O(g) \rightarrow UO_2F_2(s) + 4\,HF(g)\ . \tag{6}$$

This reaction releases about 25,000 Btu/lb-mol (58 kJ/g-mol) of H_2O, which heats the plume. At the same time, the sublimation of solid UF_6 to the vapor phase cools the plume. At normal atmospheric pressures, HF vapor is assumed to polymerize and depolymerize as an equilibrium mixture of the dimer, $(HF)_2$, hexamer $(HF)_6$, octamer $(HF)_8$, and the $HF{\cdot}H_2O$ compound as described by the following equations (Reference 18):

$$2\,HF = (HF)_2\ , \tag{7}$$

$$6\,HF = (HF)_6\ , \tag{8}$$

$$8\,HF = (HF)_8\ , \tag{9}$$

$$HF + H_2O = (HF \bullet H_2O)\ . \tag{10}$$

Figure 4.3-6 (Reference 17) shows the two-phase mixture of chemical species that may be present in a plume resulting from an atmospheric release of UF_6. Because of this two-phase mixture and the heating and cooling effects of the reactions and phase changes, the plume may alternate between negative, neutral, and positive buoyancy caused by varying plume density. Figure 4.3-7 (Reference 15) is an example of the special complications (i.e., those complications caused by the varying plume density) in simulating dispersion. Figure 4.3-7 schematically represents a moderate-velocity, vertical release of UF_6 to the atmosphere. Although the plume is initially much denser than the ambient air, the momentum of the vertical release initially causes the plume to rise as it moves downwind, as shown in Region 1 of the figure. As the momentum slows, the plume may sink as shown in Region 2 of the figure, because the plume can be much denser than the surrounding air. If it sinks all the way to the ground, the plume is designated a ground-hovering plume, as shown in Region 3 of the figure. During (and before) this ground-hovering plume phase, UF_6 reactions with water vapor occur and release more heat than the heat removed by sublimation of solid UF_6 to the vapor phase. The net heat released and the entrainment of air may cause the plume to become less dense. In turn, the plume may rise, as shown in Region 4 of the figure. In Region 5, the plume becomes neutrally buoyant because concentrations of uranium and HF are

small, reactions are essentially complete, and the temperature is close to ambient. The Gaussian plume methodology for passive, nonbouyant plumes is appropriate to model plume behavior in Region 5.

Many variations in plume trajectory shown may occur, as shown schematically in Figure 4.3-7. Depending on the release rate and mass flow of the mixture, rapid entrainment of ambient air may cause the plume to become neutrally buoyant (Region 5) very quickly. Alternatively, the UF_6 mixture may be released downward, causing a strong interaction with the ground and a direct transition into a ground-hovering plume, represented in Region 3. For a pure UF_6 gas release, the plume density may decrease by as much as a factor of 12 (the ratio, about 350:29, between the molecular weights of UF_6 and dry air) between the release point and a downwind distance of a few hundred meters.

Equations (6) through (10) are the basic chemical reactions equations used in UF_6 chemistry modules. Although included in the models, the tendency of HF polymers to form in plumes resulting from UF_6 releases [Eqs. (7) through (10)] is minimized because HF concentrations are generally far below the concentrations of about 10% required for significant polymerization (Reference 19). Because the chemical reaction of UF_6 with water vapor proceeds at an extremely high rate (Reference 20), the UF_6 hydrolysis reaction [Equation (6)] dominates the overall reaction sequence. In other words, water vapor entrained into the plume will first react with UF_6, which is restricted by a mass transfer-limited reaction rate (i.e., the limited mass transfer that occurs between the plume and ambient air at the edges of the plume) due to incomplete mixing (References 21 and 22). Any remaining water vapor mixes into the plume and reacts with the HF created by the UF_6 hydrolysis reaction.

The mass transfer-limited reaction rate (hereafter called the turbulence-limited reaction rate to conform with previous conventions established in the literature, where turbulence indicates the turbulent edge of the plume, not atmospheric turbulence), $\dot{R}$ (kmol/s^2), of UF_6 and entrained water vapor is assumed to be determined by the mixing properties of the expanding plume (Reference 15):

$$\dot{R} = \frac{3.6\, v_e}{\Lambda} \left(\frac{M_w \, x \, M_u}{2\, M \;\; + M} \right), \tag{11}$$

where

v_e is the entrainment velocity (m/s),
Λ is the ratio of the plume cross-sectional area to plume circumference (m), and
M_w and M_u are the molar flow rates (kmole/s) for water vapor and UF_6 vapor, respectively.

The entrainment velocity, v_e, is on the order of 0.6 times the jet speed (m/s) or 0.6 times the ambient friction velocity (a reference velocity that depends on the nature of the surface over which the plume is traveling and the mean wind speed in a shallow layer above the ground surface) for a low-momentum, ground-hovering plume. The ratio Λ is half the plume radius for a circular cross section.

4.3.1.2.3.3 Background on Previous Methods

This subsection discusses the different methodologies employed in the atmospheric transport analyses after a release of UF_6. The purpose of this section is to establish a basis for selecting the

methodology for this SAR. Three previous analyses are discussed: (1) the analysis used in the 1985 PGDP FSAR (Reference 23), (2) the analysis recommended by the NRC (Reference 12), and (3) the analysis used by Louisiana Energy Services for the Claiborne Enrichment Center SAR (Reference 24).

4.3.1.2.3.3.1 1985 PGDP FSAR

In 1978 existing atmospheric dispersion codes were surveyed to determine the availability of existing dispersion models that could be used to simulate atmospheric transport of a plume containing UF_6 and UF_6 hydrolysis products. At that time atmospheric plume dispersion was modeled almost exclusively by assuming a Gaussian distribution in both the vertical and cross-wind (perpendicular to the horizontal wind component) directions. Because the standard Gaussian methodology does not accurately simulate key elements of UF_6 plume dispersion, such as chemical reactivity, release of the heat of reaction, and the density variations of a UF_6 plume, DOE funded the development of a UF_6 dispersion model. The code developed and used in the 1985 PGDP FSAR was called PLUMEA. The methods used to model UF_6 dispersion and the development of the code are detailed in Reference 15, in which updates to the algorithm are included and the model is renamed PLM89A; the special aspects of UF_6 dispersion are incorporated into the model. The model incorporates the following:

- The exothermic reaction associated with the hydrolysis of UF_6 is taken into account.
- A plume containing a mixture of UF_6 and its hydrolysis products may be positively, negatively, or neutrally buoyant, depending on the density, composition, and temperature.
- A plume containing a mixture of UF_6 hydrolysis products may be either elevated or ground-hovering (gravity spreading).
- Phase changes, such as UF_6 sublimation and condensation of hydrofluoric acid (a condensed mixture of HF and water) and the associated consumption or release of heat are included.
- The plume density may decrease by more than a factor of 12 as the UF_6 reacts with ambient moisture and is diluted by air entrained into the plume.

In addition to simulating the dispersion of UF_6 and its hydrolysis products, PLM89A can simulate the dispersion and atmospheric chemical reactions associated with releases of ClF_3, F_2, and HF.

For the 1985 FSAR, uranium and HF concentrations were calculated for atmospheric releases of UF_6 associated with accidents occurring in the uranium enrichment cascade. For this analysis, the released UF_6 was assumed to pass immediately through the ventilation system into the outdoor atmosphere. Different release quantities of UF_6 were simulated. The results show that only a release of 20,000 lb (9000 kg) or more of UF_6 to the atmosphere would have toxic effects on personnel downwind of the large process buildings.

4.3.1.2.3.3.2 NUREG-1140

The purpose of NUREG-1140 is to evaluate emergency preparedness requirements for NRC material licensees possessing large quantities of radioactive materials (e.g., the GDPs) (Reference 12). NUREG-1140 establishes relatively simple calculations to determine radiation doses and chemical exposure that would occur after an accidental release at a fuel cycle facility. For the GDPs, NUREG-1140 recommends that a release of UF_6 from a hot [~250°F (120°C) or more] 14-ton cylinder be used to

establish emergency preparedness guidelines. This release was chosen because it represents the largest release of UF_6 from many possible accidents that were analyzed in two studies (References 25 and 26). This release scenario is similar to accidents that occurred at PORTS, the Sequoyah conversion plant, and the Comurhex plant.

NUREG-1140 assumes that 21,000 lb (9500 kg) of UF_6 is released in 15 min due to the rupture outdoors of a heated 14-ton cylinder, in which 11,000 lb (4800 kg) of uranium and 3600 lb (1620 kg) of HF become airborne. These airborne masses were calculated by conservatively assuming that all hydrolysis reactions and agglomeration and deposition of solid UO_2F_2 particles occur at the moment of release. Also, NUREG-1140 assumes the plume centerline rises to a final height of 66 ft (20 m) within 660 ft (200 m) of the release because of the heat generated during the hydrolysis reactions. This plume height was chosen on the basis of PLM89A model estimates (Reference 12). With these assumptions, the mass of uranium inhaled, *I* (kg), is calculated as

$$I = q_U \text{ x } B \text{ x } \frac{\chi}{Q} \ , \tag{12}$$

where

q_U is the released quantity of uranium (4800 kg),
B is the breathing rate (2.66×10^{-4} m^3/s),
χ is the atmospheric concentration (g/m^3), and
Q is the release rate (g/s).

Values for the atmospheric dispersion term, χ/Q (s/m^3), were directly obtained from a standard Gaussian plume model.

For HF exposure, NUREG-1140 uses a similar calculation to calculate concentrations, χ (kg/m^3), downwind of the release:
where

$$I = q_{HF} \text{ x } t^{-1} \text{ x } \frac{\chi}{Q} \tag{13}$$

q_{HF} is the released quantity of HF (1620 kg), and
t is the release time (assumed to be 900 s).

Based on these equations, fixed values of downwind exposure were calculated for (1) very adverse meteorological conditions (i.e., atmospheric stability equal to F with a wind speed equal to 1 m/s) and (2) more typical (but not particularly favorable) meteorological conditions (atmospheric stability equal to D with a wind speed equal to 4.5 m/s) (Reference 12). From these calculations, NUREG-1140 concludes that consequences from chemical exposure of uranium and HF are similar in severity. Additionally, the consequences of chemical exposure are much greater than consequences resulting from radioactive dose received from uranium exposure. Thus, a uranium enrichment plant can be considered more of a potential chemical hazard than a radiation hazard. The assumptions used the NUREG-1140 analysis (e.g., maximum quantity released, minimum atmospheric dilution, receptor at the plume

centerline) to provide an extreme consequence estimate (i.e., estimates that result in the absolute maximum downwind exposure to the public) from the many types of releases that could occur at PGDP.

4.3.1.2.3.3.3 Louisiana Energy Services SAR

In the Louisiana Energy Services SAR (Reference 24), two "worst case" UF_6 release scenarios were identified that resulted in off-site impact. The first scenario was a storage yard fire, which was analyzed following NUREG-1140 (described in Section 4.3.1.2.3.3.2). The second scenario was an autoclave heater malfunction for which three different release cases were analyzed to determine offsite impacts: (1) plume dispersion for which there is no building confinement (i.e., the release occurs in an open field); (2) plume dispersion from the facility stack (i.e., an elevated release) after the released material has mixed, reacted, and settled within the building; and (3) plume dispersion from the doors and other openings on the sides of the building (i.e., a ground-level release) after the released material has mixed, reacted, and settled within the building.

The three cases were simulated using (1) the NUREG-1140 modeling method (as described above), (2) a modified version of the NUREG-1140 modeling method where χ/Q values are obtained from NRC Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, and (3) the TRIAD UF_6 atmospheric dispersion model (Reference 26). Estimates from the TRIAD model are much lower than those from the other two methods because TRIAD includes the effects of exothermic/endothermic chemical reactions on plume buoyancy as well as particle deposition and settling. Plume rise estimates among the three modeling methods were found to be especially significant in estimating downwind concentrations; a higher final plume height resulted in a lower ground-level concentration.

4.3.1.2.3.4 Atmospheric Transport Methods Used in this SAR

In 1992, then Martin Marietta Energy Systems, Inc. (MMES), sponsored a review of existing atmospheric dispersion models to determine the most appropriate basis for development of a model for predicting the consequences of an accidental UF_6 release. The review was conducted by the Aeronautical Research Associates Princeton (ARAP) Group and summarized in a report by Sykes and Lewellen (Reference 27). Five models were examined in detail by Sykes and Lewellen.

- PLM89A—a UF_6 dispersion model developed by Lockheed Martin Energy Systems, Inc. (LMES, formerly Martin Marietta Energy Systems, Inc.) (Reference 15).
- TRIAD—a UF_6 model developed by the Nation Oceanic and Atmospheric Administration's (NOAA's) Air Resource Laboratory (Reference 26).
- HGSYSTEM—a suite of codes that model dense-gas dispersion and HF chemical and thermodynamic processes developed by Witlox et al. (Reference 28) of Shell Research Ltd. and available through the American Petroleum Institute (API).
- ADAM—a dense-gas model developed by Raj and Morris (Reference 29) for the United States Air Force.
- SLAB—a dense-gas model developed by Ermak (Reference 30) and available from Lawrence Livermore National Laboratory.

Sykes and Lewellen recommended the following two possible model development and modification options because none of the five candidate models completely met the eleven requirements listed as relevant to safety analysis application:

- Revise PLM89A's dense-gas dispersion algorithms but retain its sophisticated treatment of UF_6 chemistry and thermodynamics, or
- Revise HGSYSTEM—because it is widely accepted and includes HF chemistry—to include the UF_6 chemistry and thermodynamic modules employed by the PLM89A.

Sykes and Lewellen reported that the basis for selecting HGSYSTEM over SLAB and ADAM was not overly compelling. HGSYSTEM and ADAM had existing HF chemistry modules that made them favorable to SLAB; however, HGSYSTEM has a more modular construction than ADAM, which would ease import of UF_6 and chemistry modules. Furthermore, the main module in HGSYSTEM, HEGADAS, has undergone more extensive testing as a dense-gas model than ADAM and therefore is more widely accepted.

After the ARAP review, MMES decided that the best course of action would be to revise HGSYSTEM on the basis of the model's existing heavy-gas treatment, acceptance in the community, and the amount of work required to update PLM89A. The new HGSYSTEM/UF_6 model, developed by Hanna et al. (Reference 17) of Earth Technology Corporation under the sponsorship of LMES, is a hybrid model containing the best attributes of the HGSYSTEM and PLM89A models. Figure 4.3-8 shows a schematic of the development of HGSYSTEM/UF_6.

The following sections discuss the development, major features, evaluation, and limitations of HGSYSTEM/UF_6. See References 16, 17, 31, and 32 for more detailed information.

4.3.1.2.3.4.1 Development of HGSYSTEM/UF_6

HGSYSTEM was originally developed by Shell Research, Ltd., in the mid-to-late 1980s to simulate a wide variety of hazardous gas releases, including two-phase aerosol jets of HF resulting from ruptures of valves and pipelines on pressurized HF tanks (References 28 and 33). The first version of HGSYSTEM, released in 1990, incorporated the dense-gas dispersion model HEGADAS, which was developed in the late 1970s to simulate liquid spills and subsequent evaporation of liquefied natural gas (LNG) and liquefied petroleum gas (LPG) (Reference 34). By the time it was incorporated into HGSYSTEM, HEGADAS had already undergone extensive evaluation and been approved by the U.S. Environmental Protection Agency (EPA) as an alternative regulatory model (40 CFR 51, App. W).

In 1994 an updated version of HGSYSTEM (Version 3.0) was released by Shell Research Ltd., with several enhancements sponsored by API. Like HEGADAS, HGSYSTEM Version 3.0 was approved by the EPA as an alternative regulatory model (40 CFR 51, App. W). Development of HGSYSTEM Version 3.0 was closely coordinated with development of HGSYSTEM/UF_6 (Reference 17). All improvements to the Shell HGSYSTEM model have been incorporated into HGSYSTEM/UF_6. The final Shell technical documentation and user's guide contain descriptions of the UF_6 modules.

As shown in Figure 4.3-8, the UF_6 modeling system is divided into three, interrelated subprocesses: (1) plume dispersion and entrainment, (2) UF_6 chemistry, and (3) UF_6/HF thermodynamics. The key component in the plume dispersion subprocess is the calculation of entrainment rate. In turn, the entrainment rate determines the mixing-limited chemical reaction rate, which provides values for the amounts of entrained dry air and water vapor. Calculation of chemical reactions provides the heats of reaction for the thermodynamics module and determines the changes of the amounts of the UF_6, HF, water vapor, and UO_2F_2 in the plume. In the thermodynamics equilibrium routine, partitioning of phases (which affect the chemical reaction) leads to the calculation of plume density and buoyancy (which drive the plume dispersion). The numerical method and the implementation of these three interrelated subprocesses are described in detail in Chapter 5 of Reference 17.

Several enhancements were incorporated into HGSYSTEM/UF_6, including (1) effects of buildings on plume dispersion, (2) lift-off of the plume centerline from ground level as buoyancy changes from negative to positive as a result of heat input due to chemical reactions, (3) removal of gases and particles by wet and dry deposition, (4) parameterization of some meteorological variables using recent boundary-layer theory, and (5) accounting for variations in concentration with averaging time. The development of the UF_6 chemistry and thermodynamics modules and some key enhancements pertinent to this SAR are discussed immediately below.

a. Effects of Buildings on Plume Dispersion

In the development of HGSYSTEM/UF_6, enhancements were made to the model to account for the influence of buildings on dispersion. Because of the turbulent eddies that form around buildings, algorithms to model the effect of buildings on downwind concentrations, such as trapping of emissions from vents flush with the roof or with the side of a building, were incorporated into HGSYSTEM/UF_6. However, these algorithms are only applicable for nonbuoyant releases.

Two additional models have been developed for HGSYSTEM/UF_6 that simulate the influence of buildings on warm plumes (e.g., those plumes associated with a release of UF_6 from buildings at the GDPs). The first model, called WAKE, simulates a positively buoyant plume released from vents flush with the roofs of the large process buildings (Buildings C-333 and C-337). Although the WAKE model was developed with the large PGDP process building in mind, the formulations are sufficiently general that they can be applied to a broad range of warm plumes emitted from industrial buildings.

Figure 4.3-9 is a schematic of the complex flow that develops around large buildings. As the wind field impacts the upwind face of the building, streamlines will split, with a significant fraction of the flow ascending over the roof of the building. Downwind of the building, streamlines descend toward the ground surface. As the flow is split and streamlines ascend and descend over the building, many turbulent zones are created. A positively buoyant plume emitted at roof level may be affected by one or more of these turbulent zones as the rising plume passes through the region of the building wake. For instance, if a vent is located within the roof recirculation region near the upwind edge of the building, much of the plume may be recirculated toward the roof level, and relatively high concentrations would be expected (Reference 35). Also, as a positively buoyant plume rises through the roof recirculation cavity or the high-turbulence zone, it will be rapidly diluted (to ambient density), causing the height of final plume rise

to be shorter, and the plume vertical width to be larger, than that of a plume released in the absence of a building (Reference 36).

On the lee side of the building, a recirculation cavity may form. (This region is also called the near wake.) Any fraction of the positively buoyant plume captured in the near wake would be rapidly brought to ground level along recirculation streamlines. The remaining fraction of the positively buoyant plume not captured in the recirculation cavity would be influenced by the turbulent wake zone, where streamlines descend near the lee side of the building (downwash). Recent wind tunnel studies conducted by EPA (References 37 and 38) show that the actual trajectory of a rising plume is substantially affected by building downwash. With certain combinations of wind speed and direction, Scire et al. (Reference 39) report that a positively buoyant plume may actually descend to the ground surface because streamline descent overcomes the effects of buoyancy.

A primary assumption in the development of the WAKE model, as applied to the PGDP process buildings, is that all chemical reactions are completed inside the building before release to the atmosphere. Therefore, the reaction products (UO_2F_2 and $HF{\cdot}H_2O$) are dispersed as nonreactive but warm gases, and atmospheric chemical reactions can be ignored. Following ASHRAE (Reference 40), Schulman and Scire (Reference 41), and Wilson (Reference 42), the WAKE model splits the plume into two components: (1) the fraction, f_c, of the plume captured in the near wake and then transported into the far wake region and (2) the remaining fraction, $1\text{-}f_c$, of the plume that rises through the turbulent wake directly above the building. The total ground-level concentration, C_{total}, at downwind distances from the release point is the sum of the ground-level concentrations from these two components (Reference 43):

$$C_{total} = C_c + C_a \,, \tag{14}$$

where

C_c is the ground-level concentration (mg/m^3) from the component of the plume caught in the wake (f_c), and

C_a is the ground-level concentration (mg/m^3) from the component of the plume that rises above the wake (1 - f_c).

The development of equations used to calculate C_c are summarized in Hanna and Chang (Reference 43). In the near wake, C_c is calculated using formulations empirically derived from recent wind tunnel data (Reference 42):

$$C_c = \frac{Q_c}{V_o\left[1 + 13\left(\frac{T_a}{T_s}\right)^{1/2}\frac{w_o}{u_H}\right] + \frac{u_H\, x_s^2}{16}} \,, \tag{15}$$

where

Q_c is equal to the $f_c \times Q$, and Q is the mass flux (kg/s) of the plume constituent (either UO_2F_2 or HF),

V_o is the plume volume flux at the vent (m^3/s),

T_a is the temperature of the ambient air (K),

T_s is the temperature of the plume at the vent (K),

w_o is the initial plume speed (m/s),
u_H is the wind speed at the top of the building (m/s), and
x_s is the "stretched string" distance from the source to the receptor (m).

In the denominator of Equation (15), V_o is included to make sure that the predicted concentrations do not exceed the initial concentration in the vent plume. The second term, the one with T_a/T_s, takes into account reductions in concentrations due to the initial rise of the plume out of the jet. This term should be set equal to zero for capped roof vents (Reference 41). The third term calculates the concentrations on the roof and downwind sides of the buildings, similar to previous zero-momentum release algorithms incorporated in HGSYSTEM/UF_6 (Reference 17).

Equation (15) applies until the plume grows to the point that the estimated concentrations drop to the concentrations calculated using a model for a well-mixed building wake. The well-mixed building model is used to calculate concentrations at downwind distances beyond this point and is given as

$$C_c = \left(\frac{Q_c}{u_H R^2}\right) \frac{B_{LO}}{\left[0.037 + 0.03\left(\frac{x}{H_B}\right)^2 + F_{**}^2\left(\frac{x}{H_B}\right)^4 + \left(\pi \frac{\sigma_y \sigma_z}{R^2}\right)^3\right]^{1/3}}, \qquad (16)$$

where

R^2 is the scaling area in the wake as defined by Wilson (Reference 42) (m^2), with R being the representative scaling length of the building (m),
B_{LO} is the nondimensional buoyant lift-off term,
x is the downwind distance from the source to the receptor (m),
H_B is the height of the building (m),
F_{**} is the nondimensional buoyancy flux, described below, and
σ_y and σ_z are the Gaussian horizontal and vertical dispersion parameters, respectively (m).

Equation (16), an empirical formula derived by Briggs (Reference 44), provides a conservative best fit to wind tunnel data gathered by Hall and Waters (Reference 45) and Hall et al. (Reference 46). Both wind tunnel experiments focused on buoyant plumes affected by building wakes. The latter set of wind tunnel experiments (Reference 46) involved relatively complicated release simulations for a variety of vent configurations, building shapes, and wind angles. More details on the derivation of Equation (16) are detailed in Hanna and Chang (Reference 43).

In Equation (16), B_{LO}, describes the decrease in ground-level concentration due to buoyant lifting of the plume, which is determined by

$$B_{LO} = \exp\left(-6F_{**}^{0.4}\right). \qquad (17)$$

In Equation (17), F_{**} is the nondimensional buoyancy flux of the term, calculated as
where F_o is the buoyancy flux calculated using the standard Briggs plume rise equations (m^4/s^3) (References 47 and 48).

$$F_{**} = \frac{F_o}{u_H^3 W_B} , \tag{18}$$

The first three bracketed terms in the denominator of Equation (16) correspond to (1) plume dilution across the building face and recirculation cavity, (2) plume diluation due to expansion with downwind distance, and (3) plume dilution due to growth caused by buoyancy. The fourth term accounts for dispersion of the plume due to ambient turbulence not related to the presence of the building, where the Gaussian plume model is applicable. Each of the four terms is consistent with fundamental physical relations developed and verified over the past two decades (Reference 43).

To estimate ground-level concentrations resulting from the part of the plume that rises through the building wake, C_a [Equation (14)], the Industrial Source Complex—Version 3 (ISC3) (Reference 49) dispersion model is used. In calculating C_a, ISC3 is run as with building wake parameters, because the buoyant plume would be affected by the wake when rising. The source term for the part of the plume above the wake, Q_a, is calculated as:

$$Q_a = (1 - f_c) Q . \tag{19}$$

The total downwind concentration, Ctotal, is calculated using Equation (14).

The second model to simulate the influence of buildings on warm plumes, called UF_6MIXER, simulates the drifting of plumes in the horizontal direction out of a building into the lee-side recirculation cavity [i.e., the movement of an accidental release of pressurized UF_6, caused by a valve or pipe rupture during transfer operations, moving out of the large bay doors of the C-360 transfer building]. The jet of UF_6 released in such a scenario would mix with air in the transfer building as it flows around various obstacles (e.g., tanks and pipes). This in-building mixing is taken into account by assuming that the area of the plume when it exits the building is a fraction, f_A, of the area of the downwind face of the building (equal to the building width, W_B, multiplied by the building height, H_B). As a maximum, f_A equals the ratio of the area of the open doors to the area of the downwind face of the building. The value of f_A is a key input into the model, such that with increasing f_A values, the amount of UF_6 that reacts in the building increases.

The UF_6MIXER model first calculates the amount of UF_6 that has reacted to form UO_2F_2 and HF in the building. Ambient air is introduced incrementally, and all available water vapor introduced during that step is assumed to react with UF_6 completely according to Equation (6). These incremental reactions continue until the plume grows to the specified size in the building as determined by f_A.

From this point, two cases are calculated by UF_6MIXER and compared. Case I assumes that all the UF_6 has reacted in the building. Equations (15) and (16) are used to calculate ground-level

concentrations in the wake. Equation (17) is used to calculate B_{LO}, which is applied to take into account any plume lift-off that may occur. When using Equation (17), F_{**} is calculated using the temperature of the plume at the end of the chemical reactions (i.e., buoyancy flux is assumed to be conserved once UF_6 hydrolysis reactions have ceased).

Case II assumes that a significant fraction of the plume is unreacted as it leaves the building and that the plume is relatively dense as it enters the recirculation cavity. As the plume exits the building, a complete description of the plume state is input into a modified form of HEGADAS/UF_6. In the recirculation cavity, the HEGADAS/UF_6 model is run using stability class B (unstable), which is intended to characterize the turbulence in the near wake. The selection of stability class B as representative of turbulent conditions in the recirculation cavity is consistent with Wilson's (Reference 42) solution [i.e., the term $u_h x_s^2/16$ in Equation (15)] when made equivalent to the Gaussian plume method. At the end of the recirculation cavity, HEGADAS/UF_6 is applied using the original stability class (i.e., the atmospheric stability class appropriate for a given scenario). The calculation of F_{**} is made with plume variables calculated in HEGADAS/UF_6 at downwind increments because buoyancy flux is not conserved if UF_6 hydrolysis reactions are occurring. (This use of F_{**} with HEGADAS is discussed in more detail in the next section.)

The results of Case I and II are compared in the final phase of the UF_6MIXER simulation. In the recirculation cavity, the higher of the predicted concentrations is selected to estimate impacts. To maintain consistency, concentrations for the far wake are selected from the method having the highest concentration estimated in the near wake.

b. <u>Lift-Off of Ground-Level Buoyant Plumes</u>

If the UF_6 plume centerline is on the ground (or very near the ground), either because it was initially released at ground-level or because it slumped due to the high plume density, it may eventually lift off the ground. Lift-off occurs if the buoyancy forces, which lift the plume, exceed the turbulent forces in the ambient boundary layer, which spreads the plume laterally (Reference 19).

Reductions in ground-level concentrations due to lift-off of the plume centerline may be taken into account by applying the buoyant lift-off term, B_{LO} [Equation (17)]. Originally, B_{LO} was suggested by Briggs (Reference 44) for use with buoyant plumes that conserve their buoyancy flux, F_o (i.e., the buoyancy flux would be determined by release conditions and/or building dimensions). However, Hanna and Chang (Reference 43) applied B_{LO} to plumes with buoyancy fluxes that vary with time and distance, such as a reactive UF_6 plume. In this application, the u_H and W_B terms in Equation (18) are the local plume advection speed and local plume width output by the HEGADAS/UF_6 model at a particular downwind distance. The assumption made by Hanna and Chang (Reference 43) is that B_{LO} is applicable to a wide range of initially ground-based, buoyant plumes. Based on this assumption, the application of B_{LO} to HEGADAS/UF_6 is appropriate to determine the reduction of ground-level concentrations that would occur as a warm UF_6 plume lifts off of the ground. The plume lift-off calculations are applied as a postprocessor to HEGADAS/UF_6.

c. Wet and Dry Deposition of Particles, Aerosols, and Gas from the Plume

As the UF_6 plume is transported downwind, it will be composed of a mixture of gases, solid particles, and aerosols. To estimate the effects of deposition from an accidental UF_6 release, dry and wet deposition algorithms are applied as postprocessors to HGSYSTEM/UF_6. For both wet and dry removal, there is no feedback mechanism between plume chemistry and thermodynamics and deposition. In running HGSYSTEM/UF_6, all of the UF_6 in the plume is assumed to react to form HF and UO_2F_2; however, some UF_6 may actually be removed via deposition. This assumption results in upper-bound estimates of airborne uranium and HF concentrations received by a downwind receptor and, consequently, provides a conservative estimate of impact to human health.

For small particles, drops, and gases (i.e., those with aerodynamic diameters less than about 50 µm), the dry deposition modules in the ISC3 (Reference 49) dispersion model have been adopted for use in the HGSYSTEM/UF_6 postprocessor. ISC3 estimates dry deposition by assuming that the dry deposition flux, F_d (g/m^2-s), is linearly proportional to the air concentration, C:

$$F_d = C \times v_d \,, \tag{20}$$

where v_d is the deposition velocity (m/s), which is calculated using the resistance analog technique (Reference 50). The equations for deposition velocity are described in detail in the *ISC3 User's Manual* (Reference 49).

The initial flashing process may result in the formation of large aerosols and particles with diameters of thousands of micrometers (i.e., a few millimeters). Particles and aerosols with aerodynamic diameters of about 1 mm or greater have a gravitational settling speed greater than 1 m/s (Reference 16), and simple gravitational settling (as described by Stoke's Law) can be used to estimate v_d:

$$v_d = (\rho_p - \rho_a)\frac{g\, D_p\, S_{CF}}{18\mu} \,, \tag{21}$$

where

ρ_p is the particle or aerosol density (g/m^3),
ρ_a is the air density (g/m^3),
g is the gravitational constant (9.802 m/s^2),
D_p is the aerodynamic diameter of the particle (m),
µ is the dynamic viscosity of air (g/m^2-s), and
S_{CF} is the slip correction factor.

The slip correction factor, S_{CF}, is applied to account for particles with aerodynamic diameters of 50-1000 µm and is given by the empirical formula

$$S_{CF} = 1 + 0.13\,[1.257 + 0.4 \exp(-8.5\, D_p)] \,. \tag{22}$$

Concentration values from HGSYSTEM/UF_6 are applied to Equation (20) using deposition velocities calculated using Equation (21) or the ISC3 resistance model. A percentage of the concentration is applied

to fixed-particle-size diameters that vary as a function of distance. In other words, the percentage of particles with large D_p decreases with downwind distance because these particles will rapidly settle out of the plume.

HGSYSTEM/UF_6 estimates wet deposition flux, F_w, using a below-cloud scavenging mechanism (i.e., raindrops scrub plume gases and solids from the plume) employed by PLM89A and Ramsdell et al. (Reference 51). In-cloud scavenging (i.e., removal of plume gases and solids by impact with fog droplets) is neglected by the current version of HGSYSTEM/UF_6 because it is insignificant for short plume-travel times (Reference 17).

4.3.1.2.3.4.2 Major Features of HGSYSTEM/UF_6

The HGSYSTEM/UF_6 dispersion code suite consists of the following models applied to various stages of the plume or puff:

a. AEROPLUME/RK

This model estimates near-field (i.e., downwind distances ranging from tens to hundreds of meters) dispersion of elevated, two-phase (aerosol and vapor) momentum jets of UF_6 and its reaction products. This model applies to releases from pressurized tanks or cylinders at the point of release to the time when they either (1) strongly interact with the ground and become a dense ground-based plume or (2) become passive (i.e., the density approaches ambient air density and chemical reactions cease). The initials RK stand for the inclusion of a robust Runge-Kutta numerical solver that enables the user to model situations in which the plume angle changes rapidly with time, such as UF_6 releases with steep jet angles (between -10 and -45° from the horizontal) pointing toward the ground. The RK numerical solver replaces the SPRINT numerical solver employed in HGSYSTEM Version 3, which could not consistently simulate UF_6 releases with steep jet angles (Reference 43). The UF_6 chemistry and thermodynamics modules used in this model are the same as those used by HEGADAS/UF_6 (discussed below).

b. HEGADAS/UF_6

This model applies to continuous, ground-hovering plumes. The model is used for either (1) area source releases (i.e., spills) or (2) the point where AEROPLUME predicts that the dense plume will be in direct contact with the ground. Steady-state (HEGADAS-S) and transient (HEGADAS-T) modules are incorporated into the model. The transient module is used for finite duration releases (<~2 min). HEGADAS/UF_6 uses the same UF_6 modules as AEROPLUME/RK.

c. PGPLUME

This model is used in the final passive phase of the plume, in which the Gaussian plume methodology is applicable. The Gaussian plume methodology is a well documented industry standard that incorporates emission, downwind, crosswind, and vertical factors. No chemical reactions or thermodynamic processes are modeled in PGPLUME. AEROPLUME/RK will transition to PGPLUME if the plume becomes passive (neutral buoyancy/non-reactive). This would simulate the plume dynamics of region five from Figure 4.3-7.

d. WAKE

This model is used to simulate releases from roof vents and stacks on the GDP process buildings. WAKE determines the dimensions of the recirculation cavity, and calculates the plume rise to estimate the fraction of the plume captured in the cavity. It calculates the concentration for the part of the plume captured in the cavity based on the Wilson/Briggs model and estimates the correction to the concentrations for the part of the plume captured in the cavity due to possible plume lift-off based on the Briggs model. WAKE then creates all of the necessary input files for the ISC3 model for the part of the plume that escapes the cavity. A postprocessor merges the results from (1) the WAKE model for the part of the plume captured in the cavity and (2) the ISC3 model for the part of the plume that escapes the cavity.

e. ISC3

The basis of the ISC3 model is the straight-line, steady-state Gaussian plume equation, which is used with some modifications to model simple point source emissions from stacks, emissions from stacks that experience the effects of aerodynamic downwash due to nearby buildings, isolated vents, or multiple vents. It uses meteorological data to define the conditions for plume rise, transport, diffusion, and deposition. The model estimates the concentration or deposition value for each source and receptor combination. ISC3 is used in conjunction with WAKE and its postprocessors to model releases from roof vents and stacks on the GDP process buildings.

f. UF_6MIXER

This model and its postprocessors are used to simulate releases from the open bay doors of the GDP transfer buildings. UF_6MIXER determines the dimensions of the recirculation cavity and estimates the plume states (e.g., the total plume mass emission rate, the plume composition, the plume temperature, etc.) after the assumed in-building dilution and associated chemical reactions. It then estimates the plume buoyancy flux and the equivalent mass emission rates for UO_2F_2, HF, U, and F when all chemical reactions have been completed (the buoyancy flux and the mass emission rates are required by the Wilson/Briggs model). Using the Wilson/Briggs model, it calculates the concentrations and prepares the required input files for the modified version of HEGADAS/UF_6. This modified version of HEGADAS/UF_6 assumes a B stability class in the cavity to account for the observed effects of enhanced dilution in building wakes, regardless of the stability class specified by the user for the ambient atmosphere.

g. POSTMIX

This UF_6MIXER postprocessor retrieves the plume geometry and density information from the HEGADAS/UF_6 predictions to estimate the downwind distribution of the plume buoyancy flux, which in turn is used to estimate the correction to concentrations predicted by HEGADAS/UF_6 due to possible plume lift-off based on the Briggs model. The postprocessor will then select the UO_2F_2, HF, U, and F concentrations predicted by the Wilson/Briggs model at downwind distances that are (1) less than the length of the cavity based on which model gives higher predicted concentrations for U, and (2) greater than the length of the cavity based on which model gives higher predicted concentrations for U at the end of the cavity.

4.3.1.2.3.4.3 Evaluation of HGSYSTEM/UF_6

Three types of evaluations were made to assess the performance of HGSYSTEM/UF_6, as detailed in Chapter 8 of Reference 17. The first evaluation compared results from HGSYSTEM/UF_6 with data from seven field tests reported by Hanna et al. (Reference 52). These field tests involved releases of nonreactive dense gases (e.g., LNG, LPG, and Freon) and aerosols (e.g., ammonium and polymerized HF). In essence, this evaluation assessed the performance of dense gas dispersion algorithms in HGSYSTEM/UF_6 without the use of the UF_6 chemistry and thermodynamic modules. Thirteen other hazardous gas models were considered in the comparisons, including an earlier (1990) version of HGSYSTEM. The comparison showed that (1) HGSYSTEM/UF_6 produced results that are very similar to the 1990 version of HGSYSTEM, (2) the HEGABOX model, developed for instantaneous dense-gas releases, produced results that are in good agreement with the Thorney Island field data (i.e., data from an instantaneous release of dense gas), and (3) the performance measures (e.g., fractional mean bias and normalized mean square error) for the HGSYSTEM/UF_6 concentration estimates were consistently at the level of the six best-performing models.

The second evaluation compared concentration and lateral plume with observations from three French UF_6 field experiments with calculations using HGSYSTEM/UF_6 (References 53, 54, 55, and 56). The release rate in the French field experiment was about 0.2 lb/s (0.08 kg/s), about two orders of magnitude less than a potential 14-ton cylinder rupture. Also, because UF_6 was released entirely in the gas phase, UF_6 particle sublimation was not a factor. When HGSYSTEM/UF_6 is applied to these release conditions, the model quickly transitions from AEROPLUME/UF_6, the dense gas jet model, to PGPLUME, the passive gas model. Therefore, the French field data represent a passive gas release and are not adequate for assessing the performance of the UF_6 chemistry and thermodynamics modules or the dense gas dispersion. However, results from PGPLUME were compared with the ISC model (a standard Gaussian plume model) and field data. Both PGPLUME and ISC showed fair agreement with the field data. PGPLUME tended to show slight (15 percent to 50 percent) underpredictions in lateral dispersion (Reference 17).

The third evaluation compared the UF_6 chemistry and thermodynamics modules in HGSYSTEM/UF_6 with equilibrium analytical solutions calculated by Rodean (Reference 57). Rodean assumed that the initial temperature of the UF_6 release was 180°F (82°C) and that the initial release mixture was 50 percent gas and 50 percent solid. The ambient temperature was assumed to be 77°F (25°C), and the ambient relative humidity was assumed to be 100 percent. The AEROPLUME/UF_6 model was applied using input values that simulated Rodean's release conditions (Reference 16). As shown in Figure 4.3-10, results of the two solutions agree well. Differences between the two arise because the AEROPLUME/UF_6 model assumes turbulence-limited reaction rates (i.e., the solution is not in equilibrium).

An independent peer review panel (Reference 58) met in August 1996 to evaluate HGSYSTEM/UF_6 in general, and to evaluate in detail the building wake models (i.e., WAKE and UF_6MIXER) and the plume-lift algorithms incorporated in HGSYSTEM/UF_6. The review panel found in general that the models were "reasonable and scientifically dependable . . . for complex problems in an area where scientific understanding was still improving." Additionally, the peer reviewers found that "the desire for conservative predictions was apparent; if a modeling uncertainty arose, a reasonable,

conservative option was followed." The building wake equations used in WAKE and UF_6MIXER were developed from fundamental physical principles and were calibrated with wind tunnel observations by Hall and Waters (Reference 45) and Hall et al. (Reference 46). The equations in these models were shown by Hanna and Chang (Reference 43) to be conservative with respect to laboratory observations, and were designed to be conservative for building geometries typical of the GDPs (i.e., building widths much greater than building heights).

4.3.1.2.3.4.4 Limitations of HGSYSTEM/UF_6

The following list of model limitations is summarized from Reference 19:

- As with all models, HGSYSTEM/UF_6 was developed with certain release scenarios and meteorological conditions in mind. For example, a release from a nozzle on a pressurized 14-ton cylinder has been a primary test case. Similarly, the meteorological input conditions of interest have emphasized light-to-moderate wind speeds, neutral-to-stable conditions, and small-to-moderate surface roughness conditions.
- Primary concern has been for dense (negatively buoyant), neutral, or slightly positively buoyant plumes. The entrainment relations have not been fully tested for strongly positively buoyant plumes.
- The meteorological parameterizations for the ambient atmospheric boundary layer are valid primarily for heights less than about 160 ft (50 m).
- Distances of interest range from the edge of the building to a few kilometers because the distances to the plant fence lines or to the point where concentrations drop below toxic levels are usually in that range.
- Releases of mixtures of two or more chemicals (i.e., multicomponents) can be modeled only if the chemical and thermodynamic properties of the mixture can be represented by a "pseudo chemical" with molecular weight given by the weighted average of the components.

4.3.1.3 Natural Phenomena Methodology

The evaluation basis earthquake and wind events for the PGDP site have been established as 250-yr return period events, with a 0.15-g peak ground acceleration (PGA) and 70-mph fastest-mile wind speed, respectively (Reference 59). A probable maximum flood (PMF) was also considered. Four analyses (i.e., structural, equipment, piping system, and overhead crane analyses) were performed to address natural phenomena hazards. (See Chapter 2 for input to these analyses.) The structural analysis was performed first, and the results of this analysis were then used as input to the remaining analyses. The following sections describe the methods used for each type of analysis.

4.3.1.3.1 Structural Analysis

The seismic provisions of UCRL-15910 (Reference 60) were used for buildings analyzed prior to the issuance of DOE-STD-1020-94 (Reference 61). After the issuance, DOE-STD-1020-94 was used to determine seismic load levels on the buildings.

Two of the major differences between UCRL-15910 and DOE-STD-1020-94 are as follows:

- DOE-STD-1020-94 includes a seismic load factor for brittle failure modes. This factor is 1.0 for C3 facilities, which equates to UCRL-15910 “moderate hazard” category criteria because UCRL-15910 does not use a seismic load factor.

- UCRL-15910 uses different inelastic energy absorption factors for different categories of structures. With the exception of in-plane shear walls, factors from UCRL-15910 moderate hazard facilities closely match the factors in DOE-STD-1020-94. For shear walls, UCRL-15910 uses a factor of 1.7 for moderate hazard facilities, whereas DOE-STD-1020-94 specifies a value of 1.5, resulting in slightly higher demands.

For the analyses performed here, either UCRL-15910 moderate hazard or DOE-STD-1020-94 PC3 procedures were followed, and there is little difference between the two.

Computer models of the buildings were developed to obtain response to loads resulting from natural phenomena events acting in conjunction with existing in-place loads. For all but very simple structures, three-dimensional models were used.

Design drawings, design specifications, and walkdown packages were used to model, as closely as possible, existing conditions of the structures except in the case of Buildings C-331 and C-335. Analyses of these "00" buildings assumed that modifications were made to correct structural deficiencies. Design drawings and specifications were used to define geometry and material properties. Walkdown packages were used to establish changes to geometry, structural changes (e.g., added or removed walls), and in-place loads.

The walkdown packages were detailed studies that identified major configuration changes, in-place loads, reference document lists, and member sampling data, which established relevance of existing design drawings.

Where detailed three-dimensional models were used, all primary structural elements, including mezzanines, were incorporated into the model. Roof trusses either were modeled discretely or were represented by equivalent beam elements. For simpler structures, three-dimensional stick models were used by hand-calculating global stiffness and mass properties.

4.3.1.3.1.1 Earthquake

The structural analysis proceeded generally as follows :

- The site-specific spectra and the mathematical model of the structure were used and an elastic dynamic analysis was performed to determine the elastic seismic demand.
- The inelastic earthquake demand was evaluated as the elastic demand divided by the inelastic demand-capacity ratio, F.
- The total demand for the components was evaluated by adding the gravity demand and the inelastic seismic demand.
- Member capacities were evaluated from code ultimate or yield values.
- Demand was compared with capacity. If the demand was less than the capacity, the member satisfied the seismic requirements. If the demand was greater than the capacity, the capacity was expressed in terms of a threshold PGA.
- Story drifts were evaluated.
- Peer review of the analysis was implemented.

Geometrically nonlinear analysis was applied to the "00" buildings to demonstrate the capacity to meet the EBE in the final modified configuration.

For demand calculations, a 250-yr return period earthquake was used as the EBE. For Paducah, the 250-yr earthquake has a PGA of 0.165 g (see Chapter 2).

Dynamic analyses were used to determine building responses to earthquake input. In general, masses were taken from walkdown packages supplemented by information found on the original design drawings.

Two analyses were performed for each structure evaluated. First, a dynamic response spectrum analysis using mode superposition was used to determine the evaluation basis response of the structural elements. Second, a mode superposition dynamic time history analysis was performed to generate amplified, in-structure response spectra to be used for the analysis of equipment within the buildings. Site-specific input (response spectra and time histories) was used.

In the analysis, the best estimates of in-place loads were used. Included in the loads and masses on the buildings were slabs, framing, walls, equipment, and miscellaneous loads identified from walkdowns.

Masses were lumped at nodes. Enough natural frequencies were calculated and retained in the analysis that no less than 90 percent of the total mass in each direction considered (north-south, east-west, and vertical) was accounted for in the retained modes. This is in accordance with ASCE 4-86 (Reference 62) as referenced in DOE-STD-1020-94. The mass not explicitly included in the calculated modes was not ignored, but results were scaled up to approximate the effects of missing modes.

For large two-dimensional and three-dimensional models, the computer program GTSTRUDL (Reference 63) was used.

Where fewer than 50 modes were required for the analysis, modal combinations were made using either the complete quadratic combination (CQC) method or the NRC 10 percent method. When more than 50 modes were required, the NRC 10 percent method was used exclusively because of the increased computational effort required in the CQC method. The two horizontal seismic components (north-south and east-west) were always combined using the square root-sum of squares (SRSS) method. The NRC and CQC methods for modal combinations and the SRSS method for directional combination are in accordance with ASCE 4-86. The vertical contribution to seismic response was computed by including vertical modes in the modal superposition or as an equivalent static load. This static load was taken as 1.5 times the peak vertical ground acceleration times the structure gravity load. This vertical static load was combined with the horizontal seismic response and dead load.

In computing seismic demand, the inelastic energy absorption factor, *F*, was taken from DOE-STD-1020-94.

Load factors of unity were used in seismic load combinations. This is in agreement with DOE-STD-1020-94 when the EBE is for the safe shutdown condition, as is the case for the structures evaluated herein. Actual stresses were compared with code ultimate values to determine the adequacy of each member. In general, code checking of steel components was done internally by the computer programs, and concrete code checks were done by hand. Components were allowed to yield under the load combinations. The load combinations considered are shown in Table 4.3-2.

Beams, columns, walls, diaphragms, and footings were checked for the appropriate loads. Story drifts were compared with allowable levels. For in-structure spectra generation, the range of frequencies considered is shown in Table 4.3-3. These ranges are in accordance with ASCE 4-86 . In addition, the natural frequencies of the structure were included in the frequency envelope.

4.3.1.3.1.2 Wind

In the structural analysis, wind loads were applied in accordance with ASCE 7-88 (Reference 64) as referenced by UCRL-15910 and DOE-STD-1020-94. Static analyses were performed to determine the response of the buildings to wind loads in combination with gravity loads (i.e., walls, slabs, framing, equipment, miscellaneous loads).

The same models used for the dynamic seismic analyses were used for the static wind analyses. Beams, columns, walls, diaphragms, and footings were checked for the appropriate loads. Story drifts were compared with allowable levels.

A 250-yr return period straight wind was taken as the EBE. For Paducah, the 250-yr wind speed is 70 mph (see Chapter 2).

The north-south wind was assumed to act independently of the east-west wind. This is in accordance with ASCE 7-88.

Actual stresses were compared to code ultimate values to determine the adequacy of each member. For steel elements, these code checks were done internally by the computer software (Reference 63). Concrete elements were checked by hand.

4.3.1.3.1.3 Flood

The plant elevation is above the PMF (see Chapter 2). Therefore, river and stream flooding is not a hazard for the buildings. However, local ponding was investigated for the buildings. For typical buildings, the primary drainage system is roof drains. Some buildings have scuppers in the parapet. For ponding effects analysis, the primary drainage was considered to be completely blocked. In general, this meant that the roof structure had to be evaluated for a depth of rainwater up to the parapet height. This involves evaluating the roof beams, the deck, and the building columns for the load induced by standing water on the roof.

4.3.1.3.2 Equipment Analysis

The evaluation methodology for equipment analysis followed the general philosophy of the experience-based methods used by the commercial nuclear industry to evaluate equipment in older nuclear power plants for which documentation of seismic qualification was incomplete. The equipment evaluated was selected through the accident analysis process, which identified equipment whose failure from a natural phenomena event could release UF_6 or other hazardous materials. Therefore, the performance goal is defined as containment of hazardous materials or pressure boundary integrity. Continued operation of the diffusion equipment during or after a natural phenomena event is not required.

The equipment is located in four large process buildings, two feed facilities, a product withdrawal facility, a tails withdrawal facility, a toll transfer and sampling facility, and tie-line structures connecting the various buildings. Because much of the equipment and connecting piping consists of similar components arrayed in repeated patterns, equipment capacities were determined on a representative sample. About 10 percent of the equipment in the process buildings and more than 10 percent in the other buildings or facilities was sampled.

A two-step process was used to evaluate the seismic capacity of equipment identified by the accident analysis process. First, a procedurally controlled walkdown inspection of the equipment was performed to determine existing conditions and to identify equipment attributes that may result in the vulnerability of the equipment to natural phenomena effects. Next, the capacity of equipment was

determined by calculating the capacity of vulnerable elements or weak links. The capacity of the equipment was expressed in terms of PGA for the earthquake hazard and fastest-mile wind speed for the wind hazard, from which the annual probabilities of failure were calculated.

4.3.1.3.2.1 Earthquake

The equipment evaluation process, walkdown inspection, and structural assessment address two categories of equipment: that which is included in the 22 classes for which earthquake experience data are given in the DOE Electric Power Research Institute (EPRI) Seismic Qualification Utilities Group (SQUG) database and that which is not in the DOE EPRI/SQUG database (References 65 and 66). Comparisons were made between the equipment selected for evaluation and the equipment that the nuclear industry has found from experience to be seismically rugged in actual earthquakes. Equipment that is similar to the rugged equipment but does not possess all the attributes of the rugged equipment was called an outlier and was evaluated individually by analysis. The equipment not in the database was treated as an outlier and was evaluated by analysis. The EPRI/SQUG and outlier evaluation processes are described in References 65 and 67.

4.3.1.3.2.2 Wind

Equipment potentially exposed to wind effects was evaluated for fastest-mile wind pressures using the methodology described in DOE-STD-1020-94. Equipment located in buildings with siding or enclosures that were capable of withstanding the wind forces was not evaluated. In cases where the siding of the building had a low wind-speed capacity, the siding was assumed to fail, and the full pressure force from the wind was applied to exposed equipment. Wind- or tornado-driven missiles are not likely to occur for a 70-mph wind speed and were not considered.

4.3.1.3.2.3 Flood

The elevation of the ground floor slabs in buildings housing equipment identified by the accident analysis process was compared with the level of the PMF. In all cases the elevation of the ground floors of the buildings housing the equipment exceeded the water level associated with the PMF. Therefore, the effect of regional flooding was not considered further. The flood hazard for the PGDP site is described in Chapter 2.

Potential water inflow from ponding on roofs, from roof leaks, and from local flooding was determined not to affect the pressure boundary integrity function of equipment.

4.3.1.3.3 Piping Systems

The piping systems evaluated were selected through the accident analysis process, which identified piping whose failure from a natural phenomena event could release UF_6 or other potentially hazardous materials.

The piping systems are located in four large process buildings, two feed facilities, a product withdrawal facility, a tails withdrawal facility, toll transfer and sampling facility, and tie-line structures connecting the various buildings. Because much of the piping, pipe supports, and pipe-supported

components are similar and are arrayed in repeated patterns, capacities of piping systems were determined from a representative sample. Approximately 10 percent of the piping systems in the process buildings and more than 10 percent in the other buildings or facilities were sampled.

4.3.1.3.3.1 Earthquake

The evaluation methodology of piping systems for natural phenomena hazards generally follows the philosophy of experience-based methods. Earthquake experience data for piping systems are not currently included in the DOE's 22 EPRI/SQUG equipment classes, although there are considerable experience data on piping systems in earthquakes. The evaluation process focused on identifying weak links that could result in loss of pressure boundary integrity in the piping system during a seismic event.

The experience-based method for piping systems developed by Lockheed Martin Energy Systems (LMES) for use in the evaluations of piping systems at PGDP is described in References 68 and 69. Subsequent to developing these guidelines, DOE also developed similar guidelines for trial use in evaluating piping systems in existing DOE facilities (Reference 70). Both DOE and LMES utilize a two-step process consisting of a walkdown inspection and screening procedure followed by a structural assessment for piping systems that are not screened as rugged. Piping and piping supports judged to be rugged were assumed to have a capacity defined by the reference spectrum (Reference 65). The two methods are judged to give approximately the same results.

As stated previously, a two-step process was used to evaluate piping systems identified by the accident analyses. A procedurally controlled walkdown inspection of the pipe, pipe supports, and in-line components such as valves, expansion joints, and reducers was conducted to determine existing conditions and identify attributes that may make the equipment vulnerable in a seismic event. The capacity of the piping system was determined by assessing the capacity of the vulnerable features or weak links. Only certain types of valves from the GDP piping systems are included in the DOE EPRI/SQUG database. These valves were evaluated by comparing them with the database valves. All other piping system components were evaluated by analysis in accordance with guidance documents (References 68 and 69). The capacities of the piping system components are expressed in terms of the PGA, from which an annual probability of failure was calculated.

4.3.1.3.3.2 Wind

Piping systems exposed to wind effects were evaluated for the wind-induced pressure forces. The wind pressure forces are calculated by the method described in DOE-STD-1020-94. In cases where the building's siding had a low wind speed capacity, the siding was assumed to fail, and the full wind pressure force was applied to the exposed piping.

4.3.1.3.3.3 Flood

The elevations of the piping systems were compared with the level of the PMF (see Chapter 2). The elevations of the ground floors of the buildings housing the piping systems are above the water level from a PMF. Therefore, regional flooding was not considered further.

Potential water inflow from ponding on the building roof, from roof leaks, and from local flooding was determined not to adversely affect the pressure boundary integrity of piping systems components.

4.3.1.3.4 Overhead Cranes

Cranes are used throughout PGDP to lift and transport equipment and materials. During operations and while in their parked position, cranes frequently are located above equipment, piping, and components containing hazardous materials. Those cranes whose failure could potentially result in a release of hazardous materials when they are subjected to the natural phenomena hazards (e.g., earthquake and wind) were evaluated. Failure was considered to occur when either the hook load is dropped or the overhead crane falls from its support structure. Therefore, the performance objective was position retention of both the crane and hook load.

4.3.1.3.4.1 Earthquake

Cranes and crane support structures were evaluated for the evaluation basis earthquake using the methods given in Reference 61. Because the performance objective was simply position retention, in contrast to continuing operation during and after an earthquake, stress levels and deflections in the crane support structure defined in Reference 61 were relaxed.

4.3.1.3.4.2 Wind

Cranes and their support structures exposed to wind effects were evaluated for the pressure forces from a 70-mph fastest-mile wind speed. The evaluation methodology used is given in Reference 61.

4.3.2 ACCIDENT ANALYSIS RESULTS

This section presents the results of the accident analysis for the limiting initiating event combinations identified in Section 4.2.6 and the consequence analysis of potential accidents resulting from these combinations. Accidents resulting from the limiting initiating events identified in Section 4.2.6 bound all other initiating events by consequence for each combination of initiating event, operating mode, hazard state, and preventive/mitigative measures. They form the set of unique and representative evaluation basis accidents that are needed to assess the bounding consequences of facility operations.

The operational analysis determines necessary controls (i.e., equipment and administrative controls) to prevent the occurrence of initiating events or mitigate the consequences of resulting accidents. The goal is to identify controls that are necessary to prevent the EGs from being exceeded. Each of the limiting initiating events identified in Section 4.2.6 was evaluated and is described in the following sections to document the scenario, indicate the essential controls, and compare the consequences to the EGs.

The results identify safety actions and the essential controls necessary to prevent exceeding the EGs or to minimize the impact. Detailed information about the essential system capabilities and support

requirements is discussed in Section 3.15. Operating limits for the essential controls are presented in the TSRs.

4.3.2.1 Cascade Facilities

Table 4.2-11 documents the results of the hazard analysis for each of the cascade facility processes. In addition to the processes that were evaluated directly inside the cascade facilities, various waste storage/handling operations may also be present inside the facilities. These operations and their analyses are addressed in Section 4.3.2.3.

4.3.2.1.1 Compressor Failure-UF_6 /Hot Metal Reaction (Temperature Increase)

a. Scenario Description

UF_6 oxidizes most metals producing a metal fluoride and solid uranium compounds, but at moderate temperatures the reaction is mild and the reaction rate is inhibited by the layer of reaction products formed on the surface of the metal. However, if aluminum is heated above the solidus temperature [about 1100°F (593°C)], the protective metal fluoride layer is disturbed and a more vigorous exothermic reaction can occur. The reaction will continue as long as UF_6 and aluminum are available, and the heat generated by this reaction is sufficient to maintain the aluminum above the solidus temperature.

Any mechanism capable of heating the aluminum to temperatures above the solidus temperature when UF_6 is present can initiate the UF_6/aluminum reaction. However, the most probable and most historically common initiating mechanism is friction associated with component rubbing after axial compressor failure/deblade which generates sufficient heat to raise aluminum temperatures above the solidus temperature. While all axial compressors have aluminum blades, the “00” compressors have the greatest potential for UF_6/hot metal reactions because they have aluminum rotors that tend to expand more than the “000” compressor steel rotor. This expansion results in decreased rotor blade tip clearances and a greater probability of blade rubbing and deblade. Friction or rubbing of aluminum components or fragments after a deblade has the potential to provide sufficient heat to reach the solidus temperature of the aluminum and create an exothermic UF_6/hot metal reaction. The reaction will result in increased temperatures and decreased pressures locally as the UF_6 is reacted to produce solid compounds. If the reaction occurs in a vulnerable location and is not mitigated, it can damage the pressure boundary and cause a breach of the primary system. A breach would result in a release of UF_6 if the process pressure were above atmospheric pressure. In addition, under certain conditions, the heat from an exothermic reaction in the compressor can be transmitted to the cooler. If this occurs, and sufficient heat is provided to melt the aluminum components in the stage cooler, the R-114 coolant would leak into and pressurize the process system. If the R-114 coolant system is breached in a cell that is isolated from the cascade, this could result in overpressure and breach of the primary system due to the limited expansion volume available. Coolant system ruptures into the primary system are addressed in Section 4.3.2.1.6.

During the modes of operation for the enrichment cascade where the compressors are running, a number of causal factors may result in compressor failure in a cell or booster station including

(1) compressor flow starvation or compressor overload, (2) catastrophic seal or bearing failure that results

in wet air inleakage and subsequent rotor imbalance (excessive vibration) due to uranium deposition, (3) enrichment cascade disturbances which result in compressor surging, and (4) overheating the process gas stream due to coolant system malfunctions. These factors can cause the progressive effects of (1) compressor surging or overload, (2) overheating, and (3) if unmitigated, a compressor deblade. Direct compressor failure can also be caused by (1) a foreign object in the compressor suction or (2) blade fatigue. When a compressor deblades, the possibility of heat build up exists due to rubbing/friction of aluminum components or fragments sufficient to initiate a UF_6/hot metal exothermic reaction, and burn a hole in the primary system boundary and/or the R-114 coolant system boundary.

This event is an AE because a single active failure of a compressor, left unmitigated, could result in a UF_6/hot metal reaction that could lead to a breach in the process system and a release. Operational history indicates that only a small percentage of compressor failure events result in a UF_6/hot metal reaction.

A UF_6/hot metal reaction event was evaluated in the PrHA, and it was determined that the consequences could include significant on-site impact in the above atmospheric pressure modes if no mitigation were provided.

The primary concerns associated with this event are (1) the primary system temperature increase, and (2) controlling the UF_6 release if the primary system should fail. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program (see Section 5.2). The first safety action required to meet the other EGs would be to maintain the primary system temperature within EG 3. This action will prevent primary system failure, protect on-site personnel, and maintain habitability of the required control area by preventing a release of UF_6. If primary system temperature cannot be maintained within EG 3, a breach of the primary system could conceivably occur. The safety actions for above atmospheric systems of (1) primary system leakage detection, (2) primary system pressure control (to reduce the primary system pressure and minimize the UF_6 release), (3) building holdup, and (4) emergency response by on-site personnel would be required to maintain the effects of a UF_6 release within EGs 1, 2, and 6. These actions protect on-site personnel and will maintain habitability of the required control area in accordance with EG 6 as well.

Primary system temperature control is required to meet EG 3. The primary means of accomplishing this safety action is to minimize the potential for the event to occur. Typically, when one of the causal factors that could lead to a compressor deblade is identified by an abnormal motor load and confirmed by examining other process parameters, operators will initiate appropriate actions (e.g., reduce the operating pressure, take the cell off-stream, or trip the cell(s) and take off-stream) to prevent a deblade. However, once a deblade is confirmed the essential method for preventing the reaction is to trip the cell(s) from the area control room (ACR) to shut down the motors to eliminate any heat generation due to rubbing parts. If this control fails to stop the transient in sufficient time to prevent the failure of the primary system, a release is assumed to occur if the system is above atmospheric pressure. The release of UF_6 to the atmosphere could exceed EGs 1, 2, and 6 if no mitigation is accomplished. The compressor failure-UF_6/hot metal reaction produces the most limiting temperature transient event in the AE category.

b. Source-Term Analysis

In order for a UF_6/hot metal reaction event to produce a significant release of UF_6 to the atmosphere, the event must be in cells or equipment operating above atmospheric pressure. Therefore, the source-term associated with the UF_6/hot metal reaction event is addressed for the above atmospheric pressure operating mode.

The potential source term due to a breach in the primary system while the cell is operating above atmospheric pressure is bounded by the source term for the B-stream block valve closure event (Section 4.3.2.1.3). This is because UF_6 is consumed during the reaction, the compressor at the point of the breach will be pumping inefficiently if it is pumping at all, and the pressure would not significantly increase due to the temperature increase. In addition, if the breach occurs in an operating cell, operator action would be taken to trip the cell in response to the UF_6 release and/or the surging of compressors in this cell and adjacent cells. Tripping the cell compressors significantly reduces primary system pressure due to a loss of compression.

c. Consequence Analysis

The consequence analysis for the UF_6/hot metal reaction event is subdivided to address the on-site receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1)visual indication of a “white smoke” (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — The analysis for the B-stream block valve closure event (Section 4.3.2.1.3) concluded that adequate time is available for operational personnel to accomplish the essential safety actions (leakage detection and mitigation). Because the UF_6/hot metal reaction source term is bounded by the B-stream block valve closure event, adequate time would also be available for operational personnel to detect and mitigate this event prior to any need to evacuate the ACR. However,

once these essential actions have been accomplished, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) detection of the release, (2) minimization of the release by tripping applicable cells, (3) temporary holdup of the release by the existing process building structure, and (4) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential control is to detect the release of UF_6. As stated previously, the motor load indicators provide an indication of abnormal compressor operation that could lead to failure (i.e, surging and/or loss of load). Typically, this indication will be detected, and corrective action will be taken prior to the initiation of a UF_6/hot metal reaction, or prior to a UF_6/hot metal reaction progressing to the point of a primary system breach. However, should a release occur, the equipment that has the potential for causing a large release (i.e., "00" or "000" building compressors which are intended to operate above atmospheric pressure) are equipped with UF_6 release detection that alarms in the applicable ACR. Other portions of the cascade do not have operating pressures or inventories sufficient to result in any significant consequences outside the building, and this receptor would not be applicable (see Section 4.2.6.4). The second essential control, is for operators to trip the appropriate cell(s) to reduce the pressure and minimize the release of UF_6. Tripping the cell would quickly end the release as the compressors stop and the system pressure falls to atmospheric pressure. Pressure at an interbuilding booster compressor can be reduced, if needed, by tripping the compressor motor or by tripping adjacent enrichment cell compressor motors. Once the pressure has dropped to atmospheric pressure or below, the release of material is effectively terminated for any potential exposure outside the process building. Sufficient time is then available to perform any necessary valve evolutions to isolate the cell. The third essential control, process building holdup, is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

d. <u>Comparison With Guidelines</u>

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the event scenario. The EG associated with preventing overtemperature (EG 3) cannot be ensured based on operational history. However, operational history also indicates that the source term associated with this event is typically minimal. If EG 3 is not met, the other EGs for protection against releases are applicable to the event. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane operators) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the ACR were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., release detection, cell trip, building holdup,

and evacuation of areas upon detection of a release) and the analysis presented for the B-stream block valve closure event (bounding AE event), EGs 1 and 2 would be met for workers outside the process building.

e. Summary of SSCs and TSR Controls

The essential controls for the UF_6/hot metal reaction event associated with meeting EG 3 are to minimize the potential for failing the primary system due to temperature increase. These controls include detection of the compressor failure and minimizing the source of heat/friction that could lead to the elevated temperatures that allow the UF_6/hot metal reaction. For equipment operating above atmospheric pressure, the essential controls for this event are summarized as follows:

- Motor load indicators in ACR—indication of abnormal compressor operation (i.e., surging and/or loss of load) (EG 3 only); and
- Compressor motor manual trip in ACR—elimination of heat/friction (EG 3 only).

For equipment operating above atmospheric pressure, essential mitigation of any UF_6 releases associated with this event (EGs 1, 2, and 6) are the same as those described for the B-stream block valve closure event (Section 4.3.2.1.3) for on-site receptors and are summarized as follows:

- Compressor motor manual trip in ACR—minimize release to workers outside the process building (EGs 1, 2, and 6);
- UF_6 release detection system—workers outside the process building (EGs 1, 2, and 6);
- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The motor load indicators, UF_6 compressor motor manual trip systems, UF_6 release detection system, and process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.

- TSRs are provided for the motor load indicators; cascade cell trip function; UF_6 release detection system; and administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.2 Stage Control Valve Closure (Pressure Increase)

a. **Scenario Description**

The stage control valve is used to control the pressure in a stage automatically or manually. The inadvertent closure of the stage control valve in a cell will cause a pressure increase in the stages above the closed control valve. Inadvertent closure of a stage control valve could be caused by initiators such as (1) an operator error, (2) a failure in the valve controls, (3) a mechanical failure in the valve mechanism (e.g., valve disk failure), (4) a freeze-out of UF_6 in the high side instrument line, or (5) a rupture of the high-side instrument line. The valve closure(s) could cause an increase in pressure, surging, and possibly motor overload. The pressure increase is limited due to the fact that the shift in inventory required to increase the pressure will cause the stage compressor to go into surge. Once the stage compressor goes into surge, the compressor will stop pumping additional inventory above the closed valve and the pressure will stop increasing. The pressure transient associated with closure of a stage control valve would be no higher than the pressure transient associated with the closure of a B-stream block valve when the recycle valve does not open. In a B-stream block valve closure scenario where the recycle valve does not open as designed, the maximum pressure attained in a “000” stage initially running at maximum steady state pressure would be about 30 psia. For equipment operating at a lower initial pressure, inadvertent closure would result in a lower maximum pressure (e.g., if the starting pressure was 14.4 psia the maximum pressure would be limited to 20 psia). In addition, stage control valves equipped with trimmer vanes and stops allow a limited amount of process gas flow to pass through the valve when it is closed. In the event of a stage control valve closure, this design feature would limit the maximum achievable pressure in the affected cell even further since a closed B-stream block valve allows virtually no flow through when closed.

This event is an AE because a single active failure or a single operator error could cause the inadvertent closure of a stage control valve or valves. Primary system failure is not expected at the maximum pressures associated with this event; however, it is assumed for the purpose of this evaluation that a primary system breach is possible.

Closure of a stage control valve was evaluated in the PrHA, and it was determined that the unmitigated consequences could include significant on-site impact in the above atmospheric pressure mode. The evaluation determined that no significant consequences beyond the immediate area are expected if the event occurs in equipment operating in the below atmospheric pressure mode.

The primary concerns associated with this event are (1) the primary system pressure increase, and (2) controlling the UF_6 release if the primary system should fail. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program (see Section 5.2). The first safety action required to meet the other EGs would be to maintain primary system pressure control within EG 3. This action will prevent primary system failure, protect on-site personnel, and maintain habitability of the required control area by preventing a release of UF_6. If primary system pressure cannot be maintained within EG 3, a breach of the primary system is assumed to occur. The safety actions of (1) primary system leakage detection, (2) primary system pressure control (to reduce the primary system pressure and minimize the UF_6 release), (3) building holdup, and (4) emergency response by on-site personnel would be required to maintain the effects of the UF_6 release

within EGs 1, 2, and 6. These actions protect on-site personnel and will maintain habitability of the required control area in accordance with EG 6 as well.

Primary system pressure control is required to meet EG 3. The primary method of accomplishing this safety action is to detect the pressure increase and take actions to reduce the pressure. The essential method of detecting a pressure increase in the cascade equipment is through monitoring the motor load indicators. The motor load indicators (i.e., stage ammeter indications) will indicate a rise in current for the compressor motors above the point of valve closure that is proportional to the rise in pressure. Once the increased motor loads are detected by the operator, an operator response is needed to reduce the pressure. Typically, during normal operation, operators are likely to determine the cause of the rise in loads (e.g., through observing valve position indicators and compressor loads) and this will initiate routine actions to limit the pressure increase to meet EG 3. These routine actions could include tripping the cell and/or taking off-stream, establishing a split in the cascade to isolate flow to the cell, or placing the control valve in manual operating mode to regain pressure control. However, the essential method for limiting the pressure is to trip cell(s) from the ACR. Tripping the cell(s) will eliminate the compression source and limit the pressure increase. However, should the detection and/or cell trip not occur soon enough, a failure of the primary system is assumed to occur. The release of UF_6 to the atmosphere could exceed EGs 1, 2, and 6 if no mitigation is accomplished.

b. Source-Term Analysis

Operating experience indicates that this event has never resulted in a release of UF_6 due to overpressure. Therefore, failure of the primary system is not expected with this event at this frequency. However, for analysis purposes, a failure of the primary system is assumed to occur at this event frequency. During the above atmospheric pressure operating mode, a direct failure of the primary system is assumed to result because of the pressure increase associated with a stage control valve closure event. The maximum pressure would be significantly less than that evaluated for the B-stream block valve closure event (Section 4.3.2.1.3), and is therefore bounded by that analysis.

c. Consequence Analysis

The consequence analysis for the stage control valve closure event is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1) visual indication of a “white smoke” (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and

evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — The analysis for the B-stream block valve closure event (Section 4.3.2.1.3) concluded that adequate time is available for operational personnel to accomplish the essential safety actions (leakage detection and mitigation). Because the stage control valve closure event source term is bounded by the B-stream block valve closure event source term, adequate time would also be available for operational personnel to detect and mitigate this event prior to any need to evacuate the ACR. However, once these essential actions have been accomplished, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) detection of the release, (2) minimization of the release by tripping applicable cells, (3) temporary holdup of the release by the existing process building structure, and (4) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential control is to detect the release of UF_6. As stated previously, the motor load indicators provide an indication of a pressure increase in the affected cell. Typically, this indication will be detected, and corrective action will be taken prior to any failure in the primary system. However, should a release occur, the equipment that has the potential for causing a large release (i.e., “00” or “000” building compressors which are intended to operate above atmospheric pressure) are equipped with UF_6 release detection that alarms in the applicable ACR. Other portions of the cascade do not have operating pressures or inventories sufficient to result in any significant consequences outside the building, and this receptor would not be applicable (see Section 4.2.6.4). The second essential control, is for operators to trip the appropriate cell(s) to reduce the pressure and minimize the release of UF_6. Tripping the cell would quickly end the release as the compressors stop and the system pressure falls to atmospheric pressure. Pressure at an interbuilding booster compressor can be reduced, if needed, by tripping the compressor motor or by tripping adjacent enrichment cell compressor motors. Once the pressure has dropped to atmospheric pressure or below, the release of material is effectively terminated for any potential exposure outside the process building. Sufficient time is then available to perform any necessary valve evolutions to isolate the cell. The third essential control, process building holdup, is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

d. Comparison With Guidelines

The EGs for the AE frequency category from Table 4.2-2 were compared to the consequences associated with the event scenario. The EG associated with preventing overpressure (EG 3) cannot be ensured because of the lack of automatic trips on high cascade pressures associated with existing cascade configurations. However, operational history indicates that this EG is likely to be met because no primary system failures have occurred from this transient. If EG 3 is not met, the other EGs for protection against releases are applicable to the event. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane operators) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the ACR were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., release detection, cell trip, building holdup, and evacuation of areas upon detection of a release) and the analysis presented for the B-stream block valve closure event (bounding AE event), EGs 1 and 2 would be met for workers outside the process building.

e. Summary of SSCs and TSR Controls

The essential controls for the stage control valve closure event associated with meeting EG 3 are to minimize the potential for failing the primary system due to pressure increase. For equipment operating above atmospheric pressure, the essential controls associated with this EG are summarized as follows:

- Motor load indicators in ACR—indication of pressure increase (i.e., significant increase in motor load) (EG 3 only); and
- Compressor motor manual trip in ACR—decrease pressure (EG 3 only).

For equipment operating above atmospheric pressure, essential mitigation of any UF_6 releases associated with this event (EGs 1, 2, and 6) are the same as those described for the B-stream block valve closure event (Section 4.3.2.1.3) and are summarized as follows:

- Compressor motor manual trip in ACR—minimize release for all receptors except local worker (EGs 1, 2, and 6);
- UF_6 release detection system—all receptors except local worker (EGs 1, 2, and 6);
- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The motor load indicators, UF_6 compressor motor manual trip systems, UF_6 release detection system, and process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the motor load indicators; cascade cell trip function; UF_6 release detection system; and administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.3 B-Stream Block Valve Closure (Pressure Increase)

a. <u>Scenario Description</u>

Normal operation of the gaseous diffusion cascade requires a continuous A-stream (upstream) flow, and B-stream (downstream) flow, in order to complete the enrichment process. During operation of the enrichment cascade, the B-stream block valves are generally operated only to take equipment off-stream or to establish cascade splits. These are operations that are typically performed at the local cell panel while the operator has an established communication link with the ACR. During these operations, the potential exists for the inadvertent closure or failure to open of the B-stream block valve by initiators such as (1) failure in the valve controls, or (2) operator error. A B-stream block valve closure that is caused by one of these initiating events is considered to be in the AE frequency category. It is also possible for the valve to mechanically fail (e.g., valve disk failure), however this initiator is considered to be in the EBE frequency category. This inadvertent "B" stream blockage will result in the A-upflow remaining near normal initially, with the B-downflow decreasing to zero as the B-stream block valve closes. Inventory would be pumped from stages below the closed B-stream block valve to the stages above the closed valve. If the recycle valve opens automatically as designed, the Stage 1 compressor will raise the inventory and pressure in the stage immediately above the closed B-stream valve. The inventory and pressures in stages above the closed valve are postulated to continue increasing until the pressure transient exceeds the rated pressure of a primary system component (e.g., expansion joint) and results in a UF_6 release to atmosphere. Routine actions would typically be taken by operators to mitigate the event prior to system breach (stopping or reversing the closure of the B block valve, or closing the appropriate A block valve to stop the A-stream flow if the B block valve fails to open).

There are other possible unmitigated end states associated with the B-stream block valve closure initiator, however these potential end states are not credited in this analysis. These other potential end states include:

- Compressors are automatically shut down on overload by the motor overload trip system.
- Compressors deblade due to overload.
- The expansion joint internal to a converter that separates the A & B stream ruptures (the pressure differential between the B-stream and the A-stream is greater than the pressure differential between the B-stream and the atmosphere).

An unmitigated closure of a B-stream block valve was evaluated in the PrHA and it was determined that the consequences of a release could include significant off-site and on-site impact in the above atmospheric pressure operating mode if no mitigation were provided, or significant on-site impact in the below atmospheric pressure operating mode.

The primary concerns associated with this event are (1) the primary system pressure increase associated with the unmitigated inadvertent blockage of the B-stream, and (2) controlling the UF_6 release if the primary system should fail. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program (see Section 5.2). The first safety action required to meet the other EGs is to maintain primary system pressure control within EG 3. This action will prevent primary system failure, protect both on-site personnel and the off-site public, and maintain habitability of the required control area by preventing a release of UF_6. If primary system pressure cannot be maintained within EG 3, a breach of the primary system could occur. The safety actions of (1) primary system leakage detection, (2) primary system pressure control (to reduce the primary system pressure and minimize the UF_6 release), (3) building/housing holdup, and (4) emergency response by on-site personnel would be required to maintain the effects of the UF_6 release within EGs 1, 2, and 6. These actions protect both on-site personnel and the off-site public and will maintain habitability of the required control area in accordance with EG 6 as well.

Primary system pressure control is required to meet EG 3. The primary method of accomplishing this safety action is to detect the pressure increase and take actions to reduce the pressure. The essential method of detecting a pressure increase in the cascade equipment is through monitoring the motor load indicators. The motor load indicators (i.e., stage ammeter indications) will indicate a rise in current for the compressor motors above the point of valve closure that is proportional to the rise in pressure. The pressure rise is not immediate. A bounding analysis was performed to determine the minimum time-frame to reach primary system failure. This analysis was based on a B-stream block valve closure occurring in a “000” cell while the cascade is operating at maximum power levels and at an area operating at maximum steady state pressure and maximum interstage flow rates. This analysis indicates that from the time that valve closure is initiated, the valve will completely close in approximately 2.5 min, primary system pressure would begin to significantly increase approximately 1.5 min after initiation of valve closure, and primary system failure is postulated to occur after approximately 3.5 min after initiation of valve closure. Rather than taking full credit for the expected closure time of the B-stream block valve, it is conservatively assumed for this analysis that the operator has 2.5 minutes from event initiation to detect the increased motor loads and to take actions to reduce pressure and prevent rupture and thus meet EG 3 for the worst case conditions. For lower cascade power levels, lower steady-state operating pressures, lower interstage flows, and smaller equipment, the time frame for reaction would typically be significantly longer.

Once the increased motor loads are detected by the operator, an operator response is needed to reduce the pressure. Typically, during normal operation, operators are likely to determine the cause of the rise in loads (e.g., through observing valve position indicators and compressor loads) and this will initiate routine actions to limit the pressure increase to meet EG 3. These routine actions could include stopping or reversing the closure of the B block valve, stopping or reversing the closure of the B bypass valve if the B block valve fails to open, or closing the appropriate A block valve to stop the A-stream flow. However, the essential method for limiting the pressure is to trip cell(s) from the ACR. Tripping

the cell(s) will eliminate the compression source and limit the pressure increase. However, based on the minimum time-frame for operator action associated with the worst case conditions, detection or cell trip may not be accomplished in time to prevent exceeding EG 3. Consequently, a failure of the primary system is addressed. The release of UF_6 to the atmosphere could exceed EGs 1, 2, and 6 if no mitigation is accomplished.

Should the essential preventive actions fail to stop the transient in sufficient time to prevent a failure of the primary system, a release of UF_6 is assumed to occur. Operating experience indicates that this event has never resulted in a release of UF_6 due to overpressure. Therefore, failure of the primary system is not expected with this event at this frequency. However, for analysis purposes, a failure of the primary system is assumed to occur at this event frequency.

b. Source-Term Analysis

The B-stream block valve closure event is categorized as an AE because a single failure of equipment or a single operator error could initiate the event, and it is also based on operational history. There are many variables associated with this event that must be characterized to develop a source term. These variables include:

- The duration of the event prior to operator action;
- The size of the potential system failure;
- The location of the failure in the cascade (i.e., equipment associated with “00” or “000” cascade operations—other equipment is not considered credible due to lower pressures); and
- The initial pressures and associated flow rate of UF_6 at the break.

To characterize this scenario for consequence analysis, the objective was to determine the amount of material that can be released without exceeding the AE off-site EGs (i.e., 10 mg U and 5 rem) and evaluate the time frame to determine if sufficient operator time is available to mitigate the event prior to exceeding the EGs. The scenario assumes a conservative release rate equivalent to the B-stream line failure scenario release rate presented in the large UF_6 release to atmosphere event (see Section 4.3.2.1.7). The release rate is 130 lb/s (59 kg/s) of UF_6. Based on the analysis in Section 4.3.2.1.7, it would take approximately 90 s to release enough material [i.e., 11,700 lb (5307 kg)] to exceed 10 mg U at the nearest site boundary. Because of the various receptors of concern (i.e., personnel in the process building, operators, general on-site workers, and the off-site public), the EGs will be addressed based on these receptors.

c. Consequence Analysis

The consequence analysis for the B-stream block valve closure event is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1) visual indication of a “white smoke”

(i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — Operational personnel who are required to take mitigative action are located in the ACR, which typically would not be impacted by the event. However, during cold weather periods, the air on the cell floor is recirculated inside the building to minimize heat loss and maintain building temperatures. This mode of operation could result in elevated concentrations of HF in the ACR area, which would result in evacuation of the ACR. An evaluation of this potential concern concluded that adequate time is available for operators to perform the required actions prior to evacuation should the need arise. However, once these essential actions have been accomplished, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) detection of the release, (2) minimization of the release by tripping applicable cells, (3) temporary holdup of the release by the existing process building structure, and (4) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential control is to detect the release of UF_6. As stated previously, the motor load indicators provide an indication of a pressure increase in the affected cell. Typically, this indication will be detected, and corrective action will be taken prior to any failure in the primary system. However, should a release occur, the equipment that has the potential for causing a large release [i.e., “000” or “00” areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, interbuilding and tie-line housings and in interbuilding booster stations)] building compressors which are intended to operate above atmospheric pressure) are equipped with UF_6 release detection that alarms in the applicable ACR. Other portions of the cascade do not have operating pressures or inventories sufficient to result in any significant consequences outside the building, and this receptor would not be applicable (see Section 4.2.6.4). The second essential control, is for operators to trip the appropriate cell(s) to reduce the pressure and minimize the release of UF_6. Tripping the cell would quickly end the release as the compressors stop and the system pressure falls to atmospheric pressure. Pressure at an interbuilding booster compressor can be reduced, if needed, by tripping the compressor motor or by tripping adjacent enrichment cell compressor motors. Once the pressure has dropped to atmospheric pressure or below, the release of material is effectively terminated for any potential exposure outside the process building. Sufficient time is then available to perform any necessary valve evolutions to isolate the cell. The third essential control, process building holdup, is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place

or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — Because this event, as described, could involve a significant UF_6 release, a scenario is presented that determines how much material must be released at the assumed conservative flow rate to result in a 10 mg U exposure at the nearest site boundary. This information is evaluated and described in the accident analysis for a large UF_6 release to atmosphere (Section 4.3.2.1.7). For the worst-case conditions, the results indicate that it takes 11,700 lb (5307 kg) of UF_6 to reach a 10 mg U exposure at the nearest site boundary. With the conservative release rate assumed, this would result in a release time of 1.5 min. Based on the minimum time-frame to breach the primary system, the operator would have to trip the cell(s) within 4 min (i.e., 2.5 min to reach failure and 1.5 min of release) to meet EGs 1 and 2. For portions of the cascade not operating at maximum pressures and for smaller equipment, more time would be available for the operator to take action to mitigate the event. This allows adequate time for the operators to act. This is based on operational history associated with typical cascade operating configurations (i.e., no breach has occurred from this initiator), the typical location of the operators when the event is initiated (i.e., at the ACR and cell panel), operator training, and the early indications available (i.e., motor load indicators and UF_6 release detectors).

d. Comparison With Guidelines

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the event scenario. The EG associated with preventing overpressure (EG 3) cannot be ensured because of the lack of automatic trips on high cascade pressures associated with existing cascade configurations. However, operational history associated with typical cascade operating configurations indicates that this EG is likely to be met because no failures have occurred from this transient. If EG 3 is not met, the other EGs for protection against releases are applicable to the event. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane operators) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the ACR were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., release detection, cell trip, building holdup, and evacuation of areas upon detection of a release), EGs 1 and 2 would be met for workers outside the process building. Finally, an analysis was performed to determine the worst-case scenario at which an off-site exposure of 10 mg U would be reached at the nearest site boundary. Results of this analysis indicated that the operator action could be accomplished within the time frame to meet the EGs.

e. Summary of SSCs and TSR Controls

The essential controls for the B-stream block valve closure event associated with meeting EG 3 are to minimize the potential for failing the primary system due to pressure increase. Based on the results of this analysis, the essential controls associated with this EG are summarized as follows:

- Motor load indicators in ACR—indication of pressure increase (i.e., significant increase in motor load) (EG 3 only); and
- Compressor motor manual trip in ACR—decrease pressure (EG 3 only).

Essential mitigation of any UF_6 releases associated with this event (EGs 1, 2, and 6) are summarized as follows:

- Compressor motor manual trip in ACR—minimize release for all receptors except local worker (EG s 1, 2, and 6);
- UF_6 release detection system for ”000” or “00” areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, interbuilding tie-line housings, and in interbuilding booster stations)—all receptors except local worker (EGs 1, 2, and 6);
- Equipment housing holdup for compressors operating above atmospheric pressure—off-site public (EGs 1 and 2);
- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building and the off-site public (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The motor load indicators, UF_6 compressor motor manual trip systems, UF_6 release detection system, equipment housings, and process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the motor load indicators; cascade cell trip function; UF_6 release detection system; and administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.4 Limited UF_6 Release to Atmosphere (Primary System Integrity)

a. <u>Scenario Description</u>

Small passive failures in the primary system may result in limited releases of UF_6 into the process buildings. These could be caused by initiators such as failures of instrument lines, expansion joints, weld joints, valve stem packing, etc., that could be caused by vibration, fatigue, or corrosion. These types of failures are expected frequently enough to place them in the AE category.

A limited UF_6 release event was evaluated in the PrHA, and it was determined that the consequences could include significant on-site impact in the above atmospheric pressure operating mode if no mitigation were provided.

The primary concern associated with this event is controlling the UF_6 release. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 3 is not

addressed in this scenario because the primary system is assumed to fail, and EG 4 is addressed by the NCS Program (see Section 5.2). The safety actions of (1) building holdup, and (2) emergency response by local personnel would be required to maintain the effects of the UF_6 release within EGs 1, 2, and 6. Because of the limited size of the releases for this event, no additional action is required to keep the effects of the UF_6 release within EGs 1, 2, and 6 for areas outside the process buildings. These actions protect on-site personnel and will maintain habitability of the required control area in accordance with EG 6 as well. In addition, although it is not considered essential, termination of these releases would typically be accomplished via the means identified for other scenarios such as the B-line block valve failure event (Section 4.3.2.1.3).

The limited UF_6 release to atmosphere is the most limiting primary system integrity failure event for the AE category. For larger primary system integrity failures that could result in a large UF_6 release, the frequency is considered to be significantly lower. Such failures are addressed in the large UF_6 release to atmosphere event (see Section 4.3.2.1.7).

b. <u>Source-Term Analysis</u>

The limited UF_6 release to atmosphere event is considered to be an AE because minor passive failures of equipment or operator error can initiate the event and because of operational history. Many variables associated with this event must be characterized to develop a source term. These variables include:

- The duration of the release;
- The size of the potential system failure;
- The location of the failure in the cascade (i.e., “2X”, “00,” “000”, or auxiliary equipment); and
- The initial pressures and associated flow rate of UF_6 at the break.

For equipment operating below atmospheric pressure, the source term for this event would be minimal because of inleakage, and no additional consideration is warranted. However, for equipment operating above atmospheric pressure, some release of UF_6 would be expected although as indicated by operational history, the releases are typically very small. This event is associated with minor passive failures only. The size of the failure in the primary system is expected to be small and significantly less than that described for the B-stream block valve closure event (see Section 4.3.2.1.3). Based on the potential source term, this event is bounded by the B-stream block valve closure event (Section 4.3.2.1.3).

c. <u>Consequence Analysis</u>

The consequence analysis for the limited UF_6 release to atmosphere event is subdivided to address the on-site receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1) visual indication of a “white smoke”

(i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — Because of the minimal source term associated with this event, no essential actions are required of operational personnel in the ACR. However, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) temporary holdup of the release by the existing process building structure, and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. Process building holdup is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

d. Comparison With Guidelines

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the event scenario. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane operators)will maintain exposures within EGs 1 and 2 to the extent practical. There are no essential actions required of operational personnel in the ACR to meet EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., building holdup, and evacuation of areas upon detection of a release) and the minimal source term associated with this event, EGs 1 and 2 would be met for workers outside the process building.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential mitigative controls for the limited UF_6 release to atmosphere event associated with meeting EGs 1, 2, and 6 are a subset of those described for the B-

stream block valve closure event (Section 4.3.2.1.3) and are summarized as follows:

- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.5 Evacuation of Cascade Process Buildings (External Events)

a. Scenario Description

The evacuation of cascade process buildings event is a special event to be evaluated for all operational areas with significant hazardous operations to ensure that evacuation does not result in consequences from process operations. The event scenario addresses any essential actions required by the operational staff prior to evacuation of the facility for all conditions except when a release of hazardous material within the facility is the initiating event. For a discussion of releases of hazardous material within the cascade process buildings and associated operator actions, refer to the appropriate sections of this chapter for required actions. The evacuation event is an AE because various types of events associated with plant operations could result in a required evacuation of a facility. Some of these events include spurious operation of the criticality accident alarm system, potential releases of hazardous material from another facility, or a fire within the facility.

The primary concern associated with this event is to prevent release of hazardous material (e.g., UF_6) as a result of an evacuation of the facility. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program (see Section 5.2). EG 6 is addressed by this event scenario (i.e., determine what safety actions are required by the operational personnel and whether they can be accomplished for this event). The only safety action required to meet these EGs is to maintain primary system pressure control within EG 3. This action will prevent primary system failure as well as protect both on-site personnel and the off-site public.

The analysis for this scenario addressed each facility process and associated operating modes to determine the essential controls necessary to prevent failure of the primary system. The initial conditions associated with this event are assumed to be normal operations carried out within the facility.

The evacuation of cascade process buildings event is considered a limiting event because of the special nature of the analysis. All the applicable EGs are met by controlling the primary system pressure

within EG 3. Both the on-site worker and the off-site public are protected in this event by controlling the primary system pressure so that it does not exceed EG 3 and the release of UF_6 is prevented.

b. Source-Term Analysis

The objective of this analysis is to prevent failure of the primary system in the event of an evacuation of a cascade process building. This would result in no source term for the event. Although this objective might not be accomplished completely, as indicated in the following analysis, the source term would be small in relation to the other anticipated events (Sections 4.3.2.1.1 through 4.3.2.1.4, and Section 4.3.2.1.6). Therefore, source-term analysis is not applicable to this event.

c. Consequence Analysis

Consequence analysis is not applicable to the evacuation of cascade process buildings event.

d. Comparison With Guidelines

For the evacuation of cascade process buildings event, a summary of each process and its associated controls is given to indicate how primary system pressure and temperature are controlled within EG 3.

The freezer/sublimer process is automatically controlled to prevent overfilling. However, even if overfilling were to occur, no change to the sublime mode would occur during the event. Therefore, overfilling is not a threat to primary system pressure and temperature values. During the sublime mode, insufficient heat is available to cause pressures greater than the capacity of the freezer/sublimer vessel. Therefore, no controls are required to ensure that this process will meet EG 3.

The UF_6/coolant recovery process is operated at subatmospheric pressures at all times and should primary system failure occur, only local consequences would be possible. With an evacuation already performed, these consequences would be negligible.

The purge cascade (Building C-310 only) and enrichment cascade cells in this building do not have sufficient hazards to cause significant on-site consequences beyond the immediate area, even if the primary system were to fail. Therefore, EG 3 is not applicable. However, explosive concentrations of cascade gases could potentially result in a failure of the primary system during this operating mode. Should an explosion occur, only local consequences would be possible, and with an evacuation already performed, these consequences would be negligible.

The enrichment cascade was also evaluated for any actions required to protect primary system integrity should evacuation be necessary. The primary concerns associated with the enrichment cascade process include the dropping of heavy equipment and controlling primary system pressures and temperatures within EG 3.

Process building cranes could be involved in operations associated with moving heavy loads when external events require a cascade facility building to be evacuated. In this scenario, it is necessary to ensure the crane or its load is not positioned over pressurized equipment such that a crane failure (i.e., a heavy load drop) could result in a significant UF_6 release. To achieve this objective, an administrative control utilized during normal operations precludes using process building cranes to transport heavy loads above/around process equipment that is operating above atmospheric pressure. This administrative control, in conjunction with operator training and experience associated with crane operation, minimizes the risk that a process building crane failure after an evacuation event would result in a significant UF_6 release.

The only other condition that could result in a failure of primary system integrity and in the subsequent release of UF_6 or another hazard in the enrichment cascade would be excessive pressures or temperatures in the operating modes where the compressors are normally operating. The essential controls for preventing overpressurization events (e.g., B-stream block valve closure event [Section 4.3.2.1.3]) and overtemperature (e.g., UF_6/hot metal reaction event [Section 4.3.2.1.1]) are accomplished via motor load indicators in the central control facility (CCF) (one per cell, to detect compressor operating abnormalities) and associated manual trip capability in the CCF. This provides a comparable level of protection for controlling primary system pressure and temperature as compared to the ACR. Certain compressors are not provided with ammeters for motor load indication in the CCF. These include all auxiliary compressors (e.g., boosters) except the B booster compressors in Buildings C-333 and C-337.
However, motor load indicators are provided for all cells connected to these compressors. Large changes in auxiliary compressor loads would be detectable on these adjacent cell motor load indicators so that appropriate action (e.g., tripping compressors) could be initiated to meet EG3.

e. <u>Summary of SSCs and TSR Controls</u>

The essential controls for the evacuation of cascade process buildings event are summarized as follows:

- Motor load indicators in CCF—indication of pressure increase (i.e., significant increase in motor load) (EGs 3 and 6);
- Compressor motor manual trip (“00” and “000” cells only) in CCF—decrease pressure and/or eliminate source of heat/friction from CCF (EGs 3 and 6);
- Administrative Control - process building cranes shall not be used to transport heavy loads above/around process equipment that is operating above atmospheric pressure - (EGs 1, and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The motor load indicators in the CCF, and the UF_6 compressor motor manual trip system from the CCF are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the motor load indicators in the CCF and the cascade cell trip function from the CCF.

4.3.2.1.6 Coolant Tube Rupture Into Primary System (Pressure Increase)

a. Scenario Description

A failure of coolant tube(s) in a cascade cell gas cooler could result in a significant pressure increase in the primary system. If the coolant leak should occur when the cell is tied to the cascade, sufficient volume is available within the cascade to allow for expansion of the coolant without causing any significant pressurization. Coolant tube failures could be caused by initiators such as fatigue cracks or ruptures, joint failures, corrosion pitting, a loss of RCW cooling coupled with a failure of the coolant high-pressure relief system, or a UF_6/hot metal reaction burning a hole in the gas cooler tubes. This event in an off-stream cell (limited volume for expansion) could result in a rapid pressure increase above the normal operating pressures within the primary system. The pressure transient may exceed the rated pressure of the converters and expansion joints, etc. This could lead to a UF_6 release regardless of whether the cell is operating above or below atmospheric pressure. This event is an AE based on operational history.

A rupture of coolant tubes into the primary system was evaluated in the PrHA, and it was determined that the consequences could include significant on-site impact in the above atmospheric pressure or below atmospheric pressure operating modes for the enrichment cascade process if no mitigation were provided. The threshold consequence analysis performed for the PrHA determined that off-site EGs would not be exceeded for this event.

The primary concern associated with this event is controlling the UF_6 release if the primary system fails. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS program (see Section 5.2). EG 3 cannot be ensured for this event, therefore the safety actions of (1) building holdup, and (2) emergency response by on-site personnel are required to maintain the effects of a UF_6 release within EGs 1 and 2. No operator action is required for this event, therefore there are no actions required to meet EG 6.

b. Source-Term Analysis

The threshold source term analysis performed during the PrHA process determined that the maximum source term for the coolant tube rupture into the primary system event is about 11,000 lb for a "000" cell. This analysis assumes that no operator actions are taken to mitigate the event. No credit was taken for air in-leakage, nor for UF_6 remaining in the cell once it has reached atmospheric pressure. Therefore, the value given is a conservative upper bound on the maximum amount of UF_6 which could be released from a single isolated cell.

If an isolated cell running on recycle were breached, the flow rate would drop as the UF_6 is exhausted. The minimum release duration for this condition is conservatively estimated at 2.5 minutes, for an average release rate of 73 lb/sec which results in a smaller release rate than postulated for the B-stream block valve closure event (Section 4.3.2.1.3). Based on the smaller release rate and the smaller total amount of material released, this event is bounded by the analysis performed for the B-stream block valve closure event.

c. Consequence Analysis

The consequence analysis for the coolant tube rupture into the primary system event will be subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — No essential actions are required of operational personnel in the ACR. However, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) temporary holdup of the release by the existing process building structure, and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. Process building holdup is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

d. Comparison With Guidelines

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the coolant tube rupture into the primary system event. The EG associated with preventing overpressure (EG 3) cannot be ensured if the event occurs in the cascade off-stream mode. If EG 3 is not met, the other EGs for protection against releases are applicable to the event. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane

operators) will maintain exposures within EGs 1 and 2 to the extent practical. The operational personnel in the ACR were evaluated and it was determined that there are no required essential actions to meet EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., building holdup, and evacuation of areas upon detection of a release) and the analysis presented for the B-stream block valve closure event (bounding AE event), EGs 1 and 2 would be met for workers outside the process building.

e. Summary of SSCs and TSR Controls

Essential mitigation of any UF_6 releases associated with the coolant tube rupture into primary system event (EGs 1, 2, and 6) are a subset of those described for the B-stream block valve closure event (Section 4.3.2.1.3) and are summarized as follows:

- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.7 Large Release of UF_6 to Atmosphere (Primary System Integrity)

a. Scenario Description

During the above atmospheric pressure operating mode, various primary system failures may result in a large release of UF_6 within the process buildings. These failures can be initiated by a pressure increase event (see Section 4.3.2.1.3) or a primary system integrity failure event (see Section 4.3.2.1.4). The frequency of the large UF_6 release to atmosphere event is an EBE. This categorization is based on cascade operating experience and the low frequency of an AE progressing to the point of a large release.

A large release of UF_6 event was evaluated in the PrHA, and it was determined that the consequences could include significant on-site and off-site impact in the above atmospheric pressure operating mode if no mitigation were provided.

The primary concern associated with this event is controlling the UF_6 release. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the EBE frequency range. EG 3 is not

evaluated because a primary system breach is assumed to occur. The safety actions of (1) primary system leakage detection, (2) primary system pressure control (to reduce the primary system pressure and minimize the UF_6 release), (3) building/housing holdup, and (4) emergency response by on-site personnel would be required to maintain the effects of the UF_6 release within EGs 1, and 2. These actions protect on-site personnel and the off-site public and will maintain habitability of the required control area in accordance with EG 6 as well.

The large UF_6 release to atmosphere produces the most limiting primary system integrity failure event in the EBE category for the cascade facilities. Therefore, this event is analyzed for detailed source terms and consequences. While the heavy equipment drop event (Section 4.3.2.1.8) has a higher initial release rate, a B-stream block valve closure event (Section 4.3.2.1.3) that progresses to the point of a primary system rupture would pose a greater threat to exceed off-site EGs based on a higher sustained release rate (see Section 4.3.2.1.8 source term discussion). Therefore, the analysis is based on the B-stream block valve closure event.

b. <u>Source-Term Analysis</u>

There are many variables associated with the large UF_6 release to atmosphere event that must be characterized to develop a source term. These variables include:

- The duration of the event prior to operator action,
- The size of the potential system failure,
- The location of the failure in the cascade (i.e., equipment associated with “00” or “000” cascade operations—other equipment is not considered credible due to lower pressures); and
- The initial pressures and associated flow rate of UF_6 at the break.

In characterizing this scenario for consequence analysis, the objective was to determine the amount of material that can be released without exceeding the EBE off-site EGs (i.e., 30 mg U and 25 rem) and evaluate the time frame to determine if sufficient operator time is available to mitigate the event prior to exceeding the EGs. This analysis simulates an accidental release of UF_6 from a rupture in the process equipment along a B-line. The largest potential single UF_6 source term in the process buildings would be associated with a “000" cell near the location where pressures and interstage flows are the highest while the cascade is operating at maximum power (3040 MW). The cause of the rupture is a B-line block valve closure event, allowing UF_6 [at a temperature of 290°F (143°C)] to accumulate just above the closed B-line valve so that pressure rises from 21 to 40 psia (0.14 to 0.27 MPa) in that part of the B-stream. The primary system pressure of 40 psia (0.27 MPa) is an assumed failure point that was chosen as a conservative value to minimize the time allowed for operator action considering the time for the pressure to rise and the time of release of material before the off-site EGs would be exceeded. The rupture is postulated to create a 0.667-ft^2 (0.062-m^2) hole [equivalent to a circular hole about 11 in. (28 cm) in diameter] at the point of highest pressure, just above the closed block valve. Hole sizes larger than this do not significantly increase the release rate. Through this hole, UF_6 escapes into the equipment housing. For the baseline case, the release is assumed to be terminated in 480 s (8 min). This is considered to be an upper bound response time. Other time frames are also evaluated (i.e., 1.5 and 4 min) to determine the time allowed for operator action before the EGs are exceeded. An average release rate of 130 lb/s (59 kg/s) was used for this source-term analysis. For the purposes of calculating

radiological exposures, the released UF_6 is assumed to be 5.5 wt percent ^{235}U. The sensitivity of this enrichment is discussed in the consequence analysis section.

A modified version of the MELCOR computer code was used to simulate the transport of particles and vapor in the process buildings (see Section 4.3.1.2.2.2). MELCOR simulations show that the UF_6 released into the equipment housing quickly escapes (via cracks, untightened seams, and a door that is assumed to swing open to the outside) to the remainder of the unit and eventually to other units (mostly to the neighboring units). As the UF_6 escapes, it reacts with water vapor to form UO_2F_2 and HF, and it is assumed that all the UF_6 has reacted by the time of release from the "000" building to the outside atmosphere (i.e., no UF_6 is released to the atmosphere). Assuming that the release occurs during the summer, when the ventilation system is configured to work as a once through system [the ventilation configuration that results in the maximum mass of material released to the outside atmosphere], MELCOR simulations indicate that about 43 percent of the UO_2F_2 would settle on the equipment housing floor and on surfaces of equipment and piping within the building. The remaining 57 percent would escape to the outside atmosphere via the exhaust and roof vents flush with top of the building. The total mass of uranium released to the atmosphere for the baseline case would be about 24,045 lb (10,916 kg). Because HF is a gas, most (99.1 percent) of it would escape to the outside atmosphere, and the total mass of HF released for the baseline case would be about 14,165 lb (6431 kg).

Although the initial release into the equipment housing would last 8 min (baseline scenario), much of the UO_2F_2 and HF would be retained in the building for a longer time before being released to the outside atmosphere. The release of material to the outside atmosphere would occur over about 42 min. The release rate and temperature of the plume would vary substantially over this 42-min release period. Releases to the atmosphere would be expected to occur from all building vent locations (modeled as 12 roof vents and 6 motor vents for dispersion calculation purposes).

c. Consequence Analysis

This section presents a detailed quantitative discussion of the consequence calculations that were developed for the large UF_6 release to atmosphere event followed by a discussion of how the EGs are addressed for each receptor.

The detailed consequence calculations are divided into two sections: (1) baseline scenario and (2) effects on consequence estimates by varying scenario parameters.

Baseline scenario. The baseline scenario is as follows: (1) UF_6 is released into the equipment housing for 8 min prior to cell trip, (2) the release to the atmosphere occurs during early morning hours, when the atmosphere is stable, to minimize dispersion and maximize ground-level concentrations of uranium and HF, and (3) building wake effects are included. Parameters used in defining the baseline scenario are listed in Table 4.3-4. For this particular release (i.e., buoyant plumes emitted from vents flush with the tops of the large process building) under a very stable atmosphere (Class F), a higher wind speed of 7 mph (3 m/s), designated F3, provides higher consequence estimates than did a 2 mph (1 m/s) wind speed discussed in the dropped cylinder (Section 4.3.2.2.15) and parent/daughter transfer cases (Section 4.3.2.2.10). Because higher wind speeds are associated with lower final plume heights, the plume intersects the ground nearer the release site under F3 conditions than under F1 conditions. At

lesser distances from the source, with correspondingly less dispersion of the plume, the maximum ground-level concentrations for this release are greater with higher wind speeds. F3 conditions occur about 7.7 percent of the time on an annual basis [averaged over the 5-yr period 1988-1992].

Because the ventilation system configuration during warm weather periods results in significantly larger masses of material being released to the atmosphere, the temperature for the baseline scenario was assumed to be 70°F (21°C), a value associated with F stability in the summer. Although lower temperatures are possible under F stability, 70°F (21°C) was chosen because a high temperature results in higher consequence estimates because the height of final plume rise decreases as the temperature difference between the plume and the atmosphere decreases.

Unlike the dropped cylinder (Section 4.3.2.2.15) and the parent/daughter transfer cases (Section 4.3.2.2.10), the released UF_6 is assumed to have completely reacted to UO_2F_2 and HF before being released into the atmosphere. Therefore, the relative humidity, used to determine atmospheric water vapor content, is not a parameter in the dispersion modeling because there are no UF_6 reactions occurring as the plume disperses downwind.

The WAKE model (see Section 4.3.1.2.3.4.2) was used to predict downwind concentrations of uranium and HF. Figures 4.3-11 through 4.3-13 show estimated downwind consequences associated with the baseline scenario. Note that the baseline scenario (F3) is represented by the top curve on these figures. The other two curves are for different meteorological conditions and are discussed below. Calculated values of the consequence parameters were compared to EBE guideline values for uranium (25 rem for U radiological toxicity, and 30 mg U uptake for U chemical toxicity), and to the Emergency Response Planning Guidelines (ERPG-2) for HF (20 ppm for 1 hour).

Table 4.3-5 lists specific consequence estimates at the nearest site boundary, 1 mi (1600 m), and 5 mi (8050 m) downwind of the release point. The nearest site boundary is located about 0.56 mi (900 m) north of Building C-337. Consequence estimates for uranium chemical toxicity (30 mg of inhaled uranium) and HF exposure (20 ppm averaged over a 1-h period) exceed their respective comparison values at the nearest site boundary. The uranium chemical toxicity comparison value is exceeded just beyond 1.6 mi (2600 m), and the HF exposure comparison value is exceeded to about 1.7 mi (2700 m). The radioactive dose, which is sensitive to enrichment level, does not exceed the comparison value of 25 rem at downwind distances equal to or beyond 0.062 mi (100 m).

Effects on consequence estimates by varying scenario parameters. The following parameters were varied to obtain some uncertainty estimates and provide some characterization of the range of potential consequences: (1) the duration of release of UF_6 inside the building, (2) meteorological conditions, and (3) building wake effects. The results provide perspective for interpretation of the baseline scenario. The consequences presented in this section are more probable, providing a lower-bound estimate of potential consequences. For the duration of release and building wake discussions, consequence estimate comparisons are not shown for radioactive dose and HF exposure because these estimates display the same general trend as the uranium chemical toxicity dose. A discussion of the uncertainties in the analysis that have not been quantified is provided.

Duration of release into the building — The baseline case assumes that the compressors are tripped in 8 min to terminate the release. If the compressors are tripped in about 4 min (240 s) or 1.5 min (90 s), the corresponding amount of UF_6 released into the process building would be about 31,200 lb (14,165 kg) and 11,700 lb (5312 kg) respectively [assuming an average release rate of 130 lb/s (59 kg/s)]. For these comparisons, the percentage of UO_2F_2 deposited in the building (43 percent) was assumed to be the same as that used in the baseline scenario. For these cases, the release durations to the outside atmosphere were assumed to be about 23 min for the 4-min release into the building and 9 min for the 1.5-min release into the building, based on scaling calculations.

As shown in Fig. 4.3-14, consequence estimates for the 4-min and 1.5-min releases are lower than those for the 8-min release at all downwind distances. With a 4-min release into the building, the uranium chemical toxicity dose drops below 30 mg close to the nearest site boundary. With a 1.5-min release into the building, the uranium chemical toxicity dose drops below 10 mg close to the nearest site boundary.

Meteorological conditions — Consequence estimates were made for two additional meteorological conditions to compare with the baseline scenario (F3). These additional conditions are (1) a typical condition that does not provide low consequence estimates (D4) and (2) a typical condition that provides low consequence estimates (C4). For D4, the ambient air temperature was assumed to be 80°F (26.7°C). This temperature is a typical summer daytime temperature under neutral atmospheric conditions, consistent with the building ventilation condition used in the MELCOR modeling. For the C4 simulation, an ambient temperature of 80°F (26.7°C) is also used.

Figures 4.3-11 through 4.3-13 show consequence estimates for uranium chemical toxicity, radioactive dose, and HF toxicity exposure resulting during baseline (F3), D4, and C4 meteorological conditions. Consequence estimates under D4 conditions are slightly higher than under F3 conditions between downwind distances of 0.12 mi (200 m) and 0.25 mi (400 m). Although increased turbulent mixing associated with D stability can result in higher pollutant concentrations at ground-level close to the source, by the time the plume is about 0.25 mi (400 m) from the source, the general relationship of increased atmospheric turbulence producing decreased pollutant concentrations has established itself. Under D4 conditions, uranium chemical and HF toxicity estimates are below guideline values at distances of about 1 mi (1600 m) and greater. Under C4 conditions, uranium chemical and HF toxicity estimates are below guideline values at distances of about 0.43 mi (700 m) and greater.

Building wake effects — Wake effects cause higher initial dispersion, which generally has the effect of reducing ground-level concentrations far from an elevated source. However, near the source, high initial mixing can lead to high pollutant concentrations being brought to ground level before the pollutants move very far from the elevated source and undergo much lateral dispersion. As distance from the source increases, this initial wake-induced dispersion becomes smaller and smaller relative to the normal lateral and vertical dispersion of the plume, which becomes increasingly larger. At large distances from the source, wake effects and the effects of normal dispersion begin to complement, rather than counteract, each other, so that concentrations under wake conditions become almost equal to the no-wake case. However, as shown in Fig. 4.3-15, wake effects for this release scenario lead to higher consequence estimates at distances beyond 5 mi (8050 m). Note that results from the two cases would converge at distances beyond 5 mi (8050 m). For the no-wake case, consequence estimates are below the uranium

chemical toxicity dose guideline value for all downwind distances.

Uncertainties not quantified — Large air intakes are located at ground level on the outside of each process building. Any fraction of the plume captured into the building recirculation cavity may be caught by these air intakes, effectively preventing the captured plume mass from dispersing downwind. Air from the intakes enters the process buildings at the ground floor and is moved to the operating floor via large supply fans. This air would eventually be redirected to the cell floor, out the vents and motor exhaust ducts, thereby reentering the atmosphere. The fraction of the plume entering this intake circulation would be diluted, and retention time of the released material in the building would be increased. This would lower the emission rate of the released material to the atmosphere and also lower the temperature of the plume from the vents. Downwind consequence estimates would be less than those predicted for the base scenario because of the lower emission rate. Also, with a lower plume temperature, a larger fraction of the plume would enter the recirculation cavity, repeating the intake cycle and ultimately lowering downwind consequence estimates.

The following sections describe how the EGs are addressed for the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the cascade process buildings is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g. emergency egress capability) must be available for personnel operating process building cranes.

Operational personnel in the ACR — Operational personnel who are required to take mitigative action are located in the ACR, which typically would not be impacted by the event. During cold weather periods, the air on the cell floor is recirculated inside the building to minimize heat loss and maintain building temperatures. This mode of operation could result in elevated concentrations of HF in the ACR area, which would result in evacuation of the ACR. However, an evaluation of this potential concern concluded that adequate time is available for operators perform the required actions (i.e., about 4 min) prior to any evacuation should the need arise. However, once these essential actions have been accomplished, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) detection of the release, (2) minimization of the release by tripping

applicable cells, (3) temporary holdup of the release by the existing process building structure, and (4) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential control is to detect the release of UF_6. Equipment that has the potential for causing a large release [i.e., "000" or "00" areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, interbuilding and tie-line housings and in interbuilding booster stations)] are equipped with UF_6 release detection that alarms in the applicable ACR. Other portions of the cascade do not have operating pressures or inventories sufficient to result in any significant consequences outside the building, and this receptor would not be applicable (see Section 4.2.6.4). The second essential control, is for operators to trip the appropriate cell(s) to reduce the pressure and minimize the release of UF_6. Tripping the cell would quickly end the release as the compressors stop and the system pressure falls to atmospheric pressure. Pressure at an interbuilding booster compressor can be reduced, if needed, by tripping the compressor motor or by tripping adjacent enrichment cell compressor motors. Once the pressure has dropped to atmospheric pressure or below, the release of material is effectively terminated for any potential exposure outside the process building. Sufficient time is then available to perform any necessary valve evolutions to isolate the cell. The third essential control, process building holdup, is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released via the exhaust and roof vents flush with the top of the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — Because this event, as described, could involve a significant UF_6 release, a scenario is presented that indicates how much material is required to be released at the assumed conservative flow rate to result in the 30 mg U exposure at the nearest site boundary. For the worst-case conditions, the results indicate that it takes about 31,200 lb (14,165 kg) of UF_6 to reach a 30 mg U exposure at the nearest site boundary. With the conservative release rate assumed, this would result in a release time of about 4 min. The large UF_6 release to atmosphere event is characterized by the B-stream block valve closure event. The large UF_6 release to atmosphere event ignores the time required to reach a 40-psia (0.27-MPa) cascade pressure, at which the primary system is assumed to fail (about 2.5 min, see Section 4.3.2.1.3). This extra time would allow the operator even more time to react to the event (i.e., about 6.5 min to trip the compressors for the worst case assumptions). There is sufficient time for operator response based on operator presence near the controls when this event is expected to occur. In addition, with any quicker response time, different wind conditions, ventilation system settings, or variations in the wake effects, the resulting consequences would be below the guidelines.

d. <u>Comparison With Guidelines</u>

For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee, and PPE or other protective measures for crane operators) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the ACR were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the

controls identified (i.e., release detection, cell trip, building holdup, and evacuation of areas upon detection of a release), EGs 1 and 2 would be met for workers outside the process building. Finally, an analysis was performed to determine the worst-case scenario at which an off-site exposure of 30 mg U would be reached. Results of this analysis indicated that the operator action could be accomplished within the time frame to meet the EGs.

e. <u>Summary of SSCs and TSR Controls</u>

Based on the results of this analysis, the essential controls for the large UF_6 release to atmosphere event are summarized as follows:

- Compressor motor manual trip in ACR—minimize release for all receptors except local worker (EGs 1, 2, and 6);
- UF_6 release detection system for ”000” or “00” areas that are intended to be operated above atmospheric pressure (including inside the cell housings, cell bypass housings, unit bypass housings, interbuilding tie-line housings and in interbuilding booster stations)—all receptors except local worker (EGs 1, 2, and 6);
- Equipment housing holdup for compressors operating above atmospheric pressure—off-site public (EGs 1 and 2);
- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Administrative control—personal protective equipment (PPE) or other protective measures shall be available to personnel operating process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building and the off-site public (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The UF_6 compressor motor manual trip systems, UF_6 release detection system, equipment housings, and process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the cascade cell trip function; UF_6 release detection system; and administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.1.8 Heavy Equipment Drop (Primary System Integrity)

a. <u>Scenario Description</u>

During process building operations, the change-out of cascade equipment for maintenance requires that heavy equipment (converters, compressors, valves, etc.) occasionally be moved over operating cells by overhead building cranes and lifting fixtures. If this equipment should be dropped because of a failure of the crane or lifting rig, the primary system could be breached, and UF_6 released if the cell is operating above atmospheric pressure. The fall of a crane itself is not considered a credible release initiator. The cranes that are normally parked over cascade equipment have been shown to be seismically qualified in this position (see Section 3.15). The greatest potential for a UF_6 release would be from a drop of a converter on a B-bypass line operating at the maximum operating pressure. The heavy equipment drop

event has been assigned to the EBE frequency category. The assignment is justified because there is no historical precedent for a release of UF_6 as a result of such an event, and controls such as design and inspections placed on the cranes and lifting fixtures and operating procedures are in place to prevent the event.

Dropping of heavy equipment was evaluated in the PrHA and it was determined that if no mitigation were provided, the potential consequences could include (1) significant off-site and on-site impact in the above atmospheric pressure mode, or (2) significant on-site impact in the freeze, sublime, hot standby, or modified hot standby modes for the freezer/sublimer process.

The primary concern associated with this event is the control of the UF_6 release from the affected portion of the UF_6 primary system. The applicable EGs associated with this event are all of the EGs for the EBE frequency range except EG 3. EG 3 does not apply since the heavy equipment drop event does not address process pressure or temperature limits. EG 4 is addressed by the NCS program. The only safety action required to meet these EGs is an administrative control that precludes process building cranes from moving heavy loads above/around process (i.e., cascade) equipment that is operating above atmospheric pressure. This administrative control precludes the potential for a large UF_6 release since heavy equipment drop scenarios that rupture process equipment that is operated below atmospheric pressure would result in in-leakage with minimal release of UF_6.

b. <u>Source-Term Analysis</u>

For a heavy equipment drop event to produce a significant release of UF_6 to the atmosphere, the breaches must be in cells or equipment operating above atmospheric pressure. Process building cranes are administratively precluded from moving heavy loads over/near equipment that is operating above atmospheric pressure. Breaches of this type in equipment operating at sub-atmospheric pressure will result in inleakage with minimal release of UF_6. Therefore, no further source-term analysis is needed for this accident scenario since this administrative control is credited for precluding a heavy equipment drop event that would result in a large UF_6 release.

c. Consequence Analysis

Further consequence analysis is not required since the scenario description credits an administrative control that precludes a heavy equipment drop scenario that would result in a significant UF_6 release by preventing the use of process building cranes to move heavy loads above/around process equipment that is operating above atmospheric pressure.

d. Comparison With Guidelines

All of the applicable EGs for this scenario are met by the administrative control that prevents using process building cranes to move heavy loads above/around process equipment that is operating above atmospheric pressure.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential control for this event is summarized as follows:

- Administrative Control - Process building cranes shall not be used to transport heavy equipment above/around process equipment that is operating above atmospheric pressure (EGs 1, 2, 5, and 6).

Based on the above essential control, the resulting important to safety SSCs and TSRs are as follows:

- No SCCs were identified as important to safety as a result of this analysis.
- A TSR is provided that requires essential administrative controls be flowed into procedures.

4.3.2.1.9 Large Fire (External Event)

a. Scenario Description

During any of the cascade facility processes and their associated operating modes, various types of fires could occur. The hazard analysis identified the enrichment cascade and the freezer/sublimer (F/S) processes as having the most potential for significant consequences. The withdrawal facilities located in the process buildings were also considered in this event. Other processes are limited in quantity of material and pressures such that no significant impact would occur, even if primary system integrity is lost. Other hazards of concern in a fire would be the potential for criticality due to the loss of primary system integrity and subsequent moderation from the fire protection system. Criticality concerns are addressed in Section 5.2 and in Section 4.3.2.6. The fire protection program is described in Section 5.4.

The capabilities of the fixed fire suppression system and the onsite fire department provide a high degree of confidence that a postulated fire could be contained and extinguished prior to a breach of the primary system. However, for the purposes of this scenario, it is assumed that a large fire could occur that results in a failure of the primary system and a release of UF_6. Based on the installed fire suppression and on-site fire fighting capability, the large fire is categorized as an EBE.

A large fire was evaluated in the PrHA and it was determined that if no mitigation were provided, the consequences could include significant impacts beyond the immediate area in all enrichment cascade and freezer/sublimer operating modes.

The large amount of lube oil in the process buildings is an unavoidable fire hazard. The most likely cause of a large fire is the rupture of a compressor bearing lube oil supply line. This could cause compressor bearing overheating and a small localized fire. The fire would then have to spread to the point that it exceeded the capability of the fire protection systems as additional oil discharged. Another cause is an oil pump failure resulting in a release of oil and the friction heating of pump parts that could ignite the oil pool that would collect in the diked oil pit area. Other failures of oil piping will not typically result in a fire unless an ignition source is available (e.g., cutting, welding, electrical failures).

A large fire is considered to be a potential threat to primary system integrity either (1) directly from overtemperature or, (2) directly by weakening the support structures and causing failure due to falling debris. Another possibility is for a fire to indirectly cause primary system failure due to control system damage. For example, if the control system for an A valve were damaged and a cascade split were initiated, it would result in a similar scenario to the B-block valve closure event (Section 4.3.2.1.3). If the ACR is inhabited and an event such as this occurs, the essential controls presented for that scenario (Section 4.3.2.1.3 for this example) are applicable. In the event that the ACR were evacuated due to the fire, the essential controls presented for the evacuation of process building (Section 4.3.2.1.5) are applicable.

In order for this event to produce a release of UF_6 to atmosphere, the failure must be in the cascade cells or equipment piping. A large fire in the vicinity of the F/S vessel could potentially sublime the solid UF_6 in the vessel as well as cause a direct failure of primary system integrity. It is assumed in this analysis that the entire process building inventory is at risk, which includes the F/S vessel inventories.

The primary concerns associated with this event are (1) controlling the fire and (2) minimizing the effects of any UF_6 released should primary system integrity be lost. The applicable EGs associated with this event are all the EGs for the EBE frequency range. The safety actions of (1) building holdup, and (2) emergency response are the essential actions identified to maintain the effects of the UF_6 release within EGs 1 and 2. Habitability of the ACR per EG 6 cannot be ensured for this event, and is not required due to the expectation that the EGs 1 and 2 will be met regardless of actions taken in the ACR (see the consequence analysis section).

The large fire event produces the most limiting external event associated with fires in the EBE category.

b. Source-Term Analysis

The large fire event is categorized as an EBE because of the preventive/mitigative measures in place (i.e., fire protection program and fire protection system). Variables associated with this event that would be required to develop a source are as follows:

- The duration of the event,
- The size of the potential system failure (if any),
- The location of the potential failure in the cascade (e.g., "00" or "000" equipment), and
- The amount of fuel available for the fire.

Large fires could potentially result in significant consequences beyond the immediate area. However, the typical result of a large fire is a hot, buoyant plume giving rise to an elevated release of any hazardous material. With a significantly elevated release, minimal health effects would result off-site. This is consistent with the consequences for a cylinder fire event versus the release from a liquid-filled cylinder. The consequences for the cylinder fire event were evaluated (Section 4.3.2.2.16), and consequences exceeding 30 mg U were predicted out to less than 990 ft (300 m). Conversely, the release from a liquid-filled cylinder exceeds 30 mg U more than 3.4 mi (5500 m) downwind (see Section 4.3.2.2.15). Therefore, a specific source term was not developed for this event. However, a consequences analysis is provided to indicate the essential controls for minimizing the effects of this event.

c. Consequence Analysis

The consequence analysis for the large fire event will be subdivided to address the different receptors.

Local workers in the immediate area — Because of the time it would take for the primary system integrity to fail should a large fire occur, local workers in the area would have already evacuated the area due to the fire. Therefore, no specific requirements are identified for the local worker.

Operational personnel in the ACR — Depending on the timing of the event and the progression, operator action to trip operating oil pumps, compressors, or setup valving may be attempted to reduce lube oil available to the fire or to minimize UF_6 releases. Cell trips can also be performed from the CCF. Switchyard operators can trip cells or open breakers to de-energize oil pumps and other equipment as necessary. However, none of these actions are considered essential because in the event that the fire directly results in a primary system failure, none of these actions would significantly effect the quantity of UF_6 ultimately released. This is because of the extensive time required to reduce building inventory. The main concern is for operational personnel in the ACR to evacuate the facility when that decision is made.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) elevated dispersion of any release by the existing process building structure, and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The process building is expected to cause most of the UF_6 that escapes the building to be released at an elevated point. If workers outside of the process building have received no other

instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — As indicated in the source term discussion, this event is not likely to cause any off-site impact because of the extreme high temperatures generated from the fire and the rise of the plume from the heat of the fire that would occur. Therefore no off-site exposures exceeding the EGs are expected. However, the fire protection system and the fire protection program described in Section 5.4 are extremely important in preventing a small fire from becoming the large fire that could initiate this event.

d. Comparison With Guidelines

As indicated in the consequence analysis, no direct calculations of consequences were performed to provide a comparison to the EGs. However, the controls provided in the consequence analysis are expected to maintain the effects of the event within the applicable EGs.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for the large fire event are summarized as follows:

- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Process building structure providing elevated dispersion—on-site workers outside process building and the off-site public (EGs 1 and 2);
- Process building fixed fire protection system—minimize potential and mitigation of a large fire (EG 5); and
- Fire Protection Program—minimize potential for a large fire (normal operation, EG 5 only)

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The process buildings, and process building fixed fire suppression systems are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the fire protection system and its associated water supply from the HPFWS, and administrative requirements for the Fire Protection Program, and for procedures and training of workers for evacuation actions.

4.3.2.2 UF_6 Handling and Storage Facilities

Table 4.2-11 documents the results of the hazards analysis for each of the UF_6 handling and storage facilities processes. The UF_6 handling and storage processes consist of feed vaporization, toll transfer and sampling, product and tails withdrawal, and cylinder storage. The principal hazard evaluated for this group is UF_6 and its reaction products. The following summarizes the hazards and the results of the accident analysis involving these facilities.

4.3.2.2.1 Compressor Failure - UF_6/Hot Metal Reaction (Temperature Increase)

a. Scenario Description

UF_6 reacts with most metals. Typically, the reaction between UF_6 and the metals used to fabricate gaseous diffusion process equipment is relatively mild due to: (1) the relatively moderate temperatures associated with the gaseous diffusion processes, and (2) a reaction-inhibiting layer of reaction products that is formed on the metal surfaces. However, if the metal is heated above its solidus temperature (about 1100°F for aluminum) in the presence of UF_6, then the exothermic reaction is not inhibited and can become self-sustaining. Once the reaction becomes self-sustaining, it can continue as long as UF_6 and exposed metal are available for the reaction. Due to the localized nature of the event, there is no direct indication that a self-sustaining UF_6/hot metal reaction is occurring in the process. Therefore, a self-sustaining UF_6/hot metal reaction can cause a primary system failure that would result in a loss of primary system integrity.

An event involving a UF_6/hot metal reaction is applicable for the centrifugal compressors used in the tails withdrawal facilities (C-315). The product withdrawal facilities (C-310 and C-310-A) use Normetex pumps which are not subject to a UF_6/hot metal reaction due to various design considerations (e.g., oil cooling, etc). The tails withdrawal facilities (C-315) normally use low-speed centrifugal compressors to remove UF_6 from the cascade and then use Normetex pumps to move the UF_6 gas through the rest of the tails withdrawal process. However, the tails withdrawal facility also has the capability of using high-speed centrifugal compressors instead of the Normetex pumps.

The excessive heating required to start a UF_6/hot metal reaction can be generated in the centrifugal compressors due to various initiators such as frictional heating generated by misaligned pump parts rubbing together, foreign objects in the compressor's suction, etc. A loss of physical integrity associated with a UF_6/hot metal reaction in the low-speed centrifugal compressors would result in air inleakage into the tails withdrawal process since both the inlet and outlet sides of the low speed centrifugal compressors operate at sub-atmospheric pressures. However, should the high-speed centrifugal compressors suffer a similar type of failure, a UF_6 gas release could be expected since the high speed compressors operate with discharge pressures that are above atmospheric pressure.

The UF_6/hot metal reaction event is classified in the AE frequency range because a single active failure or operator error could cause the event. Past operating experience indicates that many compressor failures have occurred with

a few resulting in a UF_6/hot metal reaction. A compressor failure involving a UF_6/hot metal reaction was typically discovered only when the compressor was removed and opened up for repair. Therefore, failure of the primary system is rarely experienced for this event. However, for purposes of this analysis, a compressor failure with an associated UF_6/hot metal reaction that results in failure of the primary system is assumed to occur in the AE frequency category.

The applicable EGs associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program. The only safety action required to meet the other EGs at PGDP is an administrative control that ensures the C-315 withdrawal facility high-speed centrifugal compressors will not be used until further analysis has been performed to identify appropriate preventive and/or mitigative controls. This administrative control will protect on-site personnel, the off-site public, and maintain habitability of the control area by preventing a release of UF_6 that could result from a UF_6/metal reaction in the C-315 high-speed centrifugal compressors. The following scenario discussion is based on the existing analysis and it is included until it is superceded by further analysis.

The primary concerns associated with a UF_6/hot metal reaction event in the withdrawal facilities are (1) the primary system temperature increase associated with the reaction and (2) controlling the UF_6 release if the primary system should fail. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 4 is addressed by the NCS Program (see Section 5.2). The first safety action required to meet the other EGs would be to maintain primary system temperature within EG 3 limits. This action will prevent primary system failure, protect on-site personnel, and maintain habitability of the required control area by preventing a UF_6 release. If primary system temperature cannot be maintained within EG 3, a breach of the primary system integrity could conceivably occur. The safety actions of (1) visual/odor detection of primary leakage, (2) primary system pressure control (to reduce the primary system pressure and minimize the UF_6 release), (3) building holdup, and (4) emergency response by on-site personnel would be required to maintain the effects of a UF_6 release to within EG 1, 2, and 6. These actions protect on-site personnel and will maintain habitability of the required control area in accordance with EG 6 as well.

The expected primary system failure for a UF_6/hot metal reaction event in the tails withdrawal facilities would begin as a small hole in or near the centrifugal compressor. This hole would gradually enlarge as the event progressed. Due to the lack of direct indication that a UF_6/hot metal event is occurring, a failure of the primary system was assumed to occur for this analysis. It was determined that the consequences of the event could result in significant on-site impact if no mitigation were provided. The initiators, detection methods, EGs, safety actions, frequency, and mitigative actions associated this event in the withdrawal facilities are similar to those described for a UF_6/hot metal reaction event for compressors used in cascade operations (see Section 4.3.2.1.1). Due to these similarities, only the differences unique to the withdrawal process event will be discussed in the following analyses.

b. <u>Source-Term Analysis</u>

Source-term analysis is not applicable to this scenario since a credited administrative control ensures the C-315 withdrawal facility high-speed centrifugal compressors will not be used until further analysis has been performed to identify appropriate preventive and/or mitigative controls. The following source-term analysis is based on the existing analysis and it is included until it is superceded by further analysis.

The centrifugal compressors are subject to UF_6/hot metal reactions that could result in a primary system integrity failure. A primary system failure near the discharge of the high-speed centrifugal compressors could result in a significant UF_6 release since the discharge of these compressors are above atmospheric pressure. The compressor failure-UF_6/hot metal reaction event is similar for both the withdrawal and cascade facilities (see Section 4.3.2.1.1). However, due to differences in equipment configuration, the source-term associated with a UF_6/hot metal reaction in the withdrawal facilities is assumed to be similar to the source-term developed for a process line failure at the compression discharge scenario (see Section 4.3.2.2.12).

A process line failure (i.e., breach) at the compressor discharge in the withdrawal facilities is expected to result primarily in a vapor phase release of UF_6. Process design considerations (i.e., height differences between the accumulator and condenser) would tend to preclude any significant liquid-phase releases at a physical integrity failure near the compression discharge. However, the source-term analysis conservatively modeled the release assuming the compression source continues to pump vapor through

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the breach at 1.31 pounds per second at 30 psia while liquid UF_6 back flows through the breach at 6.73 pounds per second from other withdrawal process equipment. The gas-phase portion on the source-term assumes the release is equivalent to the normal output of the compression source. The liquid-phase backflow portion of the source-term was modeled as resulting from a one-inch diameter breach in the bottom of a vertical cylindrical tank 60 inches in diameter and 120 inches tall containing approximately 21,000 pounds of liquid UF_6. This tank is roughly modeled after a UF_6 accumulator process tank that is typically nearly empty with accumulations of UF_6 usually happening only during cylinder changes.

The liquid-phase back flow portion of the source-term represents a much larger release than would be expected from a primary system failure at the compression discharge. It is not actually plausible for liquid UF_6 to backflow from the accumulator to the compression discharge because (1) a UF_6 condenser is located between the compression discharge and the accumulator and (2) the condenser is at an elevation that is physically higher than the accumulator. The expected vapor back flow from the top of the accumulator through the condenser would be much less than modeled 6.73 pounds per second (probably on the order of one pound per second). Therefore, the combined 8.04 pounds per second release rate developed by the source-term analysis represents a release that is much larger than the actual UF_6 release expected to occur from a UF_6/hot metal reaction event that causes a process line failure at the compression discharge.

c. Consequence Analysis

Consequence analysis is not applicable to this scenario since a credited administrative control ensures the C-315 withdrawal facility high-speed centrifugal compressors will not be used until further analysis has been performed to identify appropriate preventive and/or mitigative controls. The following consequence analysis is based on the existing analysis and it is included until it is superceded by further analysis.

As discussed in the source-term analysis, it is unlikely that a UF_6/hot metal reaction would cause a line failure that would result in a 8.04 pounds per second release rate. However, the consequences associated with releasing UF_6 in the tails withdrawal facilities at a rate of 8.04 pounds per second have been evaluated. This consequence analysis determined that if no mitigation were provided, the hazardous material doses at the nearest site boundary (i.e., 1000 meters) for a 30-minute plume exposure associated with this release would be 8.56 mg of uranium and 5.3 ppm (one hour equivalent exposure) of hydrogen fluoride. The uranium exposure consequence would satisfy the EGs for the AE category. The consequences that this exposure level would have on different receptors are discussed below.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the withdrawal buildings is: (1) visual indication of a “white smoke” (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping that are common with the withdrawal facilities are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy.

Operational personnel in the ACR — The ACR in C-331 is the primary control location for the high speed compressors used in C-315. The C-331 ACR would not be affected by the release in the time frame required to take mitigative actions (i.e., trip compressors). However, these compressors can also be controlled from a local ACR in C-315 which typically would not be affected by the event. However, if operating personnel must be evacuated from the local ACR due to the release, then the required mitigative actions can be performed from C-331.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are: (1) detection of the release, (2) minimization of the release by tripping the high-speed centrifugal compressors, (3) temporary holdup of the release by the existing process building structure, and (4) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. Motor load indicators provide an indication of abnormal compressor operations that could lead to failure (i.e., surging and/or loss of load). Typically, this indication will be detected, and corrective action will be taken prior to the initiation of a UF_6/hot metal reaction, or prior to a UF_6/hot metal reaction progressing to the point of a primary system breach. However, if a primary system failure does occur and a release is confirmed (e.g., operator visual/odor indications and/or UF_6 smoke detectors), then actions can be taken to trip the appropriate high-speed compressor pump motors to minimize the release. Once the high-speed compressors stop operating, the release of material from the compressor is effectively terminated since the associated low-speed compressors operate at sub-atmospheric pressures. However, the release from the other process sources (i.e., accumulator and condenser) may continue until they are exhausted. Withdrawal process equipment housings outside of the cascade cells are not credited with providing a time delay between a release of UF_6 from the primary system to release from the building. The existing process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that escapes the building to be released at an elevated point. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — As indicated above, the postulated compressor failure-UF_6/hot metal reaction event will not result in consequences that would exceed the 10-mg EG for the AE frequency category with no mitigation other than building holdup. However, the smaller source-term expected and the release mitigation actions identified for on-site personnel provide additional assurance that off-site consequences of this event will stay below the 10-mg U EG.

d. Comparison With Guidelines

All of the applicable EGs for this scenario are met by an administrative control credited for preventing operation of the C-315 withdrawal facility high-speed centrifugal compressors. The following comparison with guidelines is based on the existing analysis and it is included until it is superceded by further analysis.

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the event scenario. The equipment configuration does not provide for automatic detection and trips on high temperatures, so compliance with EG 3 cannot be verified during normal operations. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operations personnel in the ACR were evaluated (i.e., tripping the high-speed centrifugal compressors), and they can be accomplished to meet the

requirement for EG 6. In the event that the release ultimately affects the habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded and the necessary actions could be accomplished from C-331. In addition, based on the controls identified (i.e., release detection high-speed centrifugal compressor trip, building holdup, evacuation of areas upon detection of the release), EGs 1 and 2 would be met for workers outside the process building. Finally, an analysis was performed which determined that, if no mitigation were provided, off-site exposure would not exceed guidelines.

e. Summary of SSCs and TSR Controls

The essential control for this event is summarized as follows:

- Administrative controls preclude operation of the C-315 withdrawal facility high-speed centrifugal compressors will not be used until further analysis has been performed to identify appropriate preventive and/or mitigative controls (EGs 1, 2, and 3).

Based on the above essential control, the resulting important to safety SSCs and TSRs are as follows:

- No SCCs were identified as important to safety as a result of this analysis.

- A TSR is provided that requires essential administrative controls to be flowed into procedures.

The following SCCs and TSR controls are based on the existing analysis and they are included until it is superseded by further analysis.

The essential controls for the UF_6/hot metal reaction event associated with meeting EG 3 are to minimize the potential for failing the primary system due to temperature increase. These controls include detection of the compressor failure and minimizing the source of heat/friction that could lead to the elevated temperatures that allow the UF_6/hot metal reaction. Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Motor load indicators for the C-315 high-speed compressors in ACR and C-331—early detection of compressor failure (i.e., surging and/or loss of load) (EG 3 only); and
- Compressor motor manual trip for the C-315 high-speed compressors in ACR and C-331—elimination of heat/friction (EG 3).

Essential mitigation of any UF_6 releases associated with this event (EGs 1, 2, and 6) are summarized as follows:

- Compressor motor manual trip for the C-315 high-speed compressors in ACR and C-331—minimize release to workers outside the process building (EGs 1, 2, and 6);
- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);

- UF_6 release detection associated with the high-speed withdrawal centrifugal pumps - workers outside the process building (EGs 1 and 2);
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The motor load indicators and the compressor motor manual trip system for the C-315 high-speed compressors, UF_6 release detection system - high speed centrifugal compressors (C-315 only), and the process buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the motor load indicators and compressor motor manual trip system for the C-315 high-speed compressors, UF_6 release detection system - high speed centrifugal compressors (C-315 only), and administrative requirements for procedures and training of workers for evacuation actions.

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4.3.2.2.2 Autoclave Steam Control Valve Fails Open (Pressure Increase)

a. Scenario Description

During normal autoclave operations in C-333-A, C-337-A, and C-360, the autoclave is filled with steam to heat the UF_6 in cylinders to a liquid state. Once the UF_6 has reached the liquid state, a prolonged significant increase in steam pressure in the autoclave could result in a corresponding temperature and pressure increase inside the cylinder, increasing the potential for a UF_6 release. Controls are provided to limit the normal operating temperatures within initial conditions. The allowable temperature varies for different categories of cylinders. The most limiting transient that will increase the primary system pressure is to allow excessive heat to be applied to the primary system; such heating could occur if the autoclave steam control valve were to fail in the open position. This event is an AE because a single active failure (i.e., the failure of a steam control valve in the open position) or operator error could allow a large amount of steam to enter the autoclave.

An evaluation of this event determined that the consequences could result in significant off-site and on-site impact if no mitigation were provided. The consequences are based on a liquid UF_6 release with the valve in the 6 o'clock position. This is conservative for the feed activities since they always have the valve at 12 o'clock. The toll transfer and sampling activities utilize the 6, 3 or 9 and 12 o'clock position during transfer, sampling, and heating operations.

The most severe transient associated with this event would occur after the cylinder heating cycle is completed and the UF_6 is liquefied within the cylinder. At this point in the operating cycle, the peak normal operating temperature has been achieved. The primary system pressure increase could result in the loss of expansion volume (i.e., "ullage") and could over pressurize the cylinder as a result of expansion of the liquid UF_6, possibly leading to a leak or rupture.

Various sizes of cylinders with different allowable fill values and ullage requirements can be heated in an autoclave. Each combination of allowable shipping weights and cylinder temperatures was evaluated to determine which combination would result in the most limiting pressure transient inside the primary system. The evaluation was based on maintaining a minimum of 5 percent ullage at the ANSI N14.1 allowed heating temperatures. The evaluation determined that a 14-ton, 48G thin-wall cylinders with an allowable in plant storage value of 28,000 lb (12,701 kg) of UF_6 would reach its 5 percent ullage limit at the lowest temperature [i.e., 235°F (112°C)]. This same cylinder was also used to evaluate maximum temperatures of other cylinders that have a 5 percent ullage at 250°F (121°C). This is conservative because of the thin wall of the cylinder and its heat transfer characteristics.

The initial conditions assumed to ensure this event is controlled within EG 3 were as follows:

- Initial temperature in the cylinder is 142.9°F (61.6°C) for category C cylinders, 230°F (110°C) for category B cylinders and 240°F (116°C) for category A cylinders;
- Cylinder does not exceed the allowable weight limits for category A and B cylinders; and
- Cylinder does not contain excessive noncondensables.

The initial conditions are ensured respectively by the following controls:

- Autoclave Steam Pressure Control system with a set point of less than or equal to the initial temperature limit (heating, feeding, heeling mode);
- Autoclave temperature control system with set point less than or equal to the initial temperature limit (Controlled feeding mode only);
- Administrative controls to verify category A and B cylinder weight is within allowable values (heating, feeding, heeling mode); and
- Administrative controls to verify cylinder pressure is less than or equal to 10 psia (69 kPa) prior to heating.

The most limiting transient will occur when the UF_6 within the cylinder is completely liquefied when the steam control valve fails open. The transient will result in a pressure increase inside the autoclave until the steam supply valve is closed. The autoclave steam pressure control system will detect this event and close the steam block valves. However, in the event that this system fails to isolate the steam supply, the autoclave high-pressure isolation system will detect the increase in autoclave pressure, and initiate closure of the steam supply isolation valves, stopping the transient. Once the steam isolation valves are closed, the temperature within the cylinder will continue to rise until an equilibrium temperature between that of the cylinder and that of the autoclave is reached. The final temperature within the cylinder will remain significantly less than 250°F (121°C) for category A cylinders and less than 245°F (118°C) for category B cylinders, preventing a failure of the cylinder pressure boundary. Based on the analysis, the autoclave high-pressure isolation system will provide sufficient protection for all cylinders during the normal heating modes if the initial autoclave temperature is limited to less than the assumed initial temperature conditions.

The evaluation of this event for category C cylinders is slightly different from the evaluation for category A and B cylinders. Unlike A and B cylinders, the initial conditions for a category C cylinders is controlled so that the UF_6 is maintained below the triple point temperature and pressure thus providing assurance that the UF_6 is not liquefied. This is accomplished by monitoring the actual cylinder wall temperature and controlling the steam admitted to the autoclave with this temperature signal. The autoclave temperature control system maintains the initial conditions with a setpoint less than or equal to the initial temperature limit. In the event that the system fails to control the temperature due to a control valve or other failure, the autoclave high pressure isolation system will detect the increase in autoclave pressure, and initiate closure of the steam supply block valves and thermovent line block valve, stopping the transient. Once the steam block valves are closed, the cylinder temperature will continue to rise until equilibrium temperature between that of the cylinder and autoclave is reached. The analysis of category C cylinders determined that the UF_6 will not reach the triple point temperature (147.3°F [64.1°C]) thus the UF_6 will remain in the solid/gaseous state with no liquefaction. Based on the analysis, the autoclave temperature control system will provide sufficient protection for all cylinders during the controlled feeding mode if the cylinder temperature is limited to less than the assumed initial temperature conditions. This scenario is not applicable for the cold feeding mode since there is no steam applied to the autoclave.

In addition to these active systems and administrative controls, the passive features of the UF_6 cylinders, pigtails, UF_6 primary system piping outside the autoclave, and autoclave shell and associated isolation valves would also be required. These components must be designed to withstand the transient conditions described without failure. This event is considered a limiting event for the pressure increase parameter and the AE frequency category.

The primary concern associated with this event is the primary system pressure increase associated with the increase in steam pressure inside the autoclave. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs for the AE frequency range and any initial conditions assumed (i.e., normal operation, EG 5). EG 4 is addressed by the NCS Program (Section 5.2). The only safety action required to meet these EGs would be to maintain primary system pressure control within the EG 3 limits. This action will prevent primary system failure and thus protect on-site personnel and the off-site public and maintain the habitability of the required control area by preventing a release of UF_6.

b. <u>Source-Term Analysis</u>

This is not applicable because adequate protection is available to prevent primary system failure.

c. <u>Consequence Analysis</u>

This is not applicable because adequate protection is available to prevent primary system failure.

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d. Comparison With Guidelines

All of the applicable EGs are met by controlling the primary system pressure within acceptable limits as required by EG 3. Both on-site workers and the off-site public are protected in this event because the primary system pressure is prevented from exceeding acceptable limits, and the release of UF_6 is thereby prevented.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to verify cylinder weight is within allowable values—maintain initial condition (normal operation-heating, feeding, heeling mode only, EG 5 only);
- Administrative controls to verify cylinder pressure is less than or equal to 10 psia (69 kPa) prior to heating—maintain initial condition (normal operation, EG 5 only);
- Autoclave steam pressure control system—maintain initial condition (normal operation-heating, feeding, heeling mode only, EG 5 only);
- Autoclave temperature control system – maintain initial condition (normal operation – controlled feed mode only, EG 5 only).
- Autoclave high pressure isolation system—detection of high autoclave pressure and isolation of steam lines (EG 3 only);
- Autoclave primary containment system—maintain primary system integrity (EGs 1 and 2); and
- UF_6 cylinders, pigtails, and primary system inside and outside the autoclave maintain primary system integrity (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The autoclave steam pressure control system, autoclave temperature control system, autoclave primary containment system, autoclave high pressure isolation system, UF_6 cylinders, pigtails, and primary system piping outside the autoclave are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the autoclave steam pressure control system, autoclave high pressure isolation system, UF_6 cylinders, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.3 Releases of Solid/Gaseous UF_6 to Atmosphere (Primary System Integrity)

a. Scenario Description

During routine cylinder lifting or moving operations within the various facilities as well as during on-site transportation, various initiators are present that could result in a loss of physical integrity involving a cylinder containing solidified UF_6. Loss of physical integrity involving cylinders filled with liquefied UF_6 outside of autoclaves is addressed in Section 4.3.2.2.15. Various design and administrative controls are identified to minimize the potential for loss of cylinder integrity in the hazards analysis results for the UF_6 handling and storage facilities (see Section 4.2.6.5). However, with the administrative controls in place, a single operator error or equipment failure could result in a cylinder valve failure and

loss of cylinder integrity. Past operational history indicates that physical integrity failure events involving cylinders containing solidified UF_6 have occurred. Therefore, the solid/gaseous release of UF_6 to atmosphere event is categorized in the AE frequency range since a single operator error could result in a loss of cylinder integrity.

The most severe transient in the UF_6 handling and storage facilities associated with a solid/gaseous UF_6 release event would occur after a cylinder has been placed in a temporary storage area for its required cooldown period and has cooled to its triple point temperature (147.3°F). At this point in the cooldown cycle, the amount of gaseous UF_6 within the ullage area is at its maximum for non-liquid conditions.

The primary concern associated with this event is the release of solid/gaseous UF_6 to the atmosphere. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs for the AE frequency range. EG 3 is not addressed in this scenario because the primary system is assumed to fail. EG 4 is addressed by the NCS Program (see Section 5.2). The safety action of emergency response (i.e., the plant see and flee policy which requires personnel to evacuate the area for their own protection) for local personnel is required to satisfy EGs 1, 2, and 6. Due to the limited size of the releases for this event, no additional action is required to satisfy EGs 1, 2, and 6. This action protects on-site personnel and will maintain the habitability of any of the required control areas in accordance with EG 6 as well. The release of solid/gaseous UF_6 to atmosphere event is the limiting primary system failure event for operations involving solidified UF_6.

b. <u>Source-Term Analysis</u>

A source-term analysis was performed which simulated a valve failure (i.e., removed, broken, etc.) in the 12 o'clock position for a 48G cylinder containing 28,000 pounds of fully solidified UF_6 at the triple point temperature of 147.3°F. Under these conditions, a full cylinder will contain approximately 63 pounds of UF_6 vapor. The vapor pressure of UF_6 above 134°F is greater than one atmosphere. Upon the postulated valve failure, approximately one-third of this vapor (assuming ideal gas law relationships) will be quickly released before pressures equalize and significantly decrease the release rate. Once the initial vapor content of the cylinder escapes, little additional UF_6 vapor is expected to be released even though the cylinder contains enough heat to vaporize another 700 pounds of UF_6. The vaporization rate of the remaining material will be low because of the low thermal conductivity of solid UF_6 (0.35 BTU/hr-ft-°F at 147°F), and the high thermal conductivity of the metal cylinder. The majority of the available heat will be lost through the cylinder wall to the atmosphere.

Once a UF_6 cylinder has cooled below 134°F, the vapor pressure of the material is less than one atmosphere. A broken cylinder or valve under these conditions would allow outside air to flow into the cylinder. The moisture in the air would react with the UF_6 in the cylinder. In time, the reaction products would generate a positive pressure enabling some reaction products to flow out of the cylinder.

A source-term analysis was performed to characterize the release that would occur from a 48-inch cylinder initially containing UF_6 at the ambient conditions. This analysis assumed a valve failure on a 48-inch cylinder containing a typical heel weight of UF_6 (nominal 50 pounds) at the ambient conditions of 90°F and 60 percent relative humidity. Since water vapor is the limiting reactant inside the cylinder,

a nearly empty cylinder was considered the bounding configuration for this analysis since it would maximize the volume available for wet-air to enter the cylinder. The analysis also conservatively assumed that a UF_6/moisture reaction does not begin until enough air has entered the cylinder to pressurize it to atmospheric pressure. Under these conditions, the source-term analysis determined that the release would include 2.5 pounds of UF_6, 0.1 pounds of UO_2F_2, and 0.03 pounds of HF.

c. Consequence Analysis

Although no specific dispersion analysis was performed for this event involving the release of UF_6 vapor from a solidified cylinder, the consequences of the event would be below the EGs for an AE at the site boundary due to the relatively small size of the release. The consequence analysis is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the ACR — There are no required operator actions for this event other than immediate evacuation as described for the local worker. The actions required for a general facility evacuation scenario are addressed separately (see Section 4.3.2.2.4).

Workers outside the process buildings — The essential controls for protecting on-site personnel beyond the immediate vicinity of the release are the same as the local worker.

Off-site public — As indicated above, this scenario would not result in any consequences that would exceed the 10-mg U EG for this event frequency with no mitigation.

d. Comparison With Guidelines

The EGs for the AE frequency category from Table 4.2-2 were compared to the consequences associated with the solid/gaseous UF_6 release event scenario. Specific exposures were not calculated for on-site workers in the immediate area or workers outside the process building because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. Based on these actions, on-site workers would be able to evacuate the area of concern and maintain exposures within EGs 1 and 2 to the extent practical. The operational personnel in the control area were evaluated and no actions are required other than immediate evacuation; thus, EG 6 is satisfied. Finally, with no mitigation provided, off-site exposure would not exceed guidelines.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential control for the solid/gaseous release of UF_6 to the atmosphere event is summarized as follows:

- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1, 2 and 6).

Based on the above essential control, TSRs are provided for administrative requirements for procedures and training of workers for evacuation actions in the event of a release.

4.3.2.2.4 Evacuation of the UF_6 Handling and Storage Facilities (External Event)

a. Scenario Description

The evacuation of the UF_6 handling and storage process buildings event is a special event to be evaluated for all operational areas with significant hazardous operations to ensure that evacuation does not result in consequences from process operations. The analysis for this scenario addressed each facility process and associated operating modes to determine the essential controls necessary to prevent failure of the primary system. The initial conditions associated with this event are assumed to be the normal operations carried out within the given facility. The event scenario addresses any essential actions required by the operational staff prior to evacuation of the facility for all conditions except when a release of hazardous material within the specified facility (e.g., feed, withdrawal, etc.) is the initiating event. For a discussion of releases of hazardous material within the cascade process buildings and associated operator actions, refer to the appropriate sections of this chapter for required actions. The evacuation event is an AE because various types of events associated with plant operations could result in a required evacuation of a facility. Some of these events include spurious operation of the criticality accident alarm system, potential releases of hazardous material from another facility, or a fire within the facility.

The primary concern associated with this event is to prevent release of hazardous material (e.g., UF_6) as a result of an evacuation of the facility. The primary objective of this analysis is to ensure the UF_6 handling and storage processes are equipped with sufficient controls to prevent or mitigate a failure of the UF_6 primary system in an evacuation event. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs for the AE frequency range. EG 4 is addressed by the NCS program (see Section 5.2). EG 6 is addressed by this scenario to identify operator actions that are required prior to evacuating the facility. The only safety action required to meet these EGs is to maintain primary system pressure control within EG 3. This action will prevent primary system failure as well as protect both on-site personnel and the off-site public. If EG 3 is not met and a release occurs within the evacuated facility, then controls that operate automatically or that can be operated externally to the evacuated facility are required to ensure EGs 1 and 2 will be met. The evacuation event is considered a limiting event because of the special nature of the analysis.

b. Source-Term Analysis

The scenario description specified that the initial conditions for the facility evacuation scenario are assumed to be the normal operations carried out within the facilities. Since a specific failure condition that could result in a failure of the UF_6 primary system was not defined in the scenario description, a specific source-term analysis was not performed for the facility evacuation event. However, the source-term for anticipated events that could result in a UF_6 release within the evacuated facility would be either equivalent to or bounded by other anticipated events (i.e., Sections 4.3.2.2.1 through 4.3.2.2.5, and Section 4.3.2.2.17). Refer to these sections for further discussions of the source-term associated with the specific initiating event.

c. Consequence Analysis

As indicated in the source-term analysis, the consequences of anticipated events that could result in a UF_6 release within the evacuated facility would be either equivalent to or bounded by other anticipated events (i.e., Sections 4.3.2.2.1 through 4.3.2.2.5, and Section 4.3.2.2.17). Refer to those sections for further discussions of the consequences associated with the specific initiating event.

d. Comparison With Guidelines

Each process and associated controls are summarized below to describe how primary system pressure and temperature are controlled within EG 3 as applicable. No operator actions were identified to meet EG 6 other than those actions required by other scenarios involving a UF_6 release within the facility.

Feed, Toll Transfer and Sampling Facilities — During the cylinder handling modes (Mode 1 for feed and Mode 1a and 1b for toll transfer and sampling) of operation, the only identified concern is the movement of cylinders within the facility. If evacuation of the facility is required during the movement of cylinders, the design of the transport devices must ensure that no damage is incurred when an operator evacuates the area. Therefore, the following two controls were identified to accomplish this action:

- The UF_6 cylinder handling cranes shall be designed so that when controls are released the cranes automatically stop except for small compensatory movements associated with activation of the mechanical braking mechanisms (e.g., evacuation of the building).
- Rail stops are provided to prevent cylinder transport cart movement beyond stops at the levelator and on the east end of the loading docks in the toll transfer and sampling facility.

During all other facility operations, the only concern that could result in a loss of primary system integrity is that excessive temperatures during heating operations in the autoclave could result in a primary system pressure increase and potentially a subsequent release of UF_6. Control is provided by the autoclave steam pressure control system or autoclave temperature control system. In addition to these active systems, the passive features of the UF_6 cylinders, pigtails, primary system piping outside the autoclave, and the autoclave shell and associated isolation valves would also be required.

The feed facilities are equipped with automatic detection and alarm in the facility OMR and associated “000” ACR for lines outside the autoclave (UF_6 release detection system). In addition, all autoclaves can be isolated remotely from the applicable ACR with the autoclave manual isolation system.

These systems provide protection for line failures outside the autoclave. In addition, cylinders feeding to the cascade will continue to feed until empty, removing the need for any operator action. Therefore, continued operation of the feed process would be acceptable.

The toll transfer and sampling facility is equipped with automatic detection and isolation systems for lines outside the autoclave (UF_6 release detection system zones 1 and 4). These systems provide protection for line failures outside the autoclave. Another potential concern is the inadvertent movement of a cylinder during the modes of operation in which the cylinder is connected to a transfer position. The cylinder transport carts are designed and administratively controlled so that the cylinder cannot be moved while the pigtail is connected to the cylinder. Therefore, continued operation of the toll transfer process would be acceptable.

Withdrawal Facilities — Evacuation of the withdrawal facilities was evaluated and it was determined to be a special event that was categorized in the AE frequency range because of the various types of events associated with plant operations that could result in a required evacuation of the withdrawal facilities. During the Cylinder Preparation or Removal mode of operation, the only identified concern is the movement of cylinders within the facility. If evacuation of the facility is required during the movement of cylinders, then the design of the transport devices must ensure that no damage is incurred when an operator evacuates the area. Therefore, the following preventative controls were identified to accomplish this action and to ensure that EGs 1 and 2 are met for this event:

- The UF_6 cylinder handling cranes shall be designed so that when controls are released the cranes automatically stop except for small compensatory movements associated with activation of the mechanical braking mechanisms, and

- Rail stops are provided to prevent cylinder transport cart movement beyond stops at the head of the cylinder scales to maintain the primary system integrity of the liquid process piping located at the head of the cylinder scales.

In withdrawal mode operations involving the compression loop operation, the additional concerns with the evacuation scenario are events that could result in a failure of the UF_6 primary system. Process building cranes used in the withdrawal building are designed to prevent dropping the load should the controls be released for any reason. This will assist in meeting EGs 1 and 2 during an evacuation event by minimizing the potential for a process building cranes dropping a load that could cause a breach in the UF_6 primary system that would result in a UF_6 release. A failure of the high-speed centrifugal compressors in C-315 could cause a temperature excursion that produces a UF_6/hot metal reaction that results in a UF_6 release (see Section 4.3.2.2.1). However, administrative controls are in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls. The Normetex pump can generate pressures sufficient to cause a failure of the UF_6 primary system (see Section 4.3.2.2.17). Therefore, the UF_6 release detection system - Normetex pump is required as a mitigative control to automatically shutdown the Normetex pump in the event of a UF_6 release to ensure EGs 1 and 2 are met. The withdrawal stations are equipped with automatic detection and isolation systems (the UF_6 release detection and isolation system - low voltage (“new”) system at the

withdrawal stations). This system is used as a mitigative control to ensure EGs 1 and 2 are met for potential events involving a physical integrity failure of the pigtails during the evacuation event.

This analysis indicates that the UF_6 withdrawal process facilities are equipped with sufficient preventative or mitigative controls to provide adequate protection for potential UF_6 primary failures that could occur in the withdrawal facilities after an evacuation event. Therefore, continued operation of the withdrawal process in the event of a facility evacuation is acceptable.

e. <u>Summary of SSCs and TSR Controls</u>

The essential controls for the evacuation of the UF_6 handling and storage facilities event are summarized as follows:

Feed, Toll Transfer and Sampling, and Withdrawal Facilities

- Operator training for required actions—maintain primary system integrity (EG 6);
- UF_6 cylinders, pigtails, and primary system piping—maintain primary system integrity (EGs 1 and 2);
- The UF_6 cylinder handling cranes shall be designed so that when controls are released the cranes automatically stop except for small compensatory movements associated with activation of the mechanical braking mechanisms (EGs 1 and 2);
- UF_6 cylinder handling cranes—maintain primary system integrity (EGs 1 and 2); and
- Liquid UF_6 cylinder handling equipment (scale carts, C-360 levelator and elevator)—maintain primary system integrity (EGs 1 and 2);

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Feed, Toll Transfer, and Sampling Facilities

- Autoclave manual isolation systems (feed facilities only)—maintain primary system integrity (EGs 1 and 2);
- UF_6 release detection systems - minimize potential exposure to receptors outside of the process building (EGs 1 and 2);
- Autoclave primary containment system—maintain primary system integrity (EGs 1 and 2);
- UF_6 release detection system zones 1 and 4 (toll transfer and sampling facility only)—minimize potential exposure to receptors outside of the process building (EGs 1 and 2);
- Autoclave steam pressure control system—maintain primary system temperature/pressure below allowable values (EG 5);
- Autoclave temperature control system (feed facilities only) – maintain primary system temperature/pressure below allowable values (EG 5);
- High cylinder pressure system—maintain primary system temperature/pressure below allowable values (EGs 1 and 2);
- Rail stops to prevent scale cart movement beyond stops at the levelator and on the east end of the loading docks in the toll transfer and sampling facility—maintain primary system integrity (EGs 1 and 2);

Withdrawal Facilities

- UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations minimize potential exposure to receptors outside of the process building (EGs 1 and 2);
- UF_6 release detection system - Normetex pump - minimize potential exposure to receptors outside of the process building (EGs 1 and 2);
- Administrative Control - process building cranes shall not be used to transport heavy equipment above/around process equipment that is operating above atmospheric pressure - (EGs 1 and 2);
- The C-315 withdrawal facility high-speed centrifugal compressors will not be used until further analysis has been performed to identify appropriate preventive and/or mitigative controls (EGs 1, 2, and 3);
- Rail stops to prevent scale cart movement beyond stops at the head of the cylinder scales in the withdrawal stations—maintain primary system integrity of the liquid piping at the head of the cylinder scales (EGs 1 and 2).

Based upon the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- UF_6 cylinders, pigtails, primary system piping, UF_6 cylinder handling cranes, liquid UF_6 cylinder handling equipment (scale carts, rail stops, C-360 elevator and levelator), autoclave primary containment system, autoclave manual isolation systems, UF_6 release detection system (feed facilities), UF_6 release detection system zones 1 and 4 (toll transfer and sampling facility only), autoclave steam pressure control system, autoclave temperature control system, high cylinder pressure system, UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal

stations, and UF_6 release detection system - Normetex pump, are identified as important to safety SSCs. See Section 3.15 for details including safety classification.

- TSRs are provided for the UF_6 cylinders, UF_6 cylinder handling cranes, scale carts, C-360 elevator and levelator; autoclave primary containment system, autoclave manual isolation systems, UF_6 release detection system (feed facilities), UF_6 release detection system zones 1 and 4 (toll transfer and sampling facility only), autoclave steam pressure control system, autoclave temperature control system, high cylinder pressure system, UF_6 Release detection and isolation system - low voltage ("new") system at the withdrawal stations, UF_6 release detection system - Normetex pump,

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and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.5 Limited UF_6 Release to Atmosphere (Primary System Integrity)

a. Scenario Description

During the withdrawal operating modes, small passive failures in the primary system may result in limited releases of UF_6 into the process buildings. Initiators such as vibration, fatigue, or corrosion could cause failures in instrument lines, expansion joints, or weld joints that result in small UF_6 releases. These types of failures are expected frequently enough to place them in the AE category. The limited UF_6 release to atmosphere event in the withdrawal facilities was evaluated in the PrHA and it was determined that the consequences could result in significant on-site impact in any operating mode if no mitigation were provided. Significant off-site consequences are not expected for this event due to the small size of the anticipated UF_6 release rates associated with the postulated event initiators.

The primary concern associated with this event is controlling the UF_6 release. The applicable EGs (see Table 4.2-2) associated with this event are all the EGs for the AE frequency range. EG 3 is not addressed in this scenario because the primary system is assumed to fail, and EG 4 is addressed by the NCS Program (see Section 5.2). The safety actions of (1) primary system leakage detection, (2) building holdup, and (3) emergency response by local personnel would be required to maintain the effects of the UF_6 release within EGs 1, 2, and 6 for the protection of on-site personnel. Because of the limited size of the releases for this event, no additional action is required to keep the effects of the UF_6 release within EGs 1 and 2 for off-site receptors.

The limited UF_6 release to atmosphere event is a limiting primary system integrity failure event for the AE category since consequences of the release are not postulated to exceed off-site exposure guidelines. Accident scenarios involving larger failures of the withdrawal system's physical integrity are addressed in the plugged/blocked process line failure (see Section 4.3.2.2.17), pigtail/line failure at withdrawal station scenario (see Section 4.3.2.2.11) and the process line failure at compression discharge scenario (see Section 4.3.2.2.12).

b. Source-Term Analysis

The limited UF_6 release to atmosphere event in the withdrawal facilities is categorized as an AE due to the various passive (i.e., fatigue-type) equipment failures and operator errors that could initiate this accident scenario. The UF_6 releases associated with this accident scenario are defined to originate from relatively small failures (i.e., hair-line cracks) in equipment operating above atmospheric pressure. These small physical integrity failures are expected to result in very small UF_6 release rates. However, as indicated in the scenario description, larger primary system failures can result in significantly larger release rates. There are many variables that must be characterized in order to develop a source-term for this accident scenario. These variables include the following:

- The duration of the release;
- The size of the failure;

- The location of the failure in the withdrawal process (i.e., gaseous or liquid piping); and
- The process pressures, temperatures, UF_6 concentrations, and the amount of UF_6 available to leak out of the system at the break.

The limited UF_6 release to atmosphere event in this accident scenario is associated with minor equipment failures caused by various initiators (i.e., vibration, fatigue, or corrosion). The releases rates associated with these failures are expected to be very small. However, to bound the UF_6 release that could result from these type failures, a source-term analysis was performed to identify the maximum unmitigated UF_6 release that could occur within the withdrawal facilities without exceeding AE off-site exposure guidelines. As a worst-case assumption, the source-term analysis postulated that a small hole formed in the discharge piping of the C-315 accumulator prior to the first isolation valve. The product withdrawal facility in C-310 utilizes smaller accumulators; thus the release rate associated with the defined failure in C-315 bounds the releases from a similar failure that would occur in C-310. Using an iterative analytical process, the analysis determined that an unmitigated liquid-phase UF_6 release of up to 1.00 lbs/sec could occur from this location within the C-315 withdrawal facility without exceeding the AE off-site exposure guidelines. The analysis also determined that it would require a 0.43-inch diameter hole in the discharge line of a full C-315 accumulator to result in a 1.00 lbs/sec release rate. A breach of this size in the UF_6 primary system is considered sufficiently large to bound any breach that would result from initiators such as vibration, fatigue or corrosion.

c. <u>Consequence Analysis</u>

The C-315 withdrawal facility was chosen to bound both the C-310 and C-315 withdrawal facilities since C-315 is considerably smaller than C-310, thereby providing less intra-building holdup and deposition for the postulated releases. Furthermore, the C-315 facility is closer to the nearest site boundary than C-310, which results in higher consequences given the same release and meteorological conditions. The consequence analysis determined that F_2 meteorological conditions produced the highest consequences for receptors at or beyond the site boundary. Based on the 1.00 lbs/sec source-term and assuming F_2 meteorological conditions, the peak toxicological exposure at the nearest site boundary is predicted to be 9.63 mg U intake. The radiological exposure at the nearest site boundary associated with this release is predicted to be 0.1 rem. The HF exposure at the nearest site boundary associated with this release is predicted to be 4.86 ppm. These exposure levels satisfy the off-site EGs for the AE category. The consequences that this exposure would have on different receptors are discussed in the following.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the withdrawal buildings is: (1) visual indication of a “white smoke” (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. All the cascade UF_6 processing equipment and major piping that are common with the withdrawal facilities are enclosed in housings to maintain normal operating temperatures. The configuration of the housings required to maintain normal operating temperatures, and therefore to keep UF_6 in the gaseous state, provides an inherent barrier against UF_6 releases within the housing. Although the housings provide the local worker

with additional time to detect the release and evacuate the area, the housings are not considered an essential control for this receptor rather they provide further assurance that workers will be able to evacuate the area in accordance with the plant see and flee policy. Personnel protective equipment (PPE) or other protective measures (e.g., emergency egress capability) must be available for personnel operating cab-controlled process building cranes.

Operational personnel in the ACR — Workers in the ACR typically would not be affected by limited UF_6 release to atmosphere event. Since the exact release mechanism is not defined for the limited UF_6 release to atmosphere event, no essential actions are required of operational personnel in the ACR. However, the essential control to protect these workers is evacuation, if required, upon detection of the release by sight or odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings are (1) temporary holdup of the release by the existing process building structure, and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. Process building holdup is provided by the existing process building structure. The process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released, and by causing most of the UF_6 that

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escapes the building to be released at an elevated point. Withdrawal process equipment housings outside of the cascade cells are not credited with providing a time delay between a release of UF_6 from the primary system to release from the building. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor. Although not credited as an essential control, programmatic actions (i.e., Emergency Response) will be taken to terminate an identified UF_6 release for the protection of on-site workers.

Off-site public — The limited UF_6 release to atmosphere event is not postulated to exceed AE off-site exposure guidelines.

d. <u>Comparison With Guidelines</u>

The EGs for the AE frequency category from Table 4.2-2 were compared with the consequences associated with the event scenario. The controls identified (i.e., see and flee and PPE or other protective measures for crane operators) will maintain on-site exposures to within EGs 1 and 2 to the extent practical. EG 4 is addressed by the NCS Program (see Section 5.2). There are no essential actions required of operational personnel in the ACR to meet EG 6. In the event that the release ultimately affects habitability of the ACR, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., building holdup and evacuation of areas upon detection of a release) and the minimal source-term associated with this event, EGs 1 and 2 would be met for workers outside the process building.

e. <u>Summary of SSCs and TSR Controls</u>

Based on the results of this analysis, the essential mitigative controls for the limited UF_6 release to atmosphere event associated with meeting EGs 1, 2, and 6 are a are summarized as follows:

- Visual/odor detection of release, worker training, and evacuation of affected area—all on-site workers (EGs 1 and 2);
- Design and structural capacity of the process piping and equipment to maintain integrity of the UF_6 primary system—maintain initial condition of analysis (EG 5);
- Administrative control—personnel protective equipment (PPE) or other protective measures is provided to personnel operating cab-controlled process building cranes (EGs 1 and 2); and
- Process building holdup—workers outside process building (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The process piping and buildings are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for administrative requirements for procedures and training of workers for evacuation actions, and for protective equipment/measures for crane operators.

4.3.2.2.6 Heating of a Cylinder with Excessive UF_6 (Pressure Increase)

a. <u>Scenario Description</u>

During autoclave heating modes that involve UF_6 liquefaction, controls are provided to limit the normal operating temperatures and pressures to allowable values for preventing primary system failures that would result in a loss of physical integrity. One method of increasing the primary system pressure beyond acceptable limits is to heat a cylinder with excessive UF_6. This event could only occur as a result of multiple operator errors; therefore, this event is categorized as an EBE.

This event was evaluated, and it was determined that the consequences could result in significant off-site and on-site impact if no mitigation were provided.

The primary concern associated with this event is the primary system pressure increase associated with lack of expansion volume in the cylinder during normal heating. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs for the EBE frequency range. Only a significant failure of the primary system could cause the applicable EGs to be exceeded for this event. Significant failures of the primary system during autoclave operations are addressed separately in Sections 4.3.2.2.10, 13, 14, and 15. The required controls for mitigation of any primary system failures would be similar for the same failure location (i.e., inside or outside the autoclave). Therefore, only the measures in place to prevent this event from occurring and prevent a primary system failure once the event occurs are addressed in this scenario. The only safety action required to meet these EGs is primary system pressure control. This action will prevent primary system failure as well as protect on-site personnel.

ANSI N14.1 places weight limits on the amount of UF_6 that can be in UF_6 cylinders when they are shipped. This standard is used at the GDPs and at the commercial vendors supplying UF_6 to the GDPs. When these weight limits are met, the normal heating cycles of the autoclaves may be used to liquefy the UF_6 as needed for operation. In addition, the following administrative control is in place for all autoclave operations:

- UF_6 cylinders to be heated in an autoclave have their weight verified prior to heating. (Cylinders that exceed the allowable shipping weight values are heated under controls specified in the TSRs that ensure adequate ullage.)

In addition to this administrative control, the high cylinder pressure system is available during the autoclave heating (C-360)/heating/feeding/heeling (C-333-A and C-337-A) mode of operation to detect high cylinder pressures and isolate the steam supply to stop the event prior to primary system failure. Excessive UF_6 pressure for any postulated cause would be detected during initial cylinder heatup to liquefaction. Therefore, the high cylinder pressure system is not required to be operable when a cylinder is connected to the transfer manifold at C-360. This action will minimize the potential for on-site personnel to be exposed to releases of material. In addition to this active system, the passive features of the UF_6 cylinders, pigtails, UF_6 primary system piping outside the autoclave, and the autoclave shell and associated isolation valves would also be required.

b. Source-Term Analysis

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

c. Consequence Analysis

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

d. Comparison With Guidelines

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to verify cylinder weight is within allowable values—maintain initial condition (normal operation, EG 5 only);
- UF_6 cylinders, pigtails, and primary system inside and outside the autoclave—maintain primary system integrity (EGs 1 and 2);
- Autoclave primary containment system—maintain primary system integrity (EGs 1 and 2); and
- High cylinder pressure system—minimize potential for primary system integrity failure (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The high cylinder pressure system, UF_6 cylinders, pigtails, primary system piping outside the autoclave, and the autoclave primary containment system are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the high cylinder pressure system, UF_6 cylinders, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.7 Heating of a Cylinder with Excessive Noncondensables (Pressure Increase)

a. Scenario Description

During autoclave heating modes, controls are provided to limit the normal operating temperatures and pressures to allowable values for preventing primary system failures that would result in a loss of physical integrity. One method of increasing the primary system pressure beyond acceptable limits is to

heat a cylinder with excessive noncondensables. This event could only occur as a result of multiple operator errors; therefore, this event is categorized as an EBE.

This event was evaluated, and it was determined that the consequences could result in significant off-site and on-site impact if no mitigation were provided.

This event is similar to the event described in Section 4.3.2.2.6. The only difference is that the event involves excessive noncondensables rather than excessive UF_6. Therefore, the only item addressed in this scenario is the difference in the controls to prevent heating a cylinder with excessive noncondensables.

The following administrative controls are in place for autoclave operations:

- A cold pressure check, indicating less than or equal to 10 psia (69 kPa), is performed for cylinders containing solidified UF_6 prior to initial heating. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 10 psia (69 kPa), shall not be heated. This cold pressure check is not applicable for cylinders that contain liquid UF_6 that has been processed through the transfer or sampling operations and will be immediately reheated in an autoclave.]
- In the toll transfer and sampling facility, a cold pressure check, indicating less than or equal to 5 psia (34.5 kPa), is performed for daughter (receiving) cylinders that are intended to be immediately reheated in an autoclave. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 5 psia (34.5 kPa), shall not be filled.]

The sampling and transfer facility is equipped with traps to control technetium contamination. A cylinder containing liquid UF_6 that has been processed through the transfer or sampling operations (e.g., through the technetium traps) can be immediately loaded into an autoclave for additional transfer or sampling operations. Such a cylinder does not have the potential for overpressurization due to compression of noncondensable or volatile contaminants. The cold pressure checks performed on the parent and daughter cylinders meet the intent of a cold pressure check for a cylinder that contains liquid UF_6 that was processed through the transfer and sampling process and will be immediately reheated in an autoclave. During transfer operations, noncondensable or volatile contaminants will tend to remain in the vapor space of the parent cylinder. Any remaining contaminants will remain in solution as long as the UF_6 remains liquid.

b. <u>Source-Term Analysis</u>

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

c. <u>Consequence Analysis</u>

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

d. Comparison With Guidelines

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative control to verify cylinder pressure prior to heating—maintain initial condition (normal operation, EG 5 only);
  1. A cold pressure check, indicating less than or equal to 10 psia (69 kPa), is performed for cylinders containing solidified UF_6 prior to initial heating. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 10 psia (69 kPa), shall not be heated. This cold pressure check is not applicable for cylinders that contain liquid UF_6 that has been processed through the transfer or sampling operations and will be immediately reheated in an autoclave.]
  2. In the toll transfer and sampling facility, a cold pressure check, indicating less than or equal to 5 psia (34.5 kPa), is performed for daughter (receiving) cylinders that are intended to be immediately reheated in an autoclave. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 5 psia (34.5 kPa), shall not be filled.]
- UF_6 cylinders, pigtails, and primary system inside and outside the autoclave—maintain primary system integrity (EGs 1 and 2);
- Autoclave primary containment system—maintain primary system integrity (EGs 1 and 2); and

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- High cylinder pressure system—minimize potential for primary system integrity failure (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The high cylinder pressure system, UF_6 cylinders, pigtails, primary system piping outside the autoclave, and the autoclave primary containment system are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the high cylinder pressure system, UF_6 cylinders, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.8 Heavy Equipment Drop (Primary System Integrity)

The heavy equipment drop event is limited to the cell floor of the process building in the area of the withdrawal system equipment. Drops of heavy equipment in the cylinder handling and autoclave areas are discussed in other accident analysis scenarios. These scenarios include: (1) pigtail/line failure outside autoclave (see Section 4.3.2.2.10), (2) the process line failure at the withdrawal station (see Section 4.3.2.2.11), and (3) the cylinder failure outside the autoclave (see Section 4.3.2.2.15). The frequencies of occurrence for the heavy equipment drop accident scenario in the withdrawal facilities are bounded by the discussion of the heavy equipment drop accident scenario for the cascade facilities (see Section 4.3.2.1.8). Required controls for prevention or mitigation are the same as those described for the process line failure at compressor discharge in the withdrawal facilities (see Section 4.3.2.2.12). Therefore, no additional analysis of this event is provided.

4.3.2.2.9 Heating a Damaged Cylinder (Primary System Integrity)

a. <u>Scenario Description</u>

During autoclave heating modes, controls are provided to ensure cylinders are free from obvious damage/leakage that could result in a loss of primary system integrity. This event could only occur as a result of multiple operator errors; therefore, this event is categorized as an EBE.

This event was evaluated, and it was determined for operating modes that involve UF_6 liquefaction that the consequences could result in significant off-site and on-site impact if no mitigation were provided.

This event is similar to the event described in Section 4.3.2.2.6. The main difference is that this event involves heating a damaged cylinder during normal autoclave heating modes. Other differences are that once the cylinder passes inspection, no additional controls would be required (i.e., normal operation is occurring). Therefore, the only item addressed in this scenario is the difference in the controls to prevent heating a damaged cylinder during normal autoclave heating modes that involve UF_6 liquefaction.

The following administrative control is in place for all autoclave operations:

- Cylinders are inspected for obvious damage that could threaten their ability to withstand a normal heating cycle prior to heating.

- **b. Source-Term Analysis**

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

c. Consequence Analysis

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

d. Comparison With Guidelines

Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative control to inspect for obvious cylinder damage that could threaten their ability to withstand a normal heating cycle prior to heating—maintain initial condition (normal operation, EG 5 only);
- UF_6 cylinders, pigtails, and primary system inside and outside the autoclave—maintain primary system integrity (EGs 1 and 2);
- Autoclave primary containment system—maintain primary system integrity (EGs 1 and 2); and
- High cylinder pressure system—minimize potential for primary system integrity failure (EGs 1 and 2).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The high cylinder pressure system, UF_6 cylinders, pigtails, primary system piping outside the autoclave, and the autoclave primary containment system are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the UF_6 cylinders, high cylinder pressure system, and for procedures and training of workers for evacuation actions.

4.3.2.2.10 Pigtail/Line Failure Outside Autoclave (Primary System Integrity)

a. Scenario Description

During autoclave operations, several manipulations of the cylinder and pigtail connections are made to accomplish the required tasks associated with the heating, sampling, feed, and transfer of UF_6. These operations include such activities as rolling the cylinder, connecting and disconnecting pigtails, and purging and evacuating pigtails. Due to faulty equipment (i.e., pigtail line, gaskets, etc.) or multiple inadvertent operator errors, it is possible that the pigtail line or its associated equipment connections could fail resulting in a UF_6 release. However, various administrative controls are used to prevent a pigtail/line failure including:

- UF_6 cylinders are not rolled unless the pigtail is disconnected during the operation to prevent breakage of a pigtail;
- UF_6 lines are purged and evacuated before the primary system is opened;
- Only cylinder pigtails that have been inspected and approved are used;
- UF_6 pigtails, when connected for use, are leak-tested before UF_6 is introduced;
- Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;
- UF_6 cylinders are not filled with UF_6 when there is a >40 lb (18 kg) discrepancy between shipper UF_6 cylinder weight and received cylinder weight until the weight discrepancy is explained;
- Operators disable the scale cart's air supply, and place the air supply key holder over the pigtail prior to pigtail connection. This prevents anyone from reconnecting the air supply and ensures that no inadvertent movement of the scale cart occurs while a cylinder is connected to the pigtail (toll transfer and sampling facility only); and
- No cylinder or other load (up to the cranes' rating) is moved over the C-337-A jet station barrier frame, or the heated housings and common UF_6 primary system piping between the autoclaves (feed facilities only);
- Prior to entering the transfer mode of operation for a 12B cylinder, operators shall independently verify that the 12B cylinder clamping device is properly installed and torqued.

The cylinder scale cart movement prevention system is used to prevent a pigtail failure due to inadvertent movement of the scale cart during cylinder filling operations. When a cylinder is connected to the manifold by a pigtail, this system prevents scale cart movement if the transfer manifold pressure is significantly above atmospheric (indicating the presence of UF_6).

All of the potential causes for pigtail/line failure were reviewed, along with operational experience, to determine the frequency associated with this event. Although pigtail failures have occurred in the past, the administrative controls listed above were identified as a result of these failures and have been implemented to reduce the probability of occurrence of this event. Based on the operations and administrative controls, this event was classified in the EBE frequency category because of the low probability that a pigtail/line failure would be caused by deficient pigtails or by multiple operator errors.

This event was evaluated, and it was determined that the consequences could result in significant off-site and on-site impact if no mitigation were provided. These consequences are based on a liquid/vapor UF_6 release from the parent cylinder and a liquid/vapor release from the receiving cylinder.

The primary concern associated with this event is the loss of primary system integrity and the release of UF_6. The applicable EGs (see Table 4.2-2) associated with this event are EGs 1 and 2, as well as EG 6 in the EBE frequency range. No primary containment system exists for this type of event because the break is outside the autoclave. Therefore, EG 3 does not apply. The essential safety actions associated with meeting these EGs include (1) detection of the release, (2) isolation of the primary system to stop the release (where possible), and (3) emergency response to evacuate the immediate vicinity so that the exposure of on-site personnel is minimized.

Scenarios (i.e., causes, source-terms, mitigation) associated with this event vary slightly between the feed and toll transfer autoclaves. Each variation is addressed, and the most limiting event is presented for the purpose of analysis.

All autoclaves in the autoclave open or out of service mode— During the autoclave open mode, various pigtail connections, disconnections, and cylinder rolling operations could be performed. During out-of-service mode, the autoclave is open with a cylinder present but no operation is in progress. During these operating modes, multiple operator errors or equipment malfunctions could occur that could result in a pigtail failure and release of UF_6. This event would result in significant consequences beyond the immediate vicinity only if the UF_6 is in the liquid/gaseous state. During these operating modes, there are no systems available that would isolate the cylinder should a failure of the pigtail occur at the cylinder connection. Therefore, the source-term for this event would be an unmitigated release of the contents of a cylinder. If the cylinder is in a position where the level of UF_6 is below the valve, the release would be in the vapor state. If the liquid level is above the valve, liquid UF_6 would exit the opening and flash to solid and vapor. The release of vapor only for this condition is bounded by the release at a transfer station in the toll transfer and sampling facility (see below) where the receiving cylinder is not isolated. Therefore, no additional analysis of this condition is provided. The liquid release is bounded by a cylinder failure event outside the autoclave as described in Section 4.3.2.2.15. Therefore, no additional analysis of this condition is provided. Consequently, no specific source-term and consequence analysis is provided for the autoclave open modes of operation.

Feed facilities — The C-333-A and C-337-A feed facilities UF_6 primary system lines outside the autoclave exit the autoclave shells and are routed in heated housings or are individually heated and insulated to the tie-line that enters the process buildings. Administrative controls in the feed facilities preclude moving a heavy load (up to the cranes' rating) over the C-337-A jet station barrier frame, or the heated housings, and common UF_6 primary systems piping between the autoclaves. This administrative control in conjunction with operator training minimizes the potential that operators will use the UF_6 cylinder handling cranes to move a heavy load over process piping in the feed facilities that is pressurized with UF_6. If an operator error or control failure results in a heavy load being inadvertently moved over this equipment, then an independent crane failure would be required before a heavy load drop event could result in a significant UF_6 release to the atmosphere. The design features of the cranes, UF_6 cylinder slings and lifting fixtures are controlled to minimize the potential for equipment failure. Due to these preventative design and administrative controls, it is not considered credible for heavy load drop event in the feed facilities to cause a primary system breach that results in a large UF_6 release.

A second potential line failure scenario in the feed facilities involves a heavy load impacting (i.e., running into) the C-337-A jet station piping. An administrative control precludes moving a heavy load (up to the cranes' rating) over the C-337-A jet station barrier frame. However, the most credible scenario for the

horizontal impact event involves a cylinder filled with solid UF_6 coasting past the autoclave position and impacting the C-337-A jet station barrier frame. A steel barrier frame protects the C-337-A jet station piping to preclude a horizontal impact from a crane-carried load resulting in UF_6 primary system failure. A barrier frame is not used in the C-333-A facility since the C-33A jet station I located in an area outside the crane movement areas. Analysis determined that a 14-ton cylinder/barrier frame collision for fast speed conditions (i.e., 175-185 feet per minute) would cause the barrier frame to be permanently deformed, but the fame would not collapse or come into contact with the UF_6 primary system piping. Training combined with skill-of-craft indicate that operators would not normally move heavy loads near the C-337-A jet station at the fast speeds addressed in this analysis. Due to the preventative design and administrative controls, it is not considered credible that horizontal impact from a crane-carried load would cause a breach in the C-337-A jet station piping that would result in a large UF_6 release. If the postulated cylinder/barrier frame collision causes a breach in the solid-filled cylinder, then the source-term and consequences of the UF_6 release originating from the breached solid-filled cylinder are bounded by the evaluations presented in SAR 4.3.2.2.3.

Toll transfer and sampling facility — The C-360 toll transfer UF_6 primary system lines outside the autoclave are exposed to potential hazards (e.g., equipment failure, operator errors) that could cause a pigtail/line failure to occur during autoclave transfer modes of operation. The only remaining potential for failures outside the autoclave associated with C-360 operations would be natural phenomena-initiated events, which are addressed in Section 4.3.2.5. A failure in the transfer line pigtail at the receiving cylinder interface was determined to be the limiting event for a line failure outside the autoclave for all autoclave operations. Slight variations in this scenario will bound any other pigtail/line failure associated with autoclave operations except for the liquid release in the autoclave open or out of service mode that is bounded by cylinder failure outside the autoclave (Section 4.3.2.2.15). Although the operation of the transfer station is located in the basement of C-360, the analysis assumes it is at ground level to bound operations at the feed facilities and the withdrawal facilities (see Section 4.3.2.2.11).

This scenario is a limiting event for the primary system failure and the EBE frequency category.

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b. Source-Term Analysis

The analysis for a parent-daughter transfer release simulates an accidental release of UF_6 from a postulated pigtail failure just after a 48X daughter cylinder has been filled to 21,030 lb (i.e., the maximum fill limit allowed for shipping a 48X cylinder per ANSIN14.1) from a 48Y parent cylinder that originally contained 28,600 lb (i.e., a previously allowed maximum fill limit for in-plant storage in a 48Y cylinder). Thus, this analysis assumes the 48Y parent cylinder contains 7,630 lb and the 48X daughter cylinder contains 21,030 lb at the time of the postulated pigtail failure during transfer operations. Initial temperature in both cylinders is 240°F (116°C), which is controlled by the autoclave steam pressure control system. Liquid UF_6 exits the parent through a valve in the 6 o'clock position and moves through a pigtail pipe [0.745 in. (1.89 cm) inside diameter] to a 15-ft-long (4.6-m) transfer pipe [1 in. (2.54 cm) inside diameter] and then into another pigtail pipe [0.745 in. (1.89 cm) inside diameter] before entering the valve at the 12 o'clock position of the daughter cylinder. The daughter has been filled to the maximum fill limit per ANSI N14.1, but no valves have been closed. At this point, the pigtail becomes disconnected from the valve on the daughter cylinder. This causes a release from the parent cylinder via the transfer piping and from the daughter cylinder through the cylinder valve. Releases from both the parent and daughter cylinders are assumed to last for 45 seconds before isolation [i.e., before the valves are closed by the UF_6 release detection system in the basement transfer room (Zones 4)].

A similar type of release can occur in the laboratory should a piping failure occur during sampling operations. In this scenario the release from the process piping is also assumed to continue for 45 seconds until it is isolated by the UF_6 release detection system in the laboratory (Zone 1). However, the release associated with a pigtail failure in the basement of C-360 is considered the bounding release due to the amount of material that may be released from the parent and daughter cylinders. The release associated with a pigtail failure in the basement of C-360 is evaluated further in the following.

Liquid UF_6 exits the parent cylinder at 240°F (116°C) and 87.9 psia (0.61 MPa), about 6 atm. The release rate from the end of the transfer piping is 7.26 lb/s (3.29 kg/s). The length of transfer piping between the parent cylinder and the release point has a noticeable effect on reducing the atmospheric release rate. Upon release, the liquid UF_6 flashes to a mixture of 62 percent vapor [4.50 lb/s (2.04 kg/s)] and 38 percent solid [2.76 lb/s (1.25 kg/s)], and the temperature is assumed to be lowered to 134°F (56.6°C), the temperature at which vapor and solid forms of UF_6 are in equilibrium at 1 atm.

Some liquid UF_6 exits the daughter cylinder through the valve in the 12 o'clock position and passes through the attached cylinder valve before being released. Because the level of liquid UF_6 is slightly above the valve opening of the daughter cylinder, releases from the daughter are initially in the liquid form and then in the vapor state. The liquid is released at an average rate of 8.58 lbs/s (3.89 kg/s) at an average temperature of 240°F (116°C) and a pressure of 87.9 psia (0.61 MPa). Total UF_6 released during the initial 45 seconds is 326.7 lb (148.2 kg) from the parent cylinder and 385.9 lb (175.5 kg) from the daughter cylinder.

Another variation in the above scenario is for the receiving cylinder not to be isolable because of disconnection from the pigtail at the cylinder connection. The parent cylinder will still be isolated within the 45 seconds, but the receiving cylinder will continue to release its contents until emergency personnel plug the cylinder or the amount is exhausted. This is further discussed below as variations of the baseline scenario. An additional variation in the above scenario is analyzed in Section 4.3.2.2.10.1 to analyze the addition of technetium traps in the transfer operation.

c. Consequence Analysis

The consequence analysis is divided into three sections. The first subsection details the baseline scenario that estimates conservative (i.e., reasonable upper-bound) consequences from a UF_6 release associated with a postulated accident during transfer from a parent cylinder to a daughter cylinder, including release of material from both the parent and daughter cylinders for 45 seconds before isolation. After the baseline scenario, the second subsection discusses the effects of varying input parameters from those used in the baseline scenario. The final subsection discusses the uncertainties in the analysis that

have not been quantified. Effects of varying surface roughness and initial deposition of solid UF_6 are the same as those discussed in Section 4.3.2.2.15.

Baseline scenario. Parameters that define the base scenario for the parent/daughter release are listed in Table 4.3-6. This scenario includes adverse meteorological conditions (i.e., conditions resulting in high-consequence estimates), consisting of a stable atmosphere and a low wind speed [Pasquill-Gifford stability class F and a wind speed of 1 m/s (2 mph), or simply F1]. These conditions occur at PGDP 8.4 percent of the time on an annual basis (averaged over the 5-yr period 1988-1992, inclusive).

An ambient air temperature of 40°F (4.4°C) was selected for these simulations because that temperature results in relatively high consequence estimates compared to other temperatures that occur under F1 conditions. Lower ambient temperatures [to 30°F (-1°C)] were also evaluated and indicated marginally higher consequences. However, lower temperatures introduce condensation mechanisms for which there is less confidence in model results. Therefore, 40°F (4.4°C) is the lowest ambient temperature used in this analysis. During 1992, ambient temperatures were greater than 40°F (4.4°C) about 85 percent of the time.

An ambient relative humidity of 70 percent was selected for the baseline scenario because it is a typical relative humidity for a stable atmosphere with low wind speeds at PGDP. During 1992, the median relative humidity under F1 conditions was 65 percent. Higher relative humidities (e.g., 90 percent) would result in only minimally higher consequence estimates because the corresponding increase in specific humidity (the humidity expressed as the number of grams of water vapor per kilogram of moist air) at 40°F (4.4°C) is small. The maximum relative humidity under F1 in 1992 was 90 percent. The maximum specific humidity (100 percent relative humidity) associated with an ambient air temperature of 40°F (4.4°C) is 5.5 g of water vapor per kilogram of moist air. Twenty percent of that amount (the difference between 70 percent and 90 percent relative humidity) is 1.1 g of water vapor per kilogram of air. This slight difference in water vapor available for UF_6 hydrolysis reactions would result in virtually no change in downwind consequence estimates.

The value of f_A accounts for the in-building mixing of the released UF_6 in the transfer building, and with increasing f_A values, the amount of UF_6 that reacts in the building increases (see Section 4.3.2.3.4). Values of f_A were calculated using the plume cross-sectional area at the point when all of the solid UF_6 in the plume has completely sublimated to UF_6. The cross-sectional area of the plume is a function of the release and meteorological conditions. For the baseline scenario, in-building mixing is assumed to be minimal, with a low f_A value calculated to be 0.055.

The UF_6 MIXER model was used to predict downwind consequences from the parent-daughter transfer release. Figures 4.3-17 through 4.3-19 show estimated downwind consequences associated with the baseline scenario. Note that the baseline scenario (stable atmosphere and a low wind speed [Pasquill-Gifford stability class F and wind speed of 1 m/s, or simply F1]) is represented by the top curve in these figures. The other two curves are for different meteorological conditions and are discussed below. Calculated values of the consequence parameters were compared to EBE guidelines values for uranium (25 rem for U radiological toxicity, and 30 mg U intake for U chemical toxicity), and to the Emergency Response Planning Guidelines (ERPG-2) for HF (20 ppm for 1-hour).

Table 4.3-7 lists specific consequence estimates at the nearest site boundary (1000 m), 1 mile (1600 m), and 5 miles (8050 m) downwind from the postulated release point. The postulated release point is assumed to be located outside the eastern entrance of the toll transfer and sampling facility (Building C-360). The nearest site boundary is located about 0.62 mile (1000 m) to the east of the postulated release point. Consequence estimates are less than their respective guidelines at the nearest site boundary. These consequences are significantly less than those for the dropped cylinder event (see Section 4.3.2.2.15).

Effects of varying scenario parameters on consequence estimates. The following parameters were varied to obtain some uncertainty estimates and provide some characterization of the range of potential consequences: (1) the duration of release from the daughter cylinder, (2) meteorological conditions, (3) the initial in-building mixing [indicated by the fractional area of the leeward side of building that is covered by the exiting plume (f_A)], and (4) the building wake effects on plume dispersion. The results provide perspective for interpreting the baseline scenario. The consequences presented in this section are either more probable, providing a lower-bound estimate of potential consequences, or less probable, providing a worst-case estimate of potential consequences. For the duration of release, fractional area, and building wake discussions, consequence estimate comparisons are not shown for radioactive dose and HF exposure because these estimates display the same general trend as the uranium chemical toxicity dose and are generally less than their respective guideline values.

Duration of release from the daughter cylinder — The baseline scenario assumes that the daughter cylinder valve would be isolated (closed) in 45 seconds. If the daughter cylinder valve does not isolate, then the release duration may be as long as 30 min (1800 s). The 48Y parent cylinder contains 7,630 lb and the 48X daughter cylinder contains 21,030 lb at 240°F at the time of the postulated pigtail failure. The 48Y parent cylinder releases 307.2 lb of liquid UF_6 in the 45-second period before isolation while the 48X daughter cylinder releases 5,583.1 lb of UF_6 liquid and vapor in a 30-minute period, which results in a total of 5,890.3 lb of UF_6 released during the initial 30-minute period after the postulated pigtail failure. The 45-second release period for the parent cylinder and the 240°F operating temperatures were evaluated in this scenario to bound transfer operations at both PGDP and PORTS. In Figure 4.3-20, consequence estimates are higher with the longer duration release from the daughter cylinder. The uranium chemical toxicity dose exceeds the guidelines up to about 2.9 miles (4700 m), while the HF toxicity dose exceeds the guideline up to about 3 miles (5000 m).

Meteorological conditions — Consequence estimates were made for two additional meteorological conditions to compare with the baseline scenario. The compared meteorological conditions included: (1) typical conditions that do not provide favorable or unfavorable consequence estimates [represented by neutral atmospheric stability (Pasquill-Gifford stability class equal to D) and moderate wind speeds (4 m/s = 9 mph)] and (2) typical conditions that provide relatively low-consequence estimates [represented by a slightly unstable atmosphere (Pasquill-Gifford stability class equal to C) with moderate wind speeds (4 m/s)]. These representative meteorological conditions were chosen based on a screening analysis performed using the simple Gaussian plume equation.

Table 4.3-10 shows the results of this screening analysis, where normalized concentration values (concentration, χ, divided by the source-term, Q, therefore called χ/Q values) were calculated at a downwind distance of 0.62 mile (1 km), assuming that the source was at ground level and that plume constituents were not reactive. The values of χ/Q in Table 4.3-10 are ordered such that values near the top of the table represent more favorable dispersion conditions and values near the bottom represent less favorable dispersion conditions.

The most frequently occurring meteorological condition at PGDP is D4 (stability class D, neutral, and a wind speed of 4 m/s), which occurred 14.9 percent of the time on an annual basis. As shown in

Table 4.3-10, meteorological conditions that would result in equal or lesser consequences than those produced by D4 conditions occur 47 percent of the time. Although situation D2 (stability class D and wind speed of 2 m/s) occurs almost as frequently (14.6 percent of the time) as D4 on an annual basis, and results in higher consequence estimates. An additional criterion for selecting D4 is the historical use of similar meteorological conditions in regulatory applications. The U.S. Department of Transportation has used D4.5 to calculate evacuation distances along transportation corridors for accidents involving toxic chemicals (see References 71 and 72) and the U.S. Army has used D3 as the default value for "conservative-most-likely" meteorological conditions for assessing hazards associated with accidental releases of chemical warfare agent (see References 73 and 74). Based on the selections of similar atmospheric conditions and the frequency of occurrence at PGDP, D4 was chosen to represent typical conditions that do not bias the result toward favorable or unfavorable consequence estimates. The temperature of 40°F (4.4°C) and relative humidity (70 percent) were not varied from the baseline scenario [which used F1 (stability class F, stable, and a wind speed of 1 m/s) meteorological conditions].

The C4 meteorological condition occurs about 6.5 percent of the time. As shown in Table 4.3-10, consequence estimates would be more favorable or equal to C4 about 22 percent of the time. A very unstable atmosphere with light wind speeds (i.e., A2) occurs slightly more frequently (6.6 percent vs. 6.5 percent), but this is the most favorable scenario of all (i.e., predicts the lowest hazard estimates) and is therefore, considered too propitious for the purpose of this comparative analysis. Other conditions that result in lower consequence estimates occur less frequently (e.g., D16 and C7). Therefore, C4 was selected to represent a typical condition that results in relatively low consequence estimates. The temperature and relative humidity for this scenario were selected to represent typical summer, daytime conditions when C stability is likely to occur. The temperature used for this comparative scenario was 80°F (27°C) and the relative humidity was 50 percent.

Figures 4.3-17 and 4.3-18 show consequence estimates for uranium chemical toxicity exposure and radioactive dose resulting from a parent-daughter transfer release during F1, D4, and C4 meteorological conditions. Turbulent mixing can increase ground-level concentrations (and associated consequences) close to the source such that unstable (C4) conditions produce the greatest consequences at very small downwind distances. However, by the time the plume is 165 ft (50 m) from the source, the expected relationship of increased atmospheric turbulence producing decreased pollutant concentrations and consequences has established itself and becomes increasingly apparent as distance from the source increases. Simulated consequence estimates are below guideline values at distances of 2210 ft (675 m) or greater.

Figure 4.3-19 shows consequence estimates for HF exposure. At distances of 1.40 mile (2250 m) or less, the consequences are greatest for D4 conditions rather than for the baseline conditions. This apparently counterintuitive result is due to the way in which HF exposure is calculated; in particular, it is a result of the relatively rapid spreading caused by slumping of the dense plume under F1 conditions compared with much slower spreading of such a plume under D4 conditions, where turbulent mixing is more influential in determining the initial spreading. At distances beyond 1.40 mile (2250 m), the D4 plume has spread sufficiently for the higher wind speed and increased atmospheric dispersion associated with this meteorological condition to allow consequence estimates to fall below F1. Consequence estimates for D4 conditions are below the guideline values at distances greater than about 2210 ft (675 m) from the source

Initial mixing of the released UF_6 with air in the toll transfer and sampling facility building — The fraction (f_A) of the leeward side of the building that is covered by the plume as it exits the toll transfer and sampling facility building is used to indicate the amount of initial mixing of the released UF_6 with air in the building. The value of f_A was varied from a very small fractional area (f_A = 0.0001) up to a value of 0.52. Values of f_A greater than 0.52 resulted in the plume becoming buoyant before reaching the 1000 m site boundary and therefore was not considered.

Larger values of f_A are associated with mixing a larger amount of air inside the building with the plume, and although expected to result in smaller consequence estimates, actually lead to similar consequence estimates at all distances from the source until very large values of f_A are assumed. Figure 4.3-21 shows the comparative results for uranium chemical toxicity with values of f_A equal to 0.0001, 0.055 (used for the baseline case), 0.1, and 0.52. As can be seen, the three lower values of f_A result in nearly identical consequences at all downwind distances, while the largest f_A results in initially higher consequences within 2000 m. Beyond 2000 m, the largest f_A results in increasingly lower consequences. Concentrations are below the guideline value (30 mg of inhaled uranium) at distances equal to or greater than 2620 ft (800 m) for all values of f_A.

Building wake effects — Building wake effects cause higher initial dispersion, which generally has the effect of reducing consequences for ground-level sources. (Note that for elevated sources the opposite may be true because the building wake near the source may mix and direct the plume toward the ground, thereby increasing consequence estimates; see Section 4.3.2.1.7.) As distances from the source increase, dispersion of the plume becomes larger compared with the initial dispersion caused by the wake. These effects are seen in Figure 4.3-22, which compares the uranium chemical toxicity consequences for the simulated effects of building wake to those of no building wake. At 330 ft (100 m), consequence estimates for the no-wake case are about 2.5 times higher than that for the building wake case. With increasing distance, the difference between consequence estimates decreases. At 0.62 mile (1000 m), consequence estimates for the no-wake case are about 1.6 times higher than the wake case, and at 1.2 miles (2000 m), consequence estimates for the no-wake case are about 1.4 times higher than the wake case. Estimated consequences become even closer at a distance of 5.3 miles (8500 m). Simulated uranium chemical toxicity consequences exceed guideline values at distances up to 2460 ft (750m) for the case of no building wake effects.

Uncertainties Not Quantified. This scenario would occur in Building C-360 below ground level in a room containing the transfer cylinder and associated piping. The room is generally accessed through doors that normally remain closed during transfer operations. Prior to leaving the facility (i.e., through the ventilation or up the stairs or elevator shaft), the plume would mix appreciably with in-building air, with UF_6 reacting to form UO_2F_2 and HF. The scenario was modeled as a ground-level release to ensure that other potential release scenarios at the autoclaves, feed facilities, and withdrawal facilities would be bounded.

Another conservatism in the scenario is that the release rates chosen are those for the PORTS piping and pigtail sizes, which are slightly larger than those for the PGDP. The PGDP release rates would be slightly lower, thereby resulting in slightly lower consequences.

The baseline scenario simulates dispersion of a dense, ground-hovering plume under common meteorological conditions during the early morning (stable atmosphere and light wind speeds). Such a plume would flow much like water, seeking low spots and being deflected around rises. The plume would tend to pool in low-lying areas, capturing a significant fraction of the plume mass and leading to the formation of small local areas of high concentrations. Pooling would tend to occur at downwind distances close to the release point where the plume is most dense and could possibly limit concentrations further downwind. A dense plume would tend to flow into and pool in low areas near the release point, which would essentially act as retaining basins for the released UF_6 and reaction products. Pooling would act to effectively reduce the uranium concentrations in the plume and extend the release time. As a result, exposures would be reduced.

The following sections describe how the consequences are addressed for the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the autoclave facilities is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the OMR/Lab — Operational personnel who are required to take mitigative action could be located in any of the general areas of the facility but would detect the event quickly because of the large release. As indicated for the local worker, immediate evacuation is required for operational personnel. During exit, the autoclave manual isolation system will be activated (switches located at exits) to initiate valve closure. No actions are required in the C-360 facility because automatic detection and isolation of the lines are provided.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the facilities are (1) detection of the release, (2) minimization of the release by initiating isolation, and (3) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential action is to detect the release of UF_6. For the feed facilities, a release is detected visually or by smelling the HF, and operator action would be taken to initiate the autoclave manual isolation system. For the toll transfer and sampling facility, the UF_6 release detection system (zones 1 and 4) will automatically detect the release and initiate primary system isolation. The second essential action is accomplished by the manual or automatic isolation to terminate the release. If workers outside of the process buildings have received not other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — As indicated in the consequences for the 45 second release from both parent and daughter, the consequence at the site boundary is about 12.3 mg U for the baseline scenario, while that for the f_A of 0.52 is 21.2 mg uranium. This allows for some extra time for detection and isolation prior to reaching the 30 mg U guideline. The time frame allowed for initiation of the isolation systems is about 109 sec for the baseline scenario and about 62 sec for the f_A of 0.52 scenario, before the

evaluation guidelines are exceeded. This provides adequate time for personnel to evacuate and actuate the system as they leave.

For the scenario in which the parent release is terminated at 45 sec and the daughter continues beyond 45 sec and the liquid/vapor release from a cylinder in an autoclave in the autoclave open or out of service mode, the off-site EGs could be exceeded.

d. Comparison With Guidelines

For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However the controls identified (i.e., see and flee) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the OMR/Lab were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event the release ultimately affects habitability of the OMR/Lab, this receptor would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., release detection, process isolation, and evacuation of areas upon detection of a release), EGs 1 and 2 would be met for workers outside the process building. Finally, an analysis was performed to determine the worst case scenario at which an off-site exposure of 30 mg U would be reached.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent pigtail/line failure—maintain initial condition (normal operation, EG 5 only);
  1. UF_6 cylinders are not rolled unless the pigtail is disconnected during the operation to prevent breakage of a pigtail (toll transfer and sampling facility only);
  2. UF_6 lines are purged and evacuated before the primary system is opened;
  3. Only cylinder pigtails that have been inspected and approved are used;
  4. UF_6 pigtails, when connected for use, are leak-tested before UF_6 is introduced;
  5. Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;
  6. UF_6 cylinders are not filled with UF_6 when there is a >40 lb (18 kg) discrepancy between shipper UF_6 cylinder weight and received cylinder weight until the weight discrepancy is explained (toll transfer facility only); and
  7. Operators disable the scale cart's air supply, and place the air supply key holder over the pigtail prior to pigtail connection. This prevents anyone from reconnecting the air supply and ensures that no inadvertent movement of the scale cart occurs while a cylinder is connected to the pigtail (toll transfer and sampling facility only);
  8. No cylinder or other load (up to the cranes' rating) is moved over the C-337-A jet station barrier frame, or the heated housings and common UF_6 primary system piping between the autoclaves (feed facilities only); and
  9. Prior to entering the transfer mode of operation for a 12B cylinder, operators shall independently verify that the 12B cylinder clamping device is properly installed and torqued.
- Autoclave steam pressure control system—maintain initial condition (normal operation, EG 5 only);
- Autoclave manual isolation system (C-333-A and C-337-A only)—closure of isolation valves to terminate release (EGs 1, 2, and 6 only);
- UF_6 release detection (zones 1 and 4) system (C-360 only)—closure of isolation valves to terminate release (EGs 1 and 2);
- Liquid UF_6 cylinder handling equipment (C-360 only)—maintain primary system integrity (EGs 1 and 2);
- Cylinder scale cart movement prevention system (C-360 only)—prevent inadvertent scale cart movement (EG 5);
- UF_6 cylinders, pigtails, and the primary system inside and outside the autoclave—maintain primary system integrity (EGs 1 and 2);

- Design features of the C-337-A jet station barrier frame – maintain primary system integrity (EGs 1 and 2); and
- UF_6 cylinder handling cranes – design features minimize probability of heavy load drop events – maintain primary system integrity (EGs 1 and 2)
- Operator training for required actions—closure of isolation valves to terminate release (C-333A and C-337A only) and evacuation of the area (EGs 1, 2, and 6 only).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The autoclave steam pressure control system, autoclave manual isolation system, UF_6 release detection system Zones 1 and 4 (C-360) UF_6 cylinder handling cranes, C-337-A jet station barrier frame, UF_6 cylinders, pigtails, primary system piping outside the autoclave, liquid UF_6 cylinder handling equipment (i.e., scale carts), cylinder scale cart movement prevention system (C-360 only), and the autoclave primary containment system (C-360 only) are identified as important to safety SCCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the autoclave steam pressure control system, autoclave manual isolation system, UF_6 release detection (zones 1 and 4) system, Scale cart movement prevention system, UF_6 cylinders, UF_6 cylinder handling cranes, C-337-A jet station barrier frame, and administrative requirements for procedures and training of workers for prevention of pigtail/line failure and evacuation actions.

4.3.2.2.10.1 Line Failure in the C-360 Basement Transfer Room When Technetium Traps are in Operation

a. <u>Scenario Description</u>

This scenario is a variation of the pigtail /line failure outside autoclave scenario analyzed in Section 4.3.2.2.10. The analysis in Section 4.3.2.2.10 is very conservative, as the source term and consequence analyses were presented to bound both the Portsmouth and Paducah GDPs. The model does not truly represent either PGDP or Portsmouth. The most conservative assumptions for each facility were combined into a model that would bound the accident for both plants. Hence, the highest source term from both plants was used in the consequence analyses to develop the most conservative results for both plants. The main difference in these two scenarios is the location of the postulated break. Transfer operation with the Tc traps does not invalidate any aspect of the pigtail /line failure outside autoclave scenario. The analysis in Section 4.3.2.2.10 still conservatively bounds a release from the transfer pigtail even with the Tc traps in operation.

This scenario for the Tc traps is specific to PGDP and therefore the inputs to the analyses (piping runs, valves, elbows, valve closure times, modeling of the transfer room release and distance to site boundary, etc.) are more accurate and precise. To ensure product cylinders meet customer specifications, technetium (Tc) traps have been installed in the C-360 basement transfer room. When needed, these traps can be valved in to allow the liquid UF_6 being transferred from a parent cylinder to a daughter cylinder, to pass through the traps to filter out ^{99}Tc. There are two banks of traps, with four traps in each bank.
Only one bank will be used at any given time. Although the traps and associated piping are made of Monel, and the piping and traps are welded in place, there exists the possibility that a bank of traps will have to be cut out if the MgF_2 becomes saturated with ^{99}Tc and needs to be replaced. Although a rupture of the Monel piping is expected to be extremely unlikely during transfer operations, due to the possibility of the lines being cut and rewelded, it is postulated that the Monel piping fails just down stream from a bank of traps. This event was classified in the EBE frequency category because of the extremely low probability of a piping failure.

The parent cylinder is assumed to be a 48X cylinder filled with liquid UF_6 at 235 ^oF, the maximum allowed temperature which corresponds to the autoclave steam pressure control limit of 8 psig. For a slight conservatism, the parent cylinder at the time of the pipe rupture is assumed to contain the maximum allowed amount of UF_6, or 21,030 lb. The parent cylinder, with the cylinder valve at 6 o'clock position, is connected to a 0.745-in ID pigtail which in turn is connected to 1-in transfer piping, and then connected to a bank of four Tc traps. A number of manually operated valves and two automatic isolation valves are also in the flowpath to the traps. The daughter cylinder is also assumed to be a type 48X cylinder with the cylinder valve at the 12 o'clock position, and also filled to its maximum allowed amount of UF_6 (21,030) at 235 ^oF when the release occurs. The assumption of both cylinders full is conservative and will bound all operations including blending operations. Located in the piping near the daughter cylinder is an additional automatic isolation valve. In case of a UF_6 release in the basement transfer room, the UF_6 release detection system (Zone 4) will provide a signal to close the transfer manifold automatic isolation valves located in the piping near the parent cylinder and the transfer line block valve. The automatic isolation valves are assumed to close completely within 10 seconds of the UF_6 release detection system sensing a release. A 15-second response time is assumed for the UF_6 detectors to sense a release. Therefore, the automatic isolation valves will close within 25 seconds of the UF_6 release. After a rupture of the piping just downstream from the trap bank, the liquid UF_6 will rapidly exit out the ruptured pipe from the parent and daughter cylinders for the 25 sec period until the automatic isolation valves close. The UF_6 remaining in the traps and the piping between the parent and daughter cylinder automatic isolation valves and the break location will then exit the piping, further contributing to the total amount of UF_6 released.

The primary concern, applicable EGs, and essential safety actions associated with this event are the same as those for the Pigtail/Line Failure Outside Autoclave event.

b. <u>Source Term Analysis</u>

The PIPELEAK model was used for the parent and daughter cylinders to model the releases through the parent and daughter pigtails, and associated transfer piping/fittings. The parent 48X cylinder is assumed to be located at the autoclave that provides the longest piping run to the traps. This configuration maximizes the total amount of UF_6 released for the postulated line failure event. Line breaks during transfer from a closed autoclave can result in higher release rates. However, the larger volume of UF_6 released from the lines using the longest piping run has a larger effect on the total source-term for the event than the higher release rates for the line breaks from a closed autoclave. In the 25 sec period between pipe rupture and automatic isolation valve closure, 80.9 lb of liquid UF_6 is released from the parent cylinder. During this same 25 sec period, 105.7 lb of UF_6 is released from the daughter cylinder through the piping at the rupture location. Since the liquid level in the daughter cylinder remains above the cylinder valve, the release is in the form of liquid. There is approximately 155 ft of 1-in piping from the second parent automatic isolation valve to just down stream of the traps, including branch lines to the other autoclaves and to the surge drum. This provides 174.34 lb of liquid UF_6 that could also exit the line from the parent cylinder piping. There is approximately 45 ft of 1-in piping from the daughter automatic isolation valve to the location of the break. This provides another 51.25 lb of liquid UF_6 that could exit the line through the daughter cylinder piping. Each trap is in the shape of a small cylinder, about two ft high with a maximum inner diameter of 10.24 in. At least 33 lbs of sintered MgF_2 is placed within each trap to absorb the ^{99}Tc. After insertion of the MgF_2, each trap has

approximately 0.894 ft^3 of void space in which liquid UF_6 will occupy. At a liquid temperature of 235 ^oF (density of 206.97 lb/ft^3), each trap could contain 185.03 lb of liquid UF_6. The four traps in the bank could contain 740.12 lb of liquid UF_6. Adding the amount of liquid UF_6 in the four traps (740.12 lb), a total of 1152.3 lb of liquid UF_6 would be released. The estimated time for the release to occur is approximately 142 seconds.

A variation in the above scenario is a piping failure coupled with multiple operator errors, failing to place the MgF_2 into each trap. Each trap could then contain 1.062 ft^3 of liquid UF_6, or 219.8 lb of liquid UF_6.

Four traps would contain 879.21 lb of liquid UF_6. In this case, the total amount of UF_6 released would be 1291.4 lb, with an estimated release time of approximately 162 seconds.

c. Consequence Analysis

The UF_6MIXER model was used to calculate the consequences of the UF_6 released. Figures 4.3-46 through 4.3-48 show estimated downwind consequences associated with this variation. The amount released was 1152.3 lb (522.68 kg) in a 142 sec period, providing an average release rate of 3.6809 kg/sec. The release was modeled as a liquid release, with an initial temperature of 235 ^oF before flashing to solid and vapor. No deposition or holdup within the transfer room was considered. As there are no large bay doors in the transfer room leading to ambient conditions outside, the exit location for the UF_6 to leave the room was assumed to be through opened personnel doors leading to the street level with ambient outside conditions, as well as through small cracks up the elevator shaft also leading to the street level. Based upon these two areas (door size and elevator shaft opening areas) and the cross sectional area of the facility's downwind side, an f_A of 0.006 was used for the calculations. A surface roughness of 0.03 m was used for the calculations, which is representative of low grass areas that would be found in a rural environment. The ambient temperature outside the building was assumed to be at 40 ^oF, with a relative humidity of 70%. The transfer room temperature was assumed to be at 80 ^oF, due to the cylinder and traps containing liquid UF_6. At these ambient conditions, three sets of meteorological conditions were examined. The baseline case at these ambient conditions was for F stability, 1 m/s wind speed (or simply F1) meteorological conditions, which normally provides the worst case consequences. Additionally, D stability, 4 m/s conditions (D4) were examined, as well as C stability, 4 m/s conditions (C4). The results show that the D4 and C4 conditions provided considerably lower consequences than F1 conditions. Table 4.3-7b provides a summary of the results for the F1 conditions. The uranium intake at the site boundary, 1050 m plant east, is 24.8 mg, while the radiological dose and HF concentration are 0.26 rem and 9.7 ppm respectively.

In the variation event discussed above where the MgF_2 had not been placed into the traps, 1291.4 lb would be released in approximately 162 seconds. For the most conservative meteorological conditions (F1), the uranium intake at 1050 m is 27.9 mg. The radiological dose and HF concentration are 0.29 rem and 10.9 ppm respectively. Figure 4.3-49 provides a comparison of the uranium intake consequences for the two cases of with and without MgF_2 in the traps under the worst case meteorological conditions.

d. Comparison With Guidelines

The comparison with guidelines is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the transfer area is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the C-360 Administrative Area — Operational personnel who can take mitigative action in the event of a UF_6 release associated with a line failure in the transfer area are located in the administrative area but would detect the event quickly because of the large release. In the event of a line failure, operator action will not be required because of the automatic actions of the UF_6 release detection system at the transfer station (Zone 4). As indicated for the local worker, immediate evacuation is required for operational personnel.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the facility are (1) detection of the release, (2) minimization of the release by initiating isolation, and (3) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential action is to detect the release of UF_6. The second essential action is accomplished by the automatic isolation to terminate the release. For the transfer area, the UF_6 release detection system (Zone 4) at the transfer station will automatically detect the release and initiate primary system isolation. If workers outside of the process buildings have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — The off-site consequences at the site boundary of a line failure with the Tc traps being utilized in the transfer station is about 24.8 mg U. The essential controls for protecting the off-site public are isolation of the breach to minimize the UF_6 release, and ensuring that no more than one bank of Tc traps are utilized during transfer operations.

e. <u>Summary of SSCs and TSR Controls</u>

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent line failure-maintain initial condition (normal operation, EG 5 only)
- UF_6 lines are purged and evacuated before the primary system is opened.
- Autoclave steam pressure control system-maintain initial condition (normal operation, EG 5 only)
- UF_6 release detection system (Zone 4) - closure of isolation valves to terminate release (EGs 1, 2, and 6 only)
- Operator training for required actions- evacuation of the area (EGs 1, 2, and 6 only).
- Administrative control to ensure only one bank of Tc traps is utilized during transfer operations-maintain initial condition (normal operation, EG 5 only)
- Primary system piping and equipment outside the autoclave, and the associated isolation valves-maintain primary system integrity (EGs 1, 2, and 6 only)

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The autoclave steam pressure control system, UF_6 release detection system (Zone 4), primary system piping and equipment outside the autoclave, and associated isolation valves are identified as important to safety SSCs. See Section 3.15 for details including safety classification.

- TSRs are provided for the autoclave steam pressure control system, UF_6 release detection system (Zone 4), and administrative requirements for procedures and training of workers for evacuation actions.
- TSRs are provided to ensure only one bank of Tc traps is utilized during transfer operations.

4.3.2.2.11 Pigtail/Line Failure at the Withdrawal Station (Primary System Integrity)

a. <u>Scenario Description</u>

Liquefied UF_6 is removed from the cascade in the withdrawal facilities and transferred into a cylinder through a flexible pipe or "pigtail." During withdrawal operations, several manipulations of the cylinder, pigtail, and associated mechanical connections are required in order to accomplish the tasks needed to withdraw UF_6. These operations include tasks such as connecting and disconnecting the pigtails, and purging and evacuating pigtails. Due to faulty equipment (i.e, pigtail line, gaskets, etc.) or multiple inadvertent operator errors, it is possible that the pigtail line or its associated equipment connections could fail resulting in a UF_6 release. In the event of a pigtail/line failure, the withdrawal station UF_6 detection and isolation system will minimize the amount of UF_6 released by isolating the withdrawal stations. However, various administrative controls are used to prevent a pigtail/line failure. These administrative controls include:

- UF_6 lines are purged and evacuated before the primary system is opened;
- Only cylinder pigtails that have been inspected and approved are used;
- UF_6 pigtails, when connected for use, are leak-tested before UF_6 is introduced;
- Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;
- Operators disable the scale cart's air supply, and place the air supply key holder over the pigtail prior to pigtail connection. This prevents anyone from reconnecting the air supply and ensures that no inadvertent movement of the scale cart occurs while a cylinder is connected to the pigtail; and
- UF_6 cylinders are not filled with UF6 when there is a >40 lb (18 kg) discrepancy between shipper UF_6 cylinder weight and received cylinder weight until the weight discrepancy is explained.

The cylinder scale cart movement prevention system is used to prevent a pigtail failure due to inadvertent movement of the scale cart during cylinder filling operations. When a cylinder is connected to the manifold by a pigtail, this system prevents scale cart movement if the transfer manifold pressure is significantly above atmospheric (indicating the presence of UF_6).

All of the potential causes for pigtail/line failure were reviewed, along with operational experience, to determine the frequency associated with this event. Although pigtail failures have occurred in the past, the administrative controls listed above were identified as a result of these failures and have been implemented to reduce the probability of occurrence of this event. Based on the operations

and administrative controls, this event was classified in the EBE frequency category because of the low probability that a pigtail/line failure would be caused by deficient pigtails or by multiple operator errors.

This event was evaluated and it was determined that the consequences could result in significant off-site and on-site impact if no mitigation were provided. These consequences are based on a liquid/vapor UF_6 release from the condenser/accumulator and a liquid/vapor release from the receiving cylinder.

The primary concern associated with this event is the loss of primary system integrity and the release of UF_6. The applicable EGs (see Table 4.2-2) associated with this event are EGs 1 and 2, as well as EG 6 in the EBE frequency range. EG 3 does not apply since the primary system is assumed to fail. The essential safety actions associated with meeting these EGs include (1) detection of the release, (2) isolation of the primary system to stop the release (where possible), and (3) emergency response to evacuate the immediate vicinity so that the exposure of on-site personnel is minimized.

b. Source-Term Analysis

The initiators, source-terms, and mitigation associated with a pigtail/line failure event at the withdrawal station vary only slightly from that described for a pigtail/line failure outside autoclave event (see Section 4.3.2.2.10). Only the variations from the autoclave scenarios are presented for the purpose of withdrawal scenario analysis.

This analysis assumes that the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations will significantly limit the amount of UF_6 released due to a pigtail/line failure by automatically closing isolation valves within 30 seconds after detection of a UF_6 release. Since large quantities of "white smoke" are produced when relatively small quantities of UF_6 react with atmospheric moisture, it is assumed for the purpose of this analysis that the UF_6 detectors used in the withdrawal facilities will sense a significant UF_6 release in 15 seconds. Thus, the UF_6 release associated with a pigtail/line failure in the withdrawal facilities is assumed to last for a 45-second duration before closure of the isolation valves terminating the release.

The source-term for the pigtail/line failure scenario in the withdrawal facilities is generally a function of the estimated release rate over the expected release duration. However, the release rate for this failure would be larger in the toll transfer and sampling facility than in the withdrawal facilities due to the higher operating temperatures. The initial conditions for the autoclave pigtail/line failure event scenario (Section 4.3.2.2.10) assumed that the initial temperature in the cylinder was 240°F (116°C). The temperature at the withdrawal stations is typically less than 180°F. Assuming all other conditions are constant, the vapor pressure of UF_6 associated with these operating temperatures would result in the toll transfer and sampling facility having a larger release rate than the withdrawal facilities for a pigtail/line failure event. Due to the larger release rate, the total amount of UF_6 released in the toll transfer and sampling facility would be larger than the total amount released in the withdrawal facilities for the maximum 45 second release duration expected for a pigtail/line failure event.

c. Consequence Analysis

Based on the source-term analysis, the consequences and mitigative controls associated with a pigtail/line failure event in the withdrawal facilities are bounded by the source-terms and consequences associated with a pigtail/line failure event outside of the autoclave in the toll transfer and sampling facility (see Section 4.3.2.2.10); thus no additional analysis is required for the pigtail/line failure event in the withdrawal facilities.

d. Comparison With Guidelines

The comparison with guidelines is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the autoclave facilities is (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the ACR — Operational personnel who can take mitigative action in the event of a UF_6 release associated with a pigtail/line failure in the withdrawal facilities are located in the ACR. In the event of a pigtail/line failure, ACR operator action will generally not be required because of the automated actions of the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations. However, if the UF_6 detectors associated with this system are out of service (e.g., for maintenance), then manual actuation of the isolation system is required to minimize the release. Adequate time is available for operators to perform the required actions prior to any evacuation should the need arise. However, once the essential actions have been accomplished, the essential control to protect these personnel is evacuation, if required, upon detection of the release by sight or by odor.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the facilities are (1) detection of the release, (2) minimization of the release by initiating isolation, and (3) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential action is to detect the release of UF_6. The second essential action is accomplished by the manual or automatic isolation to terminate the release. For the withdrawal facility, the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations will automatically detect the release and initiate primary system isolation. If workers outside of the process buildings have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — The off-site consequences of a pigtail/line failure in the withdrawal station are bounded by the pigtail/line failure outside the autoclave scenario (see Section 4.3.2.2.10). The essential control for protecting the off-site public is isolation of the breach to minimize the UF_6 release.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent pigtail/line failure—maintain initial condition (normal operation, EG 5 only);
  1. UF_6 lines are purged and evacuated before the primary system is opened;
  2. Only cylinder pigtails that have been inspected and approved are used;
  3. UF_6 pigtails, when connected for use, are leak-tested before UF_6 is introduced;
  4. Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;
  5. Operators disable the scale cart's air supply, and place the air supply key holder over the pigtail prior to pigtail connection. This prevents anyone from reconnecting the air supply and ensures that no inadvertent movement of the scale cart occurs while a cylinder is connected to the pigtail; and
  6. UF_6 cylinders are not filled with UF_6 when there is a >40 lb (18 kg) discrepancy between shipper UF_6 cylinder weight and received cylinder weight until the weight discrepancy is explained.
- UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations—closes isolation valves to terminate release (EGs 1 and 2);
- UF_6 cylinders, pigtails, and primary system piping and associated isolation valves—maintain primary system integrity (EGs 1 and 2);
- Operator training for required actions—closure of isolation valves to terminate release and evacuation of the area (EGs 1, 2, and 6 only);
- Liquid UF_6 cylinder handling equipment (scale carts)—maintain primary system integrity (EGs 1 and 2); and
- Cylinder scale cart movement prevention system—prevent inadvertent scale cart movement (EG 5).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations, UF_6 cylinders, pigtails, liquid UF_6 cylinder handling equipment, cylinder scale cart movement prevention system, and primary system piping and associated isolation valves are identified as important to safety SSCs. See Section 3.15 for details including safety classification.

- TSRs are provided for the UF_6 release detection and isolation system - low voltage ("new") system at the withdrawal stations, UF_6 cylinders, scale cart design, cylinder scale cart movement prevention system, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.12 Process Line Failure at Compression Discharge (Primary System Integrity)

a. Scenario Description

During withdrawal mode operations involving the compression loop, a process line failure at the compression source discharge (i.e., Normetex or centrifugal pump) could result due to various initiators including: (1) UF_6/hot metal reaction (see Section 4.3.2.2.1), (2) plugged/blocked process line (see Section (4.3.2.2.17), or (3) heavy equipment drop (see Section 4.3.2.2.8). Of these potential event initiators, the UF_6/hot metal reaction and the plugged/blocked process line events will occur in the AE frequency range and are addressed separately. This scenario bounds other events that could result in a process line failure at the compression discharge which are classified in the EBE frequency category. The greatest potential for a UF_6 release from this type of event in the EBE frequency category would involve dropping a heavy load on a compression discharge line.

The process line failure event at the compression discharge in the withdrawal facilities was evaluated, and it was determined that the consequences could result in significant off-site impact in *withdrawal and standby* modes of operation involving the compression loop if no prevention or mitigation were provided. The primary concern associated with this event is the control of the UF_6 release from the affected portion of the UF_6 primary system. The applicable EGs associated with this event are all of the EGs for the EBE frequency range. EG 4 is addressed by the NCS Program. The only safety action required to meet these EGs is an administrative control that precludes process building cranes from moving heavy loads above/around process equipment that is operating above atmospheric pressure. This administrative control precludes the potential for a large UF_6 release for this scenario since failure of the compression discharge line that is operated below atmospheric pressure will result in in-leakage with minimal release of UF_6.

b. Source-Term Analysis

An analysis was generated to determine the credible compression discharge rupture locations associated with heavy equipment drops within the product (C-310) and tails (C-315) withdrawal facilities and evaluate the possible UF_6 releases associated with the identified rupture locations. This analysis determined that there was no credible break location for product withdrawal compression discharge piping as a result of a heavy equipment drop. Evaluation of the tails withdrawal facilities involving operation of the high-speed centrifugal compressors also did not identify a credible heavy equipment drop scenario that could result in rupture of the centrifugal compression discharge lines. Evaluation of the tails withdrawal facilities involving operation of the Normetex pumps identified a credible heavy equipment drop scenario that could result in rupture of the Normetex pump discharge lines. The scenario postulated that a crane failure during the installation or removal of a Normetex pump in C-315 could result in a heavy load drop that could rupture the compression discharge piping that is common with the two other Normetex pumps used in the tails withdrawal facility. An administrative control is credited for precluding this event by preventing the use of process building cranes to move heavy loads above/around process equipment that is operating above atmospheric pressure. Failure of process equipment that is operated below atmospheric pressure will result in in-leakage with minimal release of UF_6; therefore, further analysis is not required for this event.

c. Consequence Analysis

Further analysis is not required since the scenario description credits an administrative control for precluding postulated process line failures at compression discharge events that result in a significant UF_6 release by preventing the use of process building cranes to move heavy loads above/around process equipment that is operating above atmospheric pressure.

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d. Comparison With Guidelines

All of the applicable EGs for this scenario are met by the administrative control that prevents using process building cranes to move heavy loads above/around process equipment that is operating above atmospheric pressure.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative Control - Process building cranes shall not be used to transport heavy equipment above/around process equipment that is operating above atmospheric pressure.- (EGs 1, 2, and 3).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- No SCCs were identified as important to safety as a result of this analysis.
- A TSR is provided that requires essential administrative controls be flowed into procedures.

4.3.2.2.13 Pigtail/line Failure Inside Autoclave (Primary System Integrity)

a. <u>Scenario Description</u>

During autoclave operations, several manipulations of the cylinder and pigtail connections are made to accomplish the required tasks associated with the heating, sampling, feed, and transfer of UF_6. These operations include such activities as rolling the cylinder, connecting and disconnecting pigtails, and purging and evacuating pigtails. All pigtail operations take place in the autoclave open mode of operation, which greatly reduces the potential frequency of this event. In addition, administrative controls are required to leak-test pigtails after each connection ensuring proper connections as well as only using inspected and approved pigtails. However, with multiple operator errors, it is postulated that a primary system failure could occur after the autoclave is closed. This event is an EBE because of the low probability that a primary system failure will be caused by a deficiency in the primary system or multiple operator errors during autoclave operations.

This event was evaluated and it was determined that the consequences could result in significant off-site and on-site impact if no mitigation is provided. These consequences are based on a liquid UF_6 release. Vapor releases would result in lower release rates and consequences.

The primary concern associated with this event is the loss of primary system integrity inside the autoclave and the release of liquid UF_6. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs

for the EBE frequency range. The only safety action required to meet these EGs is to establish primary containment. This action will prevent any significant release of material to the immediate area (i.e., protecting on-site personnel and maintaining habitability of the OMR/Lab) as well as limiting off-site public exposure within the EGs.

Autoclave jetting is performed for the feed and transfer/sample autoclaves to remove residual steam prior to opening the autoclave. If a small UF_6 leak were to occur from a full or partially full cylinder into an autoclave while jetting, it is possible that the autoclave containment would not be established due to the jet removing the UF_6 and/or reaction products prior to reaching the actuation pressure. The jet would then exhaust the UF_6 to the atmosphere until the leak was detected or jetting was completed. In the feed facilities, autoclaves are normally jetted once following completion of the heating/feeding/heeling cycle or following an interrupted heat cycle. Cylinders in the feed autoclave would normally only contain a heel quantity of UF_6 during the jetting evolution unless an interrupted heat cycle had occurred. Calculations have demonstrated that the probability of a pigtail failure inside an autoclave while jetting after an interrupted heat cycle is incredible. The transfer/sample autoclaves in C-360 can be jetted up to twice every heating cycle (once after initial heating prior to rotation and then again after the transfer/sample is complete if steam was reapplied.) During both of these C-360 jetting evolutions, the autoclave could contain a full or partially full cylinder. The pigtail failure inside a C-360 autoclave during jetting was determined to be in the EBE frequency category.

This event will be evaluated as two different scenarios due to the different release paths. The first scenario, pigtail failure without jetting, will be analyzed for all autoclaves. A second scenario, pigtail failure during jetting, will only be analyzed for the C-360 facility.

The initial conditions assumed in the analysis of this event were as follows:

- Initial cylinder temperature is conservatively 240°F (116°C), which is controlled by the autoclave steam pressure control system. (pigtail failure inside autoclave without jetting scenario only)
- Initial cylinder temperature is conservatively 220°F (104°C), which is controlled by the autoclave steam pressure control system. (pigtail failure inside C-360 autoclave during jetting scenario only)
- Condensate level within the autoclave is below the shell at the condensate drain, which is controlled by the autoclave water inventory control system.
- Administrative controls in place to prevent primary system failure are:
  1. Only cylinder pigtails that have been inspected and approved are used.
  2. UF_6 pigtails and primary system, when connected for use, are leak-tested before UF_6 is introduced.
  3. UF_6 cylinders are not rolled unless the pigtail is disconnected during the operation to prevent breakage of a pigtail (toll transfer and sampling facility only).

Pigtail failure inside autoclave without jetting scenario. Should these controls fail, it is postulated that a complete failure of a pigtail connection could occur within the autoclave while connected to a 14-ton cylinder filled with liquid UF_6. Analysis has shown that the release of the UF_6 would increase the autoclave pressure proportional to the rate the UF_6 is released. The initial conditions (except for cylinder administrative controls) for this scenario are identical to the event described in Section 4.3.2.2.14, cylinder failure inside autoclave. Since the cylinder failure scenario has a greater release rate

of UF_6, the source-terms, consequences, and comparison with guidelines for this scenario are bounded by Section 4.3.2.2.14. Therefore, further analysis for this scenario is not necessary.

Pigtail failure inside C-360 autoclave while jetting. This event variation is similar to the pigtail failure inside autoclave without jetting scenario, except the UF_6 leakrate is not from the complete failure of a pigtail, but is assumed to be a small leak from a pigtail connection or valve. Analysis has shown that a small leak of UF_6 can be removed from the autoclave by the jet and released to the atmosphere without actuating an autoclave isolation. The initial conditions for this scenario are the same as the scenario without jetting except for the initial cylinder temperature. A lower initial temperature maximizes the amount of UF_6 that can be removed without isolation actuation. Since this variation of the scenario has a different release path to the atmosphere than the baseline scenario, further analysis of this variation is necessary.

b. Source-Term Analysis

Pigtail failure inside autoclave without jetting scenario. Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

Pigtail failure inside C-360 autoclave while jetting. The analysis for the release of a limited amount of UF_6 from a small leak inside an autoclave during jetting operations starts with a cylinder full of UF_6 that has been fully liquefied and the autoclave is being jetted in preparation to open the autoclave. If the event occurs while the UF_6 in the cylinder is still solid, there will be no significant solid or vapor flow from the cylinder, and thus a negligible release, if any. The cylinder has been heated with saturated steam at 4 psig (129 kPa), which has a temperature of 220°F (104°C). The pressure inside the cylinder is 67.7 psia (467 kPa) (the vapor pressure of pure UF_6 at 220°F (104°C), the normal heating temperature). The autoclave is conservatively assumed to be partially jetted and to not contain any water or steam when the UF_6 release is initiated; thus there is no water/UF_6 reaction products in the autoclave. This lowers total autoclave pressure, maximizing the release of UF_6.

In this scenario the integrity of the cylinder/valve/pigtail system is lost, and UF_6 begins to flow under pressure from the cylinder into the autoclave shell. The steam jet exhausts the UF_6 from the autoclave maintaining the pressure just below the autoclave steam pressure control (ASPC) 8 psig (156 kPa) setpoint.

If the pressure increases to 8 psig (156 kPa), the autoclave steam pressure control system will isolate the steam line entering the autoclave, which has the net effect of also isolating the jet from the autoclave, thereby terminating the release of UF_6 from the jet. This occurs because the inner steam supply line isolation valve must be open in order to jet the autoclave. Following isolation of the jet, the pressure would continue to increase in the autoclave until reaching the autoclave high pressure isolation system 15 psig (205 kPa) setpoint initiating a complete isolation of the autoclave and UF_6 release paths. In addition, the autoclave steam pressure control system would provide an alarm notifying the operators of a problem and prompting manual autoclave isolation in parallel with automatic isolation by autoclave high pressure isolation system. The alarm would also initiate see and flee as appropriate.

The UF_6 pulled from the autoclave by the jet reacts with the steam that provides the motive force for the steam jet. There is sufficient steam volume to fully react with all the UF_6 leaving the autoclave. The reaction products and excess steam are released to the atmosphere at 825°F (441°C) with a velocity of 487 ft/sec (148 m/sec). The reaction product release rate to the atmosphere is 0.993 lbs/sec (0.450 kg/sec) for UO_2F_2 and 0.258 lbs/sec (0.117 kg/sec) for HF. The operation of the steam jet is a manual evolution requiring operator action to initiate and stop the jetting. Therefore, the release rate could continue until the cylinder contents were emptied or the release was identified and the jetting stopped by operator action.

The steam jet is designed for a steam inlet pressure of 60 to 120 psig but during some operations in the C-360 building when multiple autoclaves are in the initial phase of cylinder heating, the steam pressure available to the jet may drop below the design pressure. Operating experience has demonstrated that the jet is able to perform its function with reduced inlet steam pressure. Because the steam jet is more efficient with lower steam inlet pressure for the 60-120 psig range, performance values for 40 psig steam inlet pressure were conservatively extrapolated from the vender data. This data is presented as a bounding operating condition for the steam jet. In addition, heat transfer was neglected in the baseline scenario between the reaction products and the discharge piping. The effects of these scenario parameter variations will be discussed in the consequence analysis.

c. <u>Consequence Analysis</u>

Pigtail failure inside autoclave without jetting scenario. Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

Pigtail failure inside C-360 autoclave while jetting. This section presents a detailed quantitative discussion of the consequence calculations that were developed for the pigtail failure in C-360 autoclave while jetting scenario followed be a discussion of how the EGs are addressed for each receptor.

The consequence calculations are divided into two sections: (1) baseline scenario and (2) effects on consequence estimates by varying scenario parameters.

Baseline scenario. The baseline scenario is as follows: (1) UF_6 is released into the autoclave and removed by the jet supplied with 60 psig steam, (2) the release to the atmosphere occurs when the atmosphere is stable, to minimize dispersion and maximize ground level concentrations of uranium and HF, and (3) building wake effects are included. Parameters that define the baseline scenario for the pigtail failure inside C-360 autoclave while jetting are listed in Table 4.3-19. These parameters include a very stable atmosphere (Class F), and a wind speed of 4.5 mph (2 m/s), designated F2. F2 conditions provide higher consequence estimates than did a higher 7 mph (3 m/s) wind speed discussed in the large UF_6 release to atmosphere from the enrichment buildings (Section 4.3.2.1.7) or the lower 2 mph (1 m/s) wind speed discussed in the dropped cylinder (Section 4.3.2.2.15) and parent/daughter transfer cases (Section 4.3.2.2.10). This wind speed allows the plume to intersect the ground nearer the site boundary and results in the maximum ground level concentrations and thus higher consequences. The exposure time from a passing plume was limited to 30 minutes. Exposures greater than 30 minutes would result in slightly higher consequence estimates.

Because the UF_6 is released from the steam jet exhaust at a high temperature, an ambient temperature of 70°F (21°C) was chosen. Although lower temperatures are possible under F stability, 70°F (21°C) was chosen because this minimizes the temperature differential between the ambient temperature and the temperature of the reaction products exiting the pipe. Higher ambient temperatures are highly unlikely at F stability conditions.

Unlike the dropped cylinder (Section 4.3.2.2.15) and the parent/daughter transfer cases (Section 4.3.2.2.10), the released UF_6 is completely reacted to UO_2F_2 and HF before being released into the atmosphere. Therefore, like the large UF_6 release to atmosphere from the enrichment buildings (Section 4.3.2.1.7), the relative humidity, used to determine atmospheric water vapor content, is not a parameter in the dispersion modeling because there are no UF_6 reactions occurring as the plume disperses downwind.

The WAKE model (see Section 4.3.1.2.3.4.2) was used to predict downwind concentrations of uranium and HF. The peak toxicological exposure at the nearest site boundary is estimated to be 16.18 mg U intake (See Figure 4.3-50). The radiological exposure at the nearest site boundary associated with this release is estimated to be 0.169 rem (169 mrem) (See Figure 4.3-51). The HF exposure at the nearest site boundary associated with this release is estimated to be 5.64 ppm (See Figure 4.3-52). These exposure levels satisfy the off-site EGs for the EBE category and are very close to the AE category EGs. Note that the baseline scenario (F2) is represented by the top curve, at 0.65 mi (1050 m), on those figures. The other three curves are for different meteorological conditions and are discussed below.

Table 4.3-20 lists specific consequence estimates at the nearest site boundary (1050 m), 1 mile (1600 m), and 5 miles (8050 m) downwind from the postulated release point. The postulated release point is located above the roof on the west side of the toll transfer and sampling facility (building C-360). The nearest site boundary is located about 0.65 mile (1050 m) to the east of the building edge. As stated above, consequence estimates are less than their respective guidelines at the nearest site boundary. These consequences are slightly higher than those for the parent/daughter transfer event (see Section 4.3.2.2.10), but significantly less than those for the dropped cylinder event (see Section 4.3.2.2.15).

Effects on consequence estimates by varying scenario parameters. The following parameters were varied to obtain some uncertainty estimates and provide some characterization of the range of potential consequences: (1) meteorological conditions, (2) heat losses from reaction products to steam jet discharge piping and (3) reduced steam jet inlet steam pressure. The results provide perspective for interpretation of the baseline scenario. For each of these variations except meteorological conditions, consequence estimate comparisons are not shown for radioactive dose and HF exposure because these estimates display the same general trend as the uranium chemical toxicity dose.

Meteorological conditions - Consequence estimates were made for three additional meteorological conditions to compare with the baseline scenario (F2). These additional conditions are (1) a typical condition that does not provide low consequence estimates (D4), (2) a typical condition that provides low consequence estimates (C4), and (3) a typical condition similar to the baseline with slower winds (F1) to ensure F2 was bounding. For C4, the ambient temperature was assumed to be 80°F (26.7°C). This summer temperature is a typical summer daytime temperature under neutral atmospheric conditions. For F1, the same temperature was used as for the baseline temperature, 70°F (21°C).

Figures 4.3-50 through 4.3-52 show consequence estimates for uranium toxicity, radiological dose, and HF toxicity exposure resulting from baseline (F2), D4, C4, and F1 meteorological conditions. Consequence estimates under D4 conditions are slightly higher than under F2 conditions until between distances of 0.19 mi (300 m) and 0.25 mi (400 m). Although increased turbulent mixing associated with D stability can result in higher pollutant concentrations at ground level close to the source, by the time the plume is about .25 mi (400 m) from the source, the general relationship of increased atmospheric turbulence producing decreased pollutant concentrations has established itself. Under D4 conditions, uranium chemical toxicity estimates are below guideline values at distances of about 0.16 mi (250 m) and greater. Under C4 conditions, uranium chemical toxicity estimates are below guideline values at distances of about 0.10 mi (150 m) and greater. Neither C4 nor D4 condition estimates exceed radiological or nonradiological evaluation guidelines. Consequence estimates for F1 conditions never approach any of the evaluation guidelines.

Reduced jet steam inlet pressure - Previous operating experience has shown that the steam inlet pressure to the jet can be less than the operating range recommended by the vendor when multiple high steam loads occur on the C-360 building steam supply. This can affect the efficiency and pumping capabilities of the steam jet. There is not any published operating data for the lower steam pressures, but past operating experience has shown that the steam jet continues to operate adequately at lower than design pressures to evacuate the autoclaves. Therefore, performance data was extrapolated from the published jet operating data for an inlet pressure of 40 psig. While this is outside the vendor technical data, engineering judgment dictated that a conservative estimate of the pumping capability and thus UF_6 source term could be developed for the lower steam pressure. With these conservative assumptions, it was determined that as long as there was excess steam to react with all the UF_6 from the autoclave, conservative consequence estimates could be determined for the reduced steam pressure operation. (The reduced steam pressure would result in slightly higher source terms.) The analysis determined that there would be excess steam at the reduced inlet pressure of 40 psig. The reaction products and excess steam are released to the atmosphere at 919°F (492°C) with a velocity of 426 ft/sec (130 m/sec). The reaction product release rate to the atmosphere is 1.024 lbs/sec (0.464 kg/sec) for UO_2F_2 and 0.266 lbs/sec (0.121 kg/sec) for HF. Specific consequence estimates are not provided for the reduced steam pressure alone. See the heat loss discussion that follows.

Heat losses from reaction products to jet discharge piping - Heat lost from the reaction products through the jet discharge piping will result in lower discharge temperatures and velocities. Lower discharge temperatures and velocities result in higher consequence estimates. A simple convective and radiation heat transfer model was used to conservatively determine the heat lost from the reaction products. The model was used to analyze only the baseline 60 psig steam inlet pressure and the 40 psig steam inlet pressure discussed above. This would provide the most conservative and highest consequence estimates. For both the 60 psig steam and the 40 psig steam scenarios, the effects of heat loss resulted in a 25% reduction in discharge temperature and an 16% reduction in discharge velocity. This results to a uranium toxicity of 21.64 mg U and 19.43 mg U for 40 psig and 60 psig steam jet inlet pressures, respectively, at the site boundary for F2 meteorological conditions. Figure 4.3-53 shows the downwind consequence estimates associated with this variation.

The consequences that this exposure would have on different receptors are discussed in the following.

Local workers in the immediate area — Workers in the immediate area of the release would not be exposed to a significant uranium dose and/or HF exposure because the release would be outside the building at an elevated point. Any leakage from the autoclave would be very small. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the C-360 facility buildings is: (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the Lab — Workers in the Lab typically would not be exposed to a significant uranium dose and/or HF exposure because the release would be outside the building at an elevated point. Any leakage from the autoclave would be very small. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within the C-360 facility buildings is: (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the process buildings is (1) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The high velocity vertical release from the elevated point above the top of the building would provide mitigation of the consequences before workers would be exposed to the release. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor. Although not credited as an essential control, programmatic actions (i.e., Emergency Response) will be taken to terminate an identified UF_6 release for the protection of on-site workers.

Off-site public — The autoclave jetting UF_6 release to atmosphere event is not postulated to exceed EBE off-site exposure guidelines.

d. <u>Comparison With Guidelines</u>

Pigtail failure inside autoclave without jetting scenario. Further analysis is not required because this event is bounded by the cylinder failure inside autoclave event, Section 4.3.2.2.14.

Pigtail failure inside C-360 autoclave while jetting. For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However, the controls identified (i.e., see and flee) will maintain exposures within EGs 1 and 2 to the extent practical. Actions required of operational personnel in the Lab were evaluated, and they can be accomplished to meet the requirement for EG 6. In the event that the release ultimately affects habitability of the Lab, this receptor

would be able to evacuate the area before EGs 1 and 2 are exceeded. In addition, based on the controls identified (i.e., release detection, process isolation, and evacuation of areas upon detection of a release), EGs 1 and 2 would be met for workers outside the process building. Finally, an analysis was performed to determine the worst case scenario would not result in exceeding off-site EBE EGs.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent primary system failure during autoclave operations—maintain initial condition (normal operation, EG 5 only);
  1. Only cylinder pigtails that have been inspected and approved shall be are used.
  2. UF_6 pigtails and primary system, when connected for use, are leak-tested before UF_6 is introduced.
  3. UF_6 cylinders are not rolled unless the pigtail is disconnected during the operation to prevent breakage of a pigtail (toll transfer and sampling facility only).
- Autoclave steam pressure control system (C-333-A and C-337-A only)— maintain initial condition (normal operation, EG 5 only);
- Autoclave steam pressure control system (C-360 only)—maintain initial condition and detection of high autoclave pressure and isolation of steam from jet, EGs 1, 2 and 5);
- Autoclave water inventory control system—maintain initial condition (normal operation, EG 5 only);
- Autoclave high pressure isolation system — detection of high autoclave pressure and isolation of autoclave (EGs 1 and 2); and
- Autoclave primary containment system—maintain primary system integrity (EGs 1, 2, and 3).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The autoclave steam pressure control system, autoclave water inventory control system, autoclave high pressure isolation system, and the autoclave primary containment system are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the autoclave steam pressure control system, autoclave high pressure isolation system, autoclave water inventory control system, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.14 Cylinder Failure Inside Autoclave (Primary System Integrity)

a. <u>Scenario Description</u>

During autoclave operations that involve UF_6 liquefaction, the potential exists for cylinder failures that can result in a large release within the autoclave. Cylinder failure can be caused by pressure increases from heating (at normal operating temperatures) a cylinder containing abnormal contents [e.g., excessive UF_6 or excessive noncondensables (Sections 4.3.2.2.6 and 7)] or a damaged cylinder (Section 4.3.2.2.9). However, because of the autoclave controls and the administrative controls in place preventing these events from occurring, this event is an EBE.

This event was evaluated, and it was determined that the consequences could result in significant off-site/on-site impact if no mitigation were provided. These consequences are based on a liquid UF_6 release.

The primary concern associated with this event is the loss of primary system integrity and the release of liquid UF_6. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs

for the EBE frequency range. The only safety action required to meet these EGs is to establish primary containment. This action will prevent any significant release of material to the immediate area (i.e., protecting on-site personnel and maintaining habitability of the OMR/Lab) as well as limiting off-site public exposure within the EGs.

The initial conditions assumed in the analysis for this event are as follows:

- Initial temperature in the cylinder is conservatively 240°F (116°C), which is controlled by the autoclave steam pressure control system.
- The amount of water available for reaction with UF_6 is limited to the amount of water that is normally present inside the autoclave during heating conditions. This source of water includes (1) the steam supply for heating the autoclave, and (2) condensate collecting inside the autoclave. The autoclave water inventory control system provides additional assurance that condensate does not accumulate inside the autoclave.
- Administrative controls in place to prevent cylinder failure are as follows:
  1. A cold pressure check, indicating less than or equal to 10 psia (69 kPa), is performed for cylinders containing solidified UF_6 prior to initial heating [Cylinders that exceed this pressure, and cannot be cold-burped down to less than or equal to 10 psia (69 kPa), shall not be heated. This cold pressure check is not applicable for cylinders that contain liquid UF_6 that has been processed through the transfer or sampling operations and will be immediately reheated in an autoclave.]
  2. In the toll transfer and sampling facility, a cold pressure check, indicating less than or equal to 5 psia (34.5 kPa), is performed for daughter (receiving) cylinders that are intended to be immediately reheated in an autoclave. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 5 psia (34.5 kPa), shall not be filled.]
  3. Initial heat up of cylinders (2.5-, 10-, and 14-ton) is performed only with the cylinder valve in the 12 o'clock position.
  4. Cylinders are inspected for obvious damage that could threaten their ability to withstand a normal heating cycle prior to heating.
  5. UF_6 cylinders to be heated in an autoclave have their weight verified prior to heating. (Cylinders that exceed the shipping weight values are heated under controls specified in the TSRs that ensure adequate ullage.)

In addition to the administrative controls listed above, the high cylinder pressure system is available during the autoclave heating mode in C-360 (except when a cylinder is connected to the transfer manifold) and heating/feeding/heeling mode in C-333-A and C-337-A to detect high cylinder pressures and isolate the steam supply to stop the event prior to primary system failure.

However, even with these controls in place, a significant release of UF_6 could occur if the administrative controls/design controls fail to prevent a loss of the primary system integrity. This scenario is considered a limiting event for the primary system integrity failure and the EBE frequency category.

b. Source-Term Analysis

The limiting event for a loss of primary system integrity inside the autoclave is represented by the assumption that a 14-ton cylinder containing liquid UF_6 fails during a heating cycle inside the autoclave. During the heating cycle, the UF_6 expands. Ullage is lost when a cylinder is heated to an excessive temperature in relation to the amount of UF_6 in the cylinder. A cylinder is assumed to fail at some point above its hydrostatic test pressure limit. Once the primary system fails, the release of UF_6 material into the autoclave environment of saturated steam initiates the exothermic UF_6 and H_2O reaction, which generates HF and UO_2F_2 and causes a pressure increase inside the autoclave. The source-term for this event will address the amount of material that could be released prior to autoclave isolation and subsequent leakages/relief paths once isolation is completed.

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During operations in which the autoclave is closed for heating purposes, the autoclave has two penetrations that could allow release of material to the atmosphere: (1) the condensate drain line and, during autoclave jetting operations, (2) the steam jet exhaust. The condensate drain line will always be open when steam is applied to the autoclave. Any releases through this line would react with the condensate to form UO_2F_2 and HF. Both of these compounds are sufficiently soluble in water to allow very little, if any, release to the atmosphere. The steam jet exhaust will only be a release path if the cylinder failure occurs during jetting operations. The jet exhausts to the atmosphere at an elevated location outside the facility. All UF_6 is fully reacted with the steam before being released. The release from the jet exhaust is vertical at high velocity and temperature, thus minimizing concentrations of reactants. The autoclave steam pressure control system will isolate the jet from the autoclave prior to the autoclave isolation terminating the release to the atmosphere. The amount released from the jet exhaust during this event will be significantly smaller than the postulated limited UF_6 release through the autoclave jet described in Section 4.3.2.2.13, pigtail failure inside autoclave because the autoclave high pressure isolation system will isolate the autoclave and terminate the release. Once isolation of the autoclave is accomplished (typically less than 35 seconds for any significant release), the inflow of steam will be terminated to prevent additional moisture from entering the autoclave and reacting with the UF_6. The pressure inside the autoclave will continue to rise until the limiting reactant (i.e., the moisture) is consumed. An analysis indicates that the pressure inside the autoclave will not reach the maximum allowable working pressure (MAWP) for any of the autoclaves given any of the autoclave/cylinder configurations. Therefore, no release due to autoclave over pressurization is considered.

Subsequent leakage of released material from the autoclave as a result of leakage past valve seats and the autoclave shell seals is also considered. This leakage was quantified by assuming that an autoclave that was pressurized to 90 psig (0.72 MPa) would experience a time-based loss of no more than 10 psi/h (69 kPa/h) or 12 scfm. Two cases were considered. The first case assumed that the leakage occurs at the autoclave shell seal toward the top of the autoclave, resulting in a UF_6 vapor release. The release rate for this case was determined to be 3.5 lb/min (1.6 kg/min). The second case assumed that the leakage occurs at the autoclave shell seal toward the bottom of the autoclave, resulting in a liquid UF_6 release. The release rate for this case was determined to be 8.3 lb/min (3.8 kg/min). These release rates are extremely low relative to the rates evaluated in Section 4.3.2.2.10, pigtail/line failure outside autoclave. Additional leakage through the autoclave seal may also be experienced if some degradation occurs due to the environment inside the autoclave. However, the leak rate would have to be significant to result in any significant consequences beyond the immediate vicinity. This is not expected because less than 200 lb (91 kg) of HF is generated from the reaction with UF_6. Therefore, the releases from a closed autoclave would be maintained below the EGs for the EBE frequency category.

c. <u>Consequence Analysis</u>

This is not applicable because the amount of release is bounded by the event evaluated in Section 4.3.2.2.10.

d. <u>Comparison With Guidelines</u>

The comparison with guidelines is subdivided to address the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within these facilities is (1) visual indication of a “white smoke” (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the OMR/Lab — There are no required operator actions for this event. Therefore, the actions for this area are no different than those for the local worker.

Workers outside the process buildings — The essential controls for protecting the on-site personnel outside the facilities are (1) establish primary containment, (2) detection of the release, and (3) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential action is to establish primary containment by initiation of the autoclave high pressure isolation system. This minimizes release of material for all receptors. The second action is to detect the release of UF_6.
If workers outside of the process buildings have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — The consequences of this event will be bounded by the releases described in Section 4.3.2.2.10, pigtail/line failure outside autoclave, for the cases where isolation is accomplished. Therefore, off-site consequences will not exceed the EGs.

e. <u>Summary of SSCs and TSR Controls</u>

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls in place to prevent cylinder failure are as follows:
  1. A cold pressure check, indicating less than or equal to 10 psia (69 kPa), is performed for cylinders containing solidified UF_6 prior to initial heating. [Cylinders that exceed this pressure, and cannot be cold-burped down to less than or equal to 10 psia (69 kPa), shall not be heated. This cold pressure check is not applicable for cylinders that contain liquid UF_6 that has been processed through the transfer or sampling operations and will be immediately reheated in an autoclave.]
  2. In the toll transfer and sampling facility, a cold pressure check, indicating less than or equal to 5 psia (34.5 kPa), is performed for daughter (receiving) cylinders that are intended to be immediately reheated in an autoclave. [Cylinders that exceed this pressure, and cannot be cold burped down to less than or equal to 5 psia (34.5 kPa), shall not be filled.]
  3. Initial heat up of cylinders (2.5-, 10-, and 14-ton) is performed only with the cylinder valve in the 12 o'clock position.
  4. Cylinders are inspected for obvious damage that could threaten their ability to withstand a normal heating cycle prior to heating.
  5. UF_6 cylinders to be heated in an autoclave have their weight verified prior to heating. (Cylinders that exceed the shipping weight values are heated under controls specified in the TSRs that ensures adequate ullage.)

- Autoclave steam pressure control system—maintain initial condition (normal operation, EG 5 only);
- Autoclave water inventory control system—maintain initial condition (normal operation, EG 5 only);
- Autoclave high pressure isolation system—detection of high autoclave pressure and isolation of autoclave (EGs 1 and 2);
- Autoclave primary containment system—maintain primary system integrity (EGs 1, 2, and 3); and
- High Cylinder Pressure System—minimize the potential for primary system integrity failure (EGs 1 and 2)

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The UF_6 cylinders, high cylinder pressure system, autoclave steam pressure control system, autoclave water inventory control system, autoclave high pressure isolation system, and the autoclave primary containment system are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the UF_6 cylinders, high cylinder pressure system, autoclave steam pressure control system, autoclave high pressure isolation system, autoclave water inventory control system, and administrative requirements for procedures and training of workers for evacuation actions.

4.3.2.2.15 Cylinder Failure Outside Autoclave (Primary System Integrity)

a. <u>Scenario Description</u>

During feed, transfer, sampling, and withdrawal operations, handling and moving liquid- and solid-filled cylinders is a normal operation. During cylinder moving operations outside of the autoclaves, it is possible that the cylinder could suffer a physical integrity failure that could result in a large UF_6 release. The physical integrity failure can be caused by initiators such as dropping a liquid-filled cylinder, dropping a heavy component onto a liquid-filled cylinder, filling a cylinder contaminated with hydrocarbons, or impact from a vehicle. After an accidental drop of a liquid-filled cylinder at PORTS (see Section 4.3.1.2.3.1.2), various preventive controls (operator training, crane design and inspections, etc.) were instituted at both GDPs to reduce the probability of occurrence for this event. Based upon these preventive controls, an integrity failure event of a liquid-filled cylinder (i.e., liquid cylinder drop) occurring outside of an autoclave is classified in the EBE frequency category.

This scenario evaluates a physical integrity failure of a liquid-filled cylinder outside of an autoclave (specifically dropping a liquid-filled cylinder). The initial conditions assumed in the analysis of this event are as follows:

- Initial temperature in the cylinder is conservatively 240°F (116°C), which is controlled by the autoclave steam pressure control system for autoclave facilities (withdrawal facilities operate at much lower temperatures and no control is required);
- The following administrative controls are in place:
  1. UF_6 cylinder handling cranes are inspected daily (prior to first use) for obvious defects associated with the lifting system;
  2. The dual liquid UF_6 handling cranes located in each of the withdrawal facilities are not loaded or operated at the same time;
  3. No cylinder or other load (up to the cranes' rating) is moved over a cylinder containing liquid UF_6 (toll transfer and sampling facility and withdrawal facilities only);
  4. No liquid-filled cylinder is moved over a closed autoclave housing a cylinder containing liquid UF_6 (feed facilities only);
  5. No cylinder or other load (up to the cranes' rating) is moved over the C-337-A jet station barrier frame, or the heated housings and common UF_6 primary system piping between the autoclaves (feed facilities only);
  6. Only approved cylinder handling equipment is used by qualified operators for maneuvering cylinders and other heavy loads;
  7. Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;

8. Cylinders to be filled with UF_6 are verified as passing a current (within 5 years) hydrostatic pressure test;
9. Cylinders containing liquid UF_6 are staged in a designated area until solidified (this area is restricted so that routine vehicle traffic is not allowed-vehicles are required to support certain maintenance evolutions); and
10. UF_6 cylinders to be filled or heated are inspected for obvious damage that could threaten their ability to withstand normal filling, heating and moving.
11. The two UF_6 cylinder handling cranes located on the same rail at C-333-A shall not be loaded or operated at the same time.

The physical integrity failure event of a liquid-filled cylinder outside of an autoclave was evaluated for the withdrawal facilities, the feed facilities, and the toll transfer and sampling facility. These evaluations determined that a significant release of UF_6 could occur if the administrative controls/design controls fail to prevent a failure of the cylinder's primary system integrity. The liquid-filled cylinder drop scenario is considered a limiting event for the primary system integrity failure and the EBE frequency category.

The primary concern associated with this event is the release of liquid UF_6. The applicable EGs (see Table 4.2-2) associated with this event are EGs 1 and 2, as well as EG 6 in the EBE frequency range. EG 3 would not apply since the cylinder's integrity is defined to fail in the scenario description and no other containment is provided for this type of event. The essential safety actions associated with meeting these EGs for a cylinder failure outside an autoclave include detection of the release and emergency response to evacuate the immediate vicinity and downwind locations to minimize on-site/off-site personnel exposure.

b. <u>Source-Term Analysis</u>

A source-term analysis simulated dropping of a type 48G thin-wall cylinder containing the maximum permissible quantity of 28,000 lb (12,700 kg) of liquid UF_6 at 240°F (116°C) [as specified in ANSI N14.1]. The cylinder is assumed to be dropped as it is being moved outdoors which results in a physical integrity breach developing at the bottom of the cylinder. The liquid UF_6 inside the cylinder is assumed to be at 240°F (116°C) with an associated vapor pressure about 6 times atmospheric [88 psia (0.61 MPa)]. The release duration is assumed to be fixed at 5 min (300 s). The average liquid UF_6 release rate is approximately 93.3 pounds per second (42.3 kg/s). To obtain this release rate with 88 psia (0.61 MPa) internal pressure, the breach would have an effective diameter of 2.75 in. (0.07 m). The presence or absence of noncondensable gases is not significant in this case because the breach diameter is calculated from a fixed release duration (i.e., 300 s), not vice versa.

As the liquid UF_6 is released, 62.5 percent [17,500 lb (7900 kg)] would be flashed to vapor and the remaining 37.5 percent [10,500 lb (4800 kg)] is assumed to become entrained solid UF_6. Both the vapor and the solid are approximated to be at the equilibrium temperature of 134°F (56.6°C) at 1 atm (0.101 MPa). The release is assumed to be just above ground level and pointed directly toward the ground (i.e., the released UF_6 would have no net horizontal velocity). The released UF_6 is assumed to be 5.5 percent ^{235}U, by weight.

c. Consequence Analysis

The atmospheric dispersion of UF_6 associated with dropping a liquid-filled cylinder has been evaluated. The following discussion of the consequence analysis is broken into five sections. The first subsection details a baseline scenario that estimates conservative (i.e. reasonable upper-bound) consequences from a liquid UF_6 release from a dropped cylinder. The second subsection discusses the effect on consequence estimates of varying input parameters from those used in the baseline scenario. The third subsection describes maximum estimates of downwind uranium deposition that would occur with the baseline scenario. The fourth subsection compares the consequence estimates from the baseline scenario developed using the HGSYSTEM/UF_6 model with the more widely used Gaussian plume method. The final subsection discusses uncertainties in the analysis that have not been quantified.

Baseline scenario. Parameters that define the base scenario are listed in Table 4.3-8. This scenario includes adverse meteorological conditions (i.e., conditions resulting in high-consequence estimates), consisting of a stable atmosphere and a low wind speed [Pasquill-Gifford stability class F and a wind speed of 1 m/s (2 mph), or simply F1]. These conditions occur at PGDP 8.4 percent of the time on an annual basis (averaged over the 5-yr period 1988-1992, inclusive).

An ambient air temperature of 40°F (4.4°C) was selected for these simulations because that temperature results in relatively high consequence estimates compared to other temperatures that occur under F1 conditions. Lower ambient temperatures [to 30°F (-1°C)] were also evaluated and indicated marginally higher consequences. However, lower temperatures introduce condensation mechanisms for which there is less confidence in model results. Therefore, 40°F (4.4°C) is the lowest ambient temperature used in this analysis. During 1992, ambient temperatures were greater than 40°F (4.4°C) about 85 percent of the time.

An ambient relative humidity of 70 percent was selected for the baseline scenario because it is a typical relative humidity for a stable atmosphere with low wind speeds at PGDP. During 1992, the median relative humidity under F1 conditions was 65 percent. Higher relative humidities (e.g., 90 percent) would result in only minimally higher consequence estimates because the corresponding increase in specific humidity (the humidity expressed as the number of grams of water vapor per kilogram of moist air) at 40°F (4.4°C) is very small. The maximum relative humidity under F1 in 1992 was 90 percent. The maximum specific humidity (100 percent relative humidity) associated with an ambient air temperature of 40°F (4.4°C) is 5.5 g of water vapor per kilogram of moist air. Twenty percent of that amount (the difference between 70 percent and 90 percent relative humidity) is 1.1 g of water vapor per kilogram of air. This slight difference in water vapor available for UF_6 hydrolysis reactions would result in virtually no change in downwind consequence estimates.

Because the released UF_6 would impact with ground directly, all of its momentum would be transferred to the ground surface, and the plume would initially mix with the ambient air. The degree to which mixing with the ambient air would occur is unknown. Previous dispersion studies have used an initial mixing factor (ratio of the volume of ambient dry air to the volume of released UF_6) of 10. For this analysis, 50 was selected as the volume mixing ratio because 50 results in slightly higher consequence estimates than 10 does for downwind distances greater than 980 ft (300 m).

Although about 40 percent of the UF_6 is initially solid at the release point, the baseline scenario assumes that all of the solid is entrained in the airborne plume and that none of the UF_6 deposits near the release point. The entrained solid would quickly sublimate to UF_6 vapor while it is airborne; then it would react with atmospheric water vapor and be dispersed downwind. This assumption results in maximum health consequence estimates downwind of the release point because a larger mass of UF_6 is dispersed downwind. On the basis of historical accidental UF_6 releases (see Section 4.3.1.2.3.1), some initial deposition would be expected to occur near the release point.

As the UF_6 plume disperses downwind, objects projecting vertically (e.g., grass, trees, buildings) will cause mechanical turbulence, which could affect the dispersion characteristics where a greater amount of mechanical turbulence is generated by taller objects. The surface roughness is typically about one-tenth of the mean height of these objects and is a parameter used in calculating mechanical turbulence in the lower atmosphere. Surface roughness may be calculated rather than estimated from the typical height of objects for a given area, but this calculation requires detailed wind measurements that are not usually available. Normally, roughness is estimated from a limited number of field experiments that have occurred over a variety of terrains (see Reference 4.5). On the basis of these field experiments and the resulting roughness classifications, a surface roughness height of 1 in. (0.03 m) was selected because of site characteristics (i.e., long flat buildings located at and near the facility) for the baseline scenario. A roughness of 1 in. (0.03 m) is typical of low grass areas that would be found in a rural environment or a large parking lot found in an urban environment and results in relatively high downwind consequence estimates.

HEGADAS/UF_6 (see Section 4.3.1.2.3.4) was used to predict downwind concentrations of uranium and HF. Figures 4.3-23 through 4.3-25 show estimated downwind consequences associated with the baseline scenario. Note that the baseline scenario (F1) is represented by the top curve in these figures (the other two curves are for different meteorological conditions and are discussed below). Consequence estimates are expressed in terms of uranium chemical toxicity dose (see Figure 4.3-23), radioactive toxicity dose (see Figure 4.3-24), and equivalent HF chemical exposure concentration (see Figure 4.3-25). Calculation of these consequence values are made using concentration estimates from HEGADAS/UF_6. The exposure time from a passing plume was limited to 30 minutes. Exposures greater than 30 minutes would result in slightly higher consequence estimates.

Table 4.3-9 lists specific consequence estimates at the nearest site boundary, 1 mile (1600 m), and 5 miles (8050 m) downwind from the potential release point. The potential release point is assumed to be located outside the eastern entrance of the cylinder transfer building (Building C-360). This point was chosen because it represents a potential release location which would result in maximum consequences at the site boundary. The nearest site boundary is located about 0.68 mile (1100 m) to the east of the potential release point. Calculated values of the consequence parameters were compared to EBE guidelines values for uranium (25 rem for U radiological toxicity, and 30 mg U intake for U chemical toxicity), and to the Emergency Response Planning Guidelines (ERPG-2) for HF (20 ppm for 1-hour).

As shown in Figures 4.3-23 through 4.3-25, for F1 atmospheric conditions, the guideline value of 30 mg inhaled uranium is exceeded to a downwind distance of about 3.4 miles (5500 m), the 25 rem radiological toxicity dose is exceeded out to about 0.3 miles (500 m), and the 20 ppm 1-h equivalent HF

exposure is exceeded to a downwind distance of about 2.3 miles (3750 m).

Effects of varying scenario parameters on consequence estimates. The following parameters were varied to parameterize some of the uncertainty estimates: (1) meteorological conditions (specifically, atmospheric stability, wind speed, temperature, and relative humidity), (2) initial mixing of the released UF_6 with ambient air, (3) initial deposition of solid UF_6 at the release point, (4) surrounding surface roughness, and (5) plume lift-off. The difference in consequence estimates that result by varying these parameters are presented in this analysis to contribute to the understanding of baseline scenario results (as a reminder, the results from the baseline scenario are considered to provide upper-bound estimates resulting from atmospheric release of UF_6 associated with dropping a single, liquid-filled cylinder). The consequences presented in this section are less than the baseline scenario but are more probable and/or provide a lower-bound estimate of consequences; therefore, they are used to establish a range of potential consequences. For the initial mixing, initial deposition, and surface roughness sensitivity discussions, consequence estimates comparisons are not shown for radiological toxicity dose and HF exposure because these estimates display the same general trend as the uranium chemical toxicity dose.

Meteorological conditions—Consequence estimates were made for two additional meteorological conditions to compare with the baseline scenario: (1) typical conditions that do not provide favorable or unfavorable consequence estimates [represented by neutral atmospheric stability (Pasquill-Gifford stability class equal to D) and moderate wind speeds (4 m/s = 9 mph)] and (2) typical conditions that provide relatively low-consequence estimates [represented by a slightly unstable atmosphere (Pasquill-Gifford stability class equal to C) with moderate wind speeds (4 m/s)]. These representative meteorological conditions were chosen based on a screening analysis performed using the simple Gaussian plume equation.

Table 4.3-10 shows the results of this screening analysis, where normalized concentration values (concentration, χ, divided by the source-term, Q, therefore called χ/Q values) were calculated at a downwind distance of 0.62 mile (1000 m), assuming that the source was at ground level and that plume constituents were not reactive. The values of χ/Q in Table 4.3-10 are ordered such that values near the top of the table represent more favorable dispersion conditions and values near the bottom represent less favorable dispersion conditions.

The most frequently occurring meteorological condition at PGDP is D4 (stability class D, neutral, and wind speed of 4 m/s), which occurred 14.9 percent of the time on an annual basis. As shown in Table 4.3-10, meteorological conditions that would result in equal or lesser consequences than those produced by D4 conditions occur 47 percent of the time. Although situation D2 (stability class D and wind speed of 2 m/s) occurs almost as frequently (14.6 percent of the time) on an annual basis, and results in higher consequence estimates, an additional criterion for selecting D4 is the historical use of similar meteorological conditions in regulatory applications. The U.S. Department of Transportation has used D4.5 to calculate evacuation distances along transportation corridors for accidents involving toxic chemicals (see References 71 and 72) and the U.S. Army has used D3 as the default value for "conservative-most-likely" meteorological conditions for assessing hazards associated with accidental releases of chemical warfare agent (see References 73 and 74). Based on the selections of similar atmospheric conditions and the frequency of occurrence at PGDP, D4 was chosen to represent typical conditions that do not bias the result toward favorable or unfavorable consequence estimates. The

temperature of 40°F (4.4°C) and relative humidity (70 percent) were not varied from the baseline scenario [which used F1 (stability class F, stable, and a wind speed of 1 m/s) meteorological conditions].

The C4 meteorological condition occurs about 6.5 percent of the time. As shown in Table 4.3-10, consequence estimates would be more favorable or equal to C4 about 22 percent of the time. A very unstable atmosphere with light wind speeds (i.e., A2) occurs slightly more frequently (6.6 percent vs. 6.5 percent), but this is the most favorable scenario of all (i.e., predicts the lowest hazard estimates) and is therefore, considered too propitious for the purpose of this comparative analysis. Other conditions that result in lower consequence estimates occur less frequently (e.g., D16 and C7). Therefore, C4 was selected to represent a typical condition that results in relatively low consequence estimates. The temperature and relative humidity for this scenario were selected to represent typical summer, daytime conditions when C stability is likely to occur. The temperature used for this comparative scenario was 80°F (27°C) and the relative humidity was 50 percent.

Figures 4.3-23 through 4.3-25 show consequence estimates for C4 and D4 meteorological conditions. For D4, consequence estimates exceed guideline values downwind to about 2.2 miles (3500 m), 0.2 mile (300 m), and 2.2 miles (3500 m) for uranium chemical toxicity dose (30 mg), radiological toxicity dose (25 rem), and HF (20 ppm) exposure, respectively. Although D4 conditions result in lower downwind consequences when compared with those estimated for F1, all of the guideline values are exceeded at the nearest site boundary, which is about 0.68 mile (1100 m) from the release point. For C4 conditions, consequence estimates exceed guideline values downwind to about 0.59 mile (960 m), 0.12 mile (200 m), and 0.68 mile (1100 m) for uranium chemical toxicity dose, radiological toxicity dose, and HF exposure, respectively. Under C4 conditions, estimated consequences are at or below guideline values at the nearest site boundary.

Initial mixing with the ambient air — Figure 4.3-26 shows the comparison of consequence estimates (specifically, consequence estimates for uranium chemical toxicity dose) between two different mixing ratios of the volume of ambient dry air to the volume of released UF_6. For the baseline scenario, a value of 50 was used for the mixing ratio and was compared with a value of 10, which has been used in previous dispersion analyses. The results show virtually no difference between consequence estimates. A mixing value of 50 results in slightly higher downwind consequence estimates at distances beyond 984 ft (300 m) because the initial dilution with ambient air causes the plume to be cooler, and therefore the plume would have dispersed less in the vertical direction at a particular downwind distance. At distances less than or equal to 984 ft (300 m), plume concentrations would be slightly higher with a lower mixing ratio (i.e., lower initial dilution) even though the plume temperature is higher. At these close distances, sufficient vertical spreading has not occurred to reduce ground-level concentrations appreciably. It is expected that higher initial mixing ratios would also result in virtually the same downwind consequence estimates.

Initial deposition of solid UF_6 — Figure 4.3-27 shows the comparison of consequence estimates between no initial deposition of solid UF_6 and 40 percent initial deposition of solid UF_6 [the maximum initial deposition expected because about 37.5 percent of the UF_6 flashes to solid at the time of atmospheric release]. In calculating 40 percent initial deposition of UF_6, the solid UF_6 was assumed to be mixed initially with the ambient air using a mixing ratio of fifty (as detailed above) and then allowed to settle. Although 60 percent of the UF_6 used in the baseline scenario was input into the

HEGADAS/UF_6 model, downwind consequence estimates are about 63 percent of those predicted with the baseline scenario at a downwind distance of 1 mile (1600 m). This 3 percent difference results from a lower estimated plume temperature associated with the lower mass of UF_6 dispersed into the atmosphere. Because the plume temperature is lower, the plume disperses less in the vertical direction at a particular downwind distance, thus increasing ground-level concentrations. If a greater amount of solid UF_6 could initially deposit, then this effect would be somewhat more prominent.

Surface roughness — Figure 4.3-28 shows the comparison of consequence estimates between the two roughness heights, 1 in. (0.03 m) used in the baseline scenario and 3.3 ft (1.0 m). A roughness height of 3.3 ft (1.0 m) is typically associated with an urban or heavily forested area, where mechanical mixing is high and resulting ground-level concentrations are generally lower than rural areas. Very close to the release point [i.e., within 160 ft (50 m)] there is little difference in consequence estimates because this is the downwind region where the plume is very dense relative to air and is rapidly spreading horizontally due to gravitational slumping. From 160 to 1300 ft (50 to 400 m), the difference in consequence estimates increases, so that at 1300 ft (400 m), consequence estimates from 1 in. (0.03 m) roughness are about 8 times that of 3.3 ft (1.0 m) roughness. For this downwind distance range, mechanical turbulence has the greatest effect on dispersion because the plume is closest to the ground and has not yet spread appreciably in the vertical direction. At farther downwind distances, the plume begins to disperse in the vertical direction, and the difference between consequence estimates decreases. At 0.68 mile (1100 m) (the downwind distance to the nearest site boundary), consequence estimates from 1 in. (0.03 m) roughness are about 6 times that of 3.3 ft (1.0 m) roughness. At 1 mile (1600 m), 2 miles (3200 m), and 5 miles (8050 m), consequence estimates from 1 in. (0.03 m) roughness are about 5, 4, and 3.5 times higher than the 3.3 ft (1.0 m) roughness, respectively.

Because roughness at the site is not known, the baseline scenario value of 1 in. (0.03 m) was selected to provide upper-bound consequence estimates, and the 3.3 ft (1.0 m) urban roughness value was selected to provide lower-bound estimates. Actual roughness at the site would be a composite of many terrain types and would vary as the plume moves downwind. Therefore, consequence estimates for actual site roughness would probably fall somewhere between the two curves shown on Figure 4.3-28.

Plume lift-off — Lift-off of the plume centerline was simulated by allowing the UF_6 in the plume to fully react to UO_2F_2 and HF before dispersing downwind, thereby raising the plume temperature sufficiently to induce buoyancy. An initial volume mixing ratio (ambient air to released UF_6) of approximately 300 was needed to provide enough water vapor for full reaction assuming an instantaneous reaction rate. This high initial mixing ratio and instantaneous reaction rate simulate a very turbulent condition at the release point, bringing in enough water vapor to rapidly react with the released UF_6 or a situation in which there was a very high amount of water vapor present per unit volume of air [e.g., during a drizzle episode similar to the precipitation that occurred during the PORTS occurrence in 1978 (see Section 4.3.1.2.3.1.2)].

The WAKE model, developed to simulate dispersion of buoyant, fully reacted plumes, was used to predict downwind consequence estimates for the plume lift-off case. Although WAKE is primarily for releases from or nearby buildings, it may be used for releases outside of a building wake by assuming no building dimensions. Figure 4.3-29 shows the comparison of consequence estimates between the plume lift-off case and the baseline case (no plume lift-off). For the lift-off case, the plume centerline

reaches a height of approximately 410 ft (125 m) due to buoyant rise. Because concentrations are assumed to be highest at the plume centerline, ground-level concentrations are much lower with plume lift-off case because of the high plume centerline height. At 1 mile (1600 m), 2 miles (3200 m), and 5 miles (8050 m), consequence estimates from the plume lift-off case are about 118, 32, and 10 times less than the baseline case, respectively. With plume lift-off, the 30 mg uranium uptake guideline value is not exceeded at any downwind distance.

Downwind uranium deposition. A postprocessor in HGSYSTEM/UF_6 is used to estimate deposition of uranium downwind of the release point. Deposition depletes material from the plume, but there is no feedback mechanism in the model between deposition and plume dispersion, chemistry, and thermodynamics (see Section 4.3.1.2.3.4). Consequently, the deposition estimates presented in this section are considered to overpredict actual mass of deposited material per unit area.

The mass of uranium deposited along the ground, averaged over the area passed by the plume, was calculated from results obtained using the postprocessor. The potential concentration of uranium in the soil, C_s (milligrams of uranium per gram of dry soil), is approximated as:

$$C_s = \frac{m_U}{A d \rho_s}, \tag{23}$$

where

m_U is the mass of uranium deposited at a particular downwind distance (mg),
A is the area of the plume passage (m^2)
d is the depth of the surface soil, assumed to be 0.01 m (0.4 in.), and
ρ_s is the density of the surface soil, assumed to be 1×10^6 g/m^3.

The potential surface soil contamination, AC_s (picocuries per gram of dry soil) is calculated as:

$$AC_s = C_s \times SA_U, \tag{24}$$

where SA_U is the specific activity of uranium enriched to 5.5 percent ^{235}U (3820 pCi/mg).

Figure 4.3-30 shows AC_s vs downwind distance for baseline scenario conditions. Because of the large inaccuracies in the calculation method at long downwind distances (i.e., unrealistically high surface contamination estimates), values of AC_s are plotted out only to 0.62 mile (1000 m). As a comparison with these estimated values, the NRC has established a soil contamination limit of 35 pCi/g that allows for unrestricted use of sites that have been contaminated with uranium (see Reference 75). The predicted surface contamination estimates from a breach in a liquid-filled cylinder exceed this unrestricted use limit by several orders of magnitude.

Figure 4.3-31 shows rough estimates of cumulative percent uranium removed from the plume for downwind distances to 3300 ft (1000 m). At 3300 ft (1000 m), about 17 percent of the uranium is estimated to have deposited.

Comparison of results with those from the gaussian plume method. The Gaussian plume method was one of the earliest approaches used to estimate downwind hazards from accidental releases

for regulatory applications. In the Gaussian method, concentration profiles at any downwind distance in the horizontal crosswind direction (perpendicular to the transport direction) and vertical direction are represented by Gaussian (normal) distributions. Because standard Gaussian models assume that plume constituents are nonreactive and neutrally buoyant, all UF_6 hydrolysis reactions are assumed to occur prior to downwind dispersion, similar to the methodology outlined in NUREG-1140 (see Reference 72 and Section 4.3.1.2.3.3.2). For this comparison, the NUREG-1140 methodology was applied to calculate steady-state uranium concentrations [see Eq. (12) in Section 4.3.1.2.3.3.2]. Some changes were made in applying the NUREG-1140 method to maintain a consistency for comparison with HEGADAS/UF_6 and to simulate the baseline release scenario: (1) the breathing rate was not applied in the equation because only steady-state concentrations were calculated, (2) the source-term, Q, is the quantity of uranium released [18,900 lb (8600 kg)] rather than UF_6, and (3) the normalized concentration, χ/Q (s/m^3), was obtained using the Gaussian plume equation, assuming the release was at ground-level with no buoyant plume lift-off.

Figure 4.3-32 shows the results of the comparison of results between HEGADAS/UF_6 and the Gaussian plume method. The Gaussian plume method estimates higher consequence estimates (represented by steady-state uranium concentration in the figure but also higher for radiological dose and HF exposure) for all downwind distances. Differences in consequence estimates are roughly proportional to differences in plume cross-sectional areas predicted by the two models. HEGADAS/UF_6 predicts a larger plume cross-sectional area for all downwind distances due to initially rapid dense gas plume spreading. Because the pollutant mass is distributed over a larger horizontal area, the resulting plume concentration is less. The treatment of UF_6 chemistry and thermodynamics and the calculation of transient exposure also contribute to the difference in estimates, but to a smaller degree.

Uncertainties not quantified. The baseline scenario simulates dispersion of a dense, ground-hovering plume under common meteorological conditions during the early morning (stable atmosphere and light wind speeds). Such a plume would flow much like water, seeking low spots and being deflected around rises. The plume would tend to pool in low-lying areas capturing a significant fraction of the plume mass and leading to the formation of small local areas of high concentrations. Pooling would tend to occur at downwind distances close to the release point where the plume is most dense and could possibly limit concentrations further downwind. A dense plume would tend to flow into and pool in low areas near the release point, essentially acting as retaining basins for the released UF_6 and reaction products. Pooling would act to effectively reduce the uranium concentrations in the plume and extend the release time. As a result, exposures would be reduced.

This analysis assumes that the release would occur outdoors and not be affected by a building wake. However, most of the operations with liquid-filled cylinders occur indoors. An indoor release would result in lower consequence estimates because the plume would be diluted with air inside the building. Also, the building would tend to retain the released UF_6, lowering the release rate to the atmosphere and reducing downwind consequence estimates.

The following sections describe how the consequences are addressed for the different receptors.

Local workers in the immediate area — Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and

flee policy requires personnel to evacuate the area for their own protection. The essential method of detection for workers within these facilities is: (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release.

Operational personnel in the ACR/OMR/Lab — There are no required operator actions for this event. Therefore, the actions for this area are no different than those for the local worker.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the facilities are (1) detection of the release and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or odor. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor.

Off-site public — As indicated in the consequence analysis, this event could exceed the off-site EGs out to 3.4 miles (5500 m) assuming worst case conditions and no mitigative action. If the event does occur, the plant's Emergency Plan identifies contingency actions that can be taken to minimize off-site public exposure to the release. Reviewing the variations on the parameters for the analysis indicates that the consequences of the event could vary significantly depending on whether the plume rises or stays low to the ground. Additionally, the consequences are based on a 30-minute exposure at the centerline of the plume (which are conservative based on the HF concentration). Anticipated response (i.e., to HF odor) would tend toward immediate movement to avoid the plume which would also reduce the consequences of the event.

d. Comparison With Guidelines

For workers in the immediate area, specific exposures were not calculated because of variables and uncertainties associated with the calculations and because of obvious evacuation actions that would be taken by the worker. However the controls identified (i.e., see and flee) will maintain exposures within EGs 1 and 2 to the extent practical. No actions are required of operational personnel in the control area; therefore, EG 6 is not applicable to this scenario. In addition, based on the controls identified (i.e., release detection and evacuation of areas upon detection of a release), EGs 1 and 2 would be met for workers outside the process buildings. Finally, the analysis performed determined that the worst case scenario would result in off-site exposures exceeding the EBE EG for uranium (30 mg U).

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent cylinder failure—maintain initial condition (normal operation, EG 5 only);
  1. UF_6 cylinder handling cranes are inspected daily (prior to first use) for obvious defects associated with the lifting system;

2. The dual liquid UF_6 handling cranes located in each of the withdrawal facilities are not loaded or operated at the same time;
3. No cylinder or other load (up to the cranes' rating) is moved over a cylinder containing liquid UF_6 (toll transfer and sampling facility and withdrawal facilities only);
4. No liquid-filled cylinder is moved over a closed autoclave housing a cylinder containing liquid UF_6 (feed facilities only);
5. No cylinder or other load (up to the cranes' rating) is moved over the C-337-A jet station barrier frame, or the heated housings and common UF_6 primary system piping between the autoclaves (feed facilities only);
6. Only approved cylinder handling equipment is used by qualified operators for maneuvering cylinders and other heavy loads;
7. Cylinder cleaning requirements conform to ANSI N14.1 for cylinder cleaning;
8. Cylinders to be filled with UF_6 are verified as passing a current (within 5 years) hydrostatic pressure test;
9. Cylinders containing liquid UF_6 are staged in a designated area until solidified (this area is restricted so that routine vehicle traffic is not allowed-vehicles are required to support certain maintenance evolutions);
10. UF_6 cylinders to be filled or heated are inspected for obvious damage that could threaten their ability to withstand normal filling, heating and moving; and
11. The two UF_6 cylinder handling cranes located on the same rail at C-333-A shall not be loaded or operated at the same time.

- Autoclave steam pressure control system — maintain initial condition (normal operation, EG 5 only);
- UF_6 cylinder handling cranes — maintain primary system integrity (EGs 1 and 2);
- Liquid UF_6 cylinder handling equipment (scale carts, C-360 elevator and levelator)— maintain primary system integrity (EGs 1 and 2);
- Operator training for required actions — evacuate area of releases (EGs 1 and 2 only).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The autoclave steam pressure control system, UF_6 cylinder handling cranes, and liquid UF_6 cylinder handling equipment (scale carts, C-360 elevator and levelator) are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the autoclave steam pressure control system, UF_6 cylinder handling cranes, scale carts, C-360 elevator and levelator, and administrative requirements for procedures and training of workers for cylinder handling requirements and evacuation actions.

4.3.2.2.16 Large Fire (External Event)

a. <u>Scenario Description</u>

During operations associated with withdrawal, feed, toll transfer, sampling, and cylinder handling and storage operations, the potential exists for fires to occur. Small fires can be caused by welding and burning operations, electrical failures, vehicle accidents, etc. The withdrawal operations are performed in the process buildings that house lube oil and the associated fire-related concerns are addressed in the large fire event for the cascade facilities (see Section 4.3.2.1.9).

The feed and toll transfer facilities (C-360, C-360-A) and the C-745-R1 Cylinder Changeout Building do not contain any significant quantities of flammable or combustible materials. An assessment of these facilities concluded that an unmitigated fire would not compromise primary systems integrity or result in a release of UF_6. In addition, an unmitigated fire will not threaten the structural steel or the steel roof decking to cause collapse of these buildings. The assessment did not credit the sprinkler systems or manual fire fighting capabilities for the feed and toll

transfer facilities. Compensatory administrative controls are implemented for transfer of lube oil in the process building truck alleys near the feed facilities. The potential fire hazard is mitigated by (1) notifying site fire services prior to lube oil deliveries, (2) fire hydrants in the immediate area are verified to be operable prior to lube oil deliveries, and (3) a pumper truck and firefighters are present at the lube oil unloading station during unloading operations.

The cylinders in storage yards are exposed to combustible materials (i.e., fuel) from the equipment used in the cylinder handling/storage operations. If a large fire occurs in the cylinder storage yards, it has the potential to liquefy the contents of a cylinder to the point where the cylinder could hydraulically rupture. This cylinder rupture due to a large fire could result in a significant UF_6 release. The only mitigation source provided for large fire event in the cylinder storage yards is the on-site fire department. The plant Fire Protection Program (which includes the on-site fire department) is described in Chapter 5.4 and provides a high degree of protection against fires that could occur within the cylinder storage yards. The following preventive controls are used to minimize the potential for a large fire occurring during cylinder handling/storage operations:

- The presence and introduction of flammable and combustible materials in the cylinder yards are controlled by approved procedures.
    1. The following sources of flammable and combustible materials, as a minimum, are considered in the development of these procedures: cylinder handling equipment, adjacent vehicle traffic (including fuel trucks), any potential refueling operations, etc.;
    2. The following protection schemes, as a minimum, are considered in the development of these procedures: passive barriers, spatial separation, inspections, and other standard fire prevention practices;
- Daily inspection (when used) of cylinder handling equipment for obvious visual defects associated with the lifting system and potential fuel/hydraulic leaks;
- Communication capability between the cylinder handling operators and with the fire department/emergency response personnel is available; and
- Only approved cylinder handling equipment is used by qualified operators for maneuvering UF_6 cylinders or other heavy loads.

Should all of these measures fail, it is assumed that a fire could be initiated during cylinder handling operations, due to vehicle accidents, or due to a small aircraft crash and sufficient heat added such that the integrity of the cylinders could be compromised from the fire. The scenario during handling operations is the most likely method because of the proximity of the handling equipment to the cylinders (i.e., administrative controls are in place to control the presence of any other significant fuel source). Cylinder handling equipment is made like other large industrial equipment (e.g., cranes), and failure modes leading to fires would be similar. It is assumed that a line containing combustible fuel (i.e., fuel, hydraulic, lube oil) fails and releases fuel onto a hot surface, causing ignition of the fuel. Although some of the fuel would be burned up as it comes out of the line, it is assumed the remainder of the fuel also catches fire as well and starts to form a pool or flows in such a way that an entire cylinder is engulfed in the fire long enough to cause cylinder failure as a result of the hydraulic pressures generated. Operator response to the event (i.e., evacuate immediate area and contact emergency response personnel) will occur quickly, and emergency response personnel will respond quickly. If emergency response is not sufficient to prevent cylinder failure, it is assumed for analysis purposes that a cylinder will fail due to liquefaction of the UF_6 and hydraulic pressures generated.

This event was evaluated, and it was determined that the consequences could result in significant on-site impact if no mitigation were provided. These consequences are based on a liquid UF_6 release from a cylinder breach caused by a large fire in the storage yards. Due to preventive measures in place, this event is classified in the EBE frequency category.

The primary concern associated with this event is the loss of primary system integrity and the release of liquid UF_6. The applicable EGs associated with this event are EGs 1 and 2, as well as EG 6 in the EBE frequency range. Since there is no primary containment system for cylinder failures, EG 3 does not apply. The essential safety actions associated with meeting these EGs for a large fire that could result in a loss of cylinder physical integrity include (1) detection of the release, (2) notification of emergency response personnel, and (3) emergency response to evacuate the immediate vicinity and downwind locations so that the exposure of on-site personnel exposure is minimized.

b. Source-Term Analysis

It is assumed that a fire could be initiated during cylinder handling operations (e.g., due to vehicle accidents, etc.) and sufficient heat could be added to the cylinders such that the physical integrity of the cylinders could be compromised. Current cylinder handling equipment are equipped with large fuel tanks [approximately 450 gal (1703 L) of diesel fuel for the largest equipment] and some of this equipment also contains large amounts of hydraulic fluid [approximately 350 gal (1324 L)] as well as some lube oil. For purposes of this analysis, the cylinder haulers were assumed to carry a maximum of 800 gal (3027 L) of flammable or combustible liquids. Depending on the cylinder type, thickness, size, and amount of UF_6 present, analyses have been completed indicating that this amount of fuel could rupture a cylinder in less than 15 min if optimum conditions are present. Based on this analysis, a scenario for a fire event is presented as a limiting event for the cylinder yards.

Uncertainties in the source-term resulting from a fire induced UF_6 cylinder rupture results from uncertainties in fire characteristics, the portion of a cylinder or cylinders immersed in a fire, the effects of fire fighting activities, the conditions inside the cylinder at the time of rupture, and the cylinder condition after rupture.

The thermal environment associated with a fire depends on fire characteristics including the flame temperature, flame emissivity, flame height, and fire duration. These fire characteristics depend on the amount of fuel released, the fire dimensions and shape, and ambient conditions such as temperature and wind speed. The literature indicates a significant variation in thermal environments associated with fires.

10 CFR 71 provides guidance associated with hypothetical transportation accident conditions. Section 71.73 provides the following guidance for the hypothetical thermal environment:

> Exposure of the specimen fully engulfed, except for a simple support system, in a hydrocarbon fuel/air fire of sufficient extent, and in sufficiently quiescent ambient conditions, to provide an average emissivity coefficient of at least 0.9, with an average flame temperature of at least 800°C (1475°F) for a period of 30 minutes, or any other thermal test that provides the equivalent total heat input to the package and which provides a time averaged environmental temperature of 800°C. The fuel source must extend horizontally at least 1 m (40 in), but may not extend more than 3 m (10 ft),

beyond any external surface of the specimen, and the specimen must be positioned 1 m (40 in) above the surface of the fuel source. For purposes of calculation, the surface absorptivity coefficient must be either that value which the package may be expected to possess if exposed to the fire specified or 0.8, whichever is greater; and the convective coefficient must be that value which may be demonstrated to exist if the package were exposed to the fire specified. Artificial cooling may not be applied after cessation of external heat input, and any combustion of materials of construction, must be allowed to proceed until it terminates naturally.

10 CFR 71 provides an appropriate basis for evaluating and licensing containers of radiological materials. The 10 CFR 71 thermal environment was therefore selected as a reasonable basis for conducting the SAR analysis.

Based upon 10 CFR 71, the analysis of postulated fires in the UF_6 cylinder yards will be based on the following assumptions:

- The UF_6 cylinder is fully engulfed in the fire,
- A fire emissivity of 0.9,
- An average flame temperature of 1475°F,
- A surface absorptivity of 0.8,
- Simulation of convective heat transfer, and
- A 30-minute fire duration.

The convective heat transfer was calculated based on the methodology described in Reference 9.4. The analysis assumed that the cylinders are at their fill values [i.e., the mass of 28,000 lb (12,700 kg) UF_6 for a 48G; a 48Y would have slightly less but was assumed to also have 28,000 lb (12,700 kg)] and the cylinders are fully engulfed in a 1475°F fire. The analysis indicates that there is a significant variation in the conditions at the time of failure and in the post failure release conditions. An additional range of possible source-term conditions exists because of uncertainties that include the fire duration, the fire temperature, the portion of a cylinder or cylinders immersed in a fire, the effects of fire fighting activities. Because of the considerable uncertainty of the source-term, dispersion analyses considered the initial amount of UF_6 released from 400 lb (181 kg), 4000 lb (1811 kg), and 8000 lb (3629 kg) for this event.

c. <u>Consequence Analysis</u>

The results for the release are relatively insensitive to the amount of UF_6 released. For example, the 400-lb (181-kg) release provides the maximum downwind consequences for Class D stability with a 13.1 ft/s (4 m/s) wind velocity between 400 and 800 m (varying from 17.1 mg U intake at 400 m, to 8.4 mg at 800 m). For 1000 to 2000 m downwind, the 400-lb (181-kg) release in D4 conditions provides 6.9 and 3.0 mg U intake respectively. For the 8000-lb (3629 kg) release for F1 conditions, the U intake at 400 m is 2.6 mg, while at 1000 m is 9.5 mg. From 1000 to 2000 m, the 8000-lb (3629 kg) release for F1 conditions remains in the range of 9.5 to 10.6 mg U intake and represents the highest off-site consequences for the releases for all three release amounts for both meteorological conditions. The highest on-site consequences are represented by the D4 conditions for a 8000 lb initial release, falling to 30 mg U intake at about 275 m.

After the fire has been extinguished, UF_6 can continue to be released from a failed cylinder due to sublimation and cool down. If the fire is terminated within 15 minutes and no additional means of cooling the cylinder is used (i.e., continued water spray), the sublimation and cool down period where UF_6 will continue to be released from a failed cylinder can last from 1 ½ to 3 hours. However, the UF_6 vapor released during this period is less than the liquid and vapor UF_6 released upon initial failure of the cylinder. The 8000-lb (3629 kg) initial release is used to bound the creditable cylinder failure scenarios, and it is sufficient to include the amount released even with no forced cool-down for the cylinder after rupture. The scenario for this event is low probability due to the preventive measures in place, the potential on-site resources for mitigation, and the fact that operational personnel would typically be in the area when the event occurred for quick detection and fire department response. Based on these conditions, the probability of this event is significantly lower than the cylinder failure outside autoclave event addressed in Section 4.3.2.2.15. The consequences are bounded by the cylinder failure event. The essential controls for this event are no different with the added requirement for the on-site fire department. Therefore, no additional consequences are addressed.

d. Comparison With Guidelines

The comparison with guidelines will be subdivided to address the different receptors.

Local workers in the immediate area — Because of the time that lapses before a fire becomes large, workers in the immediate area of the release could evacuate the area prior to being exposed to any release. Therefore, no specific requirements are associated with the local worker.

Workers outside the process buildings — The essential controls for protecting on-site personnel outside the facilities are (1) detection of the fire and/or release (both worker and operator) and (2) training of on-site personnel to evacuate areas upon detection by sight or odor. The first essential action is to detect the fire and/or release of UF_6. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate their areas if a release is detected by sight or by odor. As indicated in the consequence analysis, on-site consequences could exceed 30 mg U out to about 900 ft (275 m) for the initial release if no mitigative actions were taken.

Off-site public — As indicated in the consequences section, the consequences for this event could vary over a wide range due to the various parameters. The essential controls for mitigation of this event are bounded by the cylinder failure outside autoclave scenario described in Section 4.3.2.2.15 with the added control of the on-site fire department.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Administrative controls to prevent a large fire—maintain initial condition (normal operation, EG 5 only);
    1. Presence and introduction of flammable and combustible materials in the cylinder yards is controlled by approved procedures;
    2. Daily inspection (when used) of cylinder handling equipment for obvious visual defects associated with the lifting system and potential fuel/hydraulic leaks;

3. Communication capability between the cylinder handling operators and with the fire department/emergency response personnel is available;
4. Only approved cylinder handling equipment is used by qualified operators for maneuvering UF_6 cylinders or other heavy loads;
5. Operator training for required actions;
6. Fire Protection Program (which includes on-site fire department); and
7. Prior to and during lube oil deliveries in the process building truck alley near the feed facilities (1) the Fire Department will be notified, (2) the fire hydrants in the immediate area will be verified operable, and (3) a pumper truck and firefighters will be present during lube oil unloading operations.

- Fixed fire suppression systems in withdrawal facilities—prevent large fires (initial condition assumption, EG 5 only).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The fixed fire suppression systems in withdrawal facilities are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the fixed fire suppression systems in withdrawal facilities; and administrative requirements for the Fire Protection Program and for procedures and training of workers for actions to be taken.

4.3.2.2.17 Plugged/Blocked Process Line (Pressure Increase)

a. Scenario Description

In the *withdrawal* mode of operations involving the compression loop, a blockage of the Normetex pump discharge line could cause a failure of the primary system due to high pressures that can be generated by the continued operation of the Normetex pump. The discharge line of the Normetex pump could become blocked due to initiators such as the formation of a solidified UF_6 plug or an inadvertent valve closure. The most likely scenario involves the inadvertent closure of the discharge valve, which causes a pressure excursion that results in a failure of the discharge expansion joint bellows. However, the scenario involving the formation of a UF_6 plug in the manifold piping common to the Normetex pumps would result in the largest UF_6 release rate. The plugged/blocked process line event is categorized in the AE frequency range since it could be caused by a single active failure (e.g., inadvertent closure of the discharge block valve). This event is also the limiting event for a scenario involving a pressure increase in *withdrawal* mode of operations involving the compression loop. The centrifugal pumps used in the C-315 withdrawal facilities are not subject to this failure scenario due to their different design and operating characteristics. Administrative controls also preclude operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls.

The primary concern associated with the failure of the plugged/blocked process line is the loss of the UF_6 primary system integrity caused by the pressure increase and the release of UF_6 to the atmosphere. The applicable EGs (see Table 4.2-2) associated with this event are all of the EGs for the AE frequency category. EG 4 is addressed by the NCS program. The passive design features of the UF_6 primary system piping and equipment are the essential preventative controls for maintaining the physical integrity of the UF_6 primary system and meeting EGs 1, 2, and 3. If a UF_6 primary system integrity failure occurs due to a plugged/blocked process line event, then the essential safety actions associated with meeting EGs 1 and 2 include: (1) detection of the release, (2) tripping the compression source to minimize the amount of UF_6 released, (3) building holdup, and (4) emergency response to evacuate the

immediate vicinity so that the exposure of on-site personnel is minimized. EG 6 is not applicable to this scenario since no required actions were identified for control area personnel.

The plugged/blocked process line event was evaluated and it was determined that the event consequences could result in a significant off-site impact if no mitigation were provided. These consequences are based on a large release of UF_6.

b. Source-Term Analysis

The most likely scenario for this event involves the inadvertent closure of the Normetex pump discharge valve. The continued operation of the positive displacement Normetex pump against the closed discharge valve would produce a pressure transient that could cause the discharge expansion joint to fail releasing UF_6 to the atmosphere. The discharge bellows on the Normetex pumps are identified as the weakest link of the withdrawal process piping with regard to pressure containment. The source-term analysis conservatively assumed that the UF_6 release rate associated with the inadvertent closure of the Normetex pump discharge valve would be equivalent to the maximum anticipated output of the Normetex pump (1.61 lb/s). A scenario involving the formation of a UF_6 plug in the manifold piping common to the Normetex pumps would result in the largest postulated UF_6 release rate for this event since the source-term analysis assumed the release rate would include the output of all operating Normetex pumps. Scenarios involving the formation of a UF_6 plug in the common piping would result in a 4.83 lb/s release (assuming three operating Normetex pumps) for both the C-310 and C-315 facilities. Backflow from the remainder of the withdrawal system would not be a contributor to the source-term for this event since the discharge line is assumed to be blocked (i.e., by a closed discharge valve or a solidified UF_6 plug) and the defined failure of the primary system (i.e., the discharge expansion joint) occurs between the pump and the blockage. The UF_6 release from this event would be terminated when the UF_6 Release Detection System - Normetex Pump detected the release, trips the pump, and isolates the pump from sources of UF_6 that are above atmospheric pressure (e.g., closes the discharge block valve).

c. Consequence Analysis

Releases within the C-315 withdrawal facility were chosen to bound both the C-310 and C-315 withdrawal facilities since C-315 is considerably smaller than C-310, thereby providing less intra-building holdup and deposition for the postulated releases. Furthermore, the C-315 facility is closer than C-310 to the nearest site boundary, which results in higher consequences given the same release and meteorological conditions. The consequence analysis determined that F2 meteorological conditions produced the highest consequences for receptors at or beyond the site boundary. Consequence analysis determined that the 1.61 lb/s UF_6 release associated with the inadvertent closure of a Normetex pump discharge valve can continue unmitigated for 3400 seconds before exceeding the AE off-site exposure guidelines. The release associated with the formation of a UF_6 plug in common manifold piping in C-315 (which would involve a 4.83 lb/s release rate) can continue unmitigated for 373 seconds before exceeding the AE off-site exposure guidelines.

The formation of a UF_6 plug in common manifold piping in the C-315 tails withdrawal facility is considered the bounding scenario for the plugged/blocked process line event since it identifies the maximum time the largest postulated release rate associated with this event can continue unmitigated before exceeding AE off-site guidelines. This analysis assumes that the UF_6 release associated with the

plugged/blocked process line event will be controlled within 373 seconds by the automatic actions of the UF_6 Release Detection System - Normetex Pump to detect the release, trip the compression source, and isolates the pump from sources of UF_6 that are above atmospheric pressure (e.g., closes the discharge block valve). Consequence analysis of the bounding event scenario (e.g., 4.83 lb/s released for 373 seconds) predicted that under F2 meteorological conditions, the predicted exposure for off-site personnel is a uranium toxicological intake of 10.0 mg, and a HF exposure of 6.4 ppm. The radiological dose associated with a UF_6 release approaching the 10 mg off-site exposure guideline would be 0.10 rem. The consequences the bounding event scenario would have on different receptors are discussed below.

Local workers in the immediate area—Workers in the immediate area of the release could be exposed to a significant uranium dose and/or HF exposure. In the event of a release, the plant see and flee policy requires personnel to evacuate the area for their own protection. The essential methods of detection for workers within the withdrawal buildings are: (1) visual indication of a "white smoke" (i.e., reaction products of UF_6 and moisture) or (2) the odor of HF, which is a product of the reaction of UF_6 and moisture. The visual indication or the odor of HF will provide indication of (1) the occurrence of a release and (2) the need for the workers to evacuate the area of the release. Personnel protective equipment (PPE) or other protective measures (e.g., emergency egress capability) must be available for personnel operating cab-controlled process building cranes.

Operational personnel in the ACR—The UF_6 release associated with plugged/blocked process line event is controlled by activation of the UF_6 release detection system - Normetex pump. The ACR operating personnel should not be affected by the release associated with this event. However, should the release affect habitability of the control area, the essential control to protect these workers is evacuation upon sight or odor detection of the release.

Workers outside the process buildings—The essential controls for protecting on site personnel outside the process buildings are: (1) sight or odor detection of the release, (2) activation of the UF_6 release detection system - Normetex pump to trip the compression source and control the release, (3) temporary holdup of the release by the existing process building structure, and (4) training of on site personnel to evacuate areas upon detection of a release by sight or by odor. The existing process building structure is expected to reduce the potential hazardous material concentrations to receptors outside of the building by holdup of a portion of the UF_6 released and by causing most of the UF_6 that escapes the building to be released at an elevated point. If workers outside of the process building have received no other instructions for action to be taken (i.e., shelter in place or take cover), then the essential control for these receptors is to evacuate the area if a release is detected by sight or by odor.

Off-site public—The essential controls for protecting the off-site public are: (1) activation of the UF_6 Release Detection System - Normetex Pump to detect the release, trips the compression source, and isolate the pump from sources of UF_6 that are above atmospheric pressure (e.g., close the discharge block valve) and (2) temporary holdup of the release by the existing process building structure. This analysis assumed that the actions of the UF_6 Release Detection System - Normetex Pump would control the release duration associated with this event to less than 373 seconds. Consequence analysis predicted that the exposures associated with postulated releases of less than this time period would meet off-site exposure EG for the AE frequency category.

d. Comparison With Guidelines

The EGs for the AE frequency category were compared with the consequences associated with the plugged/blocked process line scenario. EG 4 is addressed by the NCS program. The UF_6 primary system piping and equipment is the essential preventative control for maintaining the physical integrity of the UF_6 primary system and meeting EGs 1, 2, and 3. Activation of the UF_6 Release Detection System - Normetex Pump will control the release for the protection of the off-site public and the workers outside the process building. Actions of the UF_6 Release Detection System - Normetex pump to detect a UF_6 release, trip a compression source, and isolate the pump from sources of UF_6 that are above atmospheric pressure (e.g., close the discharge block valve) within the evaluated time period will maintain off-site exposures within EGs 1 and 2. Activation of this system in conjunction with operator training to evacuate the affected area upon sight or odor detection of a release in accordance with the plant's see and flee policy will maintain exposures of on-site workers within EGs 1 and 2. EG 6 is not applicable to this scenario since no required actions were identified for control area personnel.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- UF_6 Release Detection System - Normetex Pump - detect a UF_6 release, trip the compression source, and isolate the pump from sources of UF_6 that are above atmospheric pressure (e.g., close the discharge block valve) (EGs 1 and 2);
- Visual/odor detection of release, worker training, and evacuation of affected area - all on-site workers (EGs 1 and 2);
- Administrative control—personnel protective equipment (PPE) or other protective measures is provided to personnel operating cab-controlled process building cranes (EGs 1 and 2);
- Process building holdup—workers outside process building and the off-site public (EGs 1 and 2); and

- Primary system piping—maintain primary system integrity (EG 3 only).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The UF_6 release detection system - Normetex pump, the process buildings, and the UF_6 primary system piping are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for the UF_6 release detection system - Normetex pump.

4.3.2.3 Miscellaneous Waste Storage and Handling Facilities

The miscellaneous waste storage and handling facilities are listed in Table 4.2-9.

4.3.2.3.1 Large Fire (External Event)

a. Scenario Description

The miscellaneous waste storage and handling facilities primarily handle and store RCRA waste as well as uranium bearing compounds. The most significant hazard associated with a fire is the RCRA waste. Fires can be caused by welding and burning operations, electrical failures, vehicle accidents, etc. The Fire Protection Program (see Section 5.4) provides a high degree of protection from fires that could occur within the miscellaneous waste storage and handling facilities (see Table 4.2-9). The protection provided is both preventive and mitigative. Some facilities contain fixed fire protection systems (e.g., sprinklers and fire extinguishers) which provide additional mitigation for fires. Preventive measures (administrative practices) reduce the likelihood of any significant fires within facilities by controlling the amount of combustible materials allowed and by maintaining good housekeeping practices. Therefore, a large fire is categorized as an EBE.

This event was evaluated and it was determined that the consequences could result in significant on-site impact if no mitigation were provided. These consequences are based on a release of toxic material.

The primary concern associated with this event is the loss of primary system integrity and the release of toxic material. The applicable EGs associated with this event are EGs 1 and 2, as well as EG 6 in the EBE frequency range. Since there is no primary containment system for this type of event, EG 3 does not apply. The essential safety actions associated with meeting these EGs for a large fire include (1) detection of the release, (2) notification of emergency response personnel, and (3) emergency response to evacuate the immediate vicinity and downwind locations so that the exposure of on-site personnel is minimized.

This event is considered to result in the worst consequences for the miscellaneous waste storage and handling facilities and is therefore a limiting event for these facilities.

b. Source-Term Analysis

A realistic source term for a large fire is difficult to model. This is compounded in the waste storage facilities due to potential reactions of the various wastes during a high temperature fire. Therefore, a specific source term has not been developed for these facilities. However, the analysis addressed the essential preventive and mitigative controls necessary to control this event. The controls are the same regardless of the consequences, since automatic fixed suppression systems are not credited for these facilities.

c. Consequence Analysis

A large fire could potentially result in significant on-site consequences. This is based on the vicinity of on-site personnel and the amount of toxic material present in these facilities. As indicated in the scenario, the Fire Protection Program (Section 5.4) plays an important role in preventing a large fire in these facilities. A conservative analysis for these facilities (i.e., all of the material released from the waste is dispersed along the ground) could possibly result in some off-site consequences depending on the location of the facility relative to the site boundary and the amount of waste present. However, should a large fire occur, the typical result of a large fire is a hot, buoyant plume giving rise to an elevated dispersion of most of the hazardous material. With a significant elevated release, the health effects would be greatly minimized. Therefore, no consequence analysis calculations are provided for this type of event.

The following sections describe how the consequences are addressed by the different receptors.

Local workers in the immediate area—Because of the time that lapses before a fire becomes large, workers in the immediate area of the release could evacuate the area prior to being exposed to any release. Therefore, no specific requirements are associated with the local worker.

Workers outside the process buildings—The essential control for protecting on-site personnel outside the facilities is (1) detection of the fire and/or release and (2) training of on-site personnel to evacuate areas upon detection of a release by sight or by odor. The first essential action is to detect the fire and/or release of toxic material. On-site workers are trained to flee an area if a release is detected by sight and/or smell. As indicated in the consequence analysis, on-site consequences could result in irreversible health effects if no mitigative action was taken.

Off-site public—As indicated in the consequences section, the consequences for this event could vary over a wide range due to the various parameters. The essential controls for mitigation of this event are the notification of emergency response personnel including the on-site fire department.

d. Comparison With Guidelines

As indicated in the consequence analysis, no direct calculations of consequences were performed to provide a comparison to the EGs. There are no EGs for comparison to toxic effects with the exception of uranium. However, the essential controls identified in the consequence analysis are expected to minimize the potential consequences from this event.

e. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for the large fire event are summarized as follows:

- Administrative controls to minimize impact of a large fire (i.e., emergency response and evacuation)—maintain initial condition (normal operation, EG 5 only) and minimize consequences (EGs 1 and 2); and
- Fire Protection Program (which includes an on-site fire department)—maintain initial conditions (EG 5) and to provide mitigation of the fire (EGs 1, 2, and 6).

Based on the above essential controls, TSRs are provided for the Fire Protection Program and administrative requirements for procedures and training of workers for actions to be taken.

4.3.2.4 Miscellaneous Support Facilities

The miscellaneous support facilities are listed in Table 4.2-9.

4.3.2.4.1 Large Fire (External Event)

a. Scenario Description

The large fire event would be similar to that described in Section 4.3.2.3.1 with the exception of the hazards involved. The miscellaneous support facilities mainly contain UF_6 and associated compounds. The same uncertainties would also apply to these facilities as those described in Section 4.3.2.3.1. The analysis and resulting essential controls are the same. Based on the similarity in the analysis and the essential controls, no additional discussion of this scenario is provided.

b. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for the large fire event are summarized as follows:

- Administrative controls to minimize impact of a large fire (i.e., emergency response and evacuation)—maintain initial condition (normal operation, EG 5 only) and minimize consequences (EGs 1 and 2); and
- Fire Protection Program (which includes an on-site fire department)—maintain initial conditions (EG 5) and to provide mitigation of the fire (EGs 1, 2, and 6).

Based on the above essential controls, TSRs are provided for the Fire Protection Program and administrative requirements for procedures and training of workers for actions to be taken.

4.3.2.5 Natural Phenomena

A review of facilities having a Hazard Category of 2 or 3 in accordance with DOE-STD-1027-92 was performed to determine the capacity of essential structures and equipment to withstand natural phenomena-induced failures. The evaluation basis natural phenomena events are identified in Section 2.7. Two types of analyses were performed: (1) structural analysis and (2) equipment/piping analysis. Based on Table 4.2-10, C-310, C-310-A, C-315, C-331, C-333, C-335, C-337, C-333-A, C-337-A, C-360, C-400, C-710, C-409, C-720 (series), C-746-Q1, cylinder storage yards, and the process building tie-lines were identified for analysis. In addition, Building C-300 was analyzed even though it is not identified as a Hazard Category 2 or 3 structure. The equipment and piping selected for analysis were identified as described in Section 4.3.1.1.3.

The structural analyses were performed as described in Section 4.3.1.3.1. Table 3.15-10 provides a summary of the results of the structural analyses. The cylinder yards are outdoor storage facilities with no structure to be analyzed. The results of the analyses are addressed in the applicable subsections below for the different initiators.

Equipment and piping selected for analysis were evaluated as described in Sections 4.3.1.3.2, 4.3.1.3.3, and 4.3.1.3.4. The equipment and piping selected for analysis were primarily associated with the liquid UF_6 systems and the large cascade piping systems. Either of these systems could result in a significant release of UF_6 if the primary system were to fail during a natural phenomena-initiated event. The results of the equipment and piping system analyses are also presented in Section 3.15 for the various processes. As indicated in Tables 3.15-4 through 3.15-9 and Table 3.15-11, parts of the primary system piping and equipment do not satisfy the seismic capacity goal, but all meet the requirements for wind and flood. The following sections summarize the potential consequences due to the structures, equipment, or piping not satisfying the capacity goals.

4.3.2.5.1 Flood and Local Intense Storm (External Event)

All the facilities are above the maximum flood elevation, and no damage would be experienced from a flood at the site. However, as indicated in Table 3.15-10, Buildings C-331, C-333, C-335, and C-337 could experience some inleakage of water that may develop because of local ponding on the roof from heavy rainfall events (10,000-yr event). The analysis assumed all of the normal drainage paths were clogged, allowing no draining except over the parapets. This event would occur over a period of time, which allows for additional operator intervention prior to any inleakage occurring. The impact of water inleakage in a typical process building was reviewed (see appropriate equipment discussions in Section 3.15), and no adverse impacts (i.e., loss of primary system integrity) were identified. Any inleakage to the cell floor would typically run to the open stairwells and floor drains, which would drain to the lower elevations. Some electrical equipment may be affected because of the water flow path. However, the likelihood of the combination of a heavy rainfall, all drainage paths being clogged, no operator intervention, and multiple electrical failures was not considered credible for these large buildings. It should be noted that compressor trip capability could also be accomplished from the switchyard if necessary to mitigate the effects of this event if it were to occur. Therefore, this concern is not addressed further in the analysis. Based on this analysis, this event was not identified as causing any impact on the leased facilities.

4.3.2.5.2 High Wind (External Event)

All the facilities meet the structural requirements for high winds except C-310, C-315, C-331, C-335, C-333, C-337, C-360, and process building tie-lines (see Table 3.15-10). The types of failures associated with all buildings due to high wind are associated with loss of siding or roofing only and not with structural failures. The evaluation determined that some of the siding and roofing of these buildings could be pulled from the building. This would have no effect on the equipment inside the buildings except for wind impact. Piping and equipment were reviewed in several facilities at the plant site as indicated in Section 3.15, and no failures were identified because of wind loading. Therefore, these facilities were determined to be capable of withstanding the EBE high wind.

a. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential control for this event is summarized as follows:

- Design and structural capacity of required facilities and equipment—maintain initial condition (normal operation, EG 5 only).

Based on the above essential control, the resulting important to safety SSCs and TSRs are as follows:

- Buildings C-300, C-310, C-310-A, C-315, C-331, C-333, C-335, C-337, C-333-A, C-337-A, C-360, C-400, C-710, C-409, C-720 (series), C-746-Q1, and the process building tie-lines are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- There are no resulting TSRs from the above controls due to the passive nature of the facility structures.

4.3.2.5.3 Earthquake (External Event)

a. Scenario Description

Because PGDP is sited within approximately 60 mi (100 km) of the New Madrid Fault, the plant may be subjected to a strong earthquake. Structural (see Section 3.15 for a summary of structural evaluations) and equipment evaluations were performed to estimate potential damage to UF_6 systems that might result from an evaluation basis earthquake, as defined in Section 2.7.1. These evaluations identified potential weaknesses in equipment and piping that could lead to a release of UF_6. All operations were assumed to be normal at the initiation of this event. Therefore, liquid and gaseous UF_6 operations as well as waste storage operations are potentially at risk in the seismic event.

This event was evaluated, and it was determined that the consequences could result in significant off-site and on-site impacts if no mitigation were provided. This consequence estimate is based on the results of other scenarios, including the B-line block valve closure event, the cylinder failure outside autoclave, and the loss of NCS controls.

All facilities that process or store significant quantities of UF_6 were analyzed for seismic effects up to the evaluation basis earthquake. All facilities have structural capacities at least equal to this peak ground acceleration. Capacity is defined as no building collapse.

Equipment whose failure could directly result in a release of UF_6 was also analyzed. This equipment includes supporting equipment not directly containing UF_6, such as overhead cranes, scale carts, and autoclaves, that if not retained in position, could impact UF_6 systems. This evaluation determined that a number of components have less than the evaluation basis capacity. Weak links were identified only in the process buildings and the withdrawal facilities. These areas are considered below.

b. <u>Cascade Process System Confinement Failure</u>

Two cases were analyzed for this event: (1) maximum cascade power of 3040 MW and (2) operating cascade power of 2200 MW. Case 1 evaluated cascade operations with an extensive portion of the cascade running above atmospheric pressure, which would produce the largest releases. This power level is the maximum design power level for the cascade but is no longer possible without a major upgrade of equipment. Operation at significantly above 2200-MW would require capital improvements to the plant. Current demand does not justify these expenditures, and operation above this level is currently considered unlikely. Case 2 evaluated cascade operations at 2200 MW with most of the cascade running below atmospheric pressure. This power level is more representative of current cascade operations, which typically range between 1100 MW and 2000 MW.

Depending on operating pressures and power level, the main process buildings contain as much as 650,000 lb (295,000 kg) of UF_6 in each “000” building and as much as 150,000 lb (68,000 kg) of UF_6 in each “00” building at 3040 MW. The pressure gradient varies throughout the cascade and directly impacts any potential response to a seismic event. The equipment evaluations cited above included location-specific considerations as they relate to system operating pressures.

In general, the weak links in the cascade piping are the expansion joints. The typical seismic failure mechanism for these components is displacements in excess of capacity. For the “00” cascade buildings, the potential equipment failure locations based on engineering evaluations are indicated in Figure 4.3-33. In the “000” buildings, all failures occur near the B-stream booster pump stations.

The failures predicted at the withdrawal facilities either do not involve UF_6 (i.e., fire protection piping) or else occur in piping and equipment that contains gaseous UF_6 operating at subatmospheric pressure. Therefore, no UF_6 release is postulated for the withdrawal facilities.

All failures were assumed to occur simultaneously as a direct consequence of the seismic event. Because release conditions are maximized through the operating power assumption, the consequences are judged to be conservative from a complete site perspective.

c. Source-Term Analysis

The source-term analysis of these cases was based on the structural and equipment evaluations of the main process and auxiliary buildings described above. Potentially significant UF_6 source terms are associated with estimated damage to the enrichment cascade, located in the “00” and "000" process buildings (Buildings C-331 and C-335 and Buildings C-333 and C-337, respectively).

The source-term analysis is presented for both 3040-MW and 2200-MW operating power levels. The pressure gradients used were based on typical operation at these power levels, using a reasonable combination of product, feed, and tails flow rates and assays. The actual gradients in use at any specific power level depend on cascade conditions such as recent and projected power levels, available equipment, and the current product, feed, and tails streams. For most operating conditions, the 2200-MW power level would limit above-atmospheric pressure to the “000” buildings, while at the 3040-MW level, above-atmospheric pressure would occur in both the “00” and “000” buildings. Typical cascade pressure profiles for these two power levels are included in Figures 4.3-34 and 4.3-35 (3040 MW) and Figures 4.3-36 and 4.3-37 (2200 MW).

Structural deficiences have potentially compromised the support capabilities of sections of the interbuilding tie-line support structures. Administrative controls require that the interbuildng process piping in all interbuilding tie-lines that have structural deficiencies and that contain UF_6 be maintained below atmospheric pressure. Implementation of these administrative controls ensures that any tie-line structural failure due to a seismic event will not result in an unalayzed UF_6 release. The interbuilding process piping in the C-331/C-333 tie-line is exempt from this administrative requirement since the deficiences in the C-331/C-333 tie-line support structure have been corrected such that the tie-line structure is adequate to resist service level and natural phenomena loading as described in the SAR for above atmospheric conditions.

The remainder of this source-term discussion describes estimated source terms that would occur in the (1) 3040-MW case and (2) 2200-MW case.

Source-Term Analysis—3040-MW Case. Source-term parameters for the 3040-MW case are listed in Table 4.3-11. The source-term analysis discussion for the 3040-MW case identifies failures from the process buildings.

The estimated failures in each of the “000” process buildings occur where the tie lines from the “00” process building enter and connect to the “000” equipment. Each tie line consists of four major pipes (two A lines and two B lines). One A-B pair connects the bottom “000” unit with the stripper section of the “00” building, and the other A-B pair connects the top “000” unit to the enricher section of the “00” building. For the 3040-MW case, both of the B lines would be above atmospheric pressure. Seismic evaluations indicate that breaches of both an above-atmospheric-pressure B line and a below-atmospheric-pressure A line may occur in approximately the same location. Because the A and B tie lines are simultaneously severed, UF_6 would flow from the B lines while air flows into the A lines. Within a few seconds, the stages feeding the holes in the B lines would partially fill with air, and the supply to the breach would become a mixture of UF_6 and air.

Calculation of the release rate into the “000” building was based on the equipment flow rate and the varying concentration of UF_6 in the stage supplying the breach. As air continues to flow in through the broken A lines, the concentration of UF_6 in the B line drops to essentially zero after 10 min. Approximately 17,500 lb (7950 kg) of UF_6 vapor is estimated to be released into each “000” building.

Estimated process failures in the “00” buildings occur in the unit and cell bypass and tie line headers, which form part of a complicated system connecting the tie lines from the “000” building to units in the “00” building. However, unlike the situation in the “000” buildings, only three of the tie lines would fail: both of the A lines and the B line flowing from the “000” building to the “00” building. The B line flowing from the “00” building to the “000” building would not fail; therefore, material from this line would flow into the “000” building and contribute to the total of 17,500 lb (7950 kg) released into each “000” building reported above. With the other B line (flowing from the “000” building to the “00” building) also failing in the “000” building (as discussed above), there would be no pressure-driven flow of UF_6 from the tie lines into the “00” building.

Additional UF_6 vapor would flow into the process buildings because gravity would cause UF_6 vapor contained in the severed tie lines to flow into the process buildings. Approximately 2000 lb (910 kg) of UF_6 vapor is contained in the tie line connecting Building C-331 to Building C-333. Half the mass [1000 lb (455 kg)] is assumed to flow into each process building over 10 min. The total mass of UF_6 vapor released into Building C-333 would be about 18,500 lb (17,500 lb + 1000 lb) [8400 kg (7945 kg + 455 kg)], yielding an average release rate into the building of 1850 lb/min (14 kg/s). The UF_6 is assumed to react quickly to form UO_2F_2 and HF, with none of the UO_2F_2 and HF being retained in the building. This is an upper-bound assumption that results in the maximum amount of uranium and HF being released into the atmosphere. The corresponding release rates into Building C-333 would be 1250 lb/min (9.5 kg/s) for uranium and 420 lb/min (3.2 kg/s) for HF. The UF_6 release rate into Building C-331 from the tie line break would be about 100 lb/min (0.76 kg/s), with a uranium release rate of 68 lb/min (0.51 kg/s) and an HF release rate of 23 lb/min (0.17 kg/s).

The tie line connecting Building C-335 to C-337 contains approximately 1200 lb (545 kg) of UF_6 vapor, of which 600 lb (273 kg) would flow into each building over a 10 min period. The total mass of UF_6 vapor released into Building C-337 would be about 18,100 lb (17,500 lb + 600 lb) [8,218 kg (7945 kg + 273 kg)], yielding an average release rate into the building of 1810 lb/min (13.7 kg/s). The release rates of the reaction products into Building C-337 are 1223 lb/min (9.3 kg/s) for uranium and 411 lb/min HF (3.1 kg/s). The UF_6 release rate into Building C-335 would be about 60 lb/min (0.46 kg/s), with a uranium release rate of 41 lb/min (0.31 kg/s) and an HF release rate of 14 lb/min (0.10 kg/s).

The A- and B-lines in the unit bypass piping between units 1 and 2 are predicted to fail in both C-331 and C-335. The A-line failures do not result in a release of UF_6 to the atmosphere because the pressure is below atmospheric. Both B-lines operate below atmospheric pressure and would not release UF_6 at a plant power level of up to 2200 MW. At 3040 MW, the C-335 B-line would still operate below atmospheric pressure and would not result in a release. However, the C-331 B-line would operate at a maximum of 16.5 psia, allowing a release of 320 lb (145.5 kg) over a 10 min period with a uranium release rate of 22 lb/min (0.17 kg/s) and an HF release rate of 7 lb/min (0.05 kg/s).

Additional failures in the “00” buildings include the cell-bypass A line between Cells 7 and 9 and Cells 10 and 8 in each of the four units in each building. These A-line failures are below atmospheric pressure and would result in no release. One specific stage in Building C-331 has also been identified as a possible damage site. Stage 1 located in Cell 3 of Unit 4 in Building C-331 could lose the compressor discharge expansion joint. This cell is located near the top of the enricher and would be below atmospheric pressure even at 3040 MW and, therefore, would not result in a release into Building C-331.

Source-Term Analysis—2200-MW Case. Source-term parameters for the 2200-MW case are listed in Table 4.3-12. The source-term analysis discussion for the 2200-MW case identifies failures from the process buildings.

The identified failures in the process building would be the same as those described for the 3040-MW release scenario, except that both the A and B lines would be below atmospheric pressure. With the process operating below atmospheric pressure, air will flow into the severed lines. Past experience with large air leaks into the cascade shows that with a sizable leak, air will displace the UF_6 in that region of the process, creating a "bubble" of light gas. Compressors within the bubble will surge as the density of the gas they are pumping drops. The reaction between UF_6 and the moisture in the air takes place at the air-UF_6 interface and is rather limited by the lack of mixing between air and UF_6 inside the process. Given the large volume of the cascade, a large volume of air will flow into the process unless the leak is stopped. After the flow is halted, UF_6 or its reaction products (UO_2F_2 and HF) slowly drift back to the vicinity of the hole. Because of these characteristics, the severed ends of the below-atmospheric-pressure tie lines would not cause any appreciable release into the process buildings, except for the UF_6 contained in the tie lines that would flow out under the influence of gravity.

For the 2200-MW case, the amount of UF_6 in the tie lines is less than that for the 3040-MW case because of the lower operating pressures in the cascade. Approximately 1200 lb (545 kg) of UF_6 vapor would be contained in the tie line connecting Building C-331 to Building C-333, half of which [600 lb (273 kg)] would flow into each building. The release would occur over a 10-min period, yielding an average release rate into each building of 60 lb/min (0.46 kg/s). The release rates of the reaction products from Buildings C-331 and C-333 would be 41 lb/min (0.31 kg/s) for uranium and 14 lb/min (0.10 kg/s) for HF.

About 800 lb (363 kg) of UF_6 vapor would be contained in the tie line connecting Building C-335 to Building C-337, half [400 lb (182 kg)] of which would flow into each building. The release would occur over a 10-min period, yielding an average release rate into each building of 40 lb/min (0.3 kg/s). The atmospheric release rates of the reaction products from Buildings C-335 and C-337 would be 27 lb/min (0.21 kg/s) for uranium and 9.1 lb/min (0.068 kg/s) for HF.

d. Consequence Analysis

Figure 4.3-38 shows the building locations where UF_6 releases are postulated to occur after an evaluation basis seismic event. Also shown in this figure is the wind direction used to estimate consequences. The southerly wind direction was selected for several reasons. It is the predominant direction at the site and would be the most likely wind direction in a seismic event. Also, the nearest site boundary is almost due north of the buildings (i.e., in the direction a southerly wind would carry

contaminants). Finally, the buildings from which the releases would occur are roughly aligned along a north-south axis. With a southerly wind, releases occurring simultaneously from these buildings would appear as a single plume from the viewpoint of a downwind receptor. Therefore, consequence estimates for a southerly wind would be higher than for an easterly or westerly wind, for which the plumes would initially be separated so that their near-centerline concentrations would not be additive. For this analysis, all the releases were conservatively assumed to occur precisely along the same north-south axis [i.e., absolutely no spreading of the source locations in the crosswind (east-west) direction, even though the individual sources are not so neatly aligned]. This assumption results in slightly higher consequence estimates because some initial plume spread in the crosswind direction is ignored.

Dispersion parameters used to define the baseline scenario are listed in Table 4.3-13. For the seismic release event, typical meteorological conditions were selected to estimate consequences for the baseline scenario. The most frequently occurring meteorological condition at PGDP is D4 (stability class D, neutral, and wind speed of 4 m/s), which occurred 14.9 percent of the time on an annual basis. Other meteorological conditions that occur less frequently but result in higher consequence estimates were not chosen to represent baseline conditions because of the relatively unlikely occurrence of an evaluation basis earthquake at the site in conjunction with worst-case wind conditions. A less likely meteorological condition combined with an unlikely seismic event would lead to a release scenario that is much less credible. However, for the purposes of comparison, consequence estimates for a much less favorable meteorological condition (F3) are presented later in this section for comparison.

A typical summer daytime temperature of 80°F (26.7°C) under stability class D was used for the baseline scenario. An ambient relative humidity of 70 percent was selected for the baseline scenario because this value represents a maximum relative humidity at an ambient temperature of 80°F (26.7°C). In 1992, the maximum relative humidity recorded at PGDP for ambient temperatures of 80°F and above was about 71 percent.

The process building releases were conservatively simulated using the UF_6MIXER model (see Section 4.3.1.2.3.4) and assuming that the plume would be released to the atmosphere at ground level through a hole in the building side created by a seismic event. The temperature of the UF_6 released into the process buildings was set at 290°F (143°C), with release durations to the atmosphere assumed to be the same as the release rates into buildings. Therefore, no retention of the released material in the building was assumed. Prior to release to the atmosphere, the UF_6 in the plume was assumed to completely react to form UO_2F_2 and HF inside the process building based on the results of the MELCOR modeling performed for the large release of UF_6 to atmosphere (see Section 4.3.2.1.7). A value of f_A (the UF_6MIXER model uses f_A to take into account dilution of the plume with in-building air; see Section 4.3.1.2.3.4) equal to 0.002 was used for each process building to achieve the mixing necessary for the UF_6 in the plume to completely react just prior to release to the atmosphere. Model simulations show that the plumes exiting the process buildings would be buoyant and would rise.

For the process buildings, values of initial uranium deposition (0%) and surface roughness [1 in. (0.03 m)] were selected to provide maximum downwind consequence estimates. The selection of these parameters is discussed in more detail in Section 4.3.2.2.15. The results from the process building simulations were superimposed at selected downwind distances. All downwind distances were referenced from the northern edge of Building C-337. The remainder of this section divides the consequence estimate discussion into (1) the 3040-MW case and (2) the 2200-MW case.

Consequence estimates—3040-MW case. Figures 4.3-39 through 4.3-41 show estimated downwind consequences associated with the baseline scenario. Note that the baseline scenario (D4) is represented by the bottom curve in these figures; the top curve is for a more adverse meteorological condition (F3), as discussed below. Calculations of specific consequence parameters (amount of inhaled uranium, radioactive dose, and HF exposure) were made. Calculated values of the consequence parameters were compared to EBE guideline values for uranium (25 rem for U radiological toxicity and 30 mg U intake for U chemical toxicity) and to the Emergency Response Planning Guidelines (ERPG-2) for HF (20 ppm for 1 hour).

Table 4.3-14 lists specific consequence estimates at the site boundary and at 1 mi (1600 m) and 5 mi (8050 m) directly downwind (north) of Building C-337. The site boundary is about 0.56 mi (900 m) north of Building C-337. The consequence guideline for uranium chemical toxicity would be exceeded to about 1.1 mi (1700 m). The radioactive dose guideline value would not be exceeded at the site boundary. The HF exposure comparison value would also be exceeded to a downwind distance of about 1.1 mi (1700 m).

Figures 4.3-39 through 4.3-41 show consequence estimates for D4 and F3. The highest consequence estimates for this multisource release occur with F3 meteorological conditions. Plumes exiting the process buildings would rise because of buoyancy, with higher wind speeds resulting in lower final plume heights and higher downwind ground-level concentrations. Under F3 meteorological conditions, the uranium chemical toxicity guideline value would be exceeded to a downwind distance of about 3.4 mi (5400 m), and the HF exposure comparison value would be exceeded to a downwind distance of about 2.3 mi (3700 m).

Consequence estimates—2200-MW case. Table 4.3-15 lists specific consequence estimates at the site boundary and at 1 mi (1600 m) and 5 mi (8050 m) directly downwind (north) of Building C-337. Figures 4.3-42 through 4.3-44 show estimated downwind consequences associated with the baseline scenario. The consequence guideline for uranium chemical toxicity and the HF exposure comparison value would be exceeded to about 0.12 mi (200 m). These figures also show a comparison of the consequence estimates for the baseline scenario (D4 meteorological conditions) and F3 meteorological conditions.

Under F3 conditions, the uranium chemical toxicity guideline value and the HF exposure comparison value would be exceeded to a downwind distance of about 0.12 mi (200 m).

Potential for Inadvertent Criticality. With uncontrolled releases of enriched UF_6, there is the potential for inadvertent criticality. With PGDP's maximum assay limited to 5.5 wt %, considerable dilution and spread of the material would probably prevent accumulation of material in an unfavorable geometry. With an unfavorable geometry, a minimum solution depth of a few inches is needed to cause a criticality. Water systems are not designed for seismic loads and could present a ready moderator. However, the size of the buildings, the leakage area between floors, and the barriers between the UF_6 and the fire suppression systems make criticality a remote possibility. Nevertheless, emergency procedures require that appropriate conditions be established for reentry to an evacuated facility. Consequences from an inadvertent criticality would be similar to the consequences described in the criticality event scenario (see Section 4.3.2.6).

Lube Oil Impact. The evaluation basis seismic event may cause a release of lubricating oil used to service the compressor motors. The tanks and lines connecting to the compressors have been evaluated as part of the equipment evaluations. The supply tank located on the roof has weak anchors. Failure of this anchorage would not result in complete loss of restraint of the lube oil tanks. Failure of the attached piping is possible, however. Failure of this piping could allow oil to leak onto the roof or down around the lines that run to the individual compressors. Some of this material could spread out on the operating floor. Failure of equipment and nonstructural support components could lead to electrical shorting, creating potential ignition sources. In the absence of power, however, either as a direct result of the event or through operator action to shut down the power in the switchyard, the potential for a ready ignition source is significantly reduced. The only possible source would then be heat from mechanical components. Note that the lube oil is a low-flammability blend with a high flash point and is therefore hard to ignite. Further, the potential for water system breaks is present, and if they do occur, such breaks would also serve to abate any fire potential from failure of the lube oil system. Therefore, a large fire in the process building following a seismic event is unlikely.

Overall Seismic Conclusions. The results of the 3040-MW and 2200-MW cases show that the evaluation guidelines are exceeded beyond the site boundary for the 3040 MW case. Therefore, safety actions are required to control the potential releases from a seismic event.

The applicable EGs associated with this event are all the EGs for the EBE frequency range and any initial conditions assumed (i.e., normal operation, EG 5). The essential safety actions associated with meeting these EGs include (1) primary system pressure control to prevent, mitigate, or minimize any UF_6 release and (2) emergency response to evacuate the immediate vicinity so that the exposure of on-site personnel to UF_6, its reaction products, or ionizing radiation is minimized.

The consequences of this event are significantly overstated when the plant operates at typical power conditions. At lower power levels, significantly more of the cascade will be below atmospheric pressure. In all cases, the most important action is to control cascade system pressure.

The operating power level of the cascade is routinely varied, depending on the availability of inexpensive power in the region. The plant has a design power level of 3040 MW. At that level, most of the "000" equipment and some of the "00" equipment would be above atmospheric pressure on the B side. However, significantly exceeding 2200-MW would require capital improvements, and operation above this level is currently considered unlikely. At 2200 MW, operation above atmospheric pressure would typically be limited to the "000" process buildings, although it would be possible to operate parts of the "00" buildings above atmospheric pressure.

Cascade system pressure control can be accomplished by tripping power to the compressor motors. It is expected that a seismic event of sufficient magnitude to result in significant damage to the plant would also severely damage the power distribution system external to or within the plant boundary. No attempt was made to evaluate the plant electrical switchyard or cabling to determine capacities. Nevertheless, power was assumed to be available throughout the event. All ACR personnel would, if able, evacuate the affected facilities in direct response to the expected releases and as a result of the see and flee policy. Direct action would then be required to trip power to the compressors either in the CCF or directly in the switchyard.

Another significant conservative element in the consequence estimate is that no credit was taken for building holdup following the release. Particularly for the process buildings, significant holdup (approximately 40% of the uranium compounds) is possible with the cell housings, ventilation system (if it is assumed to operate through the seismic event), and cell floor. The building siding was analyzed and found to have sufficient capacity with original design to withstand the seismic event. The siding, however, may not fully comply with design specifications and therefore was not credited in the calculations. A similar reduction (approximately 40%) would be expected in the uranium dose off-site if the siding were credited.

e. <u>Summary of SSCs and TSR Controls</u>

Based on the results of this analysis, the essential controls for this event are summarized as follows:

- Design and structural capacity of process buildings, piping, and equipment—maintain initial condition (EG 5);
- Administrative controls require cranes be parked in a predetermined standby location when not in use—maintain initial condition (EG 5);
- Administrative controls require that the interbuilding process piping in all interbuilding tie-lines that have structural deficiencies and that contain UF_6 be maintained below atmospheric pressure. The interbuilding process piping in the C-331/C-333 tie-line is exempt from this administrative requirement since the deficiencies in the C-331/C-333 tie-line support structure have been corrected such that the tie-line structure will be adequate to resist service level and natural phenomena loading (EG5);
- "00", "000" compressor trip capability (if power is available)— primary system pressure control to minimize UF_6 releases (EGs 1 and 2);
- Administrative controls for reentry into areas with potential for criticality—minimize potential exposure for on-site personnel (EG 1).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- Design and structural capacity of process buildings, piping, and equipment (C-300, C-310, C-310-A, C-315, C-331, C-333, C-335, C-337, C-333-A, C-337-A, C-360, C-400, C-710, C-409, C-720 (series), C-746-Q1); the process building tie-lines; process building cranes; and the UF_6 compressor motor trip systems are identified as important to safety SSCs. See Section 3.15 for details including safety classification.
- TSRs are provided for compressor motor trip systems and for administrative requirements for procedures and training of workers on actions to be taken.

4.3.2.6 Criticality Events

a. <u>Scenario Description</u>

A criticality accident results in the uncontrolled release of energy from an assemblage of fissile material. The primary control for preventing an accidental criticality is the implementation of the NCS Program as described in Section 5.2. Preventing criticality is a central and very prominent objective of all fissile material activities at PGDP. Operations and equipment modifications are conducted in accordance with peer-reviewed criticality documentation that provide the limits and conditions that must be followed to ensure that criticality does not occur. The double contingency principle, a basic principle of criticality safety, applies to most operations. As described in ANSI/ANS-8.1 (Reference 76), the double-contingency principle requires a degree of safety such that two or more unlikely independent events would have to occur simultaneously before criticality could occur. Consequently, the actual frequency of accidental criticality is well below the 10^{-2}/yr threshold for EBEs. Furthermore, considering the three diffusion plants located in the United States, there have been more than 100 years of diffusion plant operation without a criticality accident.

This section uses conservative methodology to demonstrate that the potential consequences of accidental criticality, although possibly severe to workers in the immediate vicinity, would be mild to negligible for other workers on the plant site and negligible for the general public. The approach used is that outlined by NRC Regulatory Guide 3.34 (Reference 77). The potential consequences are, as a practical matter, dominated by radiological exposure. For example, a criticality event could, if it occurred inside a closed vessel, lead to a sudden pressure relief or vessel failure, but that would be less hazardous to a worker located nearby than the associated radiation exposure. For consequences from the release of the hazard to the atmosphere, refer to the appropriate release scenarios described in Sections 4.3.2.1 and 4.3.2.2. The radiological consequences are dominated by direct exposure to fission neutrons and gamma rays (prompt radiation), but the evaluation also considers the gamma radiation emitted by fission products and the exposure pathway provided by the airborne release of volatile fission products. The consequence evaluation includes both on-site and off-site exposures.

The potential radiological consequences to close-in workers in a criticality event are decided by deterministic effects, which are experienced by most individuals within hours or days after an exposure above the threshold for any given effect. Deterministic biological effects of radiation exposure imparted within a brief period are a function of the amount and quality of exposure. The quality refers to whether the exposure is to gamma or neutron radiation or to a mixture; it also depends on the energy of the rays

or particles that make up the exposure. In addition, response varies considerably from one individual to another. The deterministic effects of whole-body gamma irradiation can best be characterized by grouping them in ranges (Reference 78):

- 0-25 rem—no effects.
- 25-100 rem—mostly no effects, though a few persons may exhibit mild symptoms such as nausea and anorexia, with prognosis for recovery excellent.
- 100-300 rem—mild to severe nausea, malaise, anorexia, and infection, with recovery probable, though not assured.
- 300-600 rem—as above, plus hemorrhaging, infection, diarrhea, epilation, and temporary sterility, with guarded recovery prognosis; exposure of about 400 rem is fatal to 50 percent of individuals without medical treatment.
- 600 rem—above symptoms plus impairment of central nervous system and incapacitation for doses above 1000 rem, with death expected.

The preceding list of ranges and thresholds, as stated, is derived from data on gamma radiation. However, the results can be extended to mixtures of gamma and neutron exposure if the calculations take into account the relatively higher biological efficiency of neutron irradiation (i.e., neutron radiation is generally more harmful than gamma radiation per unit of absorbed energy). In older references the rem was a product of rad and the relative biological effectiveness (RBE). In high doses and high dose rate situations, the determination of a RBE is very difficult because of complex dosimetry and radiation biology interactions. RBEs for neutron exposure also vary significantly based on the energy of the interacting neutrons. As a result, estimation of neutron radiation dose is usually done using units of "rad". However, in this analysis, the formulas from Reg. Guide 3.34 were used to provide estimates of neutron exposure and these are reported in the Reg. Guide in rem. In the consequence evaluations below, a mixed (gamma plus neutron) exposure of 400 rem is taken conservatively to define the zone of potential lethality.

b. <u>Historical Record of Accidental Criticality Events</u>

Accidental criticality, with uncontrolled power level, has occurred on 60 known occasions (according References 80, and 95). All but 22 of these have occurred in facilities such as critical experiments facilities or reactor facilities and are thus of some interest but of limited applicability to the industrial processing activities that go on at a gaseous diffusion plant. The total yields for these events ranged from 3×10^{15} to 1.2×10^{20} fissions, with a median of about 1.3×10^{17} fissions. For the 46 events that were not terminated by automatic shutdown systems, the criticality was terminated by the negative reactivity effects of the energy released by the unintended fissions. The shutdown mechanisms can be summarized as follows:

- Density reduction, either via microbubble formation or thermal expansion.
- Loss of water moderation by boiling.
- Expulsion of part of the mass.
- Mixing of light and dense layers (dilution).
- Geometry change.

In the history of fissile material processing, 22 accidental criticality events have occurred in processing plants and are therefore relevant to the industrial setting of a gaseous diffusion plant. Table 4.3-16, taken from References 80 and 95, summarizes important facts about nine of these events, which are well known historically or because of their recent occurrence (Tokai-mura, 1999). Most of the events can be characterized by an initial main pulse followed by other, smaller pulses and, in some cases, featuring a plateau of apparently steady criticality at a low level for an extended period. The magnitude of these accidents has ranged from about 10^{15} to about 6×10^{17} fissions in the initial pulse. The largest total yield is estimated to have been about 4×10^{19} fissions accumulated as a result of an extended period of small pulses. The likelihood of an extended period of criticality provides a firm basis for prompt evacuation of process areas to minimize the radiation exposure of workers. Another significant lesson is that 21 of the 22 processing plant criticality accidents involved solutions rather than solids. This is not surprising when it is considered that solution systems can have much smaller critical masses and are quite mobile, thus inviting criticality in unexpected locations. By contrast, solids typically are nonmobile or at least do not generally move except by deliberate action of operational personnel, and the masses required for undermoderated solids are large compared with those of well-moderated solution systems.

c. <u>Possible Criticality Events at PGDP</u>

Criticality accidents that may be possible at a gaseous diffusion plant are either similar to or not worse than those that might be encountered at a fuel fabrication plant. A gaseous diffusion plant and a fuel fabrication plant share many qualitatively similar operations involving analogous forms of fissile material:

- Gaseous and solid UF_6.
- Uranium solutions.
- Slurries of low-density uranium compounds.
- Low-density dry forms of uranium compounds, with and without moderation control for criticality safety purposes.

A gaseous diffusion plant lacks the high-density forms of uranium, such as pressed and sintered UO_2, that must be handled at a fuel fabrication plant to manufacture reactor fuel. Fissile material at PGDP is conservatively addressed by consideration of solid UF_6 and uranium oxyfluorides (e.g. UO_2F_2). Other chemical compounds are possible in much smaller quantities and less reactive forms. Fissile material is processed in the cascade, UF_6 handling, laboratory, and maintenance facilities. Fissile material is also stored in large quantities outside these facilities (e.g. fissile cylinder storage yards) and is routinely transported between facilities. A criticality is considered possible in any area or operation where fissile material is stored, handled, or transported, which could include any location within the controlled access area (CAA).

Considering the range of activities at PGDP, as well as industry experience, it is reasonable to conclude that the most likely type of criticality would be one involving uranium solution. Solution processing is most common in the Decontamination and Uranium Recovery Facilities (Buildings C-400 and C-409); however, solutions are routinely handled in several other facilities (e.g., the C-710 laboratory), and accidents could theoretically occur (e.g., in conjunction with a nonroutine cleanup or maintenance operation) in any facility on-site where significant quantities of fissile material are being processed. A solution criticality event is very unlikely, but considered credible in accidents involving transportation or storage of fissile material outside of process buildings. For example, a solution criticality event is possible if large quantities of liquid moderator are able to enter a solid fissile UF_6 cylinder.

In defining a second-most-likely type of criticality event, one would have to look to the sheer size of the cascade operations (>50 acres under roof) and the large number of UF_6 gas processing units. UF_6 gas is inherently safe against criticality for conditions possible in the cascade. The possibility of criticality is introduced by the chance that a buildup of solid uranium compound in large-diameter pipes or other large equipment (i.e., equipment for

which size exceeds geometrically favorable dimensions) could become sufficiently moderated to go critical. It should be pointed out that inherent as well as intentionally maintained safety features make such an event a very unlikely and hypothetical postulate. In the cascade, the UF_6 must be kept in gaseous form, and except in the freezer/sublimer vessels, any buildup of solid forms must be avoided for the gaseous diffusion process to work properly. The deposits surveillance program (described in Section 5.2) is performed in addition to the normal cascade controls to detect buildup within the cascade. Nevertheless, buildup of solids does occur, and the buildup must be maintained in a fluorinating environment or periodically cleaned out via chemical treatment or by equipment removal and decontamination. Large quantities of solid UF_6 are also present in UF_6 cylinders. If an unmitigated breach would occur and result in gradual exposure of the UF_6 to moderator from water in air, or inclement weather, then a criticality resembling a solids-buildup event might also be possible in these cylinders.

Defining whether a solids-buildup-related criticality event warrants consideration in addition to that to be given to solution criticality requires consideration of the rate at which the hypothetical, potentially critical mass becomes moderated. If the rate of moderation were rapid (e.g., through actuation of fire sprinklers during disassembly of an equipment item with an excessive accumulation of fissile solids), then one might expect that the characteristics of the event could be similar to those of a solution criticality event. However, it is plausible that a poorly moderated critical mass could be achieved with what could be described as a damp or wet solid instead of a solution or with a mixture of damp solid and solution. Such an event is designated for consideration in the analyses presented below.

Another possibility that deserves consideration is the postulated case where fissile material builds up so slowly that when it becomes critical, it achieves a quasi-steady equilibrium power level (i.e., a "slow-cooker" event with no power excursion) that does not trip the plant criticality alarm system. Such an event has not occurred at PGDP or anywhere else. Buildups of fissile material in process equipment have occurred but have been detected before they have exceeded a critical mass. Uranium enriched to 6.0 weight percent or less ^{235}U is considered to be incapable of supporting a nuclear chain reaction without the presence of moderation (see 5.2.3.1). Solid deposits would be of greatest concern in the part of the cascade that handles the highest enrichments. The probability of a "slow-cooker" event escaping detection is low because the criticality alarm system is designed to detect the minimum accident of concern defined in ANSI/ANS 8.3 (Reference 82) (see SAR Section 3.15). Having the "slow cooker" event escape coverage is tantamount to assuming that the criticality occurs near an edge or boundary in criticality alarm system coverage. Radiation-monitoring instrumentation and programs (see Section 5.3) are in place and would be likely to alert workers before significant harm to individual workers occurs. Nevertheless, a "slow-cooker" criticality event, more properly referred to as “an event less than the ANSI standard minimum criticality accident of concern,” is designated for further consideration because of its clear-cut qualitative difference from excursion-type events.

In summary, three types of accidental criticality events are considered in this section:

- Solution criticality.
- Moderated solids criticality.
- an event less than the ANSI standard minimum criticality accident of concern ("slow-cooker").

The first two of these are power excursion events that occur over short periods and would be detected rapidly, whereas the last could conceivably avoid detection for hours, depending on specific factors such as the location, rate, and geometry of fissile material buildup. The primary means of detection is CAAS for areas and operations that require CAAS coverage. Alarming electronic personal dosimeters (EPDs) are required in areas with inoperable CAAS, for personnel involved in planned expeditious handling equipment transportation, or those involved in response to a fissile cylinder breach. Events occurring outside of CAAS coverage are only credible following some self-identifying initiating event such as a transportation accident or some external event that causes a fissile cylinder breach. The PGDP Radiological Protection Program ensures reliable detection of high radiation levels is provided for those events that might occur outside of CAAS.

d. Consequence Estimation Methodology and Assumptions

This subsection primarily addresses methodology in the context of solution criticalities. In the consequence evaluation subsections that follow, it is shown that potential consequences of the moderated solids and the slow-cooker events are adequately bracketed by the consequences of solution criticality events, analyzed as described below.

NRC Regulatory Guide 3.34 (Reference 77) not only provides important assumptions for consequence estimation but also defines the magnitude and time phasing of the accident to be considered. The NRC definition is patterned after a hypothetical solution criticality event, as explained in the regulatory guide:

> An excursion is assumed to occur in a vented vessel of unfavorable geometry containing a solution of 400 g/l of uranium enriched in ^{235}U. The excursion produces an initial burst of 10^{18} fissions in 0.5 second followed successively at 10-minute intervals by 47 bursts of 1.9×10^{17} fissions for a total of 10^{19} fissions in 8 hours. The excursion is assumed to be terminated by evaporation of 100 liters of solution.

Referring back to the historical processing plant criticality accidents summarized in Table 4.3-16, we see that the Reg. Guide 3.34 definition of a solution criticality event—in initial burst as well as accumulated total—is qualitatively similar to most of the actual criticality accidents, but that its fission yield is at least a factor of 3 or more in excess of that seen in any of them (except for the October 15, 1959, event at the ICPP fuel reprocessing plant). Reference 80 shows that an initial burst of 10^{18} fissions has a factor of conservatism of at least about 2, based on an estimated maximum potential rate of highly enriched solution transfer of 30 gallons/minute (114 L/min).

Accurate estimation of radiation exposures due to criticality events requires quantification of three potential components, listed here in descending order of importance: prompt neutron and gamma exposure (occurring at the time of the critical power excursion), gamma exposure due to decay of fission products (during and after termination of the criticality event), and exposure due to immersion in the plume of any volatile fission products released (applicable only to downwind locations). Reg. Guide 3.34 provides easily used formulas for the prompt gamma and neutron doses:

$$D_{\text{gamma}} = 2.1 \times 10^{-20}\, N\, d^{-2} e^{-3.4d},$$
$$D_{\text{neutron}} = 7.0 \times 10^{-20}\, N\, d^{-2} e^{-5.2d},$$

where,

D_{gamma} = gamma exposure (rem),
D_{neutron} = neutron exposure (rem),
N = number of fissions, and
d = distance from the source (km).

Dose reduction factors are specified by Reg. Guide 3.34 to allow convenient estimation of the benefit of intervening concrete. For gamma dose, a reduction factor of 2.5 for the first 8 inches (20 cm) of concrete and a factor of 5 for the first 1 foot (30 cm) are specified; for neutrons, factors of 2.3 for the first 8 inches (20 cm) and 4.6 for the first 1 foot (30 cm) are specified. These formulas are used

directly in the consequence calculations reported below.

Reg. Guide 3.34 recommends that delayed gamma radiation due to decay of fission products be included in the total-event exposure determination. The delayed gamma exposure values reported by Reference 83 are used here, but they are in basic agreement with those applied earlier to a consequence evaluation at PORTS (Reference 84). In the consequence estimates reported below, delayed gamma exposure is for the total event but not for the first pulse, because the regulatory guide states that the formula for prompt gamma exposure (above) has an adequate allowance for the delayed gammas that would be emitted during the first minute after an excursion.

Reg. Guide 3.34 specifies the amount of volatile fission products (100% of noble gases, 25% of radioiodines) that should be assumed to be released to the environment as a result of an accidental criticality. In addition, F stability and 1-meter/second wind speed meteorological conditions are specified for the plume transport calculations. As shown in Table 4.3-10, conditions more favorable than F stability (i.e., more dispersion of airborne plumes and lower plume exposures) are in effect more than 91 percent of the time at PGDP. The calculated plume exposures include internal (via inhalation) and external (cloud and ground shine) plume exposures reported by Reference 85 in an implementation of Reg. Guide 3.34 for the Y-12 plant. Reference 86 conservatively does not take credit for decay of fission products before, during, or after a release. In the consequence estimates given below, plume exposure is not reported for the first-pulse exposures (Table 4.3-17) because of the unlikelihood that fission products could be released from the process vessel into the building, and from the building to the environment, during the short time scale of interest for first-pulse evaluations. First-pulse duration is on the order of 0.5 sec. It is not credible for significant plume dispersion to occur within that short time frame. That remains true even if the event occurs outdoors or in buildings that have open bays. Only the total-event exposures include plume exposures.

e. <u>Consequence Estimate — Solution Criticality</u>

Table 4.3-17 reports the radiation exposures for a first pulse of 10^{18} fissions, as recommended by Reg. Guide 3.34. Values are reported for air attenuation (no shielding) as well as for 1 foot (0.3 meter) of concrete to show the sensitivity to the amount of intervening shielding (or other structure). The radius inside which exposures could exceed a potentially lethal exposure of 400 rem or greater varies from 48 feet (14.5 meters) without shielding to 23 feet (6.9 meters) for 1 foot (0.3 meter) of intervening concrete. As shown in Figure 4.3-45, first-pulse exposures at the site boundary are negligible.

Table 4.3-18 reports the radiation exposures for the entire accident, and Figure 4.3-45 plots total radiation exposures as a function of distance from the critical mass, without consideration of any intervening shielding, for both the entire event and the first pulse. As prescribed by Reg. Guide 3.34, the entire accident fission yield is assumed to be 10^{19} fissions, occurring over a period of 8 hours. Prompt neutron and gamma, delayed gamma, and plume exposures are included in the calculations. Note that the exposure calculations do not take credit for the definition of the event as being spread over 8 hours. The total exposure is given with and without plume exposure because it is doubtful that one individual would be situated at the centerline of the plume for the entire plume passage, as assumed by the plume exposure calculation.

Because of the conservative meteorological conditions assumed, the downwind plume exposures are dominant for distances exceeding about 660 feet (200 meters); thus, the total exposures shown in Figure 4.3-45 for distances exceeding about 490 feet (150 meters) are applicable only to the downwind

direction. The radius inside which exposures could exceed a potentially lethal level of 400 rem varies from about 72 feet (22 meters) with 12 inches (0.3 meter) of intervening concrete shielding to about 148 feet (45 meters) with no shielding.

Because 90 percent of the dose from this event is accumulated over an 8-hour period, there is no reason why any worker would necessarily experience more than about 10 percent of the calculated full-event exposure prior to evacuation. The total event site boundary exposure, assuming the event occurs in the building with fissile material operations closest to the site boundary (approximately 2625 ft (800 m) south from Building C-746-Q1), and including plume exposure, is 1.15 rem, well below the 25 rem EG for off-site exposures resulting from EBEs (in accordance with Table 4.2-2). The bounding event for criticality scenarios is one that occurs at the minimum distance between the CAA and the site boundary (i.e., greater than 300 m). According to Table 4.3-18, an event at 300 m would result in a dose to the off-site public of less than 8 rem, which is well below the 25 rem EG-1 value for analysis of EBEs. A total-event off-site exposure of 0.66 rem (plume exposure included), occurring at 1 km, would be more representative of most of the major processing buildings.

f. <u>Consequence Estimate—Damp/Wet Solids Criticality</u>

Damp/wet solids criticality events are not as well understood as solution criticality events because there have been no actual criticality events in this category. Computer analysis studies of damp/wet low-enriched UO_2 excursions and one study of dry high-enriched UO_2 powder criticality events have been completed (References 86, 87, 88). Note that low-enriched UO_2 will not go critical unless it is at least partially moderated. PGDP does not produce or handle UO_2, but it does handle and produce uranium compounds such as uranium oxyfluoride deposits in the cascade that could possibly become moderated. The lesson from the UO_2 studies is that the thermal effects of the power excursion are sufficient to terminate the criticality before the energy release significantly exceeds the total-event release of Reg. Guide 3.34. The results of the UO_2 studies predict total-event fission yields of between about 10^{18} and 10^{19} fissions. The time for the power deposition to occur would depend on the rate of reactivity addition. With credible rates of reactivity insertion (<1¢/s), the simulation for low-enriched UO_2 predicted an initial pulse of about 0.9×10^{18} fissions, and with continuing broad, lower pulses, the total yield reached about 0.9×10^{19} fissions over about 10 min (Reference 86).

A calculational study specific to a postulated criticality excursion in diffusion plant freezer/sublimers (Reference 89) is of interest in this category. The postulated mechanism for criticality is water inleakage via simultaneous tube breaks in the freezer/sublimer and in the condenser/reboiler during a cold standby (the mode needed to maintain the UF_6 in solid form after freezing). This defines the postulated accident as a very improbable one. For the calculations, the analyst assigned a value at the upper end of the plausible range for the nominal water ingress rate, but ran cases at 50 percent of that nominal value. Responses for both a 10-MW and a 20-MW freezer/sublimer were calculated. The calculations predict a total-event yield of about 5×10^{18} fissions over about 20-40 seconds for the 10-MW unit and between about 0.8×10^{17} and 4×10^{18} fissions over about 30-60 seconds for the 20-MW unit.

The consequences of events in this category are adequately bracketed by the Reg. Guide 3.34-based solution criticality results, presented in the previous subsection and in Tables 4.3-17 and 4.3-18, with one important stipulation—the time scale for the total-event release may be significantly

different from the 8-hour period prescribed by Reg. Guide 3.34. The time scale, of course, depends on the rate of criticality addition. A total-event fission yield between about 10^{18} and 10^{19} fissions should be regarded as physically possible, with the energy release able to take place over periods as short as 1-10 minutes. Even though the time scale for releases may be accelerated as compared with the regulatory guide, worker evacuation provides much potential for avoidance of exposure.

The on- and off-site exposures presented in Table 4.3-18 can be scaled to apply to events in this category because the calculations for Table 4.3-18 did not take credit for the 8-hour total-event duration prescribed by Reg. Guide 3.34. Accordingly, the maximum potential lethal range of this event would, depending on fission yield, be between about 49 feet (15 m) and 148 feet (45 m) without shielding and between about 26 feet (8 m) and 73 feet (22 m) with 1 foot (0.3 m) of concrete shielding. The nearest site boundary exposure, assuming the event occurs in the building with fissile material operations closest to the site boundary (approximately 800 m south from building C-746-Q1), would be between 1.11 and 1.15 rem, well below the 25 rem EG for EBEs in Table 4.2-2. The bounding event for criticality scenarios is one that occurs at the minimum distance between the CAA and the site boundary (i.e., greater than 300 m). According to Table 4.3-18, an event at 300 m would result in a dose to the off-site public of less than 8 rem, which is well below the 25 rem EG-1 value for analysis of EBEs.

g. <u>Consequence Estimate — Event Less Than the ANSI Standard Minimum Criticality Accident of Concern</u>

A wide range of consequences is possible, depending on many parameters. The following analysis is intended to estimate the range of potential consequences.

ANSI/ANS 8.3 (Reference 82) defines the minimum criticality accident of concern as one that produces a dose rate (energy absorption in free air) of 20 rad/min at a point 6.6 feet (2 m) from the critical mass, and it requires that the system be capable of latching and initiating the alarm should that defined radiation level be sustained for as long as 0.5 second. This gives the system extraordinary sensitivity to pulse-type events. As discussed in Appendix A of the ANSI/ANS 8.3, a pulse-type event as small as about 3×10^{15} fissions occurring over 1 min or less would be detected. The consequences of such an event would be a factor of 333 lower than the consequences presented in Table 4.3-17 for the Reg. Guide 3.34-defined 10^{18} fissions for the first pulse. This would be a small criticality event, with very minor consequences for anyone more than a few meters away from the critical assembly. A small, pulse-type event would represent the most favorable outcome for this event, but there is no assurance that the increase in reactivity might not instead be very slow and essentially linear instead of exponential, as postulated by Reference 90. As a worst case, it will be assumed that a critical mass is stabilized at a power level infinitesimally lower than that corresponding to the minimum accident of concern. This is tantamount to assuming that the criticality occurs near an edge or boundary in criticality alarm system coverage. Studies (e.g., Reference 91) have shown that the system would alarm much more readily for a critical mass closer to a detector.

The steady power level that corresponds to the ANSI/ANS 8.3-specified constant of a 20-rad/min dose rate at 6.6 feet (2 m) is dependent on specific material and configuration parameters, including the enrichment and moderation ratio (H/U ratio). A recent Portsmouth calculational study (Reference 92) has provided a basis for defining the power levels of events that do not trip the criticality accident alarm system as a function of enrichment:

- 1280 W at 100 percent enrichment.
- 1720 W at 20 percent enrichment.

- 2880 W at 5 percent enrichment.

Using the conversion factor of (3.3 x 10^{10} fissions/s)/W given by Reference 93, we see that the corresponding fission rates would be, respectively, 4.23 x 10^{13}, 5.68 x 10^{13}, and 9.51 x 10^{13} fissions/s. The total number of fissions experienced during the event would then depend on how long the event goes on until detection and intervention or until unaided shutdown occurs. If we define the maximum period as 8 hours, then the magnitude of the total event would be as follows:

- 1.2 x 10^{18} fissions for a 100 percent enriched critical mass operating at 1280 W for 8 h.
- 1.6 x 10^{18} fissions for a 20 percent enriched critical mass operating at 1720 W for 8 h.
- 2.7 x 10^{18} fissions for a 5 percent enriched critical mass operating at 2880 W for 8 h.

It is reasonable to assume that such a worst-case "slow-cooker" criticality event would be terminated within 8 hours. There are multiple ways in addition to the criticality alarm system for the presence of the "slow-cooker" to be detected. Therefore, the consequences of a "slow-cooker" criticality event are bounded by the consequences presented above for the Reg. Guide 3.34 solution criticality event. The worst-case consequence threshold radii could therefore possibly be greater than the Table 4.3-17 data but less than the Table 4.3-18 data. The off-site exposures would, as with the solution criticality and the damp/wet solids criticality events analyzed above, be more than an order of magnitude below the 25 rem EG for EBEs in Table 4.2-2, for events initiating from the nearest building with fissile operations to the site boundary (i.e. C-746-Q1). The bounding event for criticality scenarios is one that occurs at the minimum distance between the CAA and the site boundary (i.e., greater than 300 m). According to Table 4.3-18, an event at 300 m would result in a dose to the off-site public of less than 8 rem, which is well below the 25 rem EG-1 value for analysis of EBEs.

h. <u>Comparison With Guidelines</u>

For the criticality event, the comparison with guidelines is subdivided to address the different receptors.

Local workers in the immediate area — A criticality in the immediate vicinity of a local worker could result in significant exposure if no mitigative action is taken. The only action that can be taken is to immediately evacuate upon initiation of the CAAS, alarming electronic personal dosimeters (EPDs) when required, and upon indication of high radiation via the protection and programs of the Radiological Protection Program. EPDs are required in areas with inoperable CAAS, for personnel involved in PEH equipment transportation, or those involved in response to a fissile cylinder breach.

On-site workers — The essential controls for protecting on-site personnel are the same as those for protecting the local worker.

Off-site public — As indicated in the consequence analysis, this event would not exceed the off-site EGs if no mitigative action were taken. Therefore, no controls are required for this receptor.

i. Summary of SSCs and TSR Controls

Based on the results of this analysis, the essential controls for the criticality event are summarized as follows:

- Administrative controls to prevent a criticality (see Section 5.2)—maintain initial condition (normal operation, EG 5 only).
- Criticality accident alarm system—detects and annunciates a criticality (EG 1 for on-site personnel only).
- Administrative controls for the Radiological Protection Program (EG-1 for on-site personnel only).

Based on the above essential controls, the resulting important to safety SSCs and TSRs are as follows:

- The criticality accident alarm system is identified as an important to safety SSC. See Section 3.15 for details including safety classification.
- TSRs are provided for the criticality accident alarm system, and to require use of alarming electronic personal dosimeters (EPDs) in areas with inoperable CAAS, or for personnel involved in planned expeditious handling (PEH) transportation.

Table 4.3-1. Safety Actions.

Safety action name	Safety action purpose
PRIMARY SYSTEM PRESSURE CONTROL	This safety action is required to maintain system (e.g., UF6 system) integrity during normal operation as well as during events. This safety action is also used to assure primary system integrity (passive).
CYLINDER HANDLING RESTRICTION	This safety action is required to support all normal operational cylinder handling restrictions.
INSPECTION/TESTING/ SURVEILLANCE	This safety action is required to support all inspections and testing performed during normal operations.
PRIMARY SYSTEM LEAKAGE DETECTION	This safety action is required to detect when the primary system integrity has failed and when leakage of the hazard has occurred. The detection of the leakage will be required to meet this safety action.
PRIMARY SYSTEM ISOLATION	This safety action is required to close the primary system isolation valves when a leak is detected outside primary containment.
ESTABLISH PRIMARY CONTAINMENT	This safety action is required to establish and maintain primary containment integrity during upset conditions.
AUTOCLAVE WATER INVENTORY CONTROL	This safety action is required to maintain conditions within primary containment autoclaves within predefined limits to assure autoclave integrity should a release of UF_6 occur inside the autoclave.
CRITICALITY SAFETY CONTROL	This safety action is required to maintain essential criticality controls during normal operation and upset conditions.
ASSAY CONTROL	This safety action is required to maintain essential criticality controls during normal and upset conditions.
GEOMETRY CONTROL	This safety action is required to maintain essential criticality controls during normal and upset conditions.
EMERGENCY RESPONSE	This safety action is required to limit hazardous material releases to preestablished guidelines during upset conditions via administrative controls.
PRIMARY SYSTEM TEMPERATURE CONTROL	This safety action is required to limit temperature excursions within the primary system to prevent failures that will result in a loss of primary system integrity.
CRITICALITY NOTIFICATION	This safety action is required to provide alarms to area personnel of a criticality accident for emergency evacuation.
NO SAFETY ACTION IS REQUIRED	
FIRE PROTECTION	This safety action is required to provide fire protection systems to mitigate potential effects of the event.
OXIDANT CONCENTRA-TION CONTROL	This safety action is required to limit the amounts of oxidant concentration below acceptable amounts to preclude a violent reaction and subsequent loss of primary system integrity.
DENSITY CONTROL	This safety action is required to maintain essential criticality controls during normal operation and upset conditions.
BUILDING HOLDUP	This safety action is required to provide a temporary holdup of UF_6 released into the area and allow deposition within the facility. This will reduce the concentration of UF_6 leaving the building.
TOXIC GAS CONTROL	This safety action is required to prevent, detect, and/or mitigate the effects of a toxic material release.
HAZARDOUS MATERIAL INVENTORY CONTROL	This safety action is required to limit the amount of hazardous material to levels that will not require protection to meet the EGs should the material be released.
SAFE HANDLING PRACTICES FOR APPLICABLE HAZARD	This safety action is required to ensure that good safe handling practices are in place and are followed in accordance with an established program.

Table 4.3-2. Natural Phenomena Load Combinations.

$DL + Dl_{columns} + Dl_{walls} + EL + ML + E'$
$DL + Dl_{columns} + Dl_{walls} + EL + ML - E'$
$DL + Dl_{columns} + Dl_{walls} + EL + ML + WLNS$
$DL + Dl_{columns} + Dl_{walls} + EL + ML + WLEW$
$DL + Dl_{columns} + Dl_{walls} + EL + ML + 1.2F_p$

Notes: DL includes slabs, mezzanines, and supporting beams; EL includes equipment loads; ML includes miscellaneous supported loads; E' is the earthquake load; WLNS is the North/South wind load; WLEW is the East/West wind load; and F_p is the roof ponding load.

Table 4.3-3. ARS Frequency Array.

From frequency	To frequency	Use interval
0.5 Hz	1.6 Hz	0.10 Hz
1.6 Hz	2.8 Hz	0.20 Hz
2.8 Hz	4.0 Hz	0.30 Hz
4.0 Hz	9.0 Hz	0.50 Hz
9.0 Hz	16.0 Hz	1.00 Hz
16.0 Hz	22.0 Hz	2.00 Hz
22.0 Hz	50.0 Hz	3.00 Hz

Table 4.3-4. Parameters Defining the Base Scenario for the Large Release of UF_6 to Atmosphere (B-line block valve closure release).

Parameter	Value
Atmospheric stability	Stable (Pasquill-Gifford stability class F)
Wind speed	7 mph (3 m/s)
Ambient air temperature[a]	70°F (21.1°C)
Release rate of UF_6 inside building	59 kg/s
Duration of release inside building	8 min (600 s)
Duration of release to the outside atmosphere[b]	42 min (2500 s)
Surface roughness[c]	Rural

[a]The ambient temperature for the baseline scenario differs from Cases A2 (A stability 2 m/s wind speed), A3 (A stability 4 m/s wind speed), and A5 (A stability 5 m/s wind speed) because Case A4 (A stability, 4 m/s wind speed) simulates releases from the process building during summer ventilation configuration. This ventilation results in a significantly larger mass of material being released.

[b]The duration of the release to the outside atmosphere is greater than that of the release in the building because of mixing that occurs inside the building during transport.

[c]The WAKE model (Hanna et al. 1997) allows only two roughness scales: rural and urban. A rural roughness length is relatively low (e.g., 0.03 m), and an urban roughness length is relatively high (1.0 m). Consequence estimates are higher with the rural roughness scale than with the urban roughness scale, due to greater atmospheric turbulence and resultant plume dilution in the latter.

Table 4.3-5. Estimated Consequences for the Base Scenario for the Large Release of UF_6 to Atmosphere (B-Lne Block Valve Closure Release Case; see Table 4.3-4 for Corresponding Source Conditions).

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure	
Receptor location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Consequence Value (ppm)	Comparison Value (ppm)
Site boundary[a]	53	30	0.56	25	40	20
1 mi (1600 m) downwind	41	30	0.42	25	29	20
5 mi (8050 m) downwind	9	30	0.09	25	6	20

a. Consequence estimates were made at the site boundary nearest to Building C-337 [0.56 mi (900 m) to the north].

Table 4.3-6. Parameters Defining the Baseline Scenario for the Parent/Daughter Transfer Release.

Parameter	Value
Atmospheric stability	stable (Pasquill-Gifford stability class F)
Wind speed	2 mph (1 m/s)
Ambient air temperature	40°F (4.4°C)
Ambient relative humidity	70 %
Initial mixing (volume ratio of ambient dry air to release UF_6)	50
f_A (fraction of area of leeward side of building that is open)	0.055
Surface roughness	1 inch (0.03 m)
Initial deposition of solid UF_6	0 %

Table 4.3-7. Estimated Consequences for the Parent/Daughter Transfer Release, Baseline Scenario.

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure[a]	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Consequence Value (ppm)	ERPG-2 Comparison Value (ppm)
Site Boundary[b]	12.3	30	0.13	25	4.9	20
1 mile (1600 m)	7.35	30	0.08	25	2.9	20
5 miles (8050 m)	0.85	30	0.01	25	0.3	20

a. No guideline value is directly associated with hydrogen fluoride (HF) exposure. The guideline values for soluble uranium provide adequate control for HF exposure, since HF is produced in direct proportion with the amount of UO_2F_2 produced as a result of the UF_6 release. The Emergency Response Planning Guideline (ERPG-2) is shown for comparison.

b. Consequence estimates were made at the nearest site boundary from the potential release point [0.62 mile (1000 m) to the east].

Table 4.3-7a. Parameters Defining the Baseline Scenario for the Line Failure in the C-360 Basement Transfer Room When Technetium Traps are in Operation.

Parameter	Value
Atmospheric stability	stable (Pasquill-Gifford stability class F)
Wind speed	2 mph (1 m/s)
Ambient air temperature	40 °F (4.4 °C)
Ambient relative humidity	70 %
f_A (fraction of area of leeward side of building that is open)	0.006
Surface roughness	1 inch (0.03m)
Initial deposition of solid UF_6	0 %

Table 4.3-7b. Estimated Consequences for the Line Failure in the C-360 Basement Transfer Room When Technetium Traps are in Operation, Baseline Case

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure[a]	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Consequence Value (ppm)	ERPG-2 Comparison Value (ppm)
Site Boundary[b]	24.8	30	0.26	25	9.7	20
1 mile (1600 m)	15.8	30	0.16	25	5.9	20
5 miles (8050 m)	1.8	30	0.02	25	0.5	20

a. No guideline value is directly associated with hydrogen fluoride (HF) exposure. The guideline values for soluble uranium provide adequate control for HF exposure, since HF is produced in direct proportion with the amount of UO_2F_2 produced as a result of the UF_6 release. The Emergency Response Planning Guideline (ERPG-2) is shown for comparison.

b. Consequence estimates were made at the nearest PGDP site boundary from the potential release point (1050 m to the east).

Table 4.3-8. Parameters Defining the Baseline Scenario for the Dropped Liquid-Filled Cylinder Release.

Parameter	Value
Atmospheric stability	stable (Pasquill-Gifford stability class F)
Wind speed	2 mph (1 m/s)
Ambient air temperature	40°F (4.4°C)
Ambient relative humidity	70 %
Initial mixing (volume ratio of ambient dry air to release UF_6)	50
Surface roughness	1 inch (0.03 m)
Initial deposition of solid UF_6	0 %

Table 4.3-9. Estimated Consequences for the Dropped Liquid-filled Cylinder Release, Baseline Scenario.

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure[a]	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Consequence Value (ppm)	ERPG-2 Comparison Value (ppm)
Site Boundary[b]	486	30	5.07	25	190	20
1 mile (1600 m)	250	30	2.61	25	92	20
5 miles (8050 m)	15	30	0.16	25	6	20

a. No guideline value is directly associated with hydrogen fluoride (HF) exposure. The guideline values for soluble uranium provide adequate control for HF exposure, since HF is produced in direct proportion with the amount of UO_2F_2 produced as a result of the UF_6 release. The Emergency Response Planning Guideline (ERPG-2) is shown for comparison.

b. Consequence estimates were made at the nearest site boundary from the potential release point [0.68 mile (1100 m) to the east].

Table 4.3-10. Gaussian Dispersion of a Nonreactive, Ground-Level Source at PGDP.

Pasquill-Gifford Stability Class	Wind Speed[a] (m/s)	Normalized Concentration, χ/Q (s/m^3)[b] at 3300 ft (1000 m) downwind	Percent Occurrence	Cumulative Percent Occurrence for ≤ Identified Normalized Concentration
A	2	1.68×10^{-6}	6.6	6.6
A	1	3.36×10^{-6}	1.5	8.1
B	4	4.72×10^{-6}	2.5	10.6
C	7	7.21×10^{-6}	0.6	11.2
D	16	9.10×10^{-6}	0.04	11.3
B	2	9.45×10^{-6}	3.8	15.1
D	13	1.12×10^{-5}	0.01	15.1
C	4	1.26×10^{-5}	6.5	21.6
D	10	1.46×10^{-5}	0.5	22.0
B	1	1.59×10^{-5}	0.4	22.4
D	7	2.08×10^{-5}	5.7	28.2
C	2	2.52×10^{-5}	3.7	31.9
D	4	3.64×10^{-5}	14.9	46.8
C	1	5.05×10^{-5}	0.4	47.2
E	4	7.22×10^{-5}	3.5	50.7
D	2	7.28×10^{-5}	14.6	65.2
E	2	1.44×10^{-4}	9.9	75.1
D	1	1.46×10^{-4}	4.4	79.5
E	1	2.89×10^{-4}	4.41	83.9
F	2	3.37×10^{-4}	7.7	91.5
F	1	6.73×10^{-4}	8.4	100.0

a. The discreet wind speed reported actually represent wind speed ranges (e.g., 1 m/s = 0.45 to 1.56 m/s; 2 m/s = 1.56 to 3.35 m/s; 4 m/s = 3.35 to 5.59 m/s; 7 m/s = 5.59 to 8.27 m/s; 10 m/s = 8.27 to 11.0 m/s; 13 m/s = 11.0 to 14.1 m/s; and 16 m/s ≥14.1 m/s).

b. Estimates of χ/Q were obtained using the Gaussian plume equation.

Table 4.3-11. Source Terms Defining a UF_6 Release Associated with a Postulated Seismic Event: 3040-MW Case.

Facility Type	Building Number	Failed Equipment Resulting in Release	UF_6(a) Properties			
			Mass Released, lb (kg)	Initial State	Release Temperature °F (°C)	Release Duration s (min)
Process buildings	C-331	B line	0	vapor	290 (143)	600 (10)
		Unit B bypass (Units 1-2)	320 (146)			
		Severed tie line	1,000 (455)			
		Total	1,320 (601)			
	C-333	B line	17,500 (7950)	vapor	290 (143)	600 (10)
		Severed tie line	1,000 (455)			
		Total	18,500 (8,400)			
	C-335	B line	0	vapor	290 (143)	600 (10)
		Unit B bypass (Units 1-2)	0			
		Severed tie line	600 (273)			
		Total	600 (273)			
	C-337	B line	17,500 (7,945)	vapor	290 (143)	600 (10)
		Severed tie line	600 (273)			
		Total	18,100 (8,218)			

a. All the released UF_6 is assumed to be enriched to 5.5% ^{235}U.

Table 4.3-12. Source Terms Defining UF_6 Release Associated with a Postulated Seismic Event: 2200-MW Case.

Facility Type	Building Number	Failed Equipment Resulting in Release	UF_6(a) Properties			
			Mass Released lb (kg)	Initial State	Release Temperature °F (°C)	Release Duration s (min)
Process Buildings	C-331	Severed tie lines	600 (273)	vapor	290 (143)	600 (10)
	C-333	Severed tie lines	600 (273)	vapor	290 (143)	600 (10)
	C-335	Severed tie lines	400 (182)	vapor	290 (143)	600 (10)
	C-337	Severed tie lines	400 (182)	vapor	290 (143)	600 (10)

a. All the released UF_6 is assumed to be enriched to 5.5% ^{235}U.

Table 4.3-13. Dispersion Parameters Defining the Baseline Scenario for a UF_6 Release Associated with a Postulated Seismic Event: 3040-MW Case and 2200-MW Case.

Parameter	Value
General parameters common to process buildings and withdrawal buildings	
Atmospheric stability	Neutral (Pasquill-Gifford stability class D)
Wind speed	9 mph (4 m/s)
Ambient air temperature	80°F (26.7°C)
Ambient relative humidity	70%
Surface roughness	1 in. (0.03 m)
Parameters specific to the process building releases	
fA (fraction of the leeward side of building that is covered by the plume cross-sectional area)	0.002
Duration of release to the outside atmosphere	600 s (10 min)
Uranium deposition inside the process buildings	0%

Table 4.3-14. Estimated Consequences for a UF_6 Release Associated with a Postulated Seismic Event: 3040-MW Case, Base Scenario.

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Value (ppm)	Comparison Value (ppm)
Site boundary[a]	59	30	0.61	25	38	20
1 mi (1,600 m) downwind	31	30	0.33	25	20	20
5 mi (8050 m) downwind	3	30	0.04	25	2	20

a. Consequence estimates were made at the site boundary north of C-337 (0.56 mi [900 m]).

Table 4.3-15. Estimated Consequences for a UF_6 Release Associated with a Postulated Seismic Event: 2200-MW Case, Base Scenario.

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Value (ppm)	Comparison Value (ppm)
Site boundary[a]	4	30	0.037	25	2	20
1 mi (1,600 m) downwind	2	30	0.020	25	1	20
5 mi (8,050 m) downwind	0.2	30	0.002	25	0.1	20

a. Consequence estimates were made at the site boundary north of C-337 (0.56 mi [900 m]).

Table 4.3-16. Criticality Accidents in Fuel Cycle Facilities.

Date	Location	Yield (Fissions) First Pulse	Yield (Fissions) Total	Duration	Cause	Personnel Exposures[a]
6/16/58	Oak Ridge Y-12 Plant	1×10^{16}	1.3×10^{18}	20 min	Unsafe geometry; wash water added to $UO_2(NO_3)_2$ solution in 55-gal drum	8 people. Doses of 461, 428, 413, 341, 298, 86.5, 86.5, and 28.8 rads. No fatalities.
12/30/58	Los Alamos National Laboratory	1.5×10^{17}	1.5×10^{17}	2 to 3 s	Liquid phases of plutonium separated out in unsafe geometry tank.	3 people. Doses of 12,000, 134, and 53 rads. One fatality.
10/16/59[b]	Idaho Chemical Processing Plant (ICPP)	1.0×10^{17}	4×10^{19}	20 min	Solution transferred to unsafe geometry (5000-gal tank).	Due to shielding, no one received significant promp gamma or neutron doses. Airborne fission products resulted in combined beta and gamma doses of 50 rem (one person), 32 rem (one person), and smaller amounts to 17 others.
1/25/61[b]	ICPP	6.0×10^{16}	6×10^{17}	-1 s	Solution transferred to unsafe geometry tank	Minimal (<60 mrem) from airborne fission products. Highly shielded operation.
4/07/62[b]	Hanford Recuplex Plan	1.0×10^{16}	8.2×10^{17}	37.5 h	Plutonium solution incorrectly siphoned into unsafe geometry tank.	3 people. Doses of 110, 43, and 19 rads.
7/24/64	Wood River Junction	1.1×10^{17} 2.0×10^{16}	1.3×10^{17}	2 short pulses 1.5 h apart	Solution hand-poured into unsafe geometry tank.	3 people. Doses of 10,000, 100, and 60 rads. One fatality.
8/24/70[b]	UKAEA Windscale	1×10^{15}	1×10^{15}	<10 s	Unsafe geometry process vessel.	2 people. Estimated doses of 2 rad and <1 rad.
10/17/78[b]	ICPP	No estimate	2.7×10^{18}	18 min	Unsafe geometry process vessel.	< 0.13 rem (in shielded cell).
9/30/99[b]	Tokai-mura (Japan)	$\sim 0.5 \times 10^{17}$	2.5×10^{18}	20 h	Unsafe geometry process vessel.	3 people received severe does (2000 rad, 1000 rad, and 450 rad). Two fatalities. Off-site exposure within 350 m less than 2.5 rad.

a. Exposures given in rad because that is how they were reported in the source document. One rad is equal to 1 rem for gamma radiation exposure; for neutron exposures, 1 rad can equal significantly more than 1 rem depending on the neutron energy.

b. Note that five of the nine criticality events occurred at fuel reprocessing plants. Personnel radiation exposures tend to be much smaller for these facilities because process vessels are located inside highly shielded hot cells. None of the fatalities recorded occurred in a reprocessing plant.

Table 4.3-17. Solution Criticality Event — First Pulse Radiation Exposures (Reg. Guide 3.34 Assumption of 10^{18} Fissions in 0.5 s)

	Exposures (rem) With No Shielding (Air Only)			Exposures (rem) With 12 in. (0.3 m) of Concrete Shielding		
Distance[a] (m)	Prompt gamma[b]	Prompt neutron	Total	Prompt gamma[b]	Prompt neutron	Total
5	826.000	2730.0000	3560.000	165.0000	593.0000	758.0000
7	418.000	1380.0000	1800.000	83.0000	299.0000	382.0000
10	203.000	665.0000	868.000	41.0000	144.0000	185.0000
15	88.000	288.0000	376.000	18.0000	63.0000	81.0000
20	49.000	158.0000	207.000	9.8000	34.0000	44.0000
30	21.100	66.5000	87.600	4.2100	14.4000	18.7000
40	11.500	35.5000	47.000	2.3000	7.7000	10.0000
45	8.90	27.4	36.3	1.78	5.95	7.73
60	4.800	14.2000	19.000	0.9500	3.1000	4.1000
80	2.500	7.2000	9.700	0.5000	1.6000	2.1000
100	1.500	4.2000	5.900	0.3000	0.9000	1.2000
150	0.560	1.4300	1.990	0.1100	0.3100	0.4200
200	0.266	0.619	0.885	0.053	0.135	0.190
300	0.084	0.163	0.247	0.017	0.035	0.052
400	0.034	0.0550	0.089	0.0067	0.0120	0.0180
600	0.008	0.0086	0.016	0.0015	0.0019	0.0034
800	0.002	0.0020	0.004	0.0004	0.0004	0.0008
1000	7×10^{-4}	3.9×10^{-4}	1.1×10^{-3}	1.4×10^{-4}	8.4×10^{-5}	2.2×10^{-4}

a. The minimum distance between the CAA and the site boundary is greater than 300m.
b. The prompt gamma numbers, as explained in Reg. Guide 3.34, include delayed gammas emitted during the first minute after the pulse.

Table 4.3-18. Solution Criticality Event — Total Accumulated Radiation (Reg. Guide 3.34 Assumption of 10^{19} Fissions Over 8h)

Distance[a] (m)	Plume Exposures (rem)	Exposures (rem) With No Shielding (Air Only)					Total Exposures (rem) With 12 in. (0.3 m) of Concrete Shielding	
		Prompt Gamma	Delayed Gamma	Prompt Neutron	TOTAL No Plume	TOTAL With Plume[b]	TOTAL No Plume	TOTAL With Plume[b]
5	-[b]	8260.000	3138.000	27300.0000	38700.000	38700.00	8210.000	8210.00
10	-[b]	2030.000	771.000	6650.0000	9450.000	9450.00	2000.000	2000.00
15	-[b]	887.000	337.000	2880.0000	4100.000	4100.00	870.000	870.00
20	-[b]	490.000	186.000	1580.0000	2260.000	2260.00	478.000	478.00
30	-[b]	211.000	80.100	665.0000	956.000	956.00	203.000	203.00
40	-[b]	115.	43.5	355.	513.	513.	109.	109.
45	-[b]	89.	33.8	274.	396.	396.	84.	84.
60	-[b]	48.000	18.000	142.0000	208.000	208.00	44.000	44.00
80	-[b]	25.000	9.500	72.0000	107.000	107.00	22.600	22.60
100	-[b]	15.000	5.680	42.0000	62.000	62.00	13.200	13.20
150	9.25	5.600	2.100	14.0000	22.000	31.00	4.600	13.90
200	7.00	2.66	1.01	6.19	9.86	16.86	2.08	9.08
300	4.95	0.84	0.32	1.63	2.79	7.74	0.58	5.53
400	2.90	0.340	0.130	0.5500	1.000	3.90	0.210	3.11
600	1.65	0.076	0.029	0.0860	0.190	1.84	0.040	1.69
800	1.10	0.022	0.0082	0.0170	0.046	1.15	0.010	1.11
1000	0.65	0.007	0.0027	0.0039	0.0135	0.66	0.003	0.65
1500	0.40	5.69×10^{-4}	0.0002	1.27×10^{-4}	9.1×10^{-4}	0.40	1.85×10^{-4}	0.40

a. The minimum distance between the CAA and the site boundary is greater than 300 m.
b. Plume exposures are not reported closer than 150 m because specialized modeling would be required for in-close dispersion calculations.

Table 4.3-19. Parameters Defining the Baseline Scenario for the Pigtail Failure Inside Autoclave (while jetting), Baseline Scenario.

Parameter	Value
Atmospheric stability	Stable (Pasquill-Gifford stability class F)
Wind speed	4.5 mph (2 m/s)
Ambient air temperature	70°F (21°C)
Surface roughness	1 inch (0.03 m)
Steam jet inlet pressure	60 psig
Release period	60 minutes

Table 4.3-20. Estimated Consequences for the Pigtail Failure Inside Autoclave (while jetting), Baseline Scenario.

	Uranium Chemical Toxicity		Radiological Toxicity Dose		HF Chemical Exposure[a]	
Receptor Location	Estimated Consequence Value (mg)	Guideline Value (mg)	Estimated Consequence Value (rem)	Guideline Value (rem)	Estimated Consequence Value (ppm)	ERPG-2 Comparison Value (ppm)
Site Boundary[b]	16.18	30	.169	25	5.64	20
1 mile (1600 m)	12.41	30	.129	25	4.44	20
5 miles (8050 m)	1.86	30	.019	25	0.68	20

a. No guideline value is directly associated with hydrogen fluoride (HF) exposure. The guideline values for soluble uranium provide adequate control for HF exposure, since HF is produced in direct proportion with the amount of UO_2F_2 produced as a result of the UF_6 release. The Emergency Response Planning Guideline (ERPG-2) is shown for comparison.

b. Consequence estimates were made at the nearest site boundary from the potential release point [0.65mile (1050 m) to the east].

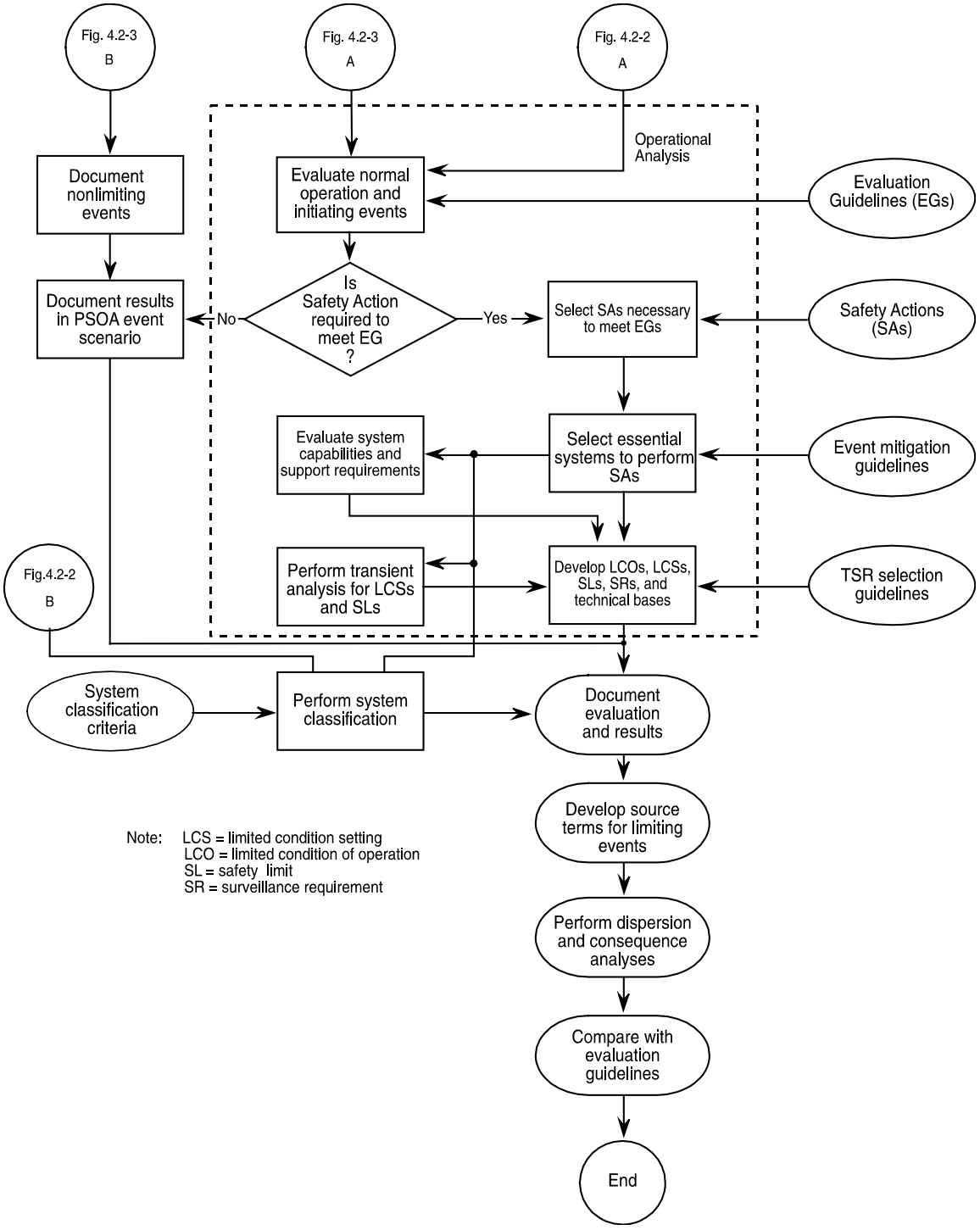


Figure 4.3-1. Operational Analysis

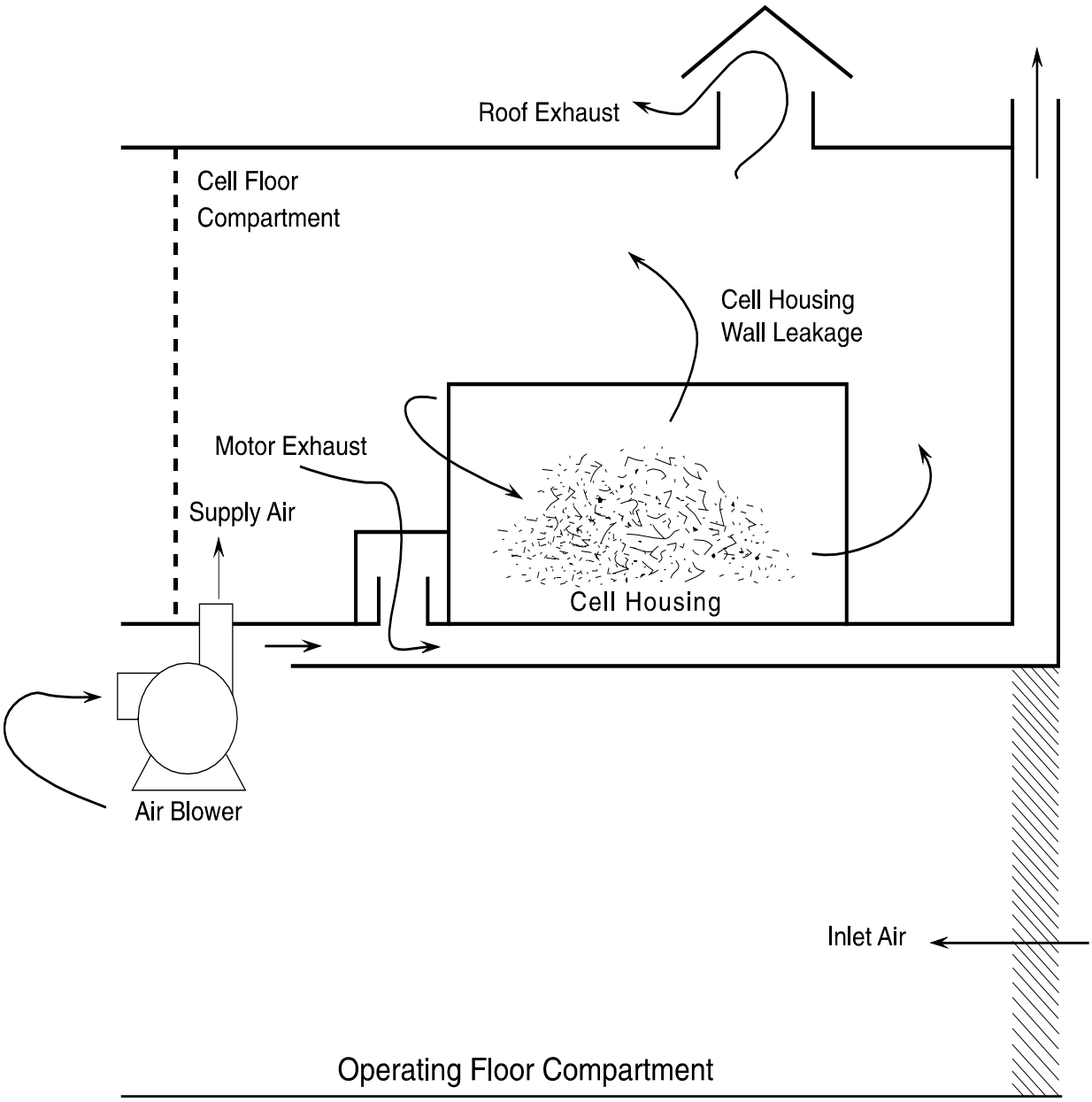


Figure 4.3-2. Summer ventilation pattern of one unit of the process building.

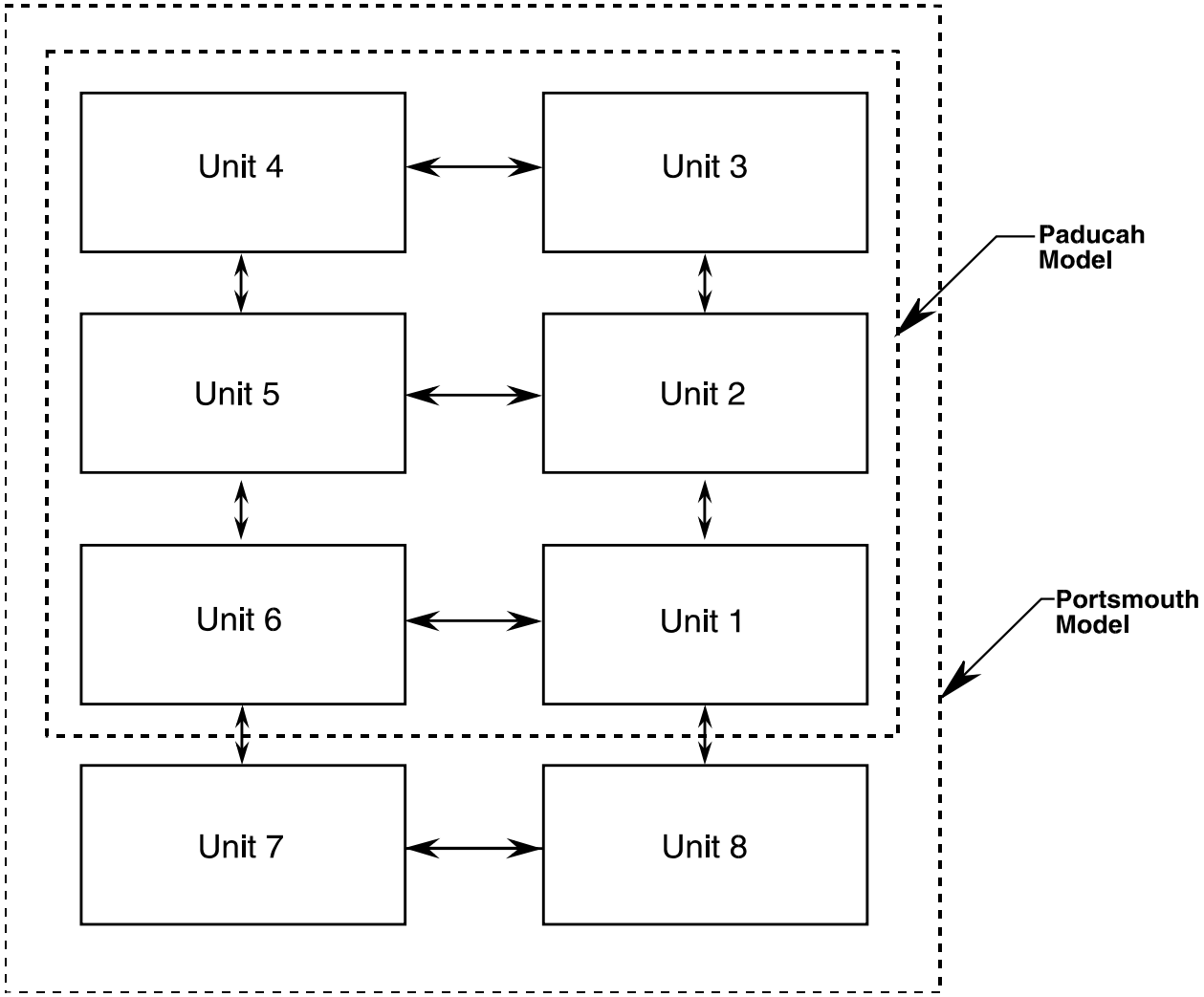


Figure 4.3-3. Control volume and unit layout of a “000" building.

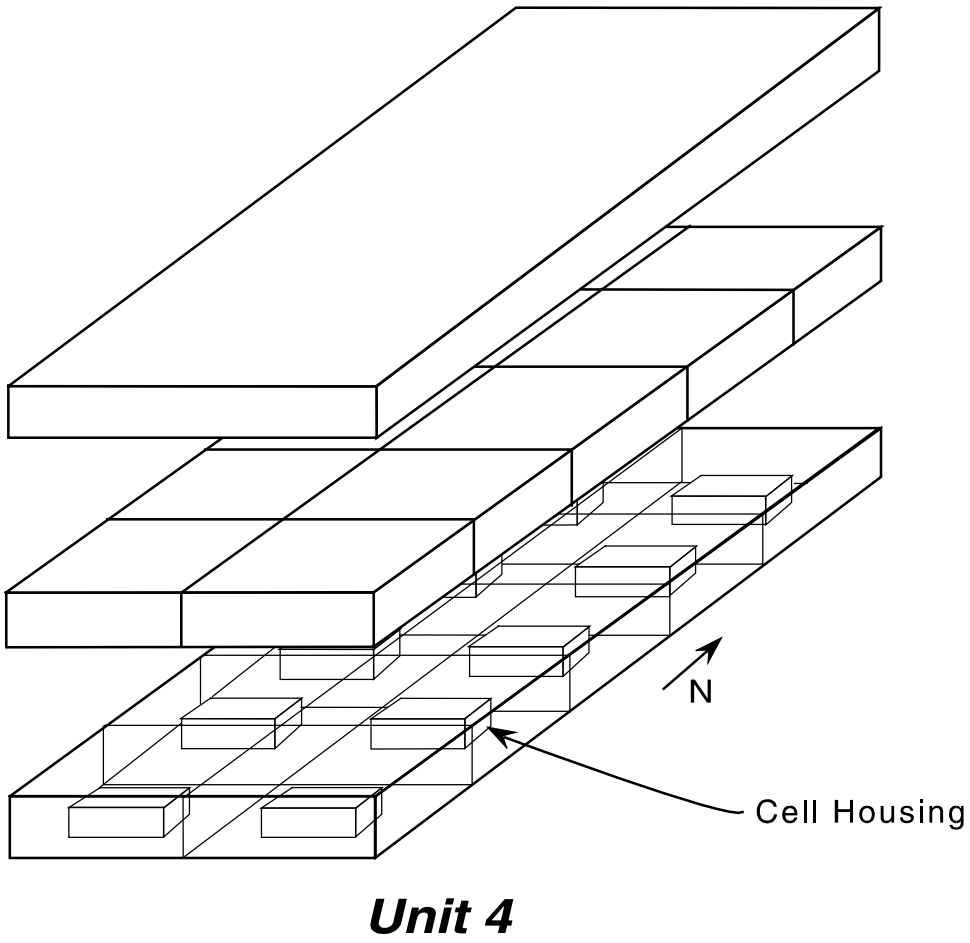


Figure 4.3-4. MELCOR control volumes of one unit in the process building.

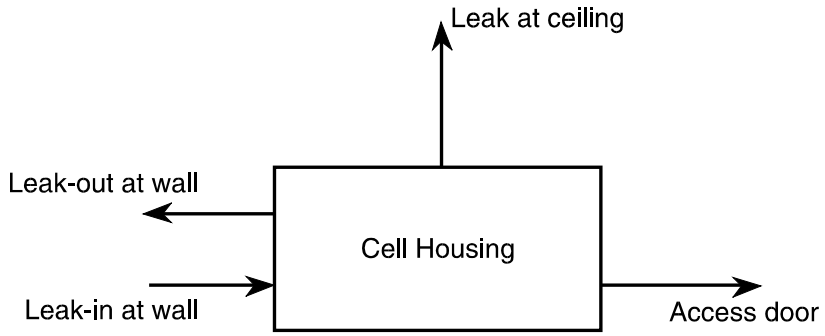


Figure 4.3-5. Assumed MELCOR flow paths of cell housing leakage.

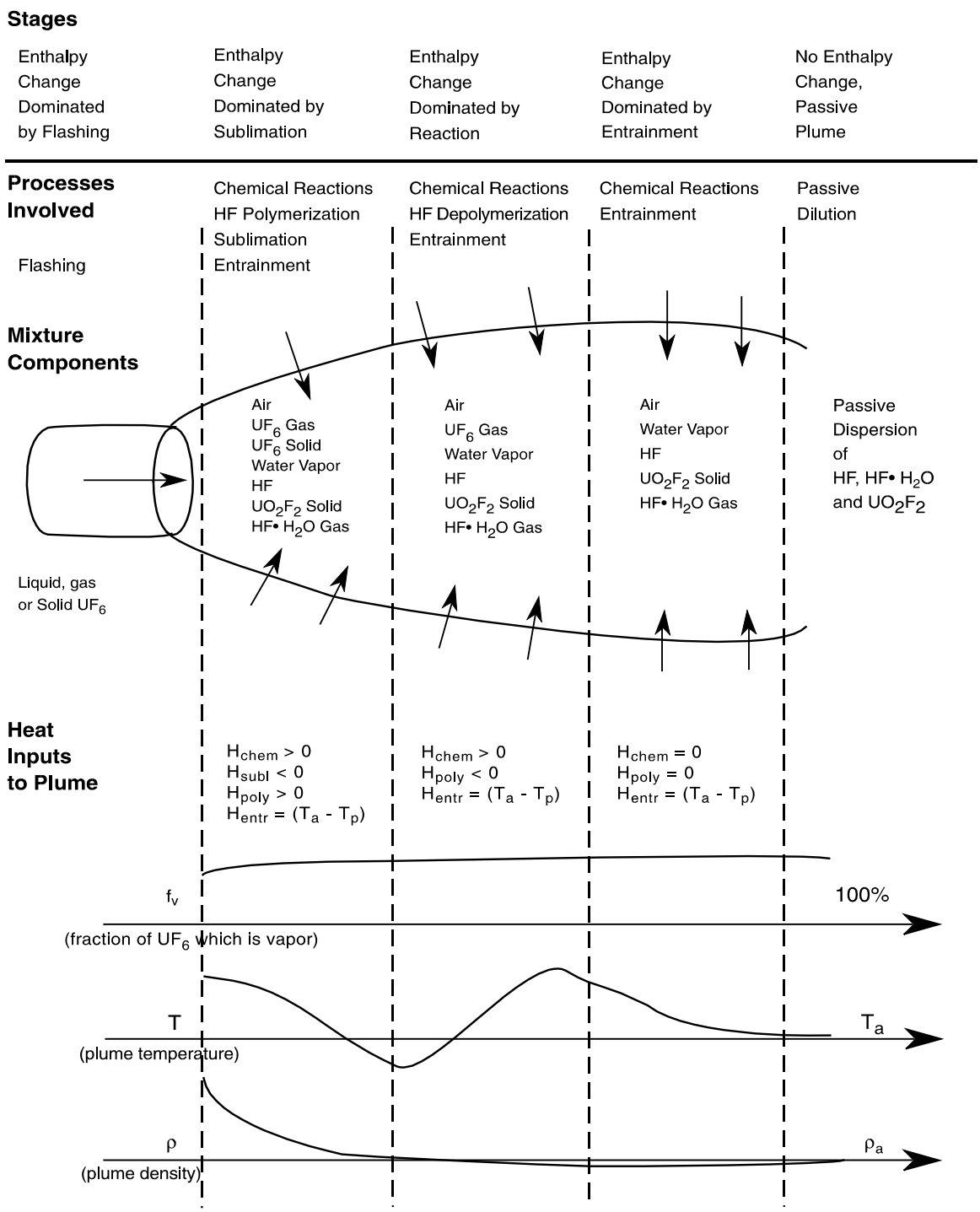


Figure 4.3-6. Schematic diagram of processes involved in UF_6 releases.

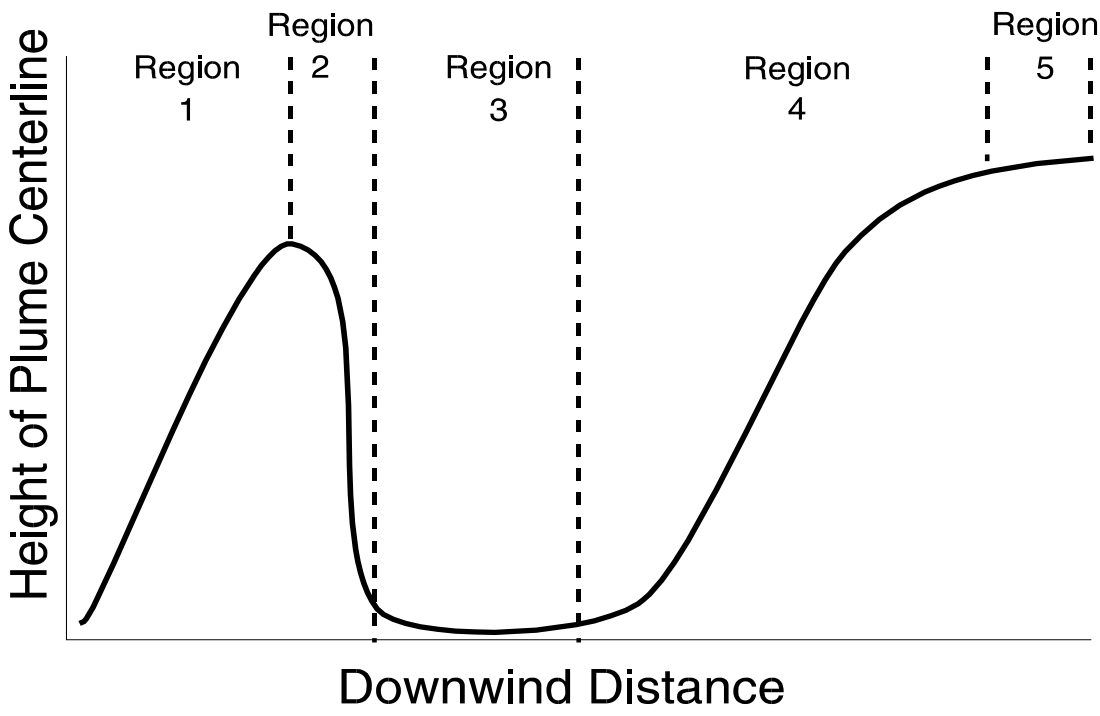


Figure 4.3-7. Example of a possible plume trajectory from a moderate-velocity, vertical release of UF_6 vapor.

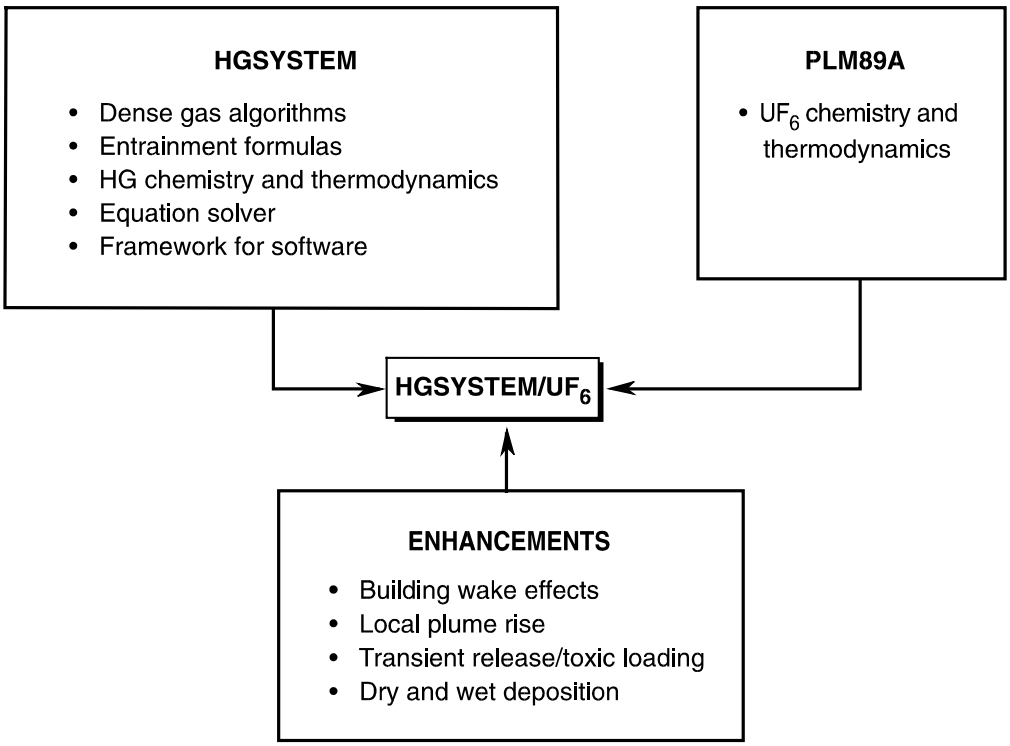


Figure 4.3-8. Schematic showing the development and enhancements of HGSYSTEM/UF_6

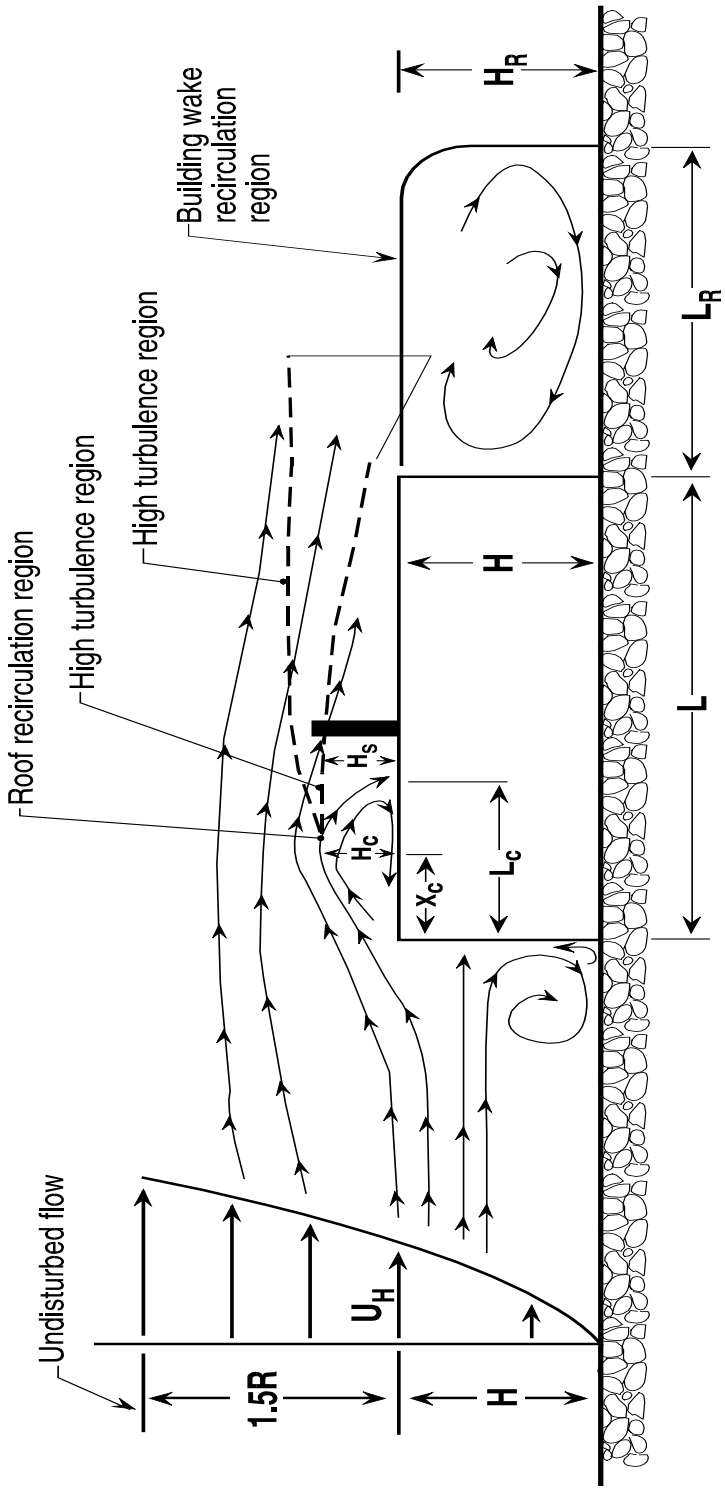


Figure 4.3-9. Flow over a building for wind normal to the upwind face.

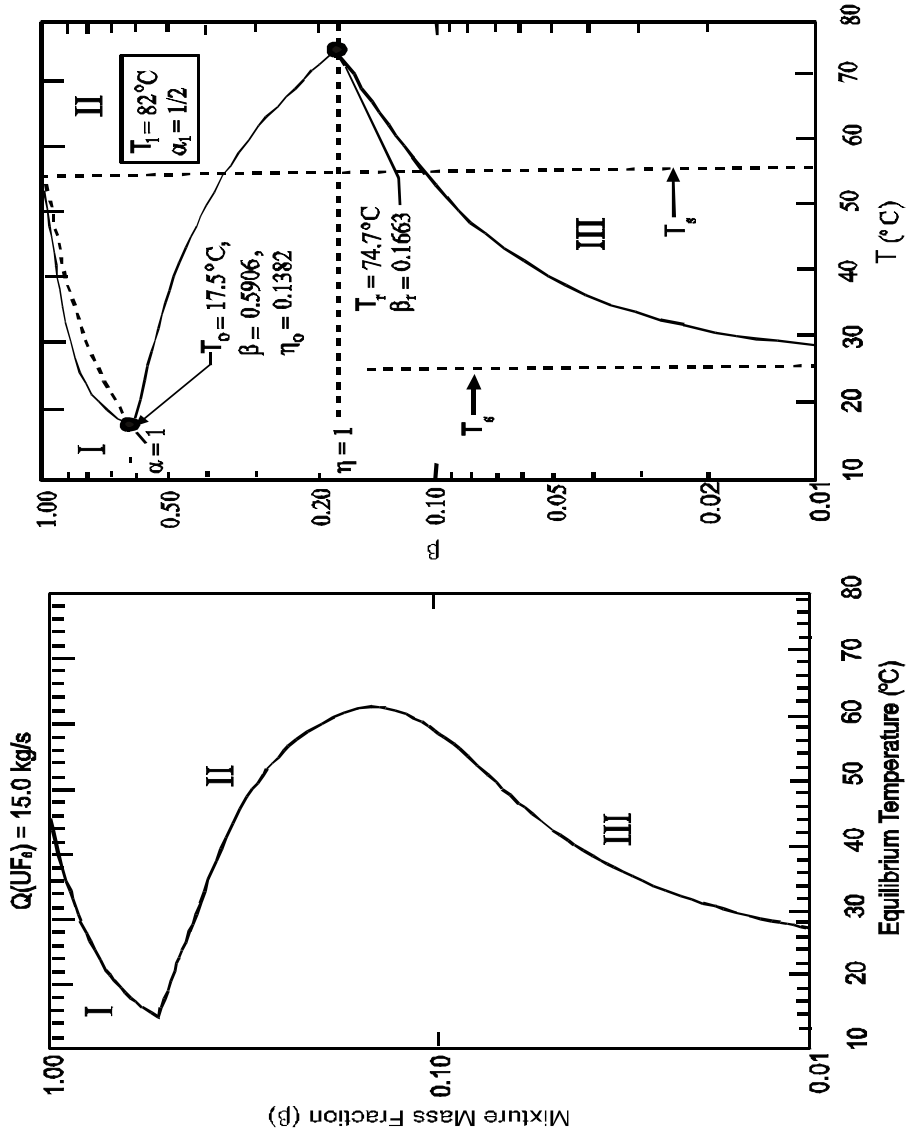


Fig. 4.3-10. **Mixture mass fraction, β, for HGSYSTEM/UF_6 predictions (left side) and for Rodean's (1989) equilibrium solution (right side). Three regions are seen: (I) cooling due to evaporation of solid UF6; (II) warming due to reaction of UF6 vapor with water vapor; and (III) dilution of products (HF and UO2F2) by entrainment.**

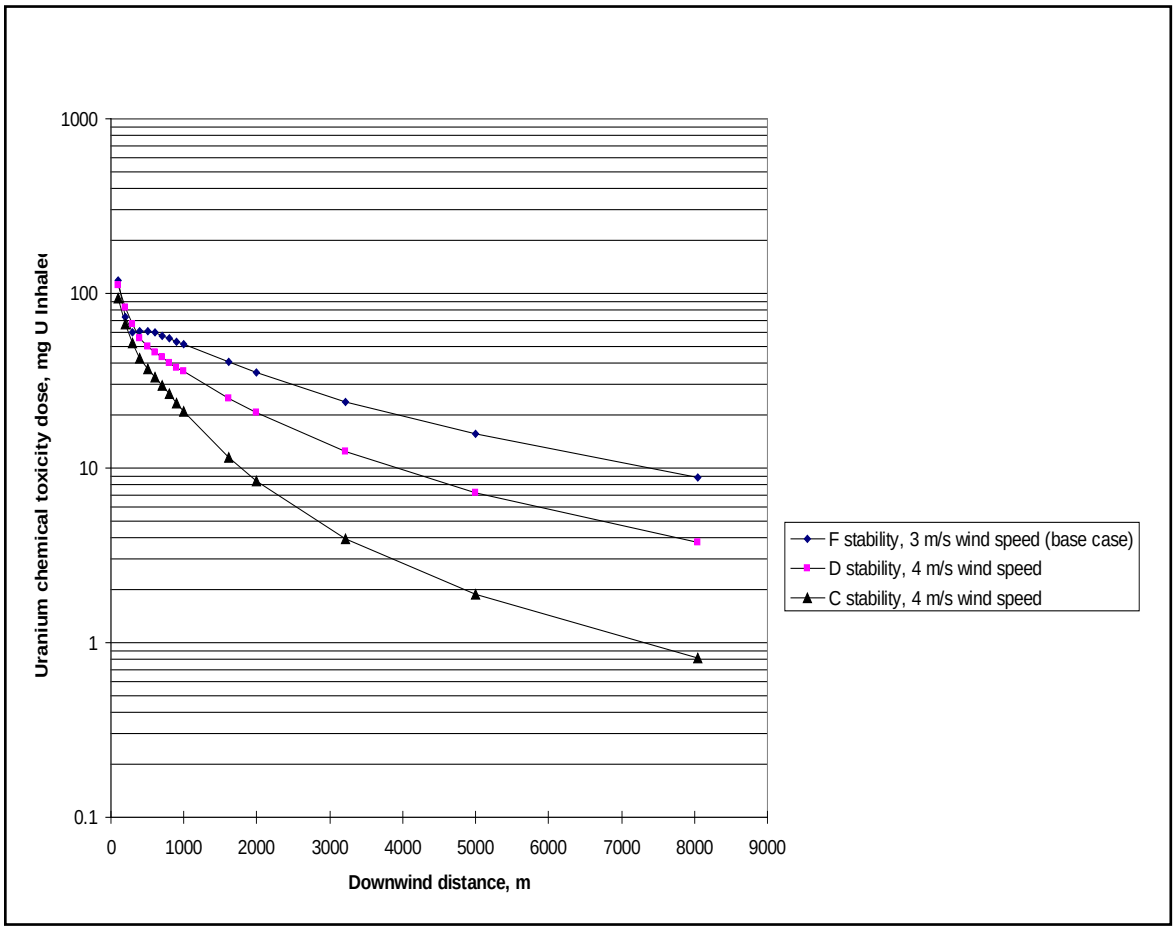


Figure 4.3-11. Estimated uranium chemical toxicity vs. downwind distance for three meteorological conditions after an 8-minute duration (indoor) UF_6 release associated with a large release of UF_6 to atmosphere.

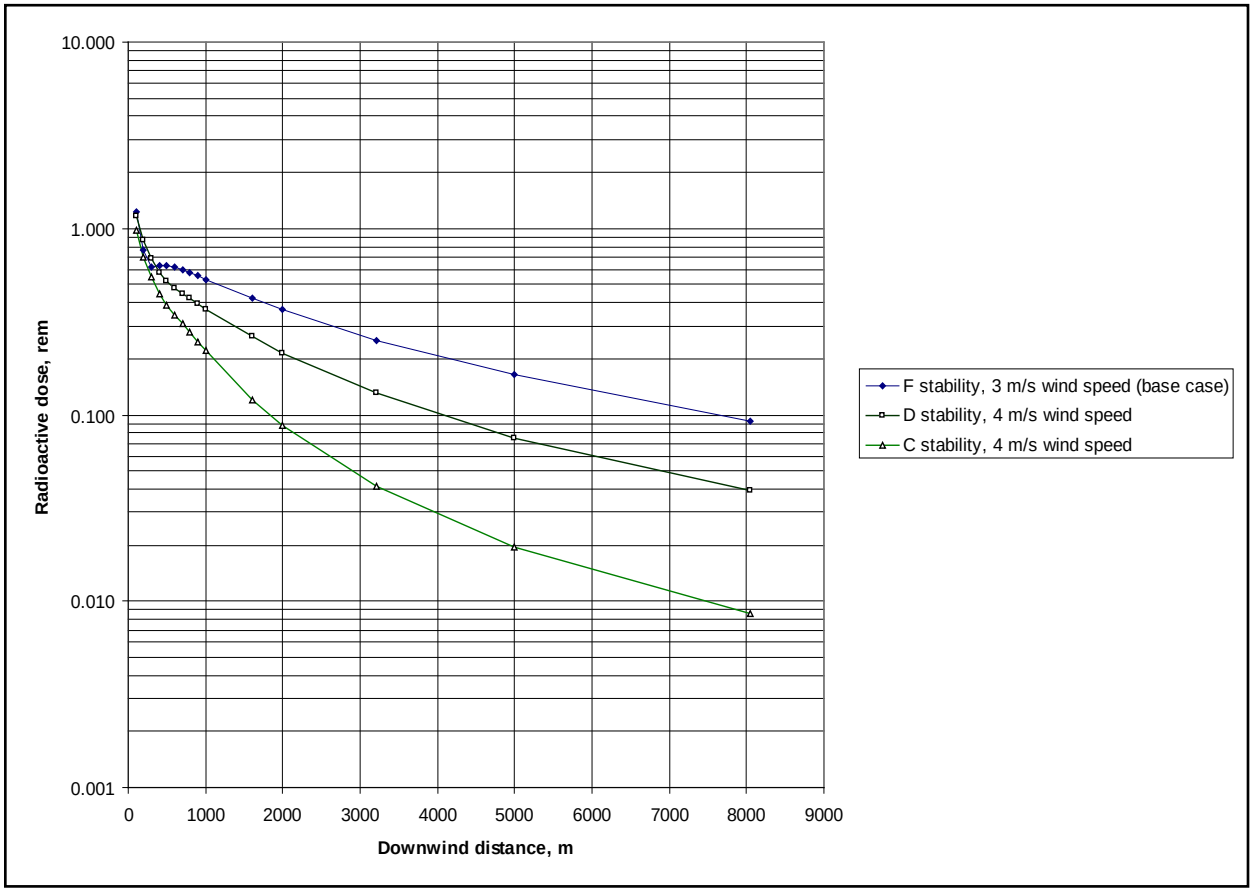


Figure 4.3-12. Estimated radiocative dose vs. downwind distance for three meteorological conditions after an 8-minute duration (indoor) release associated with a large release of UF_6 to atmosphere.

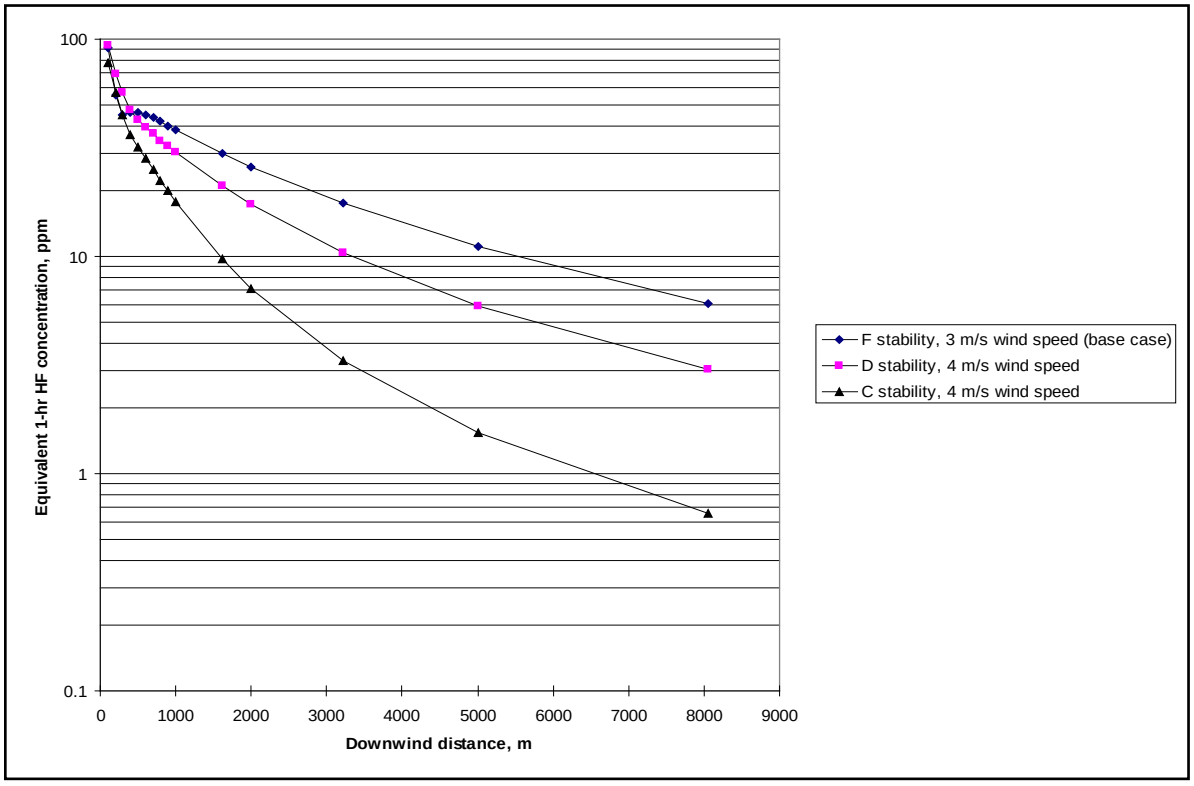


Figure 4.3-13. Estimated hydrogen fluoride (HF) toxicity vs. downwind distance for three meteorological conditions after an 8-minute duration (indoor) UF_6 release associated with a large release of UF_6 to atmosphere.

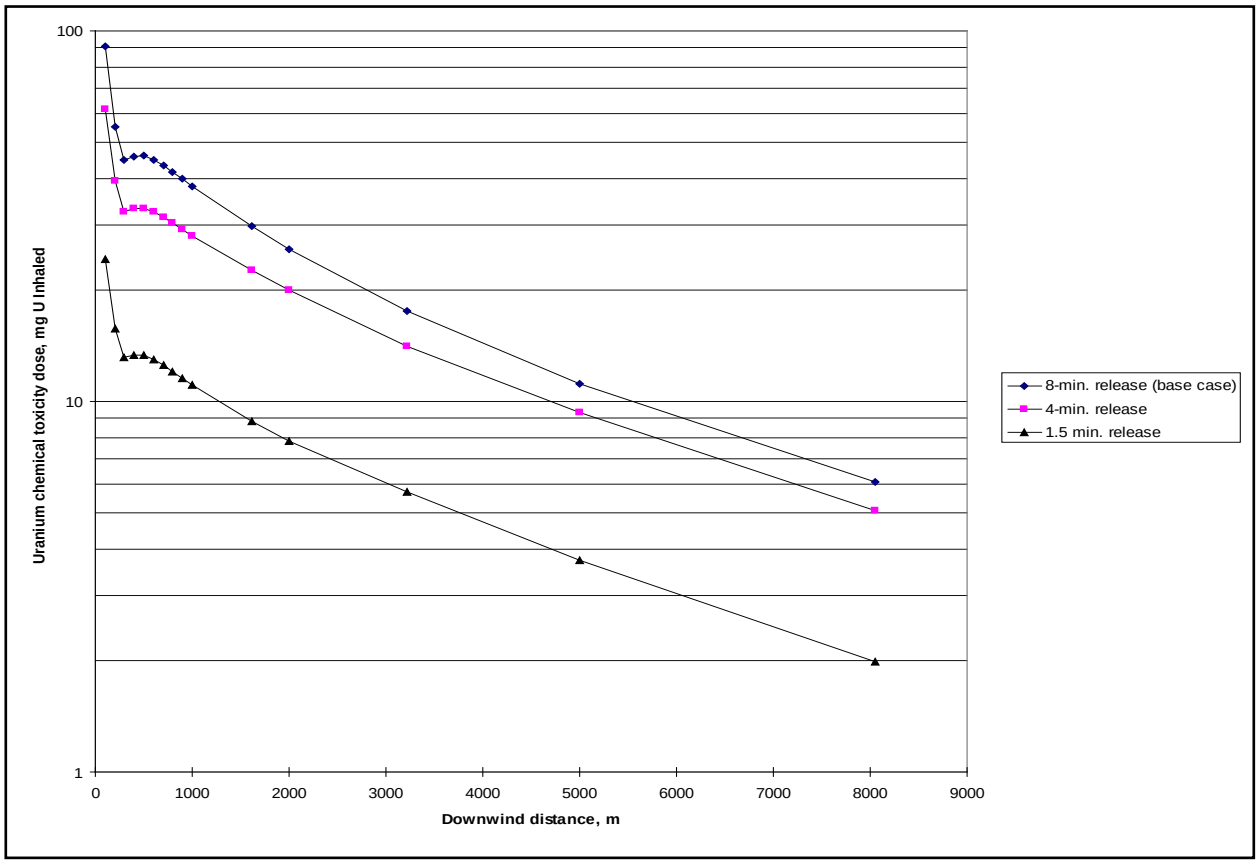


Figure 4.3-14. Comparison of uranium chemical toxicity vs. downwind distance for UF_6 release durations associated with a large release of UF_6 to atmosphere for F stability, 3 m/s wind speed.

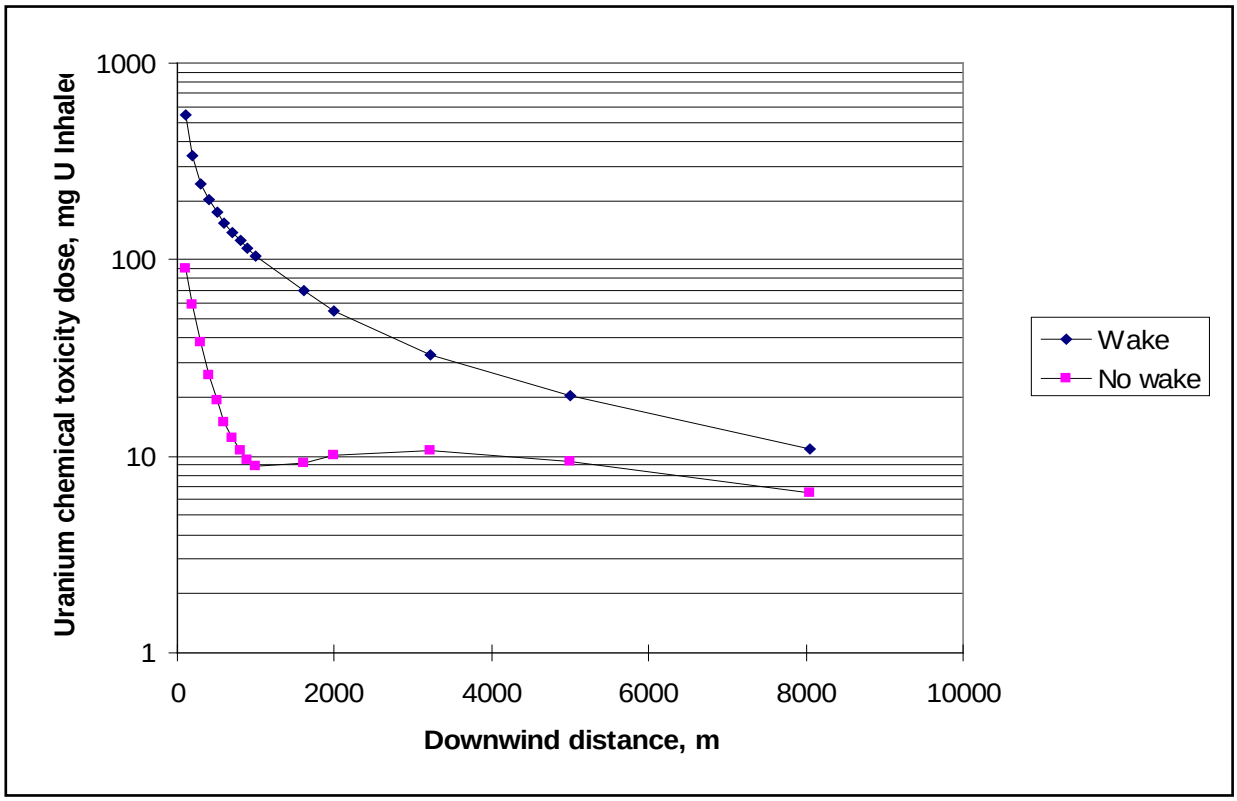
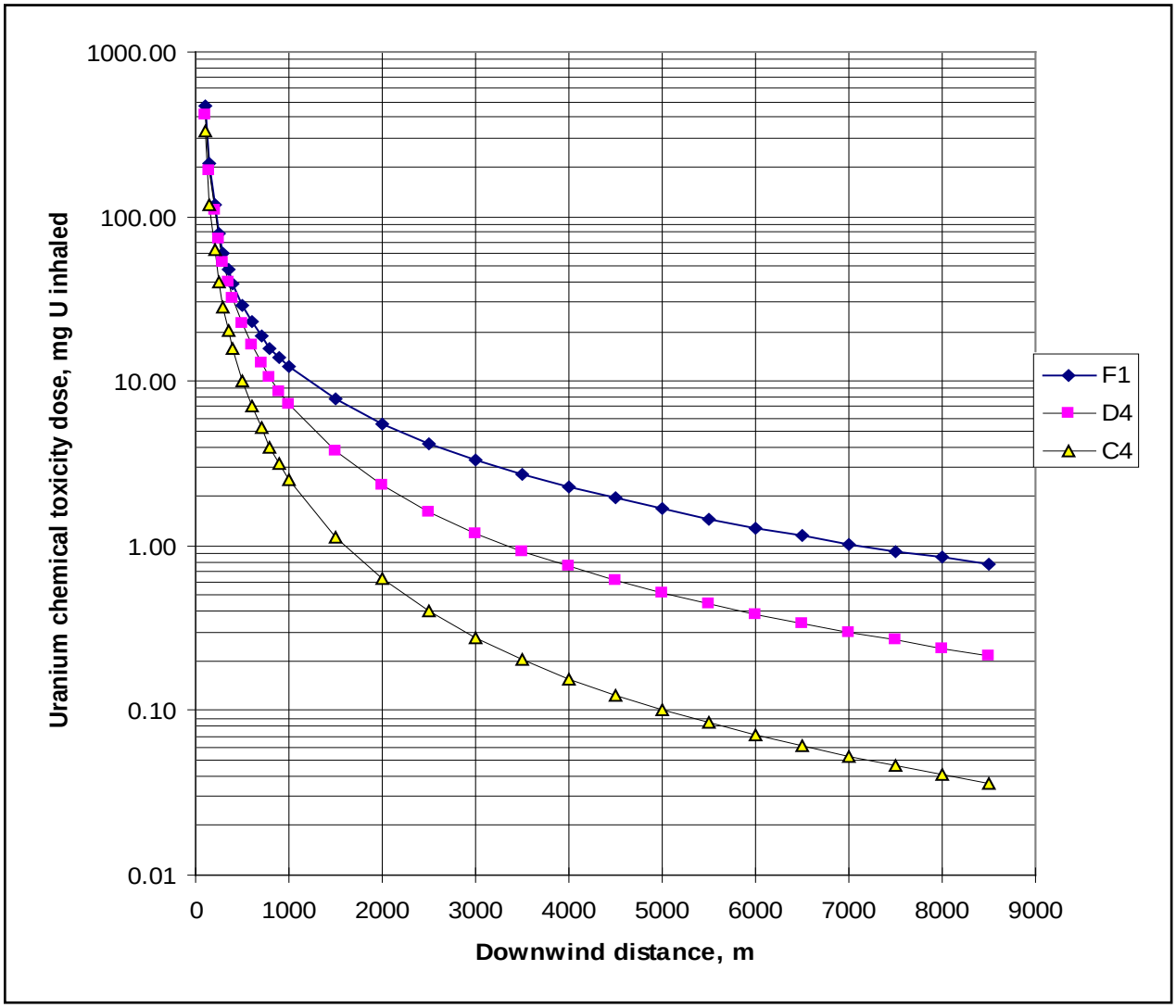


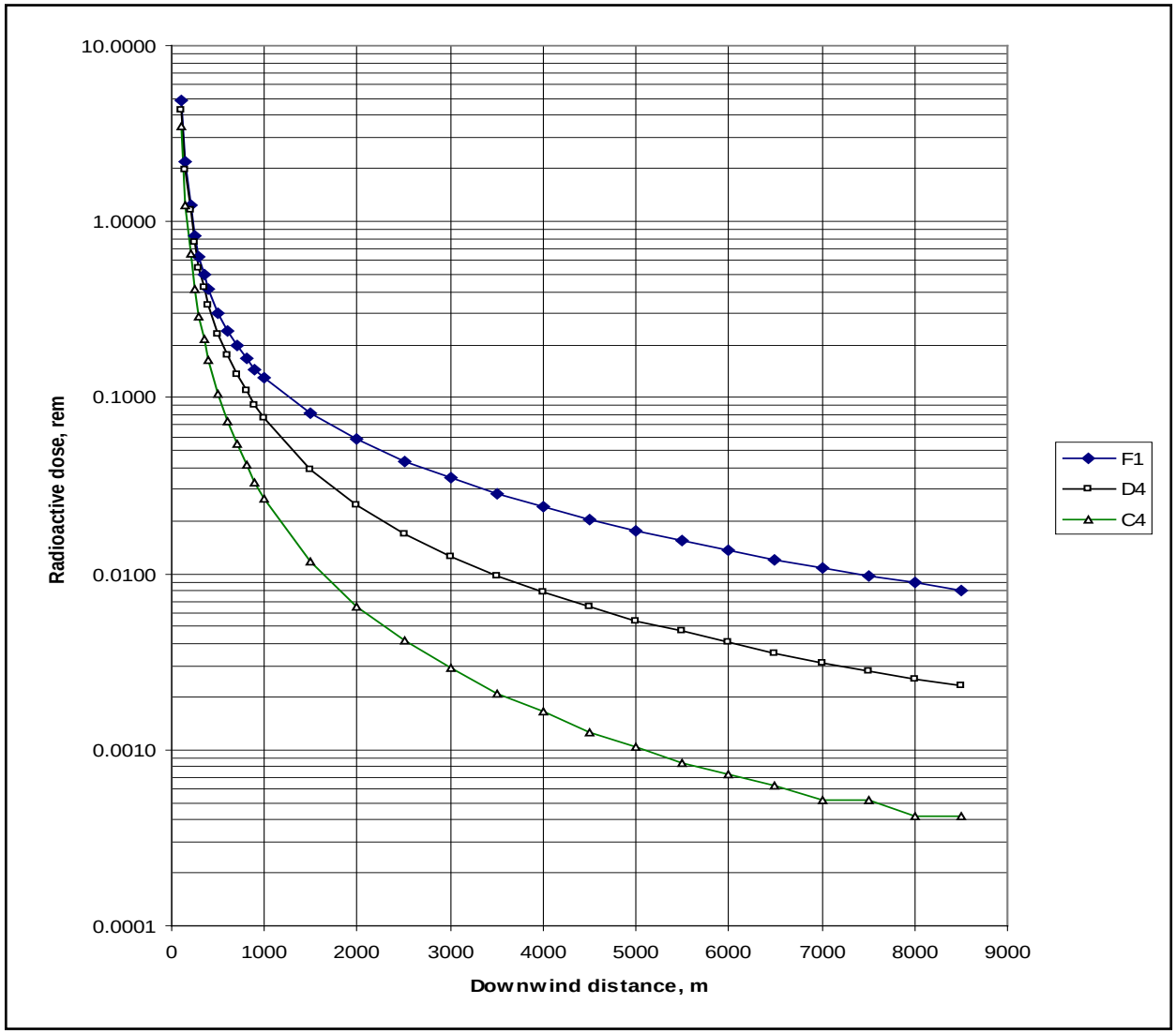
Figure 4.3-15. Comparison of uranium chemical toxicity vs. downwind distance for building wake and no building wake after a 10-minute duration (indoor) release associated with a large release of UF_6 to atmosphere for F stability and 3 m/s wind speed.

Figure 4.3-16. ***Figure Deleted***



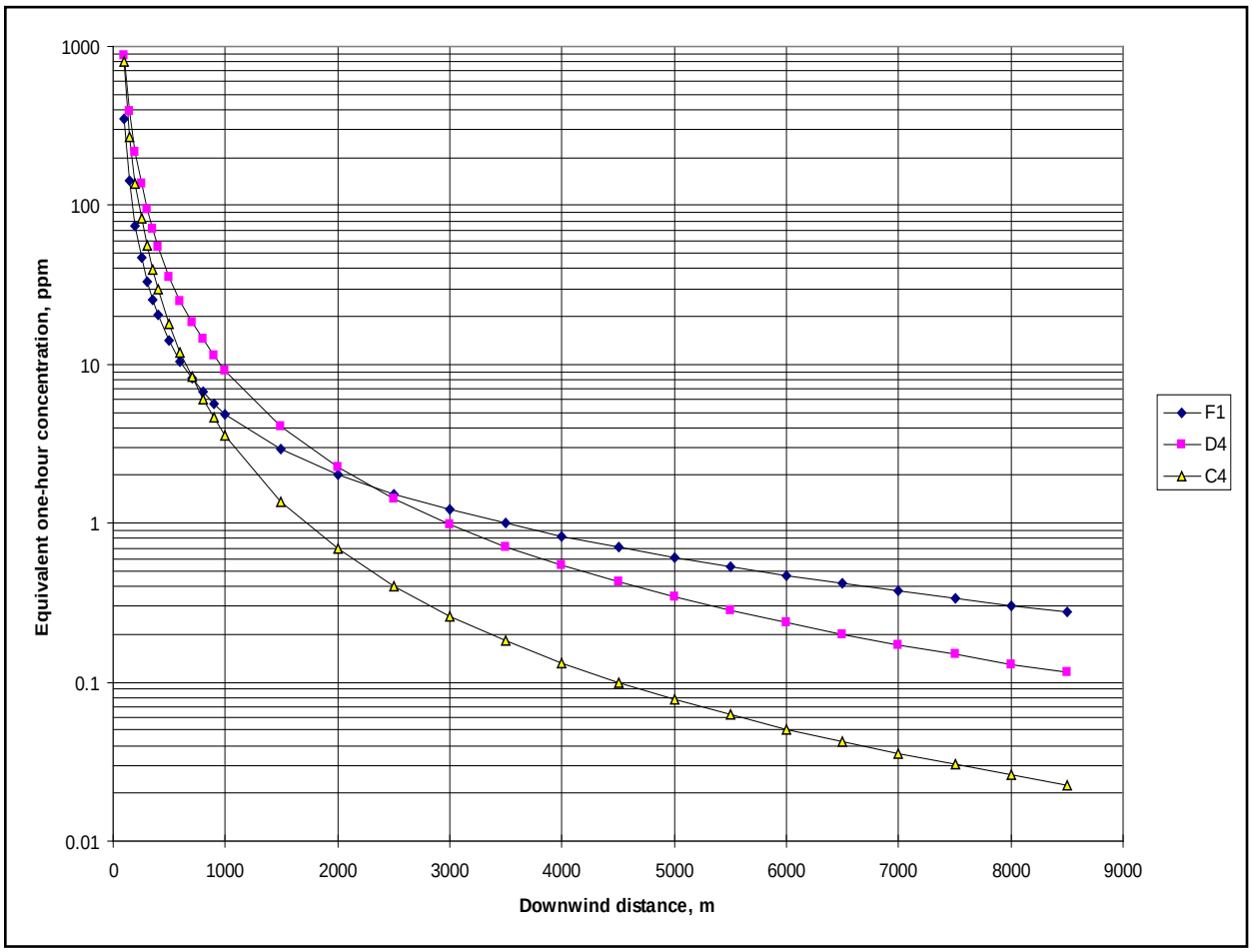
F1 = F stability, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-17. Estimated uranium chemical toxicity vs downwind distance for three meteorological conditions after a 45-second release during transfer of UF_6 from the parent to daughter cylinders.



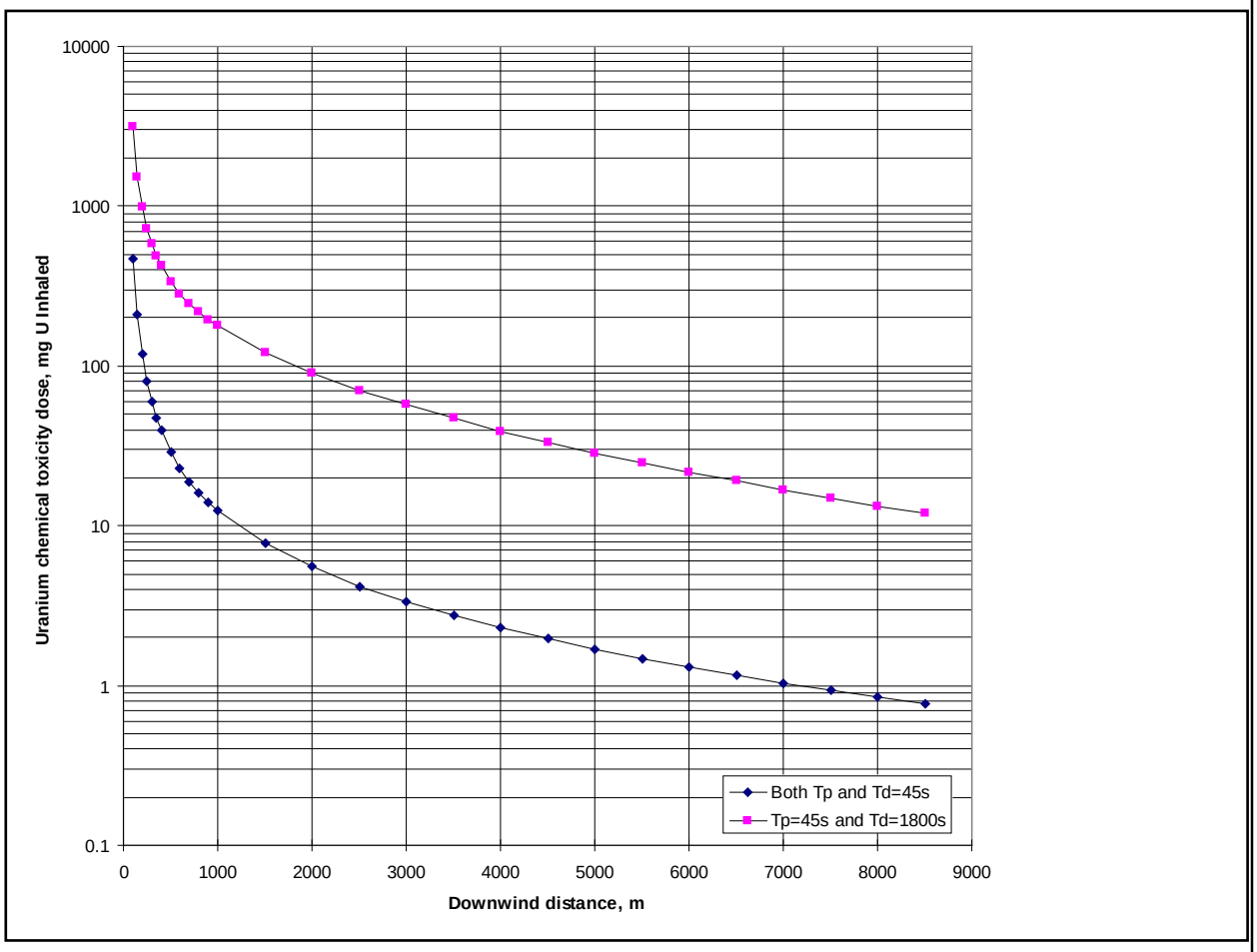
F1 = F stabillity, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-18 Estimated radioactive dose vs downwind distance for three meteorological conditions after a 45-second release during transfer of UF_6 from the parent to daughter cylinders.



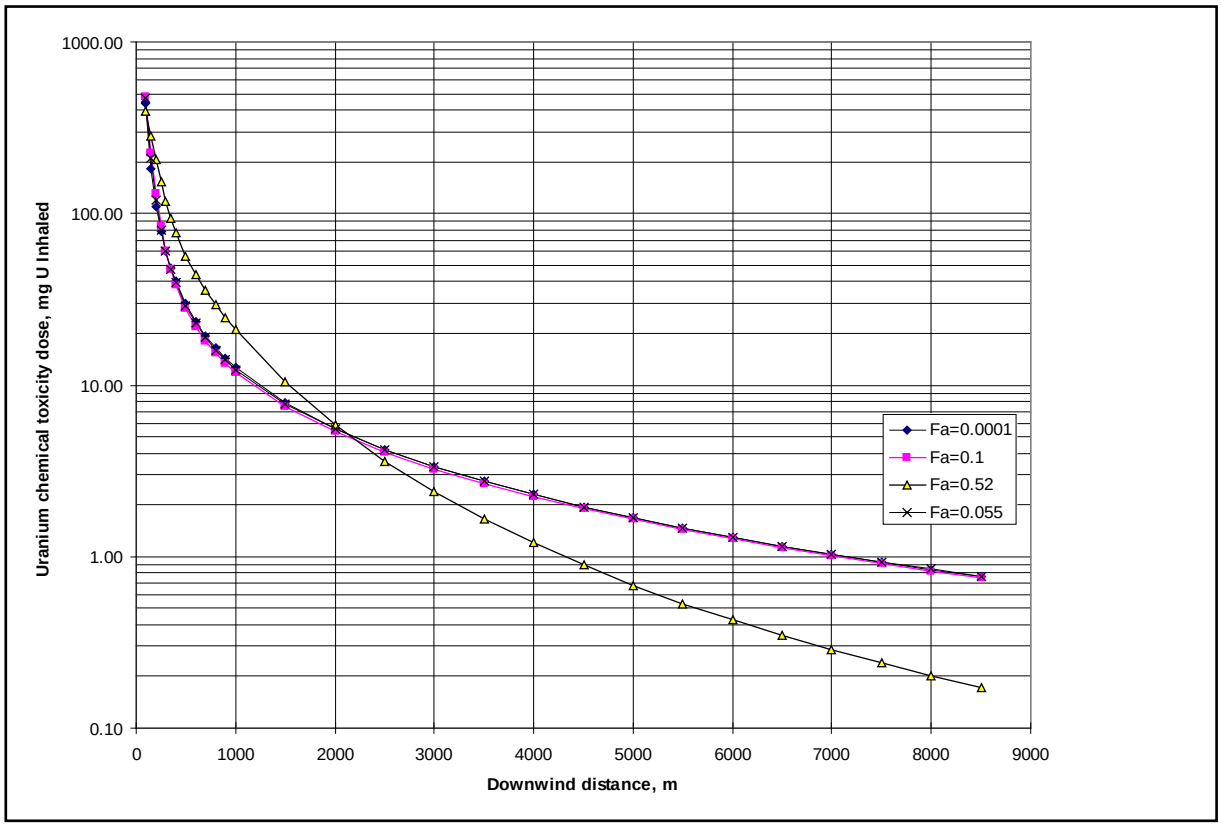
F1 = F stability, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-19. Estimated hydrogen fluoride (HF) toxicity vs downwind distance for three meteorological conditions after a 45-second release during transfer of UF_6 from the parent to daughter cylinders.



T_p = time for parent cylinder
T_d = time for daughter cylinder

Figure 4.3-20 Comparison of uranium chemical toxicity vs downwind distance for two different release durations during transfer of UF_6 from the parent to daughter cylinders.



F_a = the ratio of the plume's cross-sectional area exiting the building over the cross-sectional area of the building

Figure 4.3-21. Comparison of uranium chemical toxicity vs downwind distance for four different release areas for a 45-second release during transfer of UF_6 from the parent to daughter cylinders.

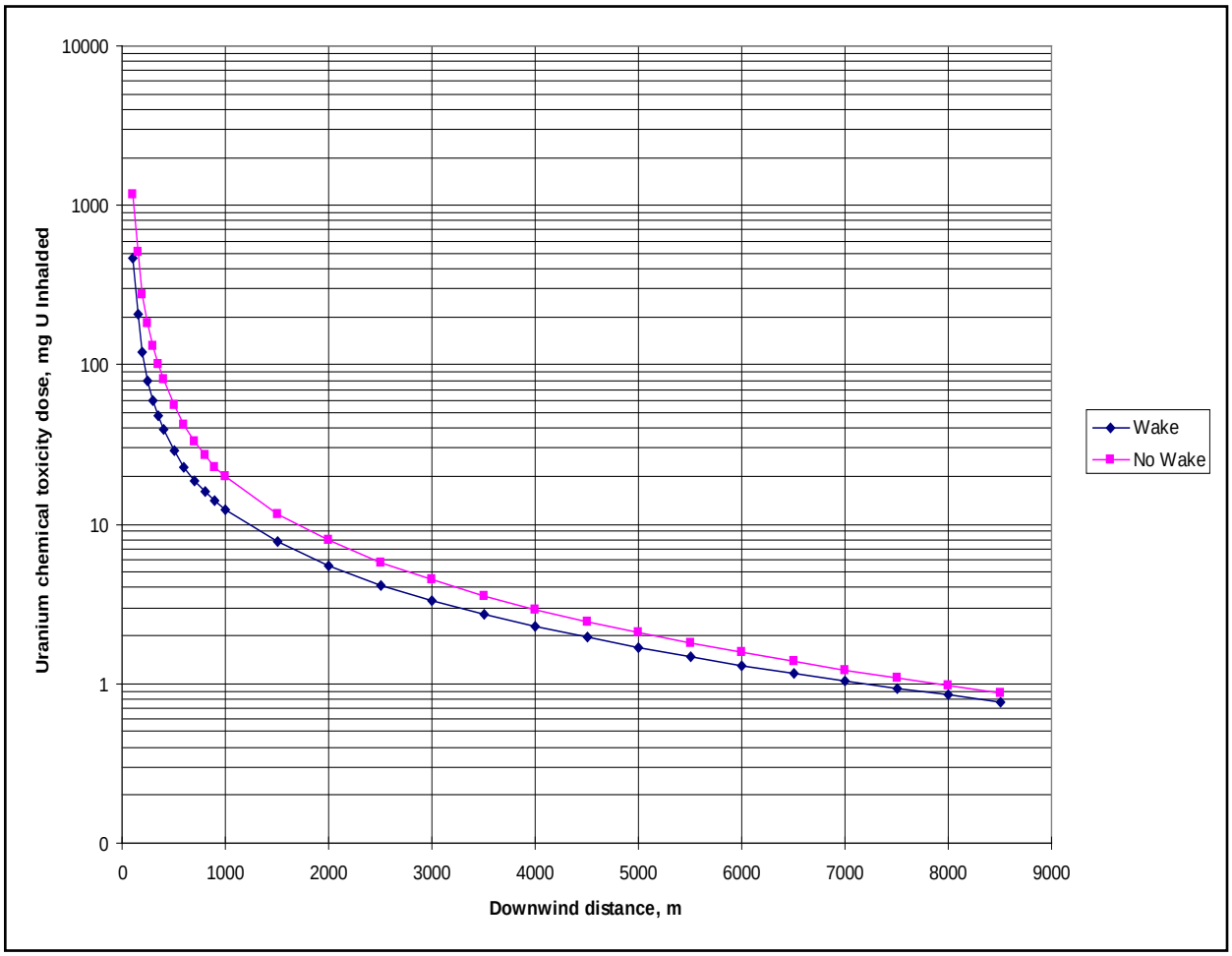
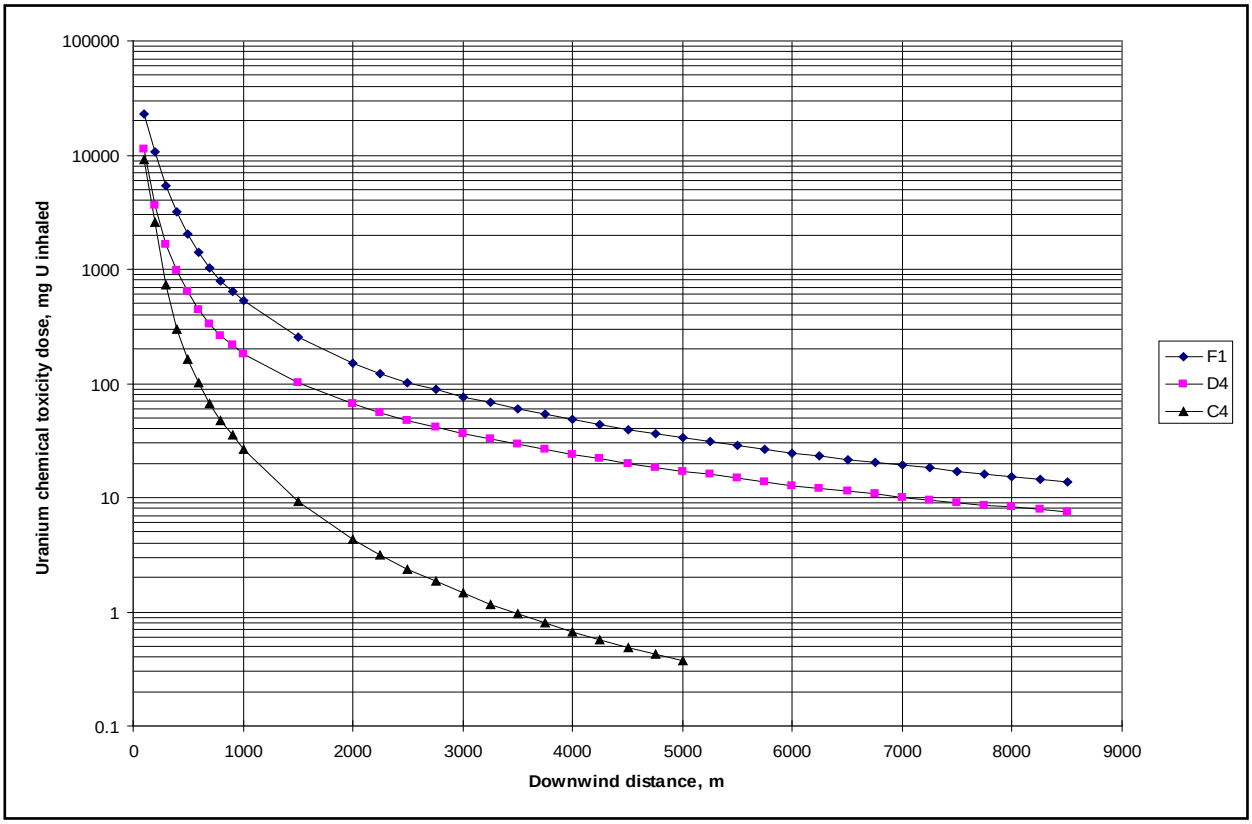
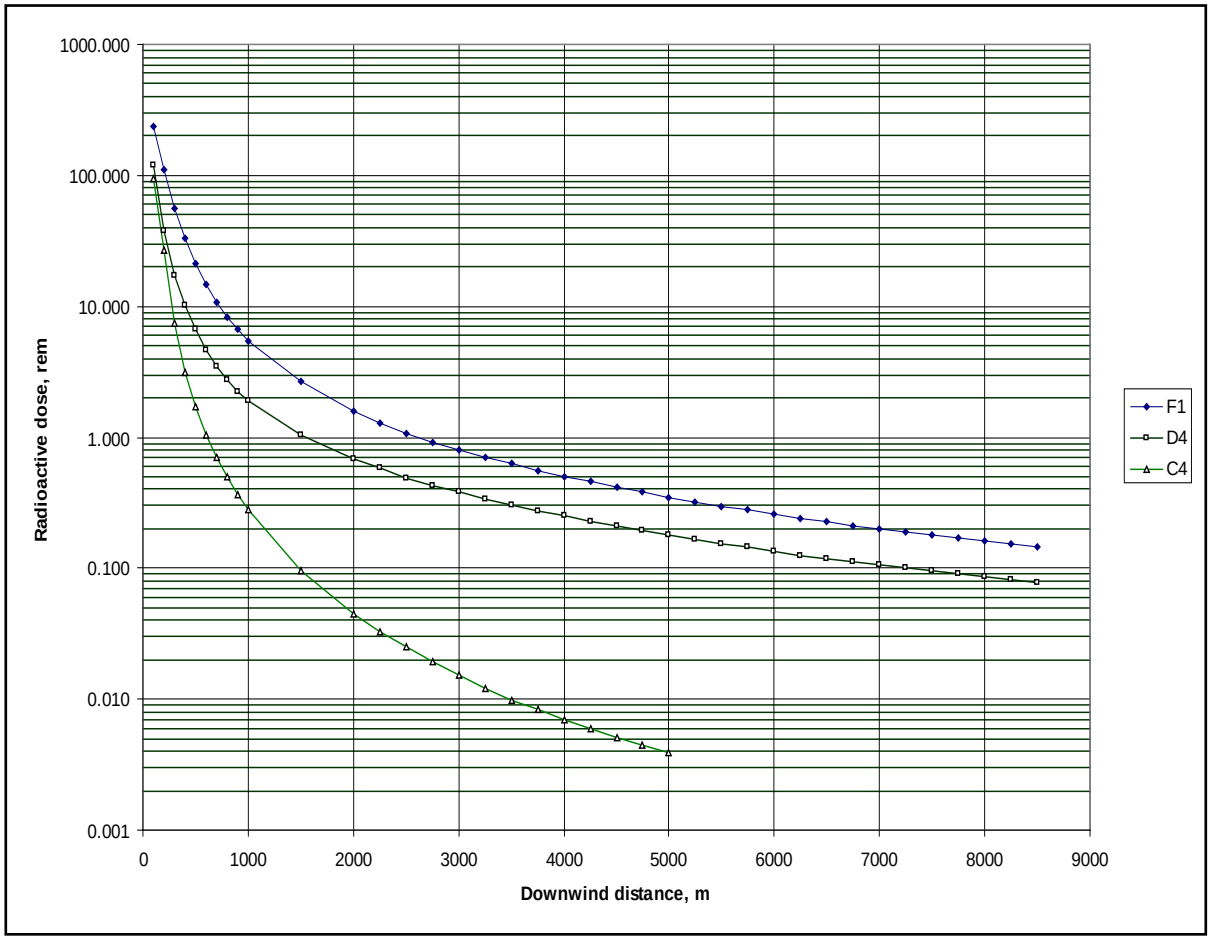


Figure 4.3-22. Comparison of uranium chemical toxicity vs downwind distance for building wake and no building wake cases after a 45-second release during transfer of UF_6 from the parent to daughter cylinders.



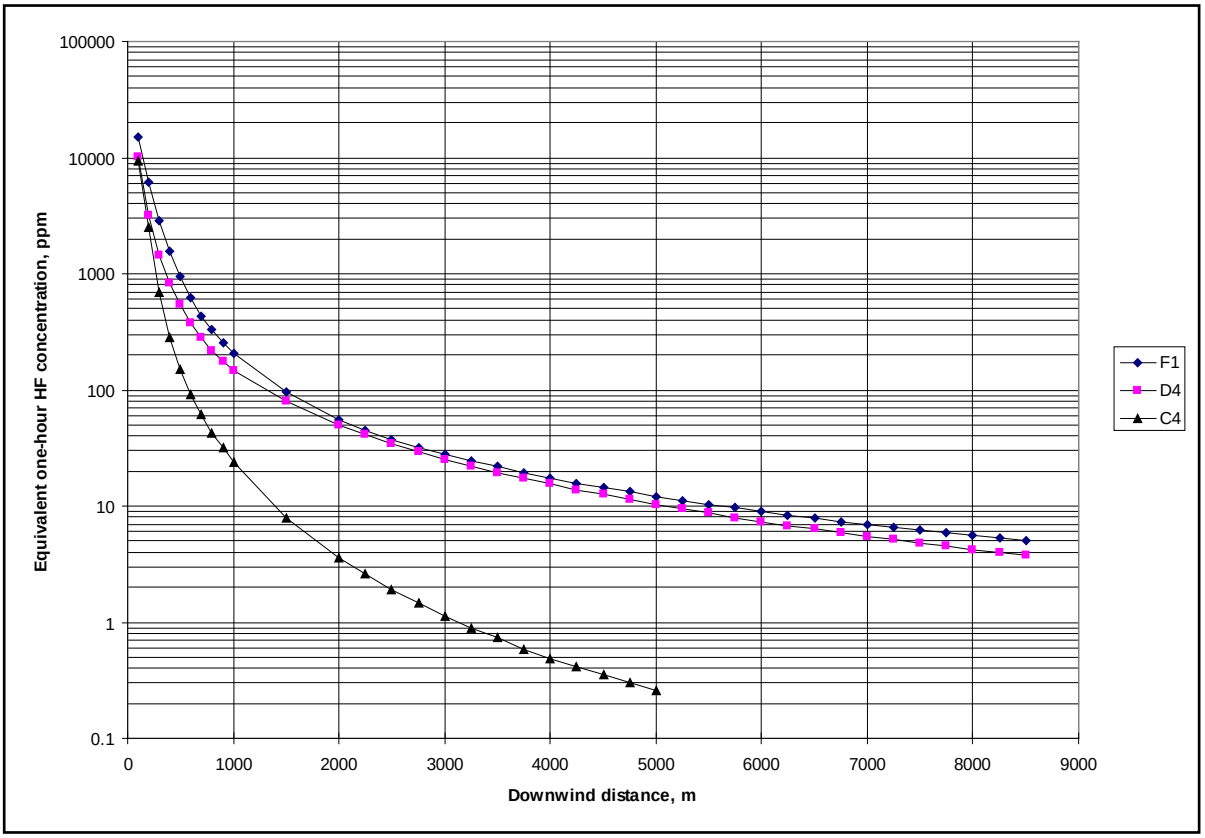
F1 = F stability, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-23. Estimated uranium chemical toxicity vs downwind distance for three meteorological conditions after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



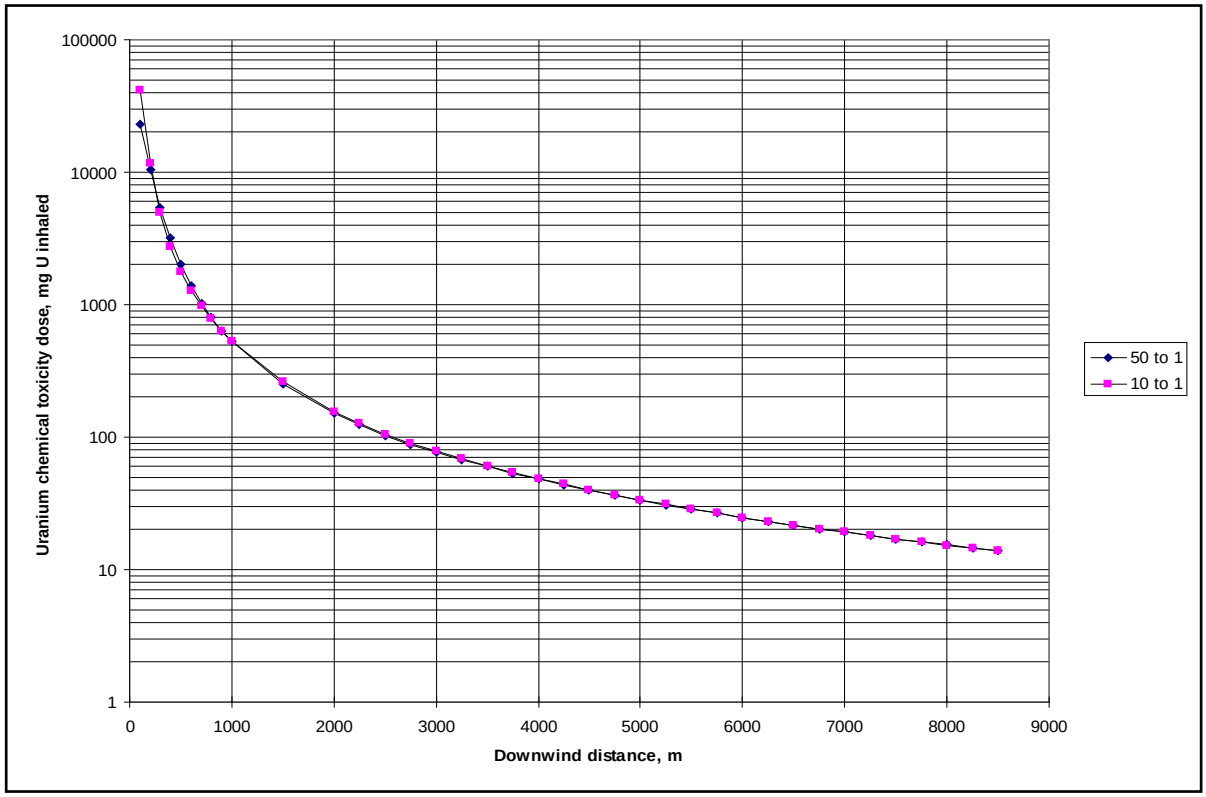
F1 = F stability, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-24 Estimated radioactive dose vs downwind distance for three meteorological conditions after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



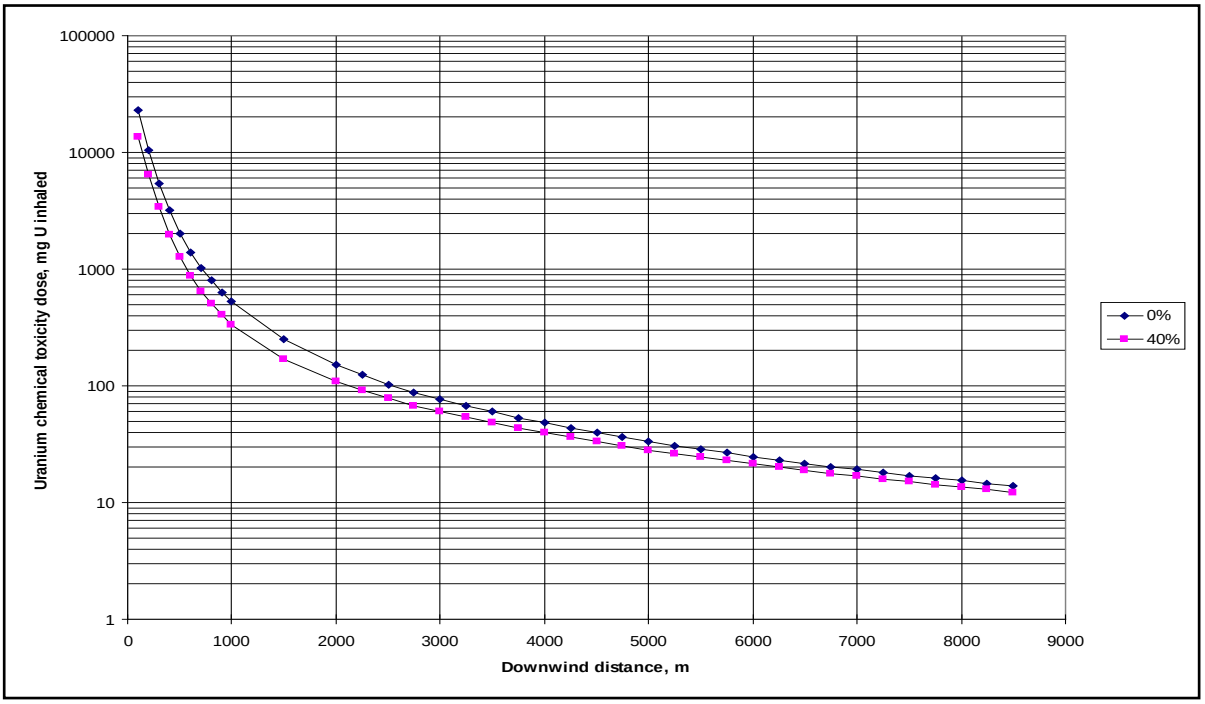
F1 = F stability, 1 meter per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed

Figure 4.3-25. Estimated hydrogen fluoride (HF) toxicity vs downwind distance for three meteorological conditions after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



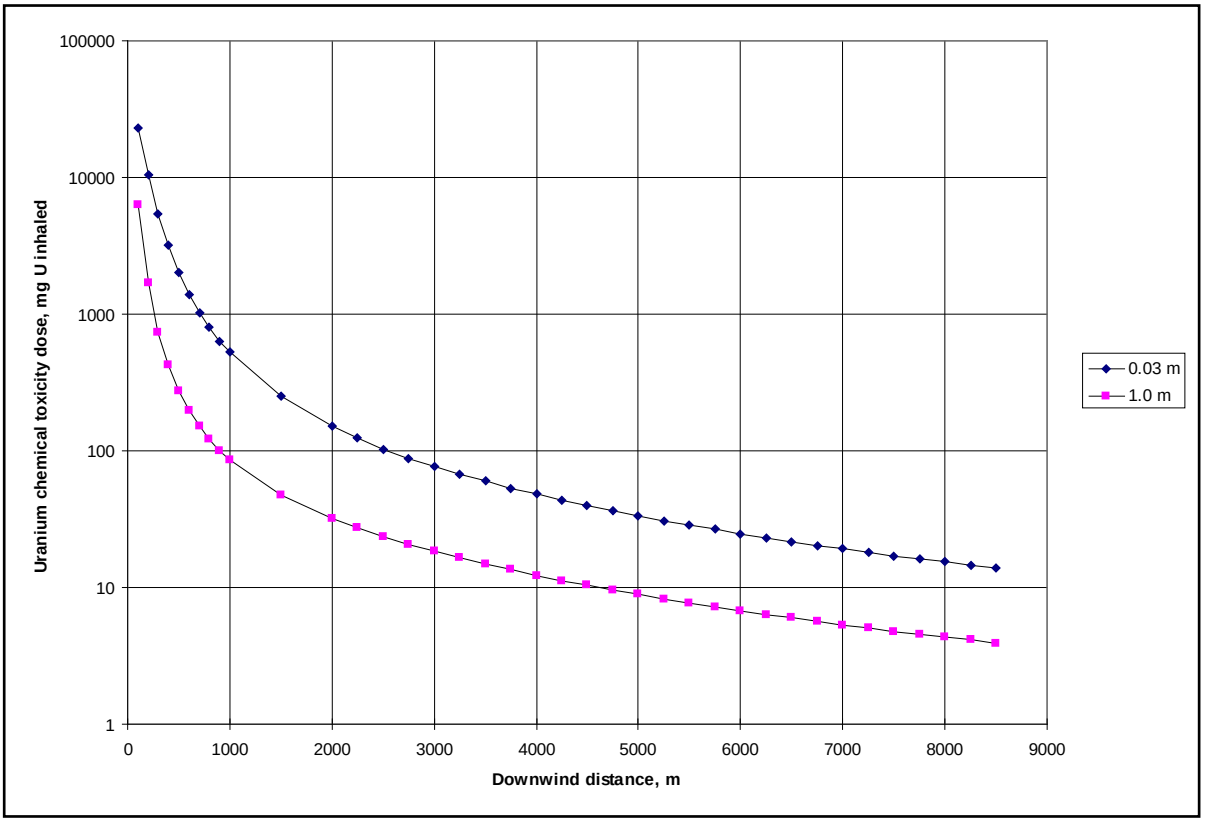
-◆- = assumed 50 to 1 initial mixing ratio
-■- = assumed 10 to 1 initial mixing ratio

Figure 4.3-26. Comparison of uranium chemical toxicity vs downwind distance for two different initial mixing cases after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



-◆- = assumed 0 percent initial deposition
-■- = assumed 40 percent initial deposition

Figure 4.3-27. Comparison of uranium chemical toxicity vs downwind distance for two different initial deposition cases after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



-◆- = assumed surface roughness height of 0.03 meters
-■- = assumed surface roughness height of 1.0 meters

Figure 4.3-28. Comparison of uranium chemical toxicity vs downwind distance for two different surface roughness heights after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).

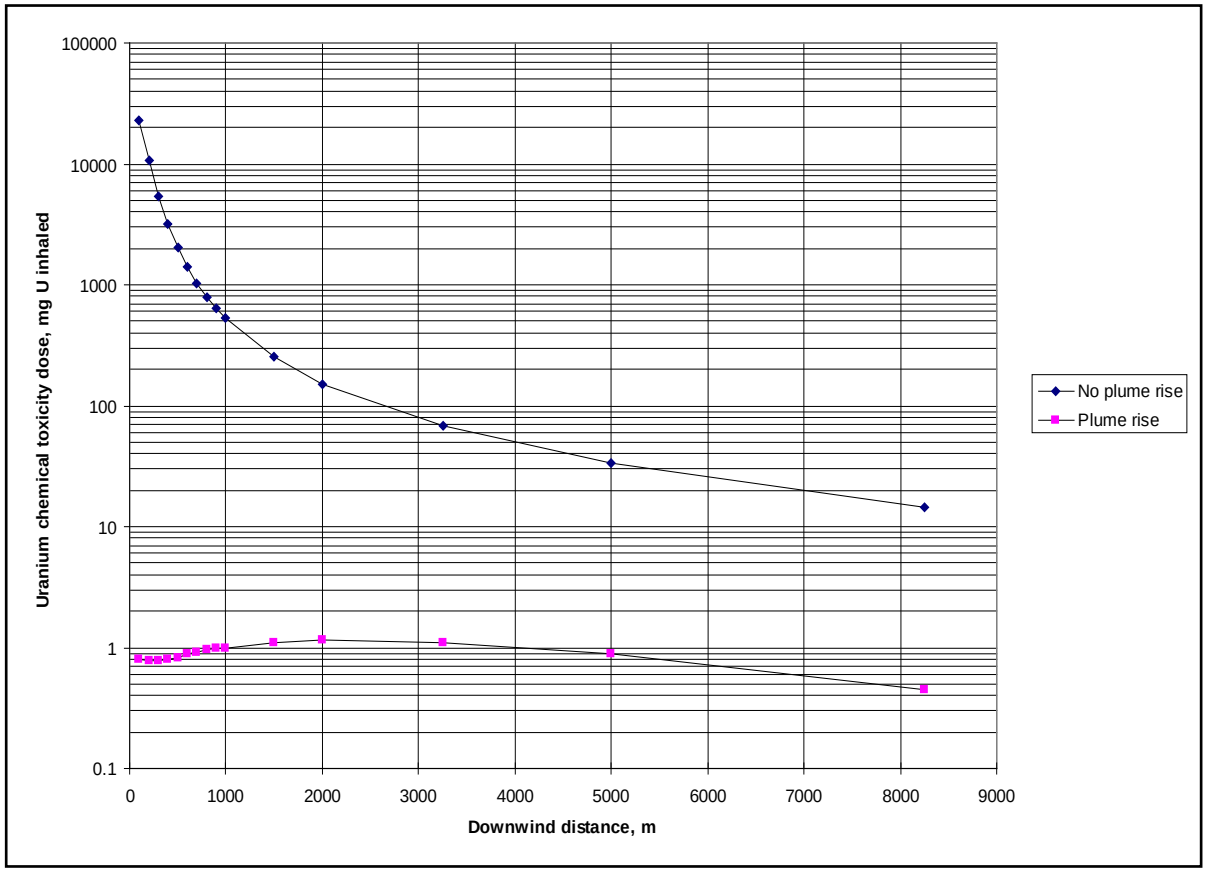
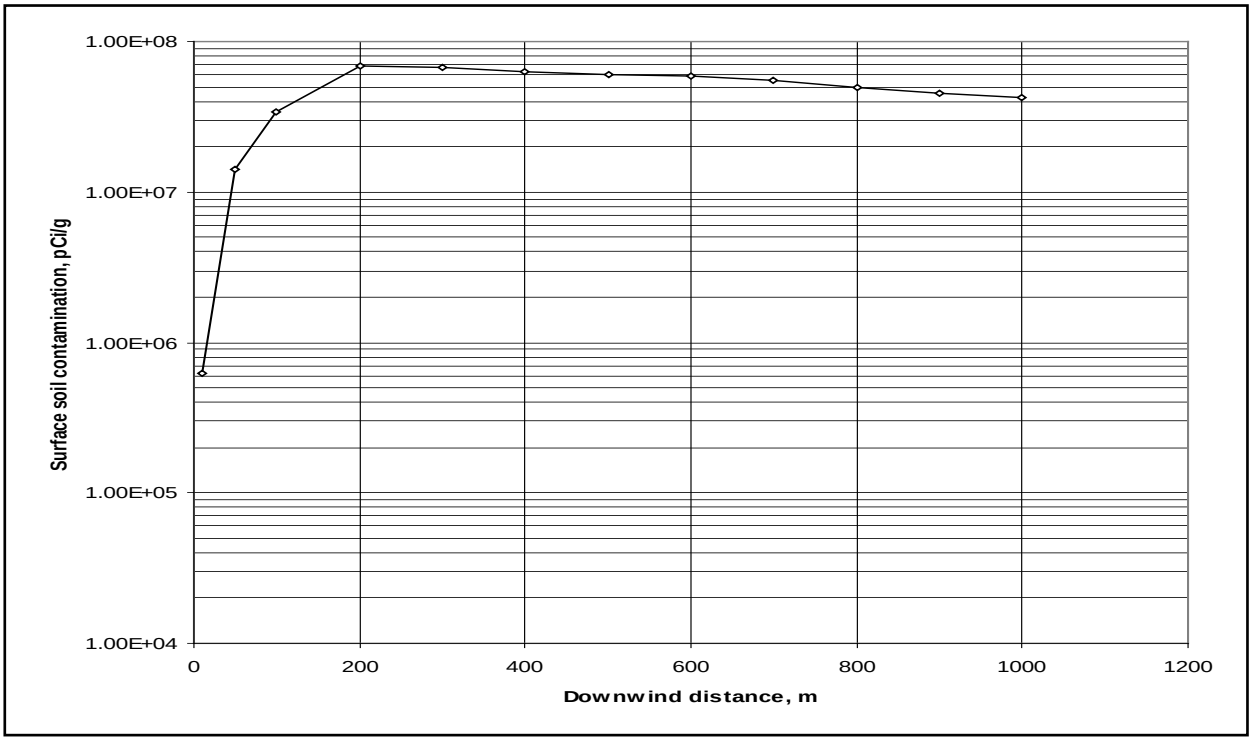


Figure 4.3-29. Comparison of uranium chemical toxicity vs downwind distance for no plume lift-off vs plume lift-off after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).



Surface soil contamination = Ac_s

Figure 4.3-30 Estimated downwind uranium contamination in the soil after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).

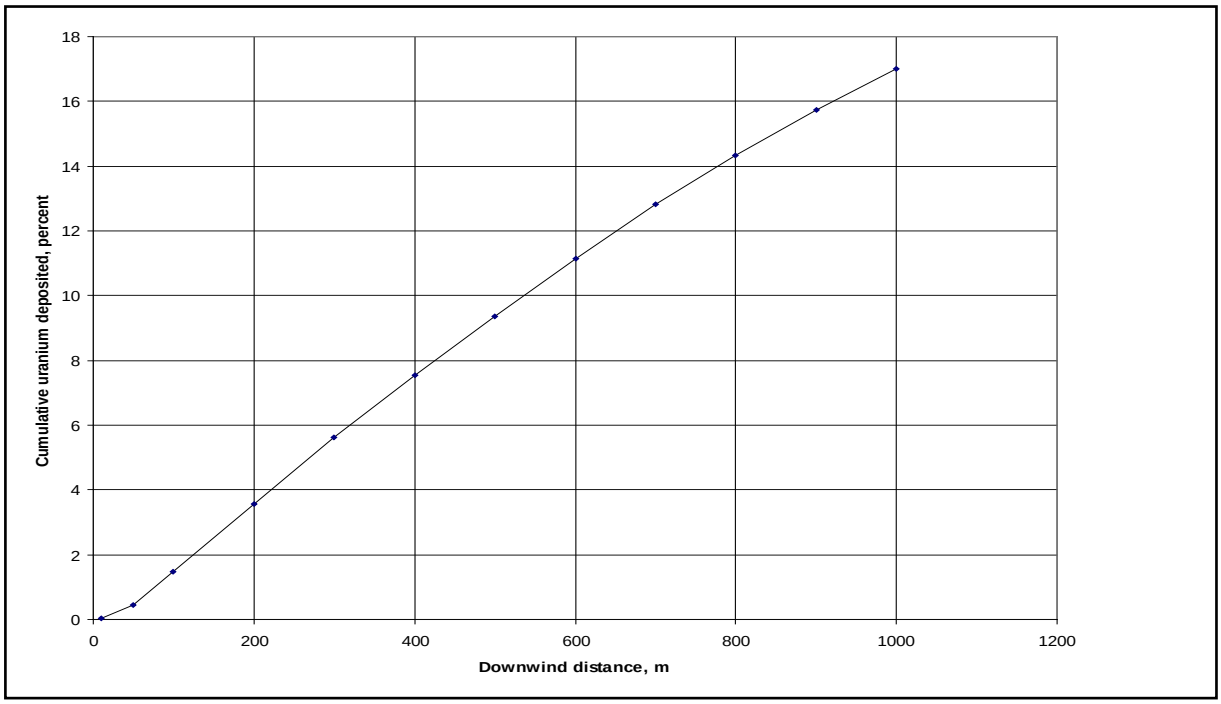


Figure 4.3-31. Estimated cumulative fraction of uranium removed from the plume after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).

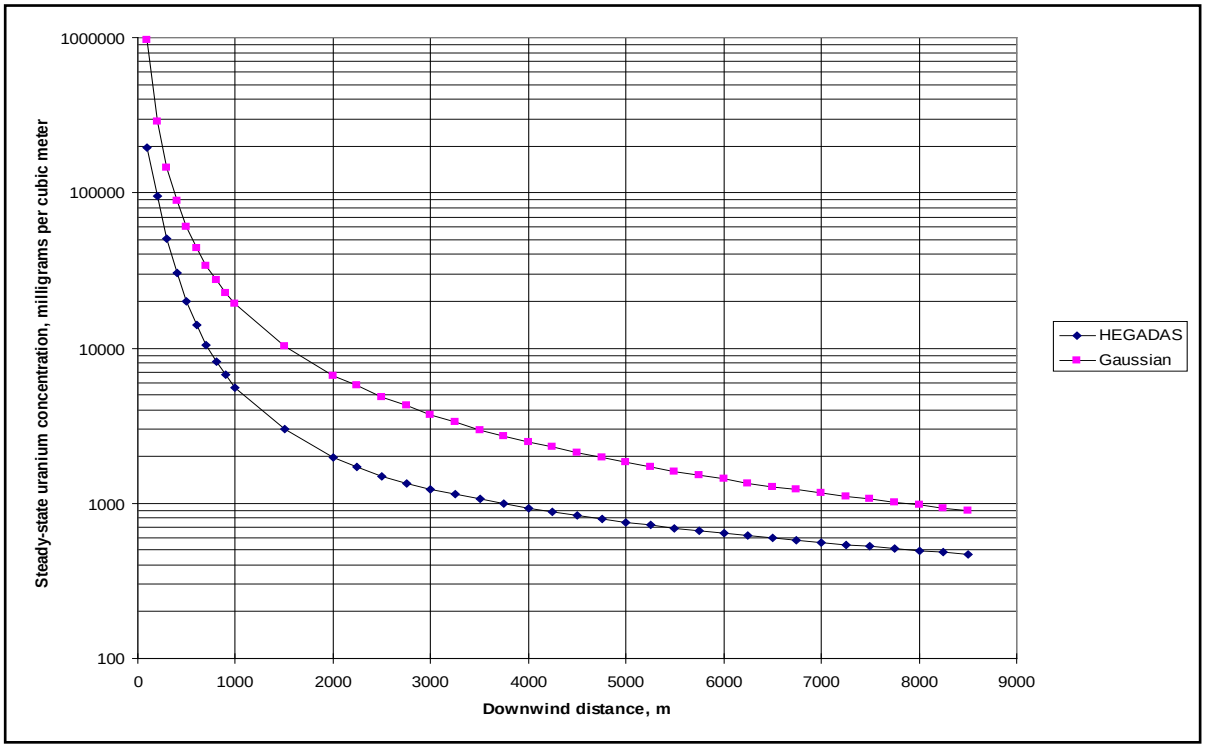


Figure 4.3-32. Comparison of results (steady-state uranium concentrations vs downwind distance) between HEGADAS/UF_6 and the Gaussian plume equation after a UF_6 release from a liquid-filled cylinder (i.e., dropped cylinder).

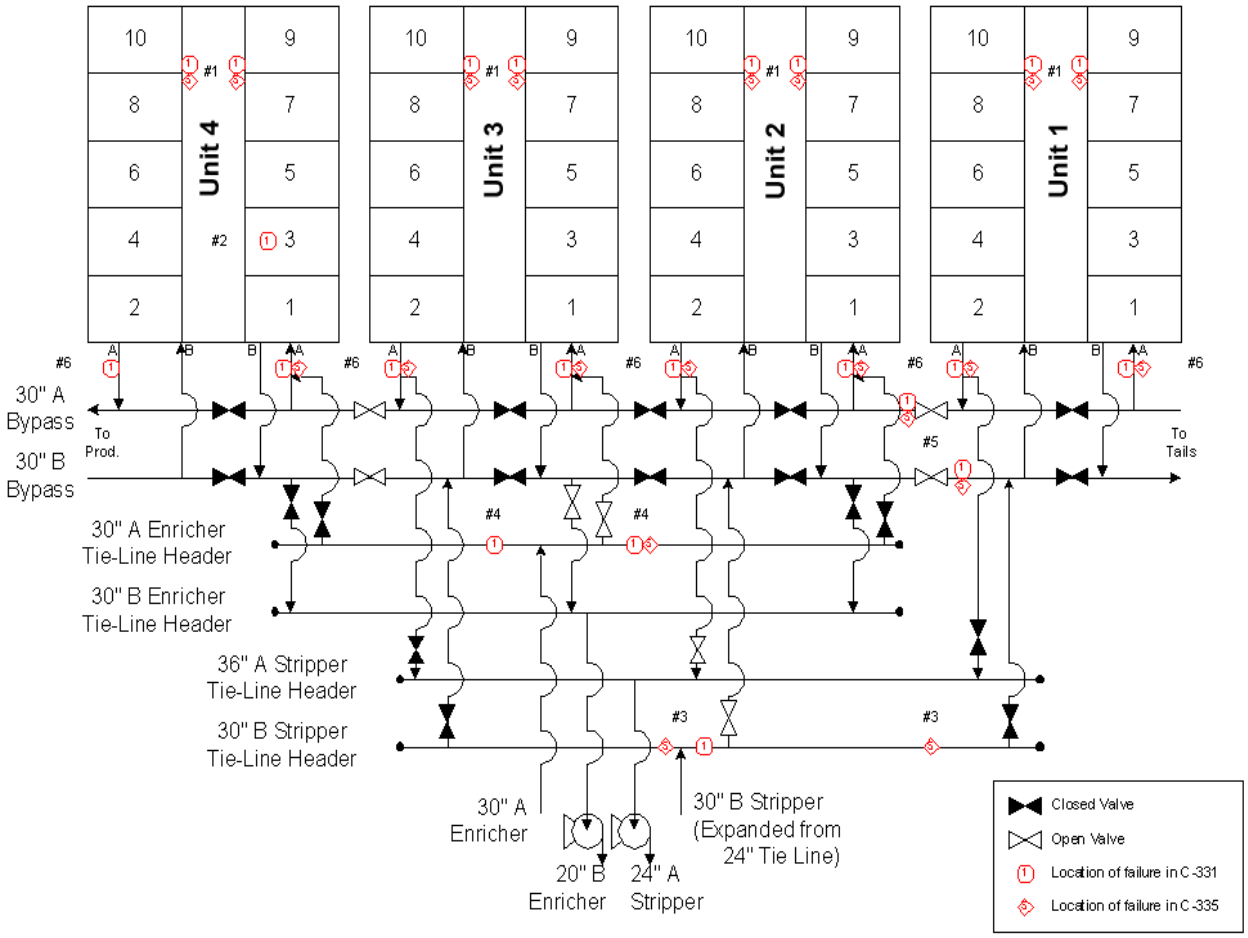


Figure 4.3-33. Seismic Failure in Paducah "00" Unit Bypass and Tie-Line Piping.

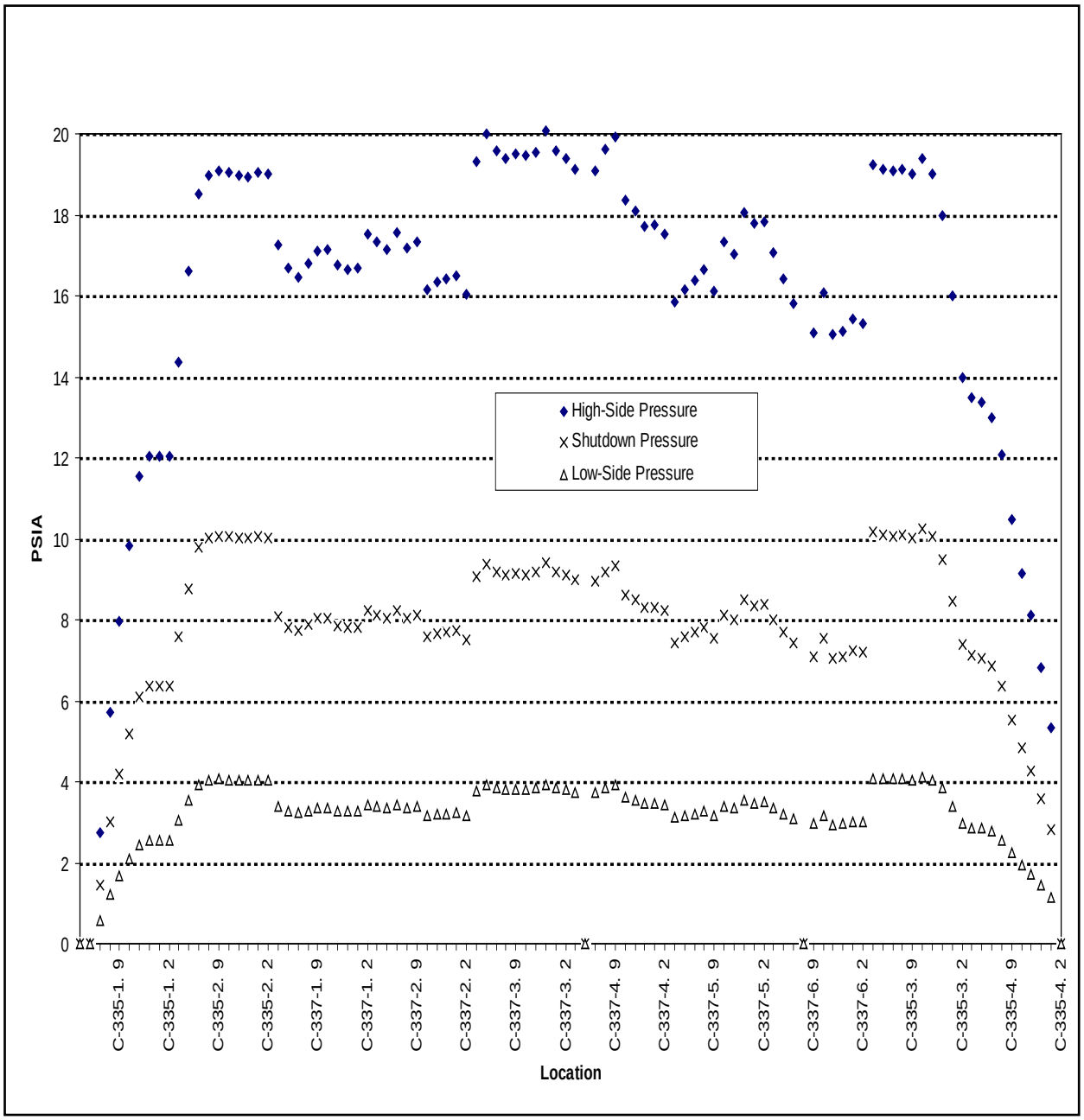


Figure 4.3-34. Typical Paducah upper cascade pressures - 3040 MW.

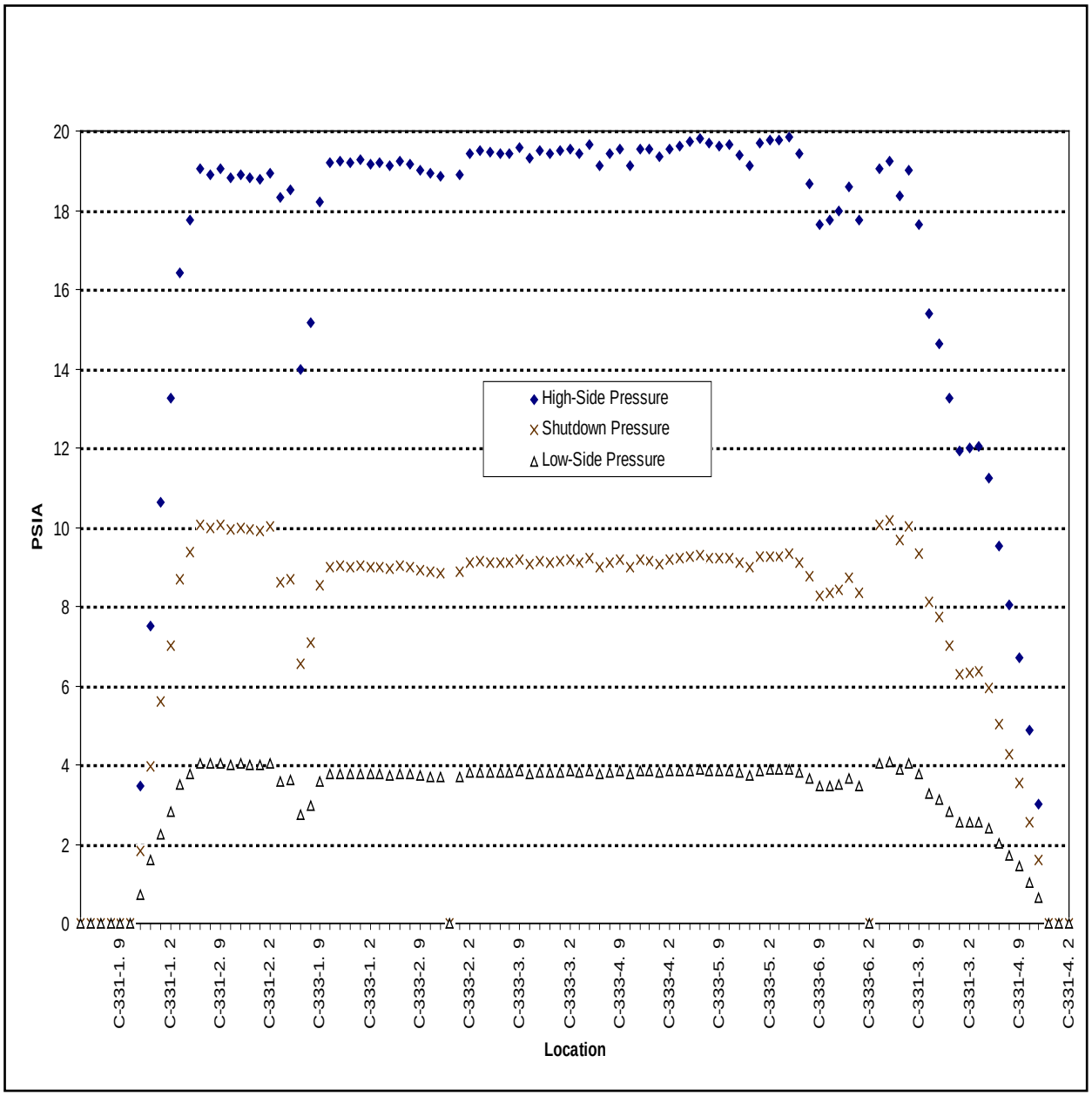


Figure 4.3-35. Typical Paducah lower cascade pressures - 3040 MW.

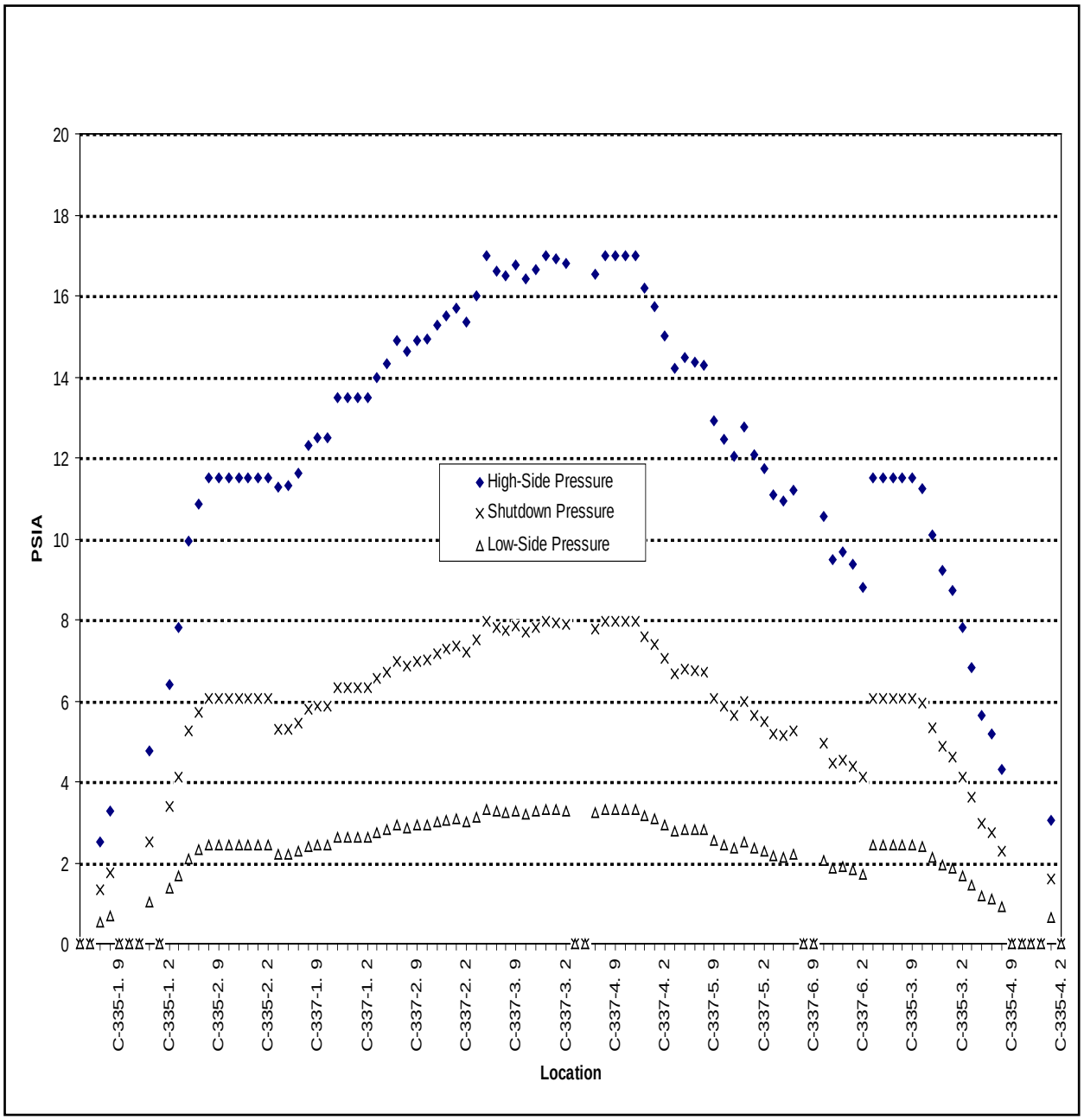


Figure 4.3-36. Typical Paducah upper cascade pressures - 2200 MW.

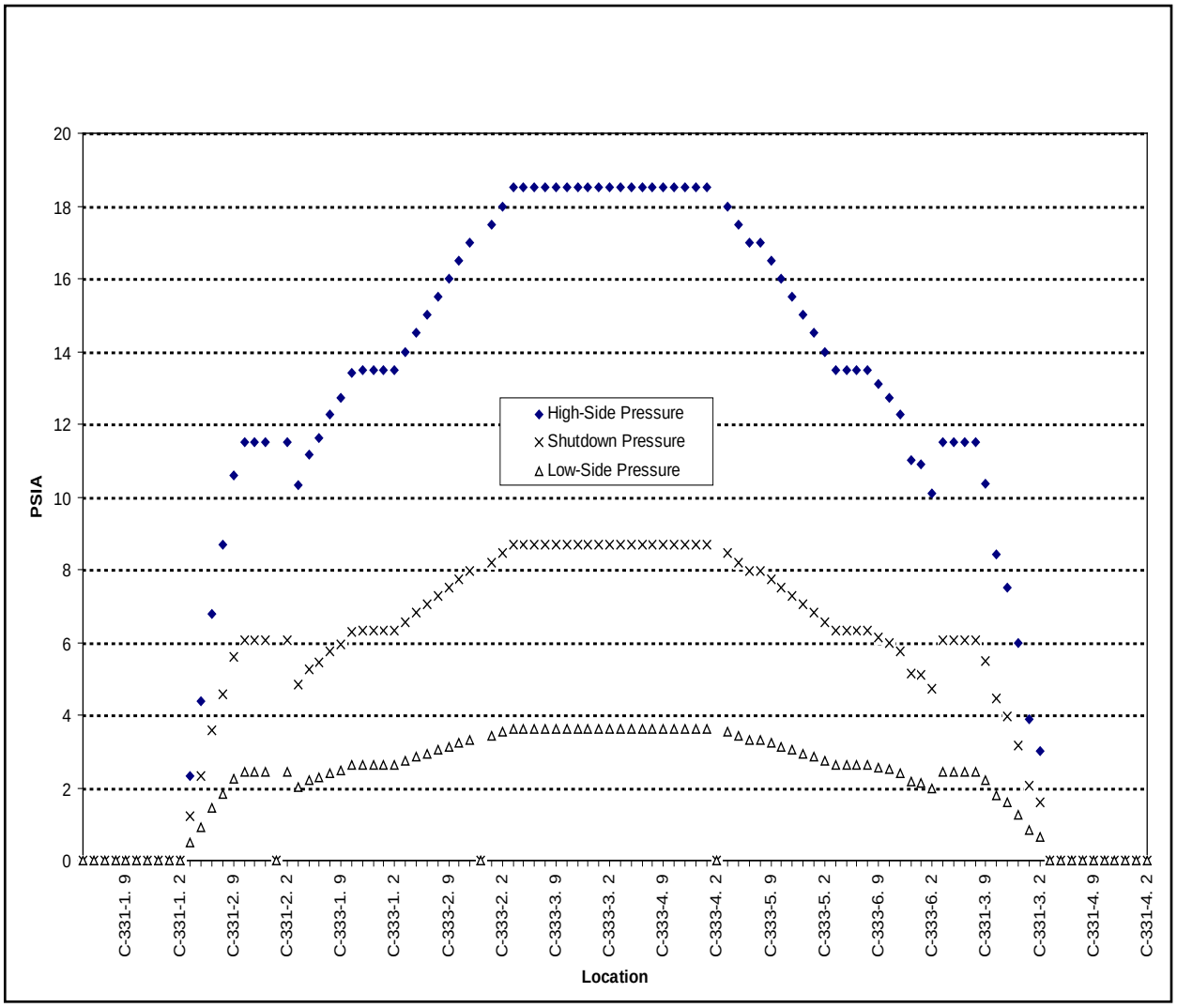


Figure 4.3-37. Typical Paducah lower cascade pressures - 2200 MW.

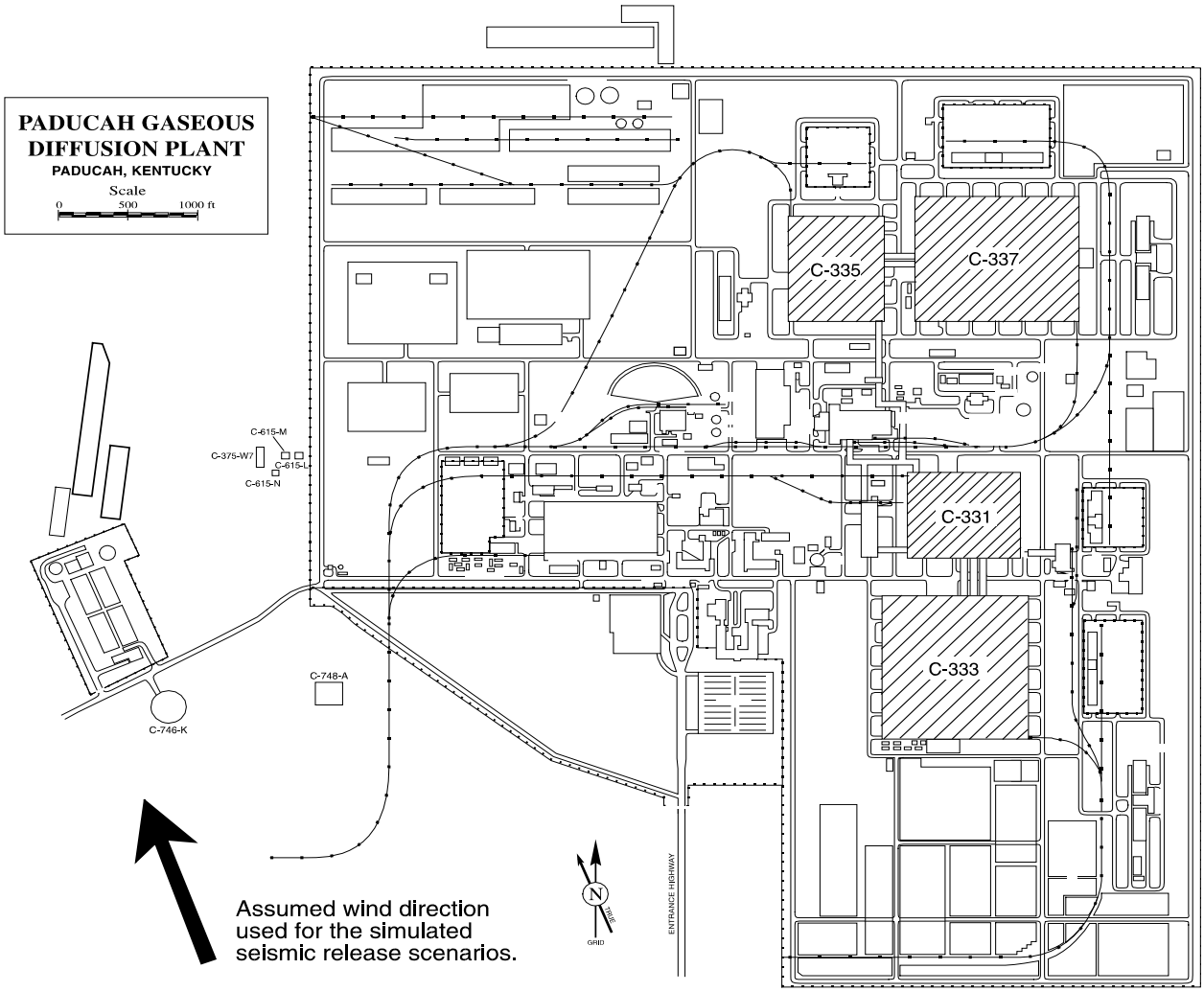
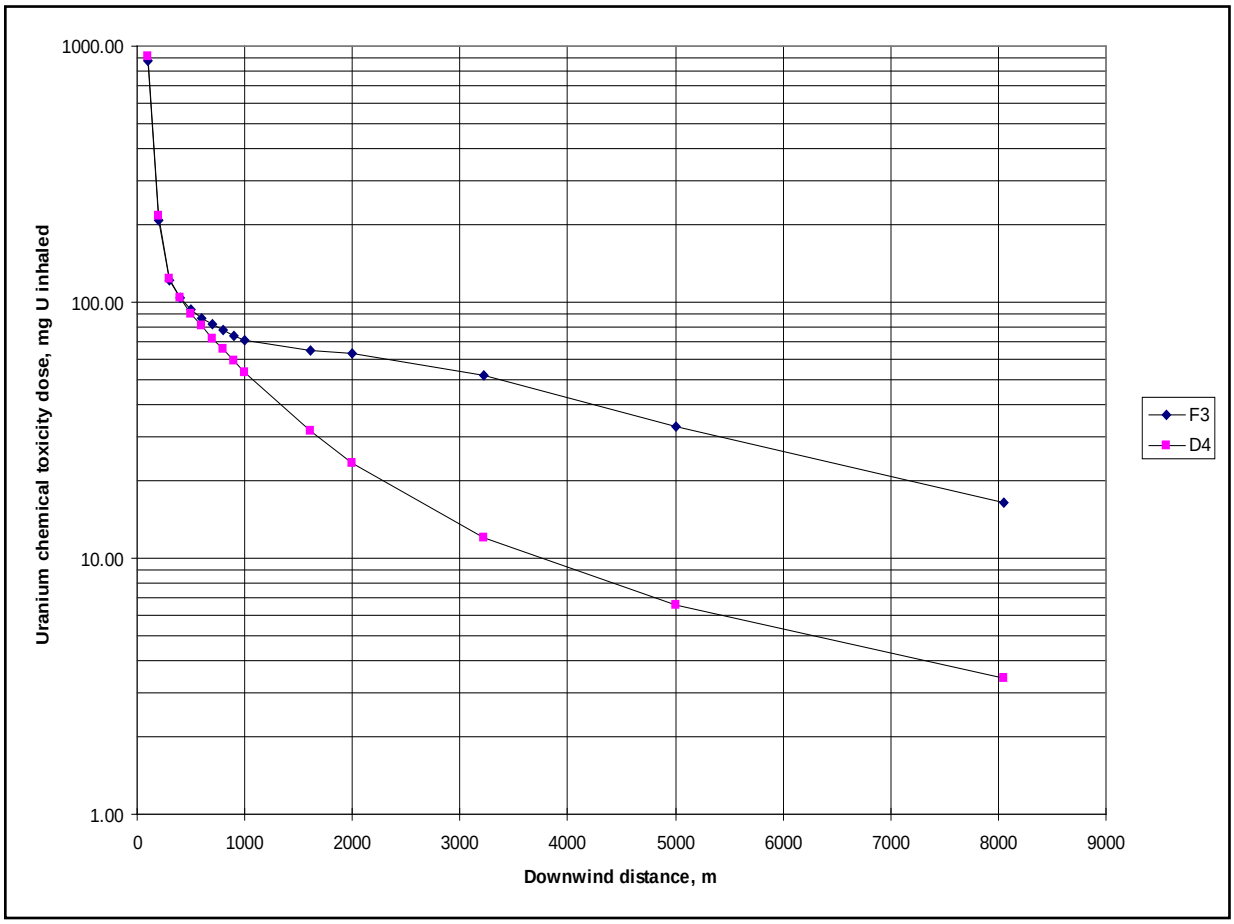
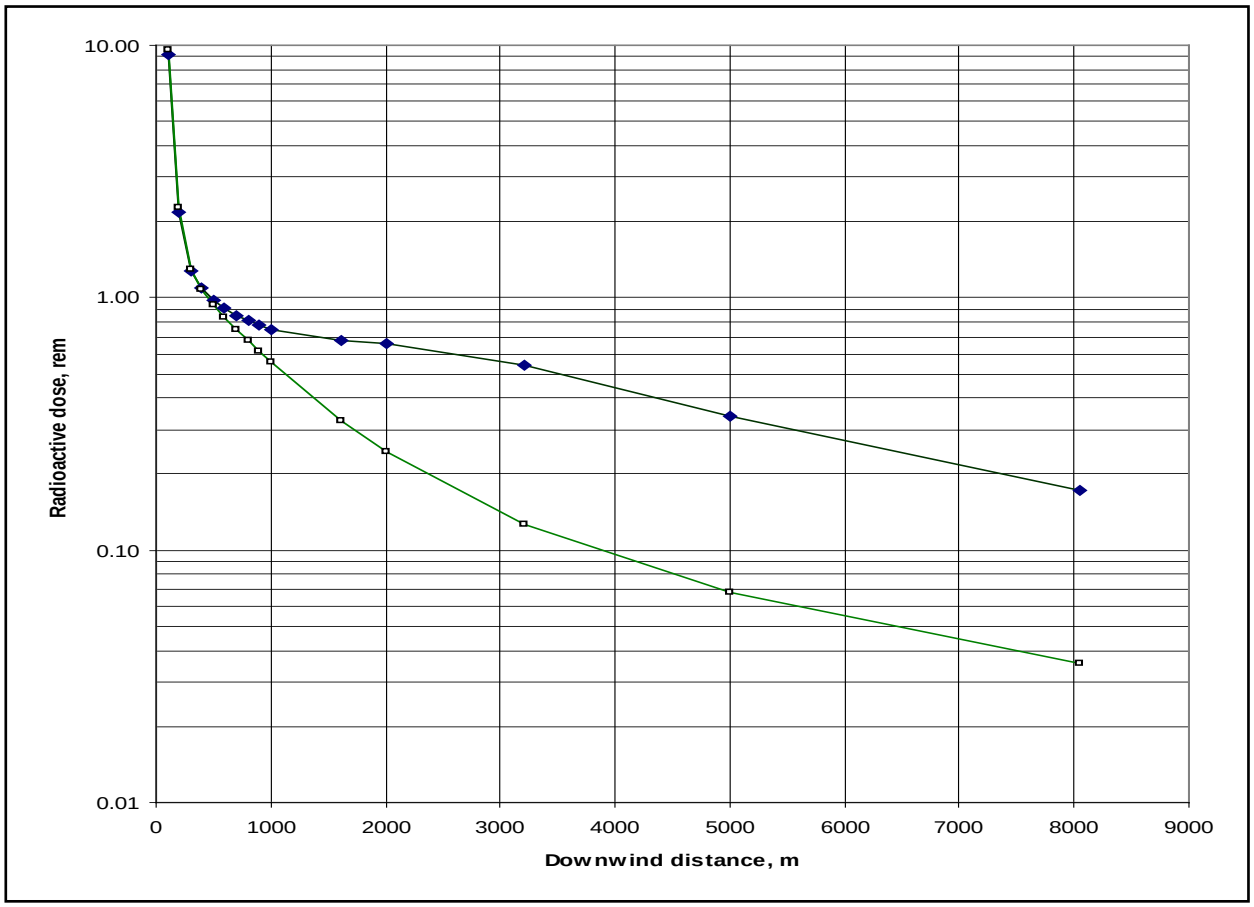


Figure 4.3-38. Potential seismic release locations (cross hatched facilities)



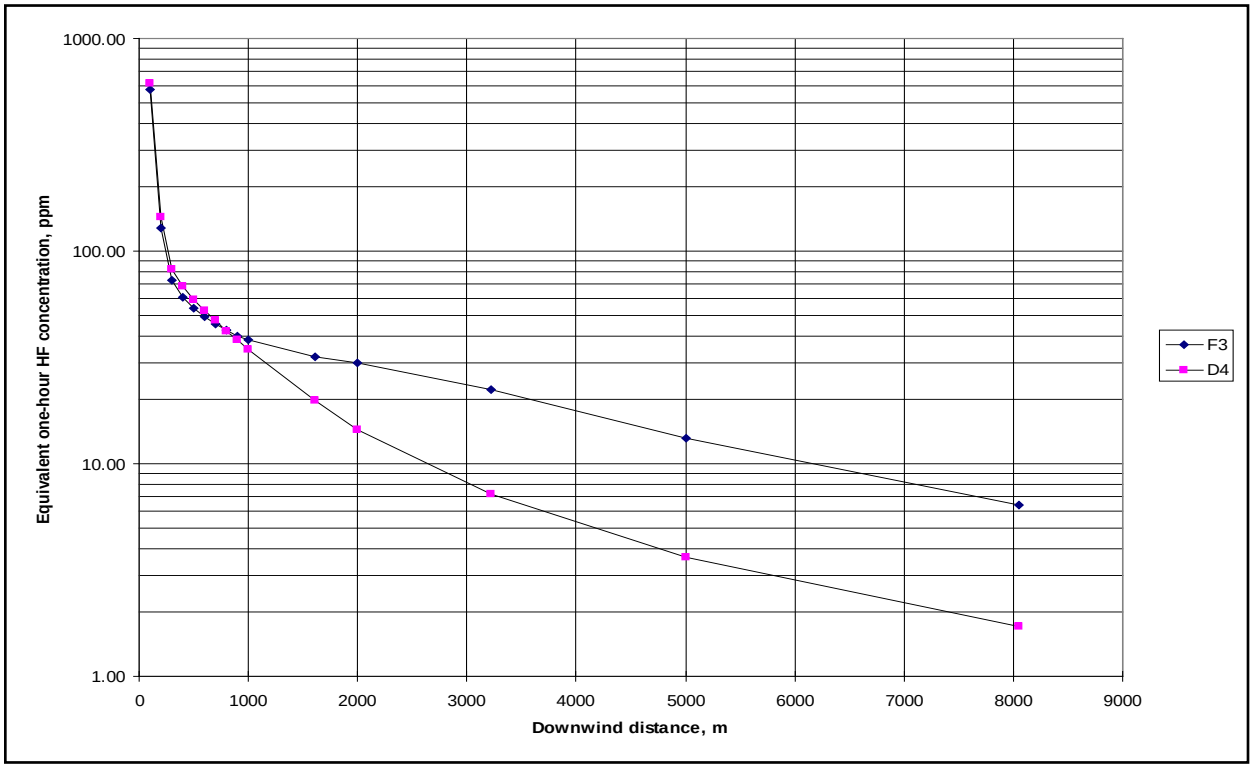
F3 = F Stability, 3 meters per second wind speed
D4 = D Stability, 4 meters per second wind speed (base case)

Figure 4.3-39. Estimated uranium chemical toxicity vs. downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 3040 MW case. (See Tables 4.3-11 and 4.3-13 for release conditions and Table 4.3-14 for a summary of consequences.)



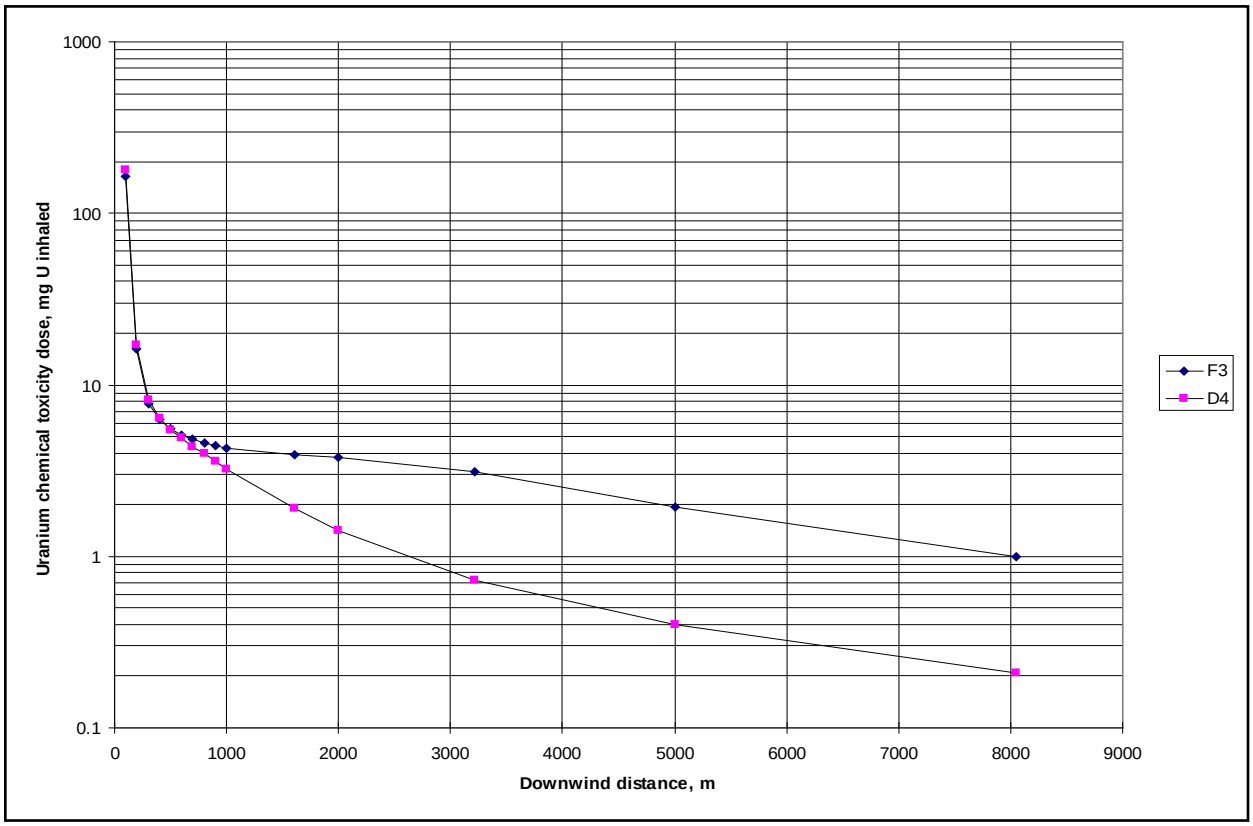
F3 = F stability, 3 meters per second wind speed
D4 = D stability, 4 meters per second wind speed (base case)

Figure 4.3-40 Estimated radioactive dose vs downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 3040 MW case. (See Tables 4.3-11 and 4.3-13 for release conditions and Table 4.3-14 for a summary of consequences.)



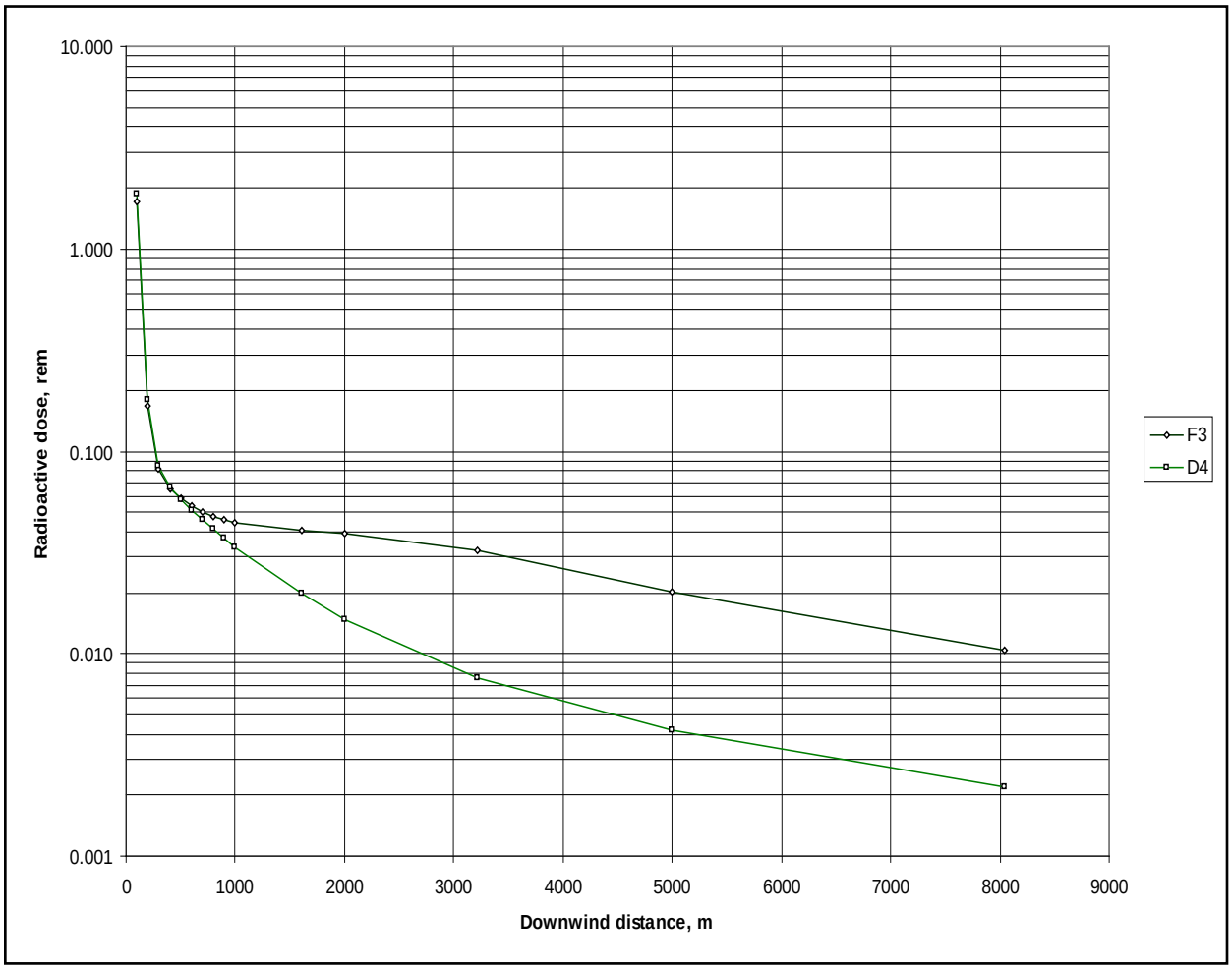
F3 = F stability, 3 meters per second wind speed
D4 = D stability, 4 meters per second wind speed (base case)

Figure 4.3-41. Estimated hydrogen flouride dose vs. downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 3040 MW case. (See Tables 4.3-11 and 4.3-13 for release conditions and Table 4.3-14 for a summary of consequences.)



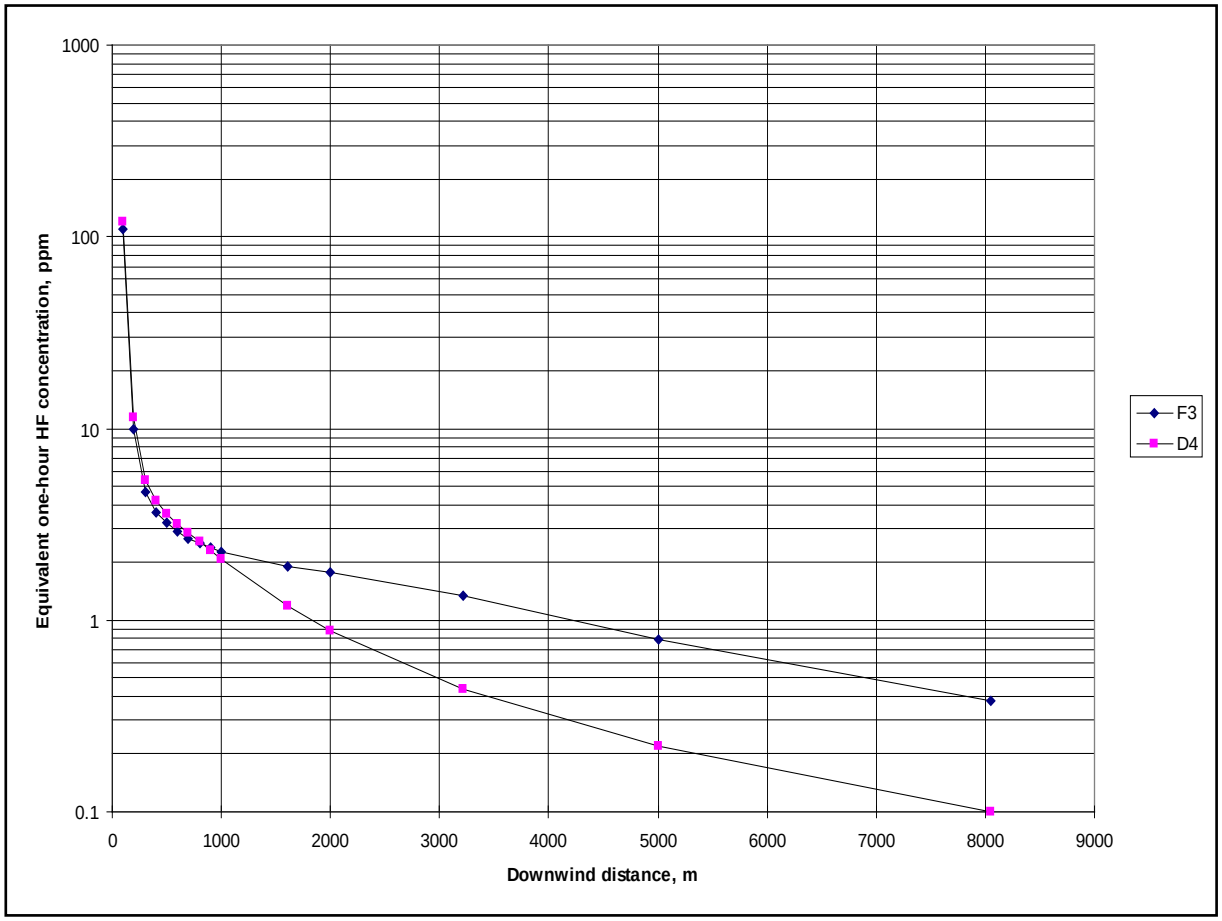
F3 = F Stability, 3 meters per second wind speed
D4 = D Stability, 4 meters per second wind speed

Figure 4.3-42. Estimated uranium chemical toxicity vs. downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 2200 MW case. (See Tables 4.3-12 and 4.3-13 for release conditions and Table 4.3-15 for a summary of consequences.)



F3 = F stability, 3 meters per second wind speed
D4 = D stability, 4 meters per second wind speed

Figure 4.3-43. Estimated radioactive dose vs downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 2200 MW case. (See Tables 4.3-12 and 4.3-13 for release conditions and Table 4.3-15 for a summary of consequences.)



F3 = F stability, 3 meters per second wind speed
D4 = D stability, 4 meters per second wind speed

Figure 4.3-44. Estimated hydrogen flouride toxicity vs. downwind distance for two meteorological conditions for a UF_6 release associated with a postulated seismic event: 2200 MW case. (See Tables 4.3-12 and 4.3-13 for release conditions and Table 4.3-15 for a summary of consequences.)

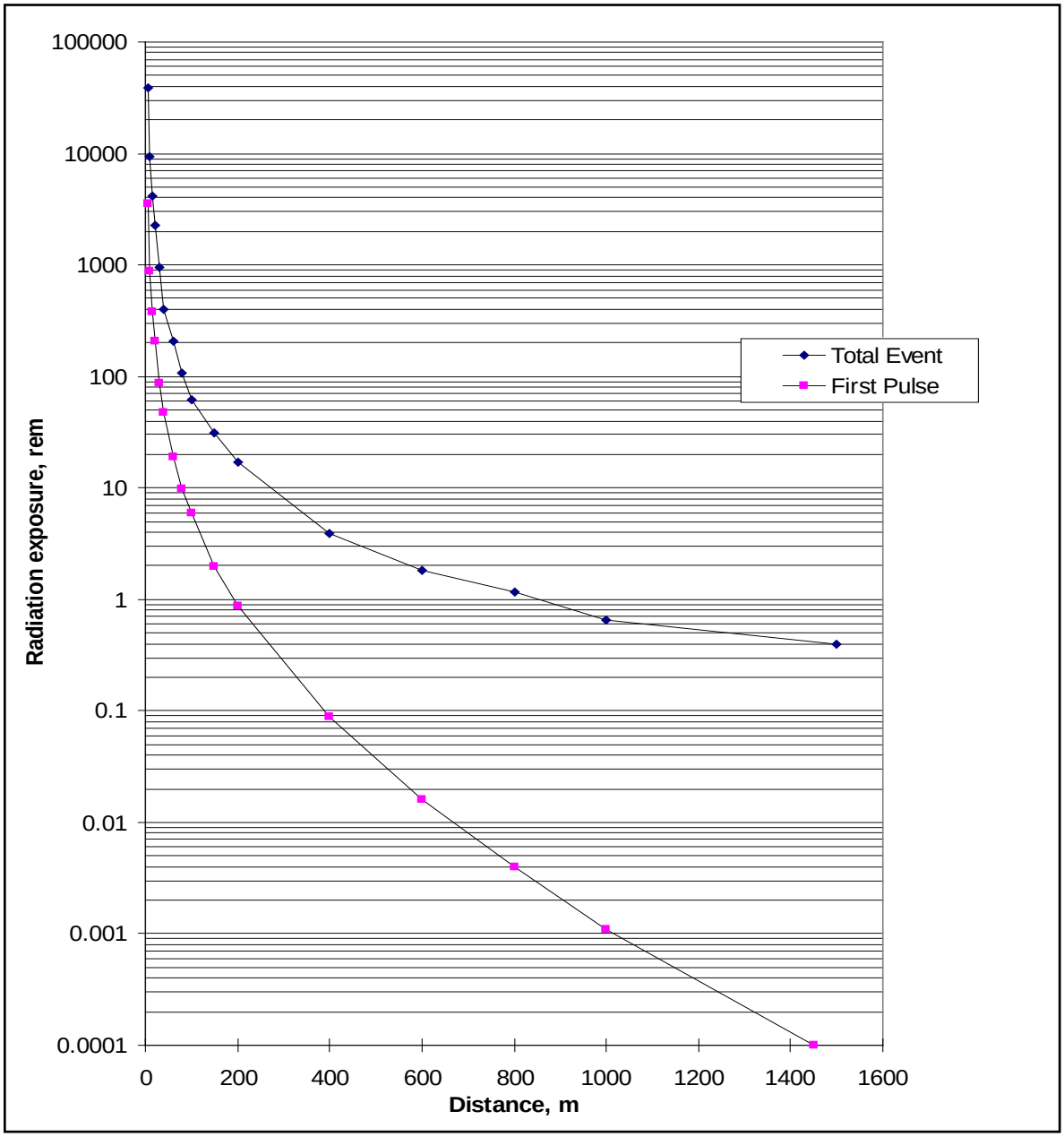


Figure 4.3-45. Total event (10^{19} fissions over 8 h) and first pulse (10^{18} fissions in 0.5 s) radiation exposures for Reg. Guide 3.34 accidental criticality event (no-shielding - air attenuation only).

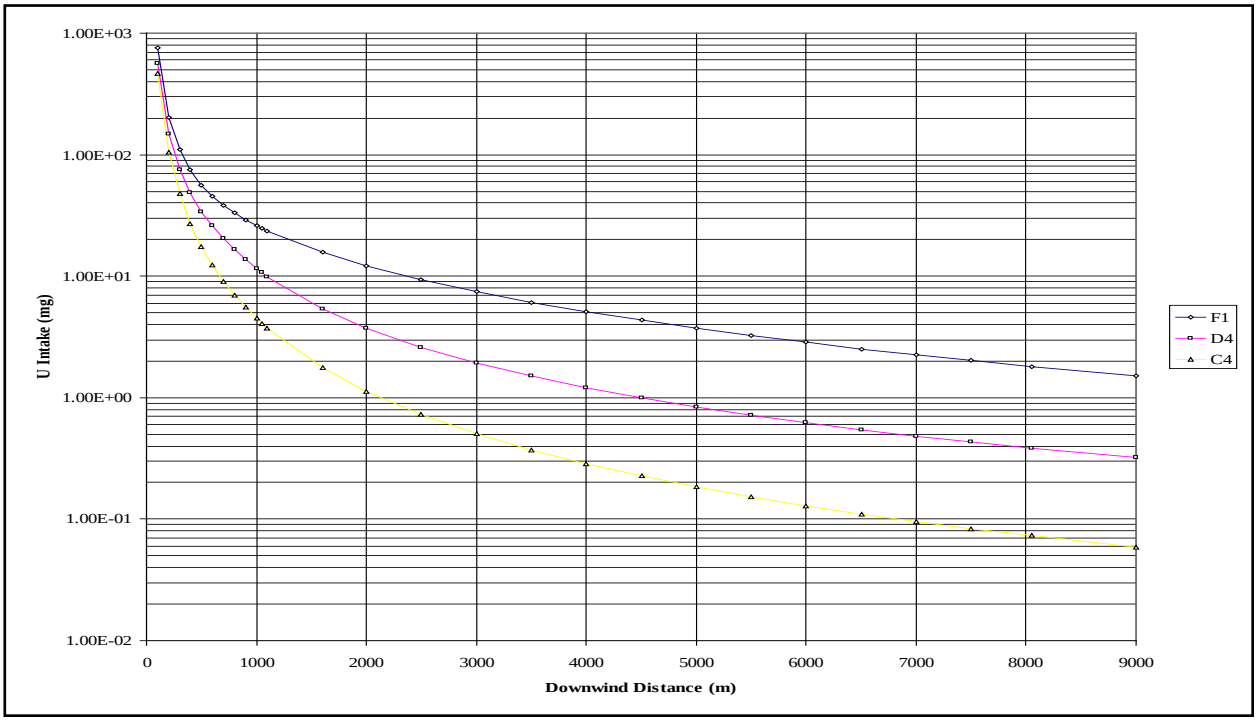


Figure 4.3-46. Estimated uranium chemical toxicity vs downwind distance for three meteorological conditions after a piping failure at the C-360 technetium traps.

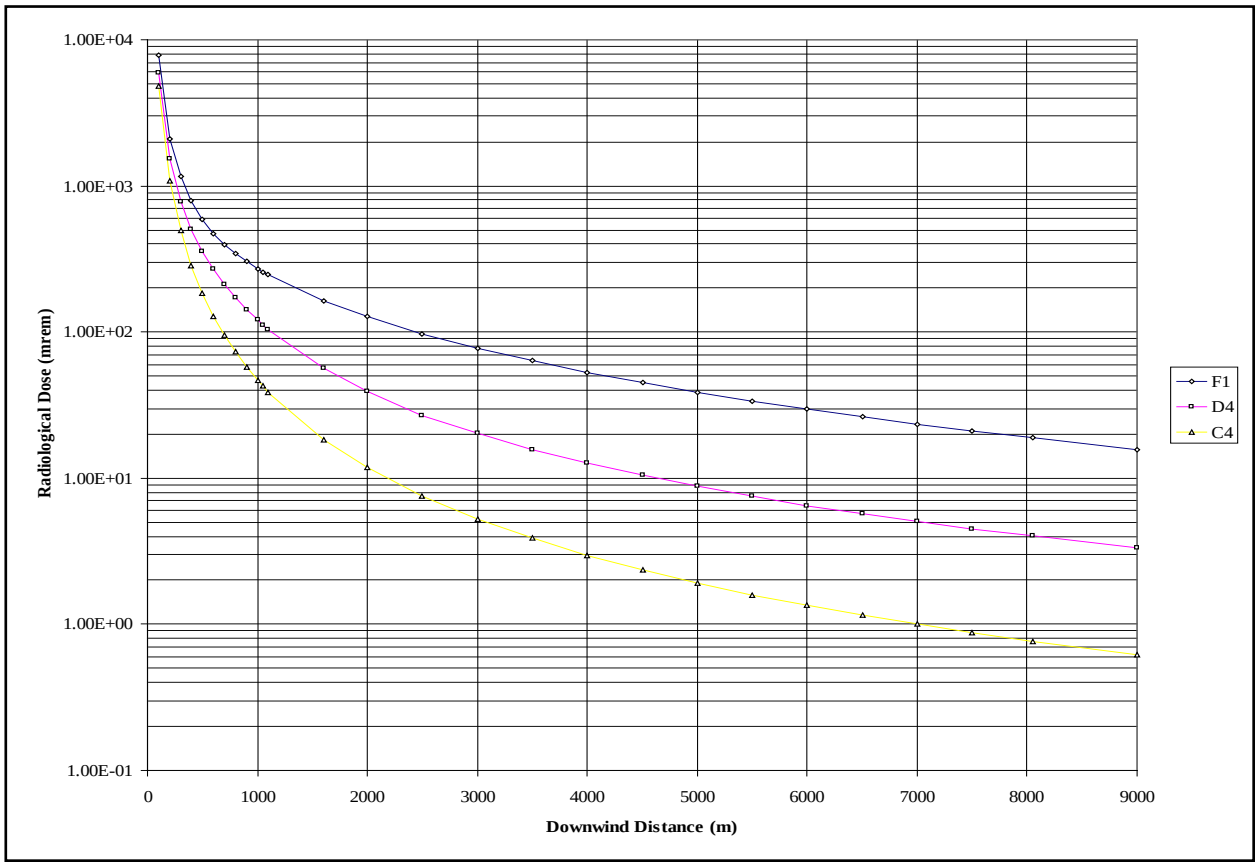


Figure 4.3-47. Estimated uranium radiological dose vs downwind distance for three meteorological conditions after a piping failure at the C-360 technetium traps.

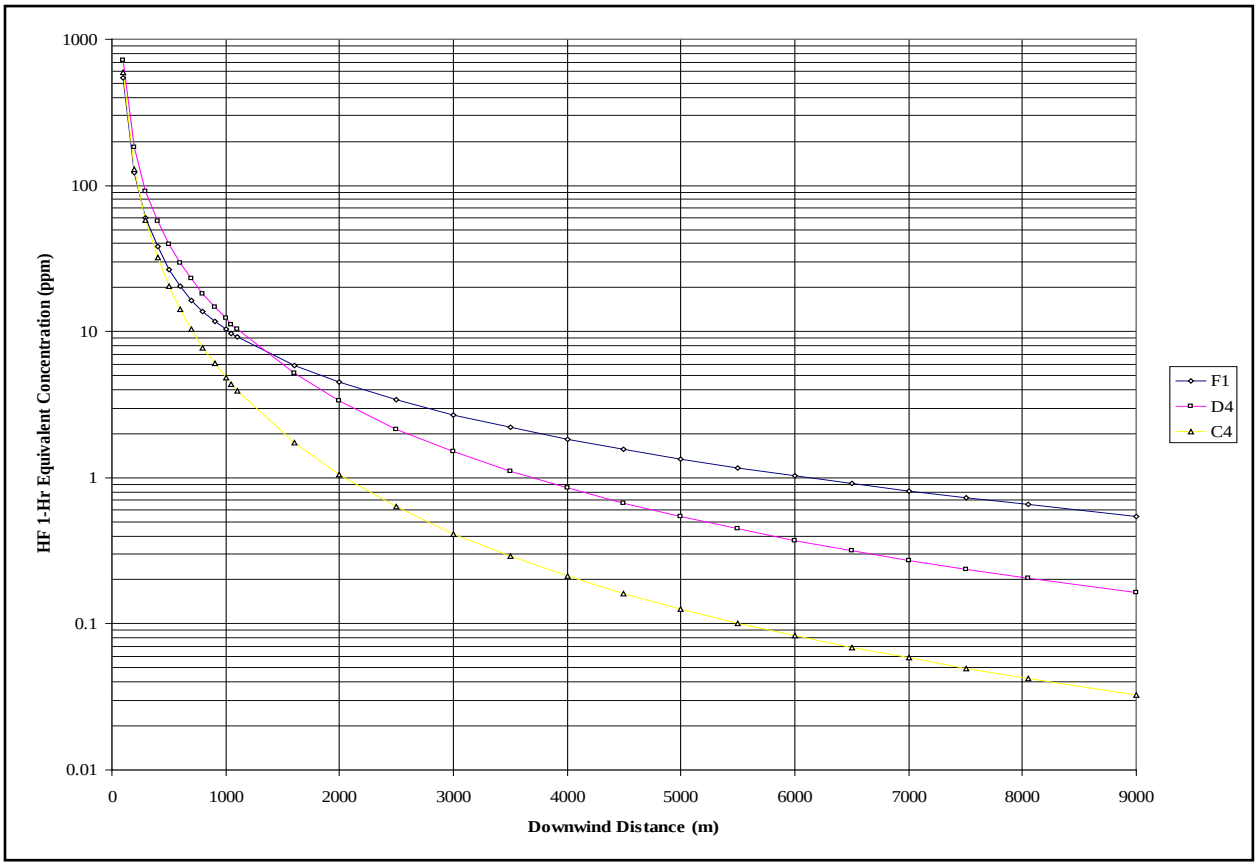


Figure 4.3-48. Estimated hydrogen fluoride (HF) toxicity vs downwind distance for three meteorological conditions after a piping failure at the C-360 technetium traps.

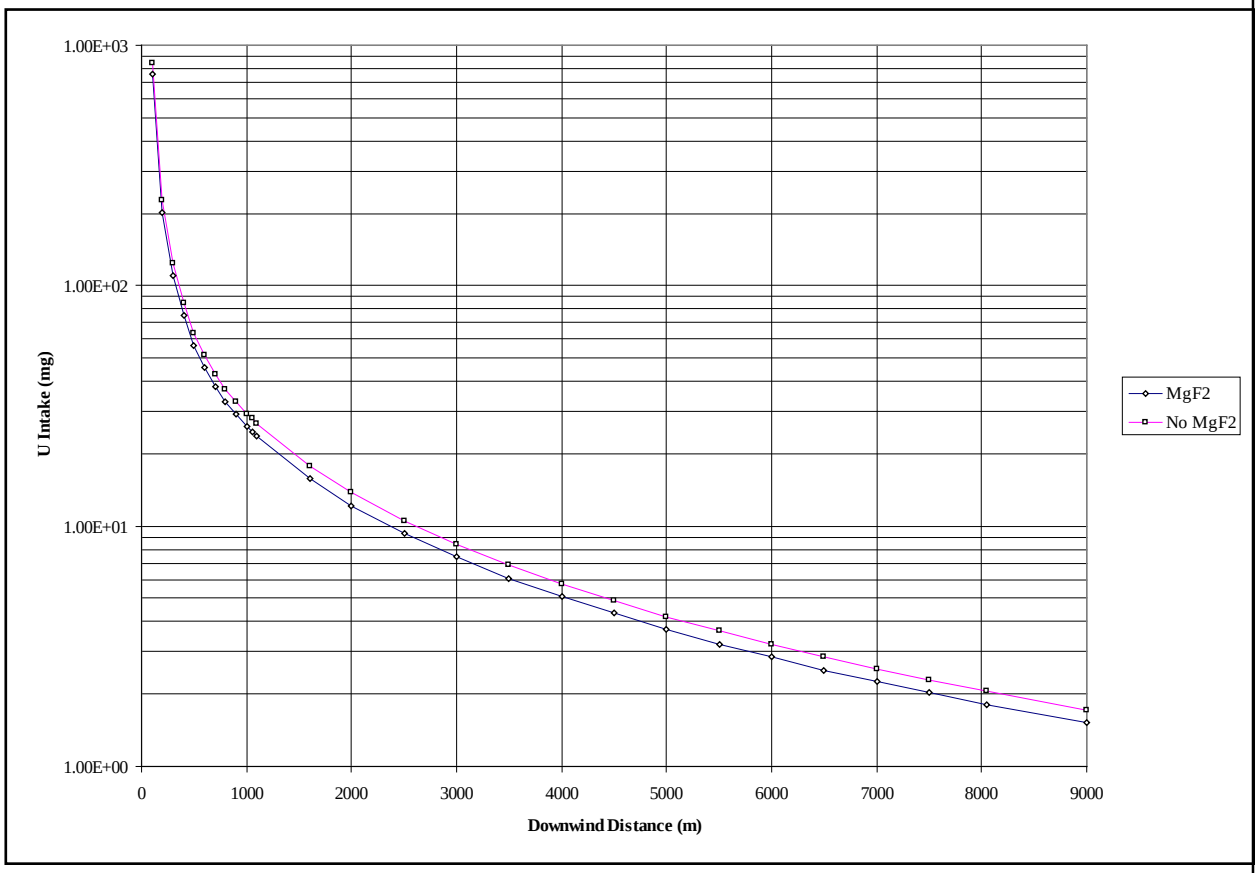
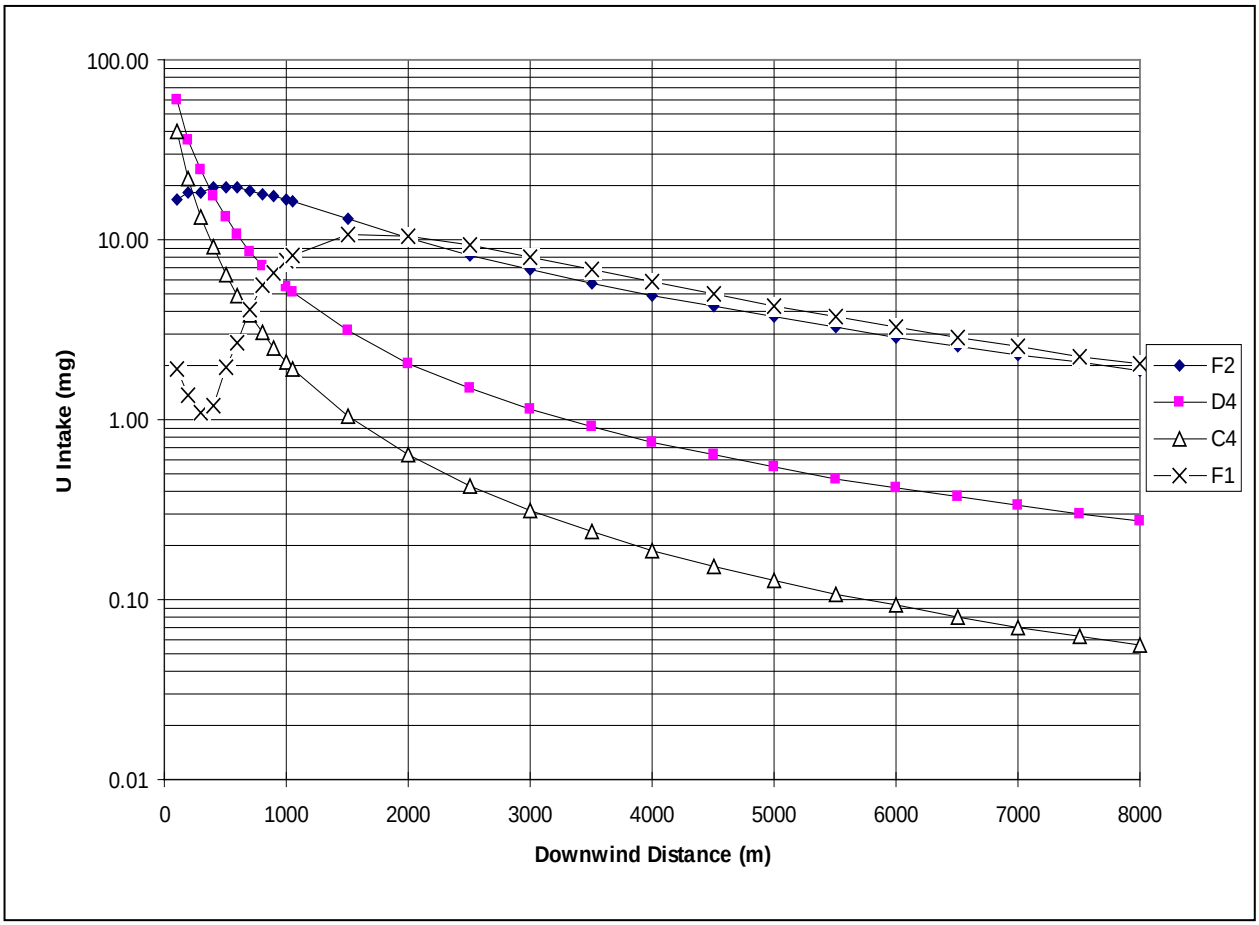
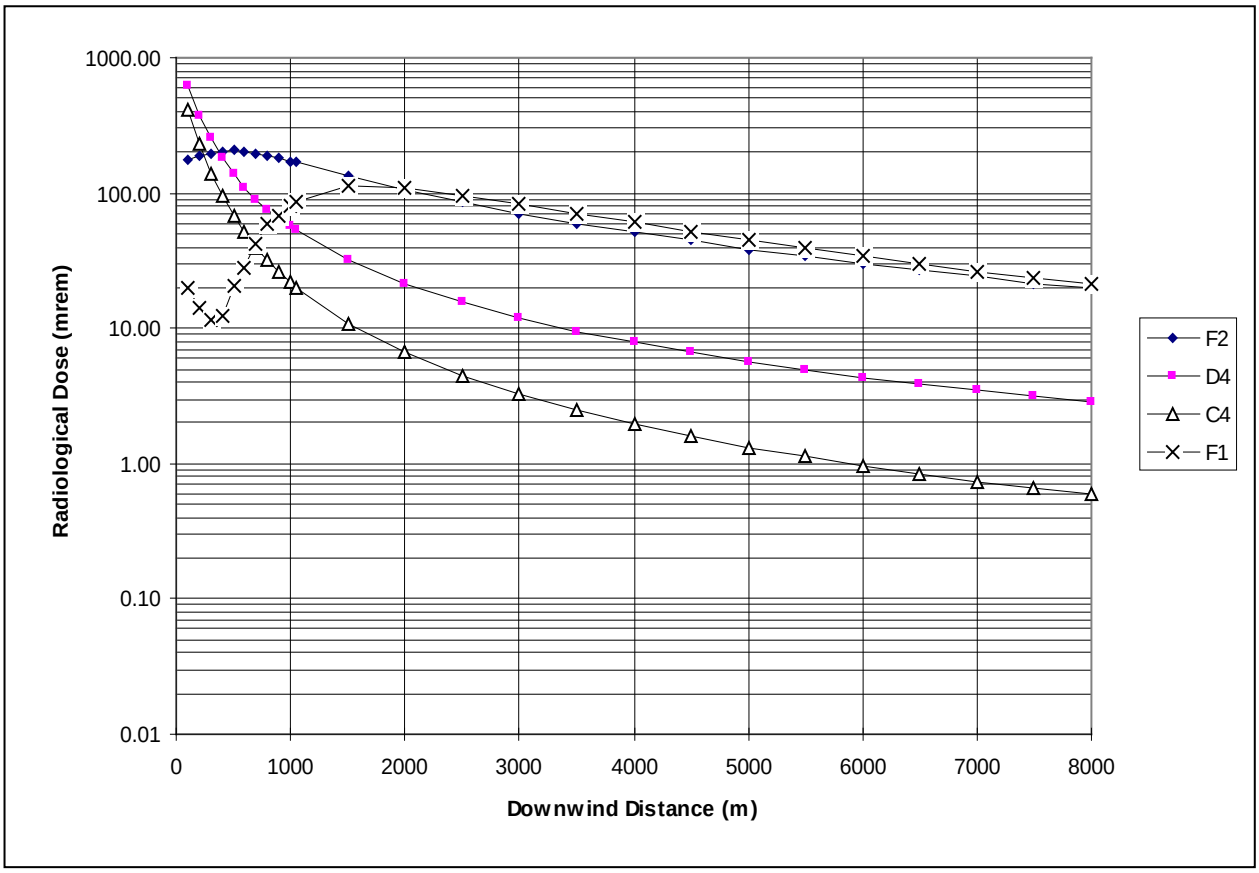


Figure 4.3-49. Comparison of estimated uranium chemical toxicity vs downwind distance after a piping failure at the C-360 technetium traps for traps with and without MgF_2.



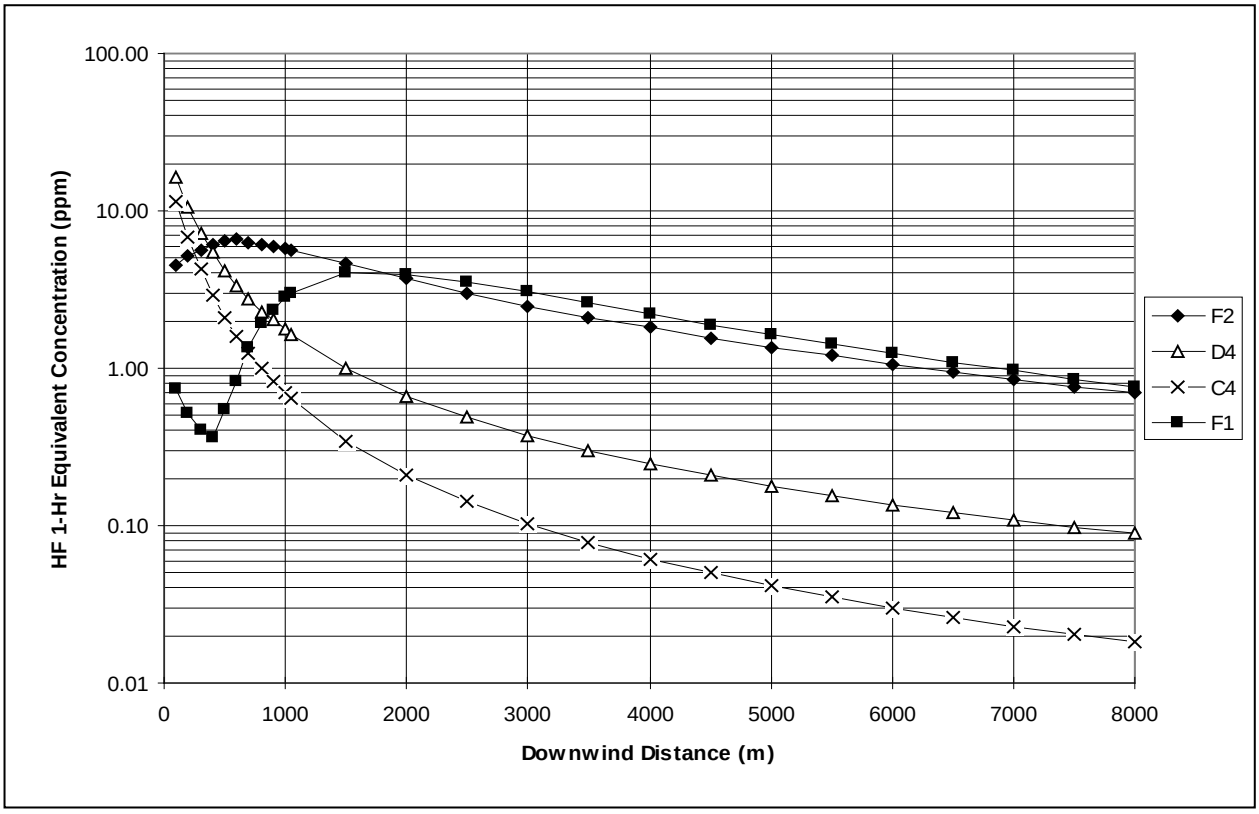
F2 = F stability, 2 meters per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed
F1 = F stability, 1 meters per second wind speed

Figure 4.3-50. Uranium toxicological doses as a function of downwind distances for four meteorological conditions, for a pigtail failure inside C-360 autoclave during jetting, 60 minute release, 60 psig jet steam inlet pressure



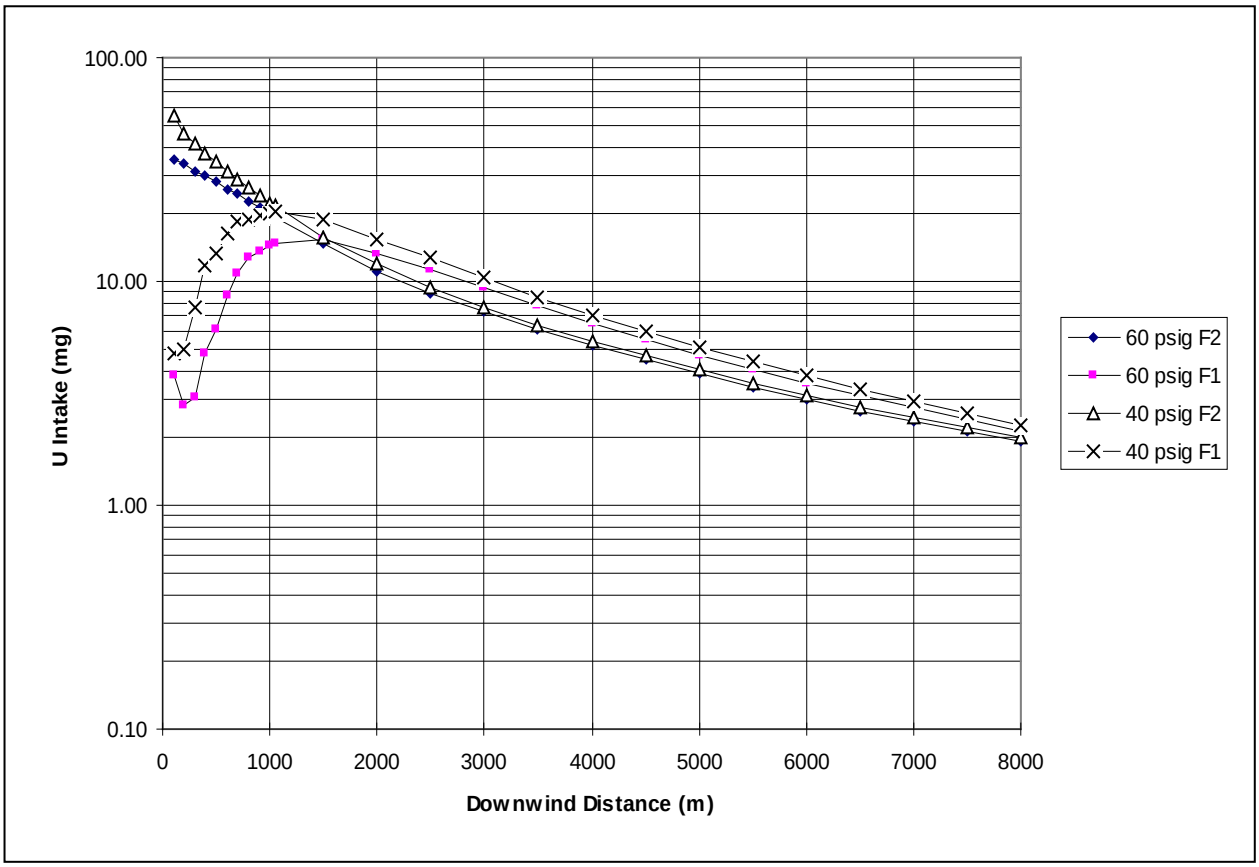
F2 = F stability, 2 meters per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed
F1 = F stability, 1 meters per second wind speed

Figure 4.3-51. Uranium radiological doses as a function of downwind distances for four meteorological conditions, for a pigtail failure inside C-360 autoclave during jetting, 60 minute release, 60 psig jet steam inlet pressure



F2 = F stability, 2 meters per second wind speed
D4 = D stability, 4 meters per second wind speed
C4 = C stability, 4 meters per second wind speed
F1 = F stability, 1 meters per second wind speed

Figure 4.3-52. HF average concentration as a function of downwind distances for four meteorological conditions, for a pigtail failure inside C-360 autoclave during jetting, 60 minute release, 60 psig jet steam inlet pressure



F2 = F stability, 2 meters per second wind speed
F1 = F stability, 1 meters per second wind speed

Figure 4.3-53. Uranium toxicological doses as a function of downwind distances for cases assuming heat loss, for a pigtail failure inside C-360 autoclave during jetting, 60 minute release, 60 and 40 psig jet steam inlet pressure

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5. NUCLEAR SAFETY PROGRAMS

5.1 ENVIRONMENTAL PROTECTION—RADIOLOGICAL

As a condition of certification, 10 CFR 76.60(d) requires that the United States Enrichment Corporation (USEC) comply with the applicable provisions of 10 CFR Part 20, Standards For Protection Against Radiation, not later than the date of the Director's decision on the initial application and/or as specified in an approved plan for achieving compliance. This section addresses the USEC management of radiological environmental protection.

5.1.1 Emission and Effluent Control Systems

Control of plant gaseous emissions and liquid effluents follows the As Low As Reasonably Achievable (ALARA) principle. The following policy has been established regarding the control of effluents:

- The dose to members of the public resulting from gaseous emissions and liquid effluents shall be maintained in accordance with the ALARA principle and below regulatory limits.

- It is the responsibility of each employee to conduct his or her activities in such a manner so as to prevent or minimize the discharge of radioactive material to the environment and to report any unusual or excessive discharge of such material.

Environmental ALARA activities take place in conjunction with the radiological protection ALARA and Waste Minimization/Pollution Prevention programs. The Environmental, Safety, and Health Manager serves on the plant Radiation Protection Committee. Radiological emission data is reviewed by the Radiation Protection Committee and Environmental, Safety and Health (ES&H) personnel. Baseline Effluent Quantities (BEQs) are established for the discharge points described in SAR Sections 5.1.1.1 and 5.1.1.2. Environmental data are reviewed against these goals by the plant Radiation Protection committee as a monitor of the effectiveness of the ALARA program.

It is also the policy of the Gaseous Diffusion Plant to practice pollution prevention for business reasons and to demonstrate commitment to long-term environmental protection. USEC's commitment to environmental protection goes beyond ensuring operations meet just current environmental regulatory requirements. The goal is to minimize the impact to human health and the environment and to preserve resources for future generations. USEC will reduce pollution production at the source using innovative pollution prevention methods, education, training, and awareness.

To this end, USEC is developing and following five strategies for pollution prevention:

- Strategy I — Reduce usage of toxic chemicals.

- Strategy II — Implement a cost-effective waste minimization and pollution prevention program that reduces the generation of radioactive and RCRA/mixed wastes and minimizes discharges to air and water.

- Strategy III Incorporate pollution prevention considerations into plant operations including process design, engineering, acquisition, procurement, and public outreach.
- Strategy IV Maintain full compliance with Emergency Planning and Community Right-to-Know Act (EPCRA) regulations dealing with reporting requirements and emergency planning and response.
- Strategy V Promote a pollution prevention ethic through education, training, and awareness programs.

5.1.1.1 Airborne Emissions

Airborne Emission Standards

PGDP maintains and uses emission treatment systems, as appropriate, to maintain releases of radioactive material in gaseous emissions to unrestricted areas below the limits specified in 10 CFR 20.1301 and in accordance with ALARA principles as described in Sections 5.1.1 and 5.3.1.1. Unrestricted areas are those areas beyond the DOE reservation boundary and to which any member of the public has unrestricted access. Compliance with 10 CFR 20.1301 is demonstrated as required by 10 CFR 20.1302. Section 5.1.3 discusses methods of evaluation and demonstration of compliance. Furthermore, controls are maintained in order to comply with 40 CFR 61, Subpart H, and 40 CFR 190.

Action Levels for 40 CFR 61 and for Control of Airborne Emissions

Action levels (i.e., BEQs) for control of airborne radionuclide emissions are based on the ALARA philosophy and are shown in Table 5.1-1. The action levels described in this table provide indicators which can aid in identifying operational control system deficiencies. These deficiencies can then be investigated and corrected in a responsible manner so that the dose to the most exposed member of the public remains well below the regulatory limits. There is a BEQ at every continuously sampled radiological vent within the leased premises. At a minimum, these BEQs are reviewed annually. Table 5.1-2 provides a list of current BEQs for each of the continuously sampled radiological vents.

The first action level in Table 5.1-1 is triggered by a single sample exceeding the BEQ. The second action level is triggered by either one of two situations: (1) If a daily uranium sampling result is ten times greater than its BEQ or if a monthly technetium sampling result is 80 times its BEQ, or (2) If the six-month average of sampling results is twice the respective BEQ for uranium or 16 times the BEQ for technetium.

The BEQs are established based on process capability studies and historical operating data.

BEQs are established by the ES&H organization and the manager responsible for the facility from which the emission originates. At a minimum, the BEQs are reviewed annually by ES&H and the facility manager.

Managers of the facility from which the emission originates and the Plant Shift Superintendent are jointly responsible for taking the actions specified in this section.

Airborne Emission Controls

The PGDP environmental program, as described in this chapter, includes a system of process and administrative controls to prevent the release of radionuclides above regulatory limits and to maintain airborne effluents ALARA.

Airborne radionuclide emission points are described below. In addition, the primary emission controls are identified. The locations of the individual emission sources are identified in Figure 5.1-1. Data concerning vent and stack characteristics is presented in Table 5.1-3. This table does not identify individual laboratory hood exhaust points and individual building ventilation system exhaust vents.

Radionuclide discharges from these sources are summarized in the *National Emission Standards for Hazardous Air Pollutants (NESHAP) Annual Report*. For the purposes of NESHAP reporting and dose calculation, some sources have been grouped to facilitate the calculations. The location of the NESHAP reporting groups are shown in Figure 5.1-2.

The C-400 facility contains several systems. The decontamination spray booth uses high-pressure water to remove radioactive contamination from equipment using liquid solutions. The water stream dissipates within 20 inches of the work surface, and the water is drained from the spray booth. Mist eliminators remove any droplets of contaminated liquids from the booth exhaust system prior to venting. For the purposes of determining dose to the public from this source (see Section 5.1.3.1), this emission is part of a grouped source from C-400 (Figure 5.1-2, location A).

The uranium precipitation unit uses a rotary vacuum filter to remove precipitated uranium particles from aqueous solutions. The contaminated solids remain on the filter surface, which uses diatomaceous earth as the filter media. The filter exhaust air flows through an entrainment separator prior to discharging through a building roof vent. This source is also part of the C-400 grouped source (Figure 5.1-2, location A).

Clothing laundered in C-400 is dried in large forced-air dryers. The air exhaust is passed through lint traps prior to venting. This source is also part of the C-400 grouped source (Figure 5.1-2, location A).

Cylinders that have been cleaned are hydrotested periodically using water. The cylinders are dried in C-400 before reuse using a dry air stream. The air exhaust is vented outside the building. This is identified as point B in Figure 5.1-2.

The C-710 Laboratory processes uranium in liquid, solid, and gaseous forms for product and feed analyses, environmental monitoring programs, waste analysis programs, and other activities. Operations involving gaseous UF_6 occur in closed systems with emissions limited by the use of cold or chemical traps. The C-710 Laboratory is identified as location D in Figure 5.1-2.

The purge cascade uses gaseous diffusion to separate UF_6 continuously from lower molecular weight (light) gases that have entered the process. A diffusion cascade flow sheet is shown in Figure 5.1-3. The UF_6 is returned to the main cascade, and the "lights" are passed through chemical traps. The C-310 cylinder burp facility is used to vent lower molecular weight gases from product cylinders. The gases from the cylinder burp facility are also passed through chemical traps. The process system is depicted in Figure 5.1-4. These gases are continuously sampled prior to venting through the C-310 Purge Vent Stack. This is identified as location E in Figure 5.1-2.

The wet air evacuation system is a maintenance support system. The wet air evacuation system consists of vacuum pumps that remove air from diffusion equipment. Each system's exhaust is passed through chemical traps, pump oil, and mist eliminators before venting. Process buildings (C-310, C-331, C-333, C-335, and C-337 each have a wet air exhaust system. In some cases, this vent may be combined with the building seal exhaust vent. The basic system is depicted in Figure 5.1-5. For the purposes of determining the dose to the public from emissions from these systems (see Section 5.1.3.1), these are grouped into a single emission point (Figure 5.1-2, location F).

The enrichment cascade is divided into control areas, each of which has a seal exhaust station. The seal exhaust air stations collect and vent air that has leaked through the shaft seals of cascade compressors. This air passes through chemical traps, pump oil, and mist eliminators before venting. Process buildings C-310, C-315, C-331, C-333, C-335, and C-337 are each equipped with a seal exhaust system. The C-333 system is depicted in Figure 5.1-5. As discussed above, these may be combined with the wet air exhaust vents. These are also grouped into a single emission point along with the wet air exhausts (Figure 5.1-2, location F).

The C-335 5.5 wt.% UF_6/R-114 Separation System is primarily used when relatively large amounts of R-114 coolant have entered the cascade and mixed with UF_6. The UF_6 and R-114 mixtures are passed through the 5.5 wt.% UF_6/R-114 Separation System to recover and return the UF_6 to the cascade. The discharge from the cold traps passes through chemical traps before the gases are routed to the seal exhaust/wet air system. The discharge from the separation system passes through additional chemical traps, pump oil, and mist eliminators via the seal exhaust system before venting. Therefore, emissions from the separation system are grouped with the seal exhaust/wet air grouping for purposes of dose determination.

UF_6 is charged to and removed from the diffusion cascade using large cylinders that are connected to the cascade with short lines called "pigtails". Portable or permanent vacuum systems equipped with HEPA filters are used to contain any small releases that may have occurred during disconnection activities. These sources are grouped into a single emission point (Figure 5.1-2, location F). Cylinders are sampled using similar pigtails at the C-360 facility which is included in location H of Figure 5.1-2.

The C-409 facility contains several systems for handling materials and solutions that contain uranium above the assays to which C-400 is limited. Cylinders that have contained UF_6 at an assay up to 5.5 percent are washed in C-409 using an appropriate cleaning solution. The exhaust gases from this system flow through a soda-ash solution scrubber prior to discharge. The cylinders are dried using compressed air, which is exhausted outside the building. These discharges are part of a grouped source for NESHAPS reporting (Figure 5.1-2, location G).

Aqueous solutions containing uranium at an assay greater than 1.5 percent are processed in a precipitation and rotary vacuum filter system. The filter exhaust air flows through an entrainment separator prior to discharge. This source is part of the grouped source for C-409 (Figure 5.1-2, location G).

All buildings with radiological areas have building exhaust systems. The Radiological Contamination Control Program and uranium containment systems provide the primary emission controls from these facilities. These systems are generally grouped with the seal exhaust and wet air group (Figure 5.1-2 location F). Some building exhaust systems are grouped with their respective building if the building has its own emission point or group.

5.1.1.2 Waterborne Effluents

Waterborne Effluent Standards

PGDP maintains and uses liquid effluent treatment systems to maintain releases of radioactive material in liquid effluents to unrestricted areas below the limits specified in 10 CFR 20.1301 and in accordance with ALARA principles as described in Section 5.1.1. Compliance with 10 CFR 20.1301 is demonstrated as required by 10 CFR 20.1302. Section 5.1.3 discusses methods of evaluation and demonstration of compliance.

Action Levels for Control of Waterborne Effluents

Action levels (i.e., BEQs) for control of liquid radionuclide effluents are based on the ALARA philosophy. The action levels described in Table 5.1-4 provide indicators which can aid in identifying operational control system deficiencies. These deficiencies can then be investigated and corrected in a responsible manner so that the most exposed member of the public remains well below regulatory limits. The BEQ used in Table 5.1-4 is the maximum statistical effluent expected under normal operating conditions. There is a BEQ at every USEC leased outfall that is continuously sampled for radionuclides. At a minimum, these BEQs are reviewed annually. The outfalls and BEQs are listed in Table 5.1-5.

Action levels for non-continuously sampled outfalls are based on previous years' data. Should an action level be exceeded, or a trend indicate that an action level could be exceeded in the future, an evaluation shall be conducted for each exceedance and/or trend to determine the need for further investigation. If necessary, an investigation shall be initiated to identify the cause(s) of the trend or exceedance and facility operators shall be assisted in taking actions to reduce discharges of radioactive material as required. If it is determined that an investigation is not required, the reason(s) for not initiating an investigation shall be documented.

The first action level in Table 5.1-4 is triggered by a single sample exceeding the BEQ. The second action level is triggered by either one of two situations: (1) If a uranium sampling result is ten times greater than its BEQ or a technetium sampling result is 80 times greater than its BEQ, or (2) If the six-month average of sampling results is twice the respective BEQ for uranium or 16 times the BEQ for technetium.

The BEQs listed in Table 5.1-5 are the maximum statistical radiological levels expected during normal operating conditions. BEQs are established by the ES&H organization in conjunction with the organization responsible for the facility from which the effluent originates. At a minimum, the BEQs are reviewed annually by ES&H.

The manager of the facility from which the effluent originates and the Plant Shift Superintendent are jointly responsible for implementing the actions specified in this section.

Waterborne Effluent Controls

The PGDP environmental program, as described in this chapter, includes a system of process and administrative controls to prevent the discharge of radionuclides above regulatory limits and to maintain waterborne effluents ALARA.

A total of 10 outfalls are leased by USEC. Eight outfalls, 002, 008, 009, 010, 011, 012, 013, and 016, are sampled for radiological contaminants. Another outfall, 001, is not leased by USEC. However, because it receives discharges from USEC facilities the USEC contribution to Outfall 001 is sampled for radiological constituents. Locations are shown in Figure 5.1-6. The primary contributors to each USEC outfall are listed in Table 5.1-6. Sampling frequencies and parameters for the outfalls sampled for radionuclides are listed in Table 5.1-7. Sampling frequencies are based upon permit requirements and historical potential for uranium discharges.

Wastewater streams at PGDP can be classified into several categories as follows:

- Recirculating water (RCW) blowdown
- Nonprocess wastewater
- Process wastewater
- Sanitary wastewater
- Runoff

Nonprocess wastewater includes once-through cooling water from pumps, air conditioners, etc., steam condensate, drinking fountain drains, safety shower drains, eyewash bath drains, and other uses of potable and nonpotable water. Nonprocess wastewaters are kept separate from process wastewaters, and there is little possibility of radiological contamination of the nonprocess wastewaters unless a release or other unusual event occurs. Nonprocess wastewaters are discharged directly to the outfalls.

Process wastewaters include decontamination and cleaning solutions, contaminated laboratory aqueous wastes and other wastewaters which are collected and treated prior to discharge. Process wastewaters treated for removal of contaminants must be sampled and analyzed prior to discharge. Where possible, treated process wastewater is reused on-site.

Sanitary wastewater includes all grey-water and black-water discharges and some wastewaters for cleaning activities (C-750 Garage Wastewater). Sanitary wastewater is treated at the C-615 Sewage Treatment Facility prior to discharge through Outfall 004 which then discharges through Outfall 008. Plant sanitary flows are shown in Figure 5.1-7.

Runoff includes all runoff from building roof drains, parking lots, roads, and facility grounds.

Flow diagrams depicting contributors for USEC outfalls monitored for radionuclides, other than those that handle only surface runoff, are presented in Figures 5.1-8 through 5.1-15.

There is no direct contact between UF_6 and water in any of the cascade enrichment facilities. Water effluents from these buildings are noncontaminated unless a release or other unusual event occurs that may result in the contamination of an effluent stream. If contamination is suspected, the water is collected for sampling and analysis and, if necessary, treatment prior to discharge.

Contaminated water is generated in C-400 and, in small quantities, in C-720 and the C-710 laboratory. Contaminated waste streams are identified and are routinely collected for treatment prior to discharge.

The C-400 and C-409 facilities generate the majority of and process radiologically contaminated wastewaters. These wastes include solutions for the radiological decontamination of equipment and UF_6 storage cylinders. Prior to discharge, decontamination solutions are processed in one of the waste treatment units located in C-400 or C-409. Contaminated wastewaters from other sources (e.g., laboratory solutions, spill cleanup solutions) are also processed in C-400 or C-409. Treated wastewaters from these facilities are discharged through outfall 008. Details of these waste treatment systems are provided in the Radioactive Waste Management program included as part of this application.

Other process wastewaters known to be radiologically contaminated above the limits for release to unrestricted areas are collected, stored, and then treated in the C-400 wastewater treatment facilities to remove radionuclides prior to reuse or discharge.

The C-400 laundry and safety equipment cleaning wastewaters are discharged directly to the on-site sewage treatment plant, which discharges to a sampled outfall, Outfall 008.

Wastewaters treated to remove radiological contamination must meet the limits in Column 2, Table 2 of Appendix B of 10 CFR 20 prior to discharge.

The C-616 Wastewater Treatment Facility treats the RCW blowdown from the cooling towers for phosphorous. Effluent from the treatment process discharges to the C-616-F lagoon which then discharges to the DOE Outfall 001. Nonprocess wastewater, process wastewater, and rain runoff from various sources are also pumped to the C-616-F lagoon via the C-616-C lift station located in the north/south diversion ditch. Figure 5.1-8 provides a flow diagram that identifies these sources.

The C-615 Sewage Treatment Plant treats sewage and various nonradioactive process effluents identified in Figure 5.1-7 for discharge through Outfalls 004 and 008. The influent flows through a comminutor and grit basket for size reduction into the primary basin. Liquid from the primary basin

flows to the trickling filter. From the trickling filter, a portion of the liquid flows to the primary basin for recycle and a portion flows to the secondary basin. The effluent from the secondary basin is chlorinated and flows to Outfall 004. Outfall 004 flows in Outfall 008 before being discharged. A sodium thiosulfate feed station dechlorinates Outfall 004.

The C-611 Water Treatment Plant (Outfall 006) uses a conventional treatment process coupled with lime softening to treat water from the Ohio River for use in the plant's cooling and drinking water systems. Sludge from the lime softening process is discharged to the C-611-V lagoon for settling. The C-611-V sludge lagoon overflows into the C-611-Y fullflow lagoon and then discharges through Outfall 006 to Big Bayou Creek. Figure 5.1-10 shows the two lagoons and the outfall.

Outfall 008 discharges nonprocess wastewater and rain runoff from buildings and terrain on the west side of the facility in addition to sanitary wastewater from the C-615 sewage treatment plant. Figure 5.1-11 shows the configuration of the processes discharging to this outfall. The 008 ditch is equipped with an underflow dam that consists of a dam, quiet zone, and weir. Adjacent to the dam is an oil containment pond. The dam creates a quiet zone to allow oil and other buoyant materials to separate from the water. A skirted oil boom diverts floated materials to a slightly submerged float-controlled weir. Most of the ditch flow underflows the floating boom and then overflows the dam. Diverted materials flow to the containment pond and remain there for manual skimming as necessary. An underflow dam maintains the water level in the containment area. A sodium thiosulfate feed station dechlorinates water discharging through Outfall 008.

Outfall 009 discharges nonprocess wastewater and rain runoff from building and terrain on the southwest side of the plant. Figure 5.1-12 schematically shows the sources of the wastewater. A sodium thiosulfate feed station dechlorinates the water discharge through Outfall 009.

The C-617 lagoon collects water from four outfalls on the east side of the plant (Outfalls 002, 010, 011, and 012) for dechlorination. Sodium thiosulfate is added to the lagoon to dechlorinate the water, and then the water is discharged through Outfall 010 or 011 to Little Bayou Creek. Outfalls 002, 010, 011, and 012 collect nonprocess wastewater from buildings on the east side of the plant. Each outfall ditch is equipped with a lift station to pump the effluents to the C-617 lagoon. The lift stations are designed to handle normal operational flow only. When moderate to heavy rainfall occurs at the site, the resulting runoff will overflow the lift station sumps and will discharge through the four outfalls to Little Bayou Creek. The configurations of Outfalls 002, 010, 011, and 012 and the C-617 lagoon are presented schematically in Figures 5.1-9, 5.1-13, 5.1-14, and 5.1-15.

Outfall 013 collects and discharges rain runoff from terrain on the southeast corner of the plant including the C-745 cylinder storage yards.

Outfall 016 collects and discharges rain runoff from the southwest side of the plant and runoff from fire training activities at the fire training facility. A portable sodium thiosulfate feed station is used when needed at this outfall during fire training activities to dechlorinate the runoff.

5.1.2 Environmental Monitoring Program Description

PGDP conducts routine environmental surveillances as described in this section in relation to the operation of the facility. The surveillances provide long-term trending data which is used to evaluate the effects of plant operations on the environment.

Environmental monitoring locations are chosen to provide a representative measurement of environmental dispersion of plant emissions and effluents including upwind and downwind locations for airborne emissions and upstream and downstream locations for waterborne effluents. Effluent data are provided in the Paducah Environmental Compliance Status Report. The ES&H organization is responsible for establishment and oversight of the environmental monitoring program. Detail concerning the Paducah Analytical Program is provided in the Analytical Program description.

Sampling frequencies for various environmental samples are specified in this section. These frequencies are the frequencies with which individual samples are obtained or composites prepared from individual samples. Further compositing of samples beyond that established in this section is not performed. Each sample is analyzed in a timely manner to support both the demonstration of compliance with 10 CFR 20 and long-term trending of environmental data.

5.1.2.1 Air Emission Monitoring

The air emission monitoring program, as described in this chapter, includes continuous vent samplers on discharges determined to be “major” sources as defined in 40 CFR 61, Subpart H (NESHAP), and in accordance with the site “Compliance Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Airborne Radionuclides,” January 1992, between DOE and EPA. For “minor” sources, periodic sampling, use of indirect monitoring, or the use of emission estimation methods established in the NESHAP regulations may be used to estimate source emissions. Continuous sampling is provided on all process vents that have the potential to emit radionuclides that could result in a 0.1 mrem/yr or greater dose to the public.

Emissions from unmonitored sources are estimated in accordance with NESHAP regulations. Where possible, methods such as mass balances or analytical method standards are used to estimate emissions. Emission factors, which are determined in accordance with Appendix D of 40 CFR 61, are also used where direct measurements are not possible.

Evaluation intervals for sources which are not continuously sampled are established in the NESHAP Quality Assurance Plan. For minor sources for which periodic sampling is used to determine emissions, the sampling is performed at five-year intervals. For sources for which indirect measurements/monitoring or NESHAP emission factors are used, each source is evaluated annually.

A continuous sampling system monitors C-310 Purge Vent Stack emissions from either the 70-foot stack or the 200-foot stack depending on which stack is in service. The continuous sampling system consists of a series of three caustic (KOH solution) scrubbers, a sample flow totalizer, and a vent stack flow totalizer.

The first bubbler in the C-310 purge and vent sample train is changed daily. Samples are sent to the laboratory for analysis, and monthly and quarterly composite samples are prepared from the daily samples. Table 5.1-8 shows the analyses performed on the C-310 stack samples. The gross beta analysis is used as an indicator of ^{99}Tc. If the gross beta analysis is higher than normal, an analysis for ^{99}Tc is run. A flow diagram of the system is shown in Figure 5.1-16.

Several emission sources have been "grouped" as single sources and are modeled as theoretical stacks for the purposes of calculating the dose to the public from airborne radionuclides. One such grouping includes the seal exhaust and wet air vents. Representative sampling is conducted on these vents at five-year intervals. Sampling results are used to estimate annual radionuclide emissions from these sources.

Another such grouping includes the C-400 grouped sources (decontamination spray booth, uranium precipitation unit #5, and the laundry dryers). This grouping is identified as location A in Figure 5.1-2. Emissions from the spray booth and the uranium precipitation unit are based upon total radionuclide usage determined from the analysis of liquids processed through the systems. Emissions from the laundry dryers are based upon health physics surveys of the dryer lint.

A third grouping consists of the cylinder pigtail connections (included with the seal exhaust/wet air systems, location F in Figure 5.1-2). Sampling in 1992 identified no emissions from the permanent high efficiency particulate air (HEPA) filter systems used to contain any small quantities of UF_6 from these systems. Emissions from cylinder pigtail connections are controlled through the use HEPA filter systems (either permanent or portable). Emissions are estimated based upon the total number of pigtail disconnections for the respective calendar year and the volume of each release.

A fourth grouping consists of the C-409 sources. Emissions from the cylinder wash and precipitation/filtration units are estimated from total radionuclide throughput based on sampling and analysis of solutions used or processed in the units. Cylinder drying unit emissions are based on sampling and analysis of the cylinder wash solutions.

Building ventilation emissions are based on air monitoring programs conducted by Health Physics. A dose assessment is not performed on the emissions if the annual average air concentration in the building is determined to be less than 10 percent of the derived air concentration (DAC) value for ^{237}Np as referenced in 10 CFR 20, Appendix B. This assumes that all of the alpha activity is due to ^{237}Np, which has the lowest DAC of any radionuclide present in the diffusion process.

Laboratory hood emissions are estimated based on the quantities of uranium used in the hood on an annual basis.

5.1.2.2 Meteorological Monitoring

The site will use either data from an on-site meteorological monitoring system or from the National Weather Service for the purposes of dose estimation from airborne emissions. (See SAR Section 2.3.2).

5.1.2.3 External Gamma Radiation Monitoring

The site maintains external gamma radiation monitoring at various locations. Thermoluminescence detectors (TLDs) are located at four types of locations: (1) along the site perimeter fence, (2) at the reservation boundary, (3) at nearby residences and communities, and (4) at two "remote background" locations distant from the site. The locations are shown in Figure 5.1-19. The TLDs are collected and read on a quarterly basis.

The only significant sources of gamma radiation at the site are the uranium isotope ^{235}U and the short-lived ^{238}U daughters.

5.1.2.4 Water Monitoring

Radiological analyses are performed on samples from USEC-leased site water outfalls originating within the site security area discharging to waters of the United States. The outfall locations are shown in Figure 5.1-6. The outfalls sampled, the type and frequency of sampling, and the radiological parameters are shown in Table 5.1-7. These outfalls are identified by the numbers assigned in the KPDES permit.

The frequencies in Table 5.1-7 represent the frequency of sampling. Weekly and monthly samples collected with flow proportional continuous samplers are composited to obtain the sample for quarterly analysis.

KPDES outfalls have either continuous or intermittent flows. Intermittent flow occurs only when sufficient rainfall occurs exceeding the absorbent capabilities of the soil and/or the hold-up areas in the ditches or lift station capacity resulting in a discharge.

Sampling methods used are related to the type of discharge and the potential for having radiological materials in the effluent. Continuous, flow proportional sampling is used in the continuously flowing KPDES outfalls. The intermittent or rainfall outfalls are sampled using grab samples because they discharge on an unplanned basis. The required sampling frequency is based on data relating the uranium activity to limits established in 10 CFR 20 by comparing the total uranium activity in the effluent to the sum of the 10 CFR 20, Table 2 limits for ^{235}U and ^{238}U (6E-7 μCi per ml). This data is reviewed annually and the sampling frequencies are adjusted if necessary.

For the outfalls equipped with continuous flow proportional samplers, the following minimum sampling frequencies have been established:

Percent of Combined 10 CFR 20 Limit for ^{235}U and ^{238}U	Sampling Frequency
< 1	Quarterly
≥ 1	Weekly

The minimum sampling frequencies established using the 10 CFR 20, Table 2 limits for uranium were modified to provide additional capabilities to detect unplanned releases and to better quantify releases.

For outfalls where grab samples are required, if the past annual data indicates that the total uranium is less than 1 percent of the combined 10 CFR 20 limit for ^{235}U and ^{238}U, quarterly sampling is scheduled. If the total uranium in the outfall is equal to or greater than 1 percent of the limit, weekly sampling is scheduled. These outfalls are sampled only when there is flow at the sampling location.

Receiving streams around the plant are monitored for radioactive constituents at designated sampling locations as shown in Figure 5.1-20. The sampling frequencies, sample types, and parameters for which surface waters are analyzed are listed in Table 5.1-9. Action levels (i.e., BEQs) for surface water samples are established based on previous years data. In addition, the surface water data is reviewed to identify trends which could indicate changes in plant effluent content. Should an action level or BEQ be exceeded, or a trend indicate that an action level or BEQ could be exceeded in the future, an evaluation shall be conducted for each exceedance and/or trend indication to determine the need for further investigation. If necessary, an investigation shall be initiated to identify the cause(s) of the trend or exceedance and facility operators shall be assisted in taking actions to reduce discharges of radioactive materials as required. If it is determined that an investigation is not required, the reason(s) for not initiating the investigation shall be documented.

5.1.2.5 Biological Monitoring

Biological monitoring is done to directly assess the impact of plant operations on food crops in the immediate vicinity of the plant site. This monitoring supplements indirect assessments consisting of emission monitoring, atmospheric dispersion modeling, and similar methods. The monitoring program

consists of annual sampling and analysis of various food crops grown in the vicinity of the plant site. Sample locations are selected annually based on meteorological data and the availability of food crops for sampling. If possible, crops from areas of predicted maximum radionuclide concentrations are collected. A background location for food crops is located approximately 10 miles from the site in the least prevalent wind direction for comparison to indicator locations. Food crop sampling locations for 2007 are shown in Figure 5.1-21. These are typical of the locations sampled annually. However, exact locations may change slightly due to meteorological changes, and crop plantings vary from year to year. Food crop samples are analyzed for total uranium and ^{99}Tc.

Action levels for food crop sampling data are established based on previous years data and the data from background sampling locations. Should an action level be exceeded, or a trend indicate that an action level could be exceeded in the future, an evaluation shall be conducted for each exceedance and/or trend indication to determine the need for further investigation. If necessary, an investigation shall be initiated to identify the cause(s) of the trend or exceedance and facility operators shall be assisted in taking actions to reduce discharges of radioactive materials as required. If it is determined that an investigation is not required, the reason(s) for not initiating the investigation shall be documented.

5.1.2.6 Soil and Sediment Monitoring

Soil samples are collected and analyzed annually to determine whether airborne emissions from the site are influencing the soil surrounding the site. Sediment sampling at the site is conducted annually to assess potential radionuclide accumulation in the surrounding receiving streams. Soil and sediment sampling locations are shown in Figure 5.1-22. For trending purposes, soil samples are collected from the same areas each year. The soil samples are obtained from locations which are, in general, in the four cardinal compass directions and just outside the reservation boundary, and from two "remote" locations to the west and southwest of the plant. Sampling points S1, S2, and S5 (east and north locations) are in the prevailing downwind directions from the plant site. The other sampling points (southwest and west) are in the prevailing upwind direction. Sediment samples are analyzed for total uranium, ^{239}Pu, ^{237}Np, ^{235}U, ^{230}Th, and ^{99}Tc. Soil samples are analyzed for total uranium.

Action levels for soil and sediment sampling data are established based on previous years data and the data from upstream (sediment) and background (soil) locations. Should an action level be exceeded, or a trend indicate that an action level could be exceeded in the future, an evaluation shall be conducted for each exceedance and/or trend indication to determine the need for further investigation. If necessary, an investigation shall be initiated to identify the cause(s) of the trend or exceedance and facility operators shall be assisted in taking actions to reduce discharges of radioactive materials as required. If it is determined that an investigation is not required, the reason(s) for not initiating the investigation shall be documented.

5.1.2.7 Data Management

The ES&H Organization is responsible for the collection and verification in accordance with established procedures of field and analytical data for the Environmental Monitoring Program necessary for the demonstration of compliance with 10 CFR 20 dose limits as described in Section 5.1.3, and other requirements of this section. Personnel are responsible for the maintenance of field notebooks, field data and other supporting quality control (QC) documentation. The Laboratory (see Section 5.7) is responsible for sample analysis and the logging of analytical results and quality assurance/quality control (QA/QC) documentation. Data for the demonstration of compliance described in Section 5.1.3 are also provided by other plant organizations. These data are obtained in accordance with applicable procedures.

On-site radiological analysis requests are initially placed into the laboratory information system through which the laboratory electronically inputs analytical results. These data, with the

exception of C-310 stack data, are then transferred electronically to the environmental data base for quality assurance checks and data verification. The environmental data base is the final storage area for verified data. Data are checked to ensure that units, sample numbers, etc. are correct.

The evaluation of data is the responsibility of the ES&H Organization. Data from water effluent and gaseous emission points where BEQs have been established are compared to the BEQs and are also trended. Data from the external gamma radiation, surface water, biological, soil, and sediment sampling programs are also reviewed to identify trends over time. In addition, results from monitoring points in the vicinity of the plant site are reviewed against data from background monitoring points.

Field sample data, including notebooks, calculations, and analytical data and information are reviewed for completeness. Data and information are also reviewed by environmental monitoring personnel to ensure that data acceptance criteria are met. ES&H personnel review data and calculations and approve the data and reports for distribution. ES&H personnel also review data for trends over time and exceedances of BEQs.

The C-310 stack sampling results are used for emission trending and the assessment of potential impacts of emissions on the public. When the laboratory results are obtained from the laboratory, the uranium emission data from C-310 are calculated and the results are communicated to the plant cascade coordinator.

When a result exceeds an established limit, results of other parameters that may be related to the parameter in question are checked to confirm the result. If the result is still in question, the responsible lab is contacted to verify the reported results. An initial verbal investigation includes checks for calculation or transcription errors. If this does not detect any problems, the lab may be requested to reanalyze the sample in question. Results of the laboratory investigation are returned to the ES&H Organization.

5.1.2.8 Quality Control

QC activities for environmental samples and data address both sampling and data management. Sampling QC activities include the use of field blanks, duplicate samples, and chain-of-custody procedures to identify sampling and sample preparation problems, and to ensure sample integrity. Data review and verification, as described in Section 5.1.2.7, form the basis of the data management QC program.

The QA/QC activities for the laboratory analysis of samples are managed by the Production Support and Product Scheduling Organization.

5.1.3 Methods of Evaluation and Demonstration of Compliance

5.1.3.1 Airborne Radionuclides

Characterization of the radiological consequences of radionuclides released to the atmosphere from PGDP is accomplished by calculating the committed effective dose equivalents (CEDE) to the maximally

exposed person and to the entire population residing within 80 km (50 miles) of the plant. The dose calculations are made using the CAP-88 package of computer codes. This package contains the most recently approved versions of the AIRDOS-EPA and DARTAB computer codes and the ALLRAD88 radionuclide data file. The AIRDOS-EPA computer code implements a steady-state, Gaussian plume, atmospheric dispersion model to calculate concentrations of radionuclides in the air and on the ground. It uses Regulatory Guide 1.109 (October 1977) food-chain models to calculate radionuclide concentrations in foodstuffs (e.g., vegetables, meat, and milk) and subsequent intakes by individuals.

Inputs to the computer model include actual and estimated radionuclide emissions. The uranium isotopes ^{235}U is determined from isotopic analysis. ^{234}U and ^{238}U are calculated based on the ^{235}U content. Other radionuclides—^{99}Tc, ^{230}Th, ^{237}Np, and ^{239}Pu—are included when the analysis of emissions or of inventories used in the emission estimates indicate their presence.

Other inputs include distances and directions to the nearest receptors and available wind rose data collected from either an on-site meteorological monitoring system or from the National Weather Service.

The default values for rural sources in CAP-88 are used for the consumption of meat, milk, and vegetables.

Radionuclide emissions used to determine the CEDE are quantified by continuous monitoring, periodic sampling, or estimation methods set forth in 40 CFR Part 61, Appendix D (NESHAPS) as described in Section 5.1.2.1.

Annualized meteorological data used in the calculations consist of joint frequency stability array (STAR) distributions of wind direction, wind speed, and atmospheric stability that is prepared from data collected from an on-site meteorological monitoring system or from the National Weather Service.

Specific emission and dose data is presented in the Environmental Compliance Status and Environmental Monitoring Report.

5.1.3.2 Waterborne Radionuclides

Water is sampled at USEC-leased site water outfalls and at selected surface water locations. There are no intakes of surface water for domestic or routine livestock watering purposes in Big or Little Bayou Creek. There are also no water intakes on the Ohio River within 15 miles downstream of the plant. As there is no exposure pathway associated with any of the surface water streams to which plant effluents are discharged, no dose from liquid effluent releases is calculated.

5.1.3.3 Direct Radiation

As described in Section 5.1.2.3, the site monitors direct radiation levels at several points within the vicinity of and remote from the plant. There are three monitoring points, EG5, EG6, and EG16 (see Figure 5.1-19), near the location of the DOE site reservation boundary that is the boundary between the controlled area (the DOE reservation) and unrestricted areas as described in the Emergency Plan. The USEC contribution to direct radiation levels at the boundary of the unrestricted area will not exceed the limits of 10 CFR 20.1301.

5.1.3.4 Radionuclide Effluent Data

Radionuclide effluent data are summarized in the Paducah Environmental Compliance Status Report.

5.1.4 Items Addressed by Compliance Plan

Section deleted.

5.1.4.1 Trending of Environmental Data

Section deleted.

5.1.4.2 Establishment of Ambient Air Monitoring Action Levels

Section deleted.

Table 5.1-1. Plant action levels for airborne radionuclide emissions.

Sample Results		Required Actions[b]
Uranium[a] (Daily)	Technetium[a] (Monthly)	
Baseline Effluent Quantity (BEQ)	Baseline Effluent Quantity (BEQ)	Review emission data for previous six months to identify trends. If a trend of increasing emissions is identified, initiate investigation into the cause(s) of the increased emissions and take corrective action, as appropriate.
10 x BEQ or 2 x BEQ averaged over 6 months	80 x BEQ or 16 x BEQ averaged over 6 months	Determine whether increased emissions are ongoing or a single spike. Initiate investigation into cause(s) of increased emissions. Evaluate whether mitigative and/or corrective measures are necessary to reduce public dose. Implement mitigative and/or corrective measures as needed.
EPA Reportable Quantity (RQ)[c] (0.1 Ci in 24 hours)	EPA Reportable Quantity (RQ)[c] (10 Ci in 24 hours)	Notify shift superintendent. Trace source of abnormal emissions and establish control or shutdown as needed. If emissions cannot be mitigated within 24 hours, elevate to next level.
1 Ci[d]	8 Ci[d]	Close affected vents until control of emissions is re-established.[e]

a. Uranium has an approximately 8-fold greater dose response than 99Tc.

b. Required actions for any level include all required actions listed under lower emission levels.

c. Reportable quantities (RQs) do not include permitted emissions. PGDP is regulated under 40 CFR 61, Subpart H for release of airborne radionuclides from the entire plant site up to the equivalent of 10 mrem/year EDE to the most exposed member of the public.

d. Approximately equivalent to 10 mrem at most exposed residence.

e. The shift superintendent has the authority to restore operations.

Table 5.1-2. Air emission point BEQs.

Emission Point	BEQs	
	Uranium	^{99}Tc
C-310 Purge Vent Stack	5.3 g/day[a]	170 μCi/month[c]

a. This represents an estimated annual EDE to the most exposed individual of approximately 1.2E-2 mrem.

b. Text deleted.

c. This represents an estimated annual EDE to the most exposed individual of approximately 2.4E-3 mrem.

Table 5.1-3. Air emission point data.

Source	Location	Release Height (m)	Diameter (m)	Emission Determination Method	NESHAPs Group (Fig. 5.1-2)
Purge stack (200 ft)	C-310	60.96	0.305	Continuous sampler	E
Alternate Purge Stack (70 ft)	C-310	21.34	0.254	Continuous sampler	E
Seal exhaust	C-310	18.28	0.127	Periodic sampling	F
Product withdrawal pigtail exhaust	C-310	20.12	0.61 × 0.76	Estimated	F
Seal exhaust	C-315	12.14	0.051	Periodic sampling	F
Tails withdrawal pigtail exhaust	C-315	20.12	0.61 × 0.81	Estimated	F
Seal exhaust	C-331	21.33	0.103	Periodic sampling	F
Wet air	C-331	20.73	0.103	Periodic sampling	F
Seal exhaust/wet air	C-333	26.21	0.103	Periodic sampling	F
Seal exhaust/wet air	C-335	21.34	0.103	Periodic sampling	F
5.5 wt.% UF_6/R-114 Separation System	C-335	21.95	0.103	Periodic sampler	F
Seal exhaust/wet air	C-337	26.21	0.152	Periodic sampling	F
Pigtail system HEPA filters	C-360	15.2	0.254	Estimated	H
Sample cabinet exhaust	C-360	15.2	0.254	Estimated	H
Cylinder drying station	C-400	2.40	0.050	Estimated	B
Spray booth	C-400	17.37	0.254	Estimated	A
Laundry dryers	C-400	12.19	Not applicable	Estimated	A
Rotary vacuum filter	C-400	11.28	0.102	Estimated	A
Cylinder drying station	C-409	2.62	0.013	Estimated	G
Cylinder wash scrubber	C-409	5.95	0.106	Estimated	G
Rotary vacuum filter	C-409	2.34	0.076	Estimated	G
Laboratory hoods	C-710	7.09 (Avg)	Not applicable	Estimated	D
Building ventilation system exhaust	Radiological Areas	Variable	Variable	Health Physics air monitoring	F

Table 5.1-4. Plant action levels for waterborne radionuclide effluents.

Sample Results		Required Actions[b]
Uranium[a]	Technetium[a]	
Baseline Effluent Quantity (BEQ)	Baseline Effluent Quantity (BEQ)	Review emission data for previous six months to identify trends. If an increasing effluent concentration is identified, initiate investigation into the cause(s) for increased effluent concentrations and take corrective action, as appropriate.
10 x BEQ or 2 x BEQ averaged over 6 months	80 x BEQ or 16 x BEQ averaged over 6 months	Determine whether increased releases are ongoing or a single spike. Initiate investigation into cause(s) of increased releases. Evaluate whether mitigative and/or corrective measures are necessary to reduce public dose. Implement mitigative and/or corrective measures as needed.
EPA Reportable Quantity (RQ)[c] (0.1 Ci in 24 hours)	EPA Reportable Quantity (RQ)[c] (10 Ci in 24 hours)	Notify plant shift superintendent. Trace source of abnormal releases and establish control or shutdown as needed. If releases cannot be mitigated within 24 hours, elevate to next level.
1 Ci[d]	8 Ci[d]	Close affected outfalls until control of effluent is re-established.[e]

a. Uranium has an approximately 8-fold greater dose response than ^{99}Tc.

b. Required actions for any level include all required actions listed under lower effluent levels.

c. Reportable quantities (RQs) do not include permitted releases.

d. See Table 5.1-7 for analysis intervals.

e. The shift superintendent has the authority to restore operations.

Table 5.1-5. Water effluent point BEQs.

Effluent Point	BEQs	
	Uranium (mg/l)	^{99}Tc (pCi/l)
C-616F Lagoon	0.024	33
008	0.052	36
009	0.0058	26
010[a]	0.039	38
011[a]	0.039	38

[a] Only one of these outfalls receives continuous flow at any time. The BEQ applies to the outfall receiving continuous flow.

Table 5.1-6. Major contributors to USEC KPDES outfalls.

KPDES Outfall	Major USEC Effluent Sources
C-616F Lagoon Effluent	C-616 Liquid Pollution Abatement Facility (including C-616-E and -F Lagoons) C-600 Steam Plant C-335 Air Plant C-335 and C-337 Cascade Buildings C-535 and C-537 Switchhouses and Switchyards Coal Pile Runoff
002	C-360 Toll Transfer Facility C-337 Cascade Building C-637 RCW System Pumphouse
004	C-615 Sewage Treatment Plant
006	C-611 Water Treatment Plant
008	C-744 Lubrication Storage Building C-745-A 14-Ton Cylinder Yard C-600 Steam Plant and Coal Pile Runoff C-400 Building C-310 and C-331 Cascade Buildings C-720 Maintenance Facility C-724 and C-725 Paint Shops C-615 Sewage Treatment Plant Fire training water C-409 Building
009	C-800 and C-811 Parking Lots C-310, C-331, and C-333 Cascade Buildings C-720 Maintenance Facility C-710 Laboratory Facility C-100, C-101, C-102 Administration Buildings C-200 Fire and Guard Office Building C-300 Central Control Facility C-302 Office Building C-750 Garage
010	C-331 Cascade Building C-531 Switchyard
011	C-533 Switchyard and C-532 Switch House C-315, C-331 and C-333 Cascade Buildings

Table 5.1-6. (Continued)

KPDES Outfall	Major USEC Effluent Sources
012	C-633 RCW Pumphouse C-533 Switchyard and Switch House C-333 Cascade Building C-333-A Feed Vaporization Facility
013	Surface runoff from the southwest corner of the plant C-633 RCW Drift and Windage
016	Fire Training water Surface runoff from southwest corner of plant

Table 5.1-7. Radiological liquid effluent monitoring program.

Parameter	Frequency of sampling			
	Continuous samplers		Rain runoff (grabs)	
	C-616-F Lagoon Effluent & 010[a]	008 & 009	011[a]	002, 012, 013, 016
Total uranium	quarterly/weekly[b]	quarterly/weekly[b]	quarterly/weekly[b]	quarterly/weekly[b]
% ^{235}U	quarterly/weekly[b]	quarterly/weekly[b]	quarterly/weekly[b]	quarterly/weekly[b]
^{99}Tc	quarterly	quarterly	weekly	quarterly
^{237}Np	quarterly	quarterly	quarterly	quarterly
^{239}Pu	quarterly	quarterly	quarterly	quarterly
^{230}Th	quarterly	quarterly	quarterly	quarterly
Dissolved alpha	quarterly	quarterly	quarterly	quarterly
Dissolved beta	quarterly	quarterly	quarterly	quarterly
Suspended alpha	quarterly	quarterly	quarterly	quarterly
Suspended beta	quarterly	quarterly	quarterly	quarterly

a. Depending upon operational factors either 011 or 010 will be sampled using the continuous sampler. The other outfall will be sampled during periods of rain runoff.

b. Frequency determined based on annual review of monitoring results.

Table 5.1-8. C-310 stack sampling parameters and analyses.

Parameter	Frequency and Type of Sample
Total uranium	Daily
Gross beta	Daily
^{99}Tc	Monthly composite
^{230}Th	Quarterly composite
^{237}Np	Quarterly composite
^{239}Pu	Quarterly composite

Table 5.1-9. Collection frequencies of surface water samples.

Station (a)	Parameter	Collection Frequency	Sample Type
L1	Gross alpha and beta, ^{99}Tc, total uranium, ^{235}U	Monthly	Grab
L5, L10	Gross alpha and beta, ^{99}Tc, total uranium, ^{235}U	Monthly	Grab

L1 - Upstream Big Bayou Creek

L5 - Downstream Big Bayou Creek

L10 - Downstream Little Bayou Creek

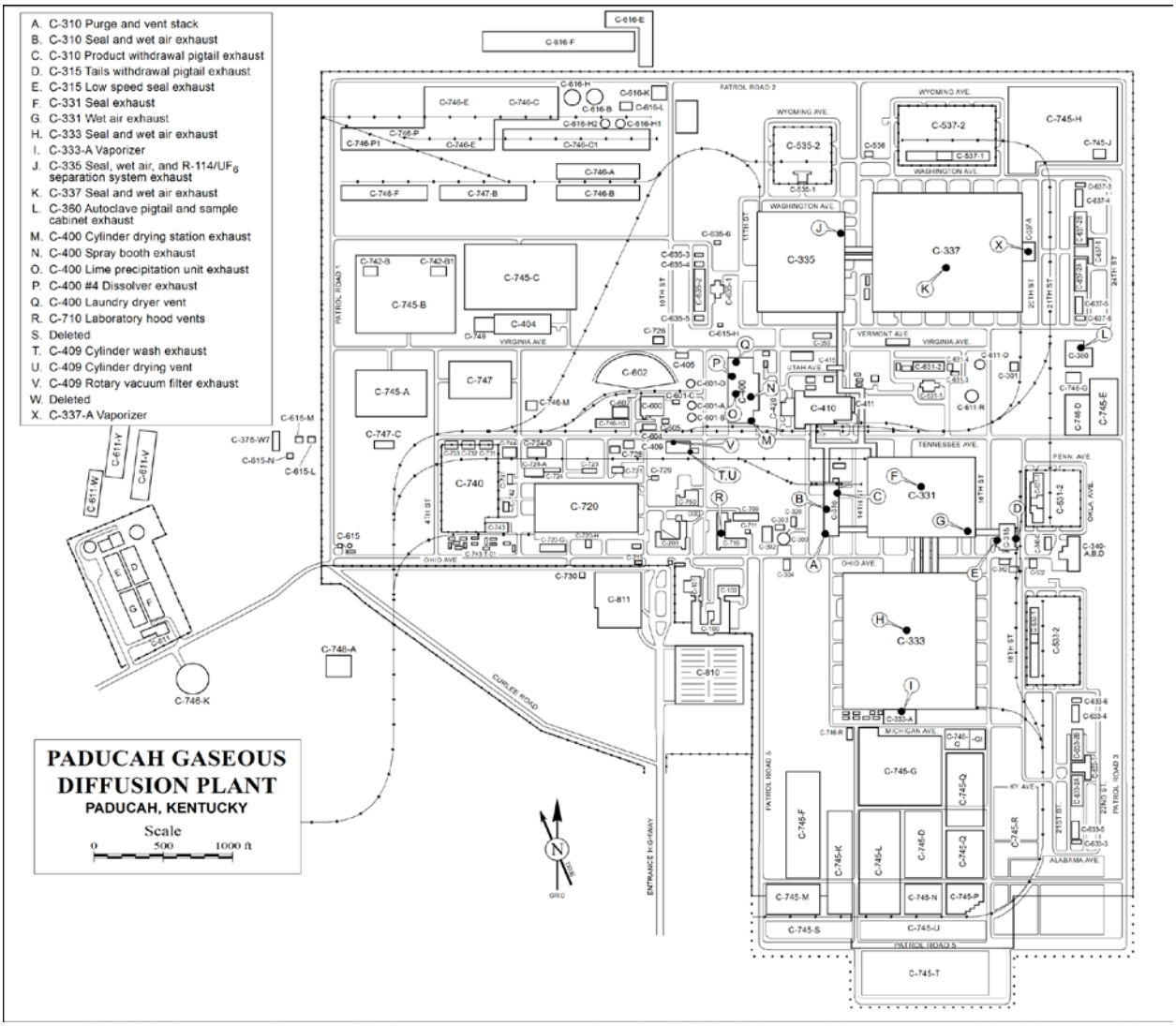

Figure 5.1-1. PGDP NESHAP emission points.

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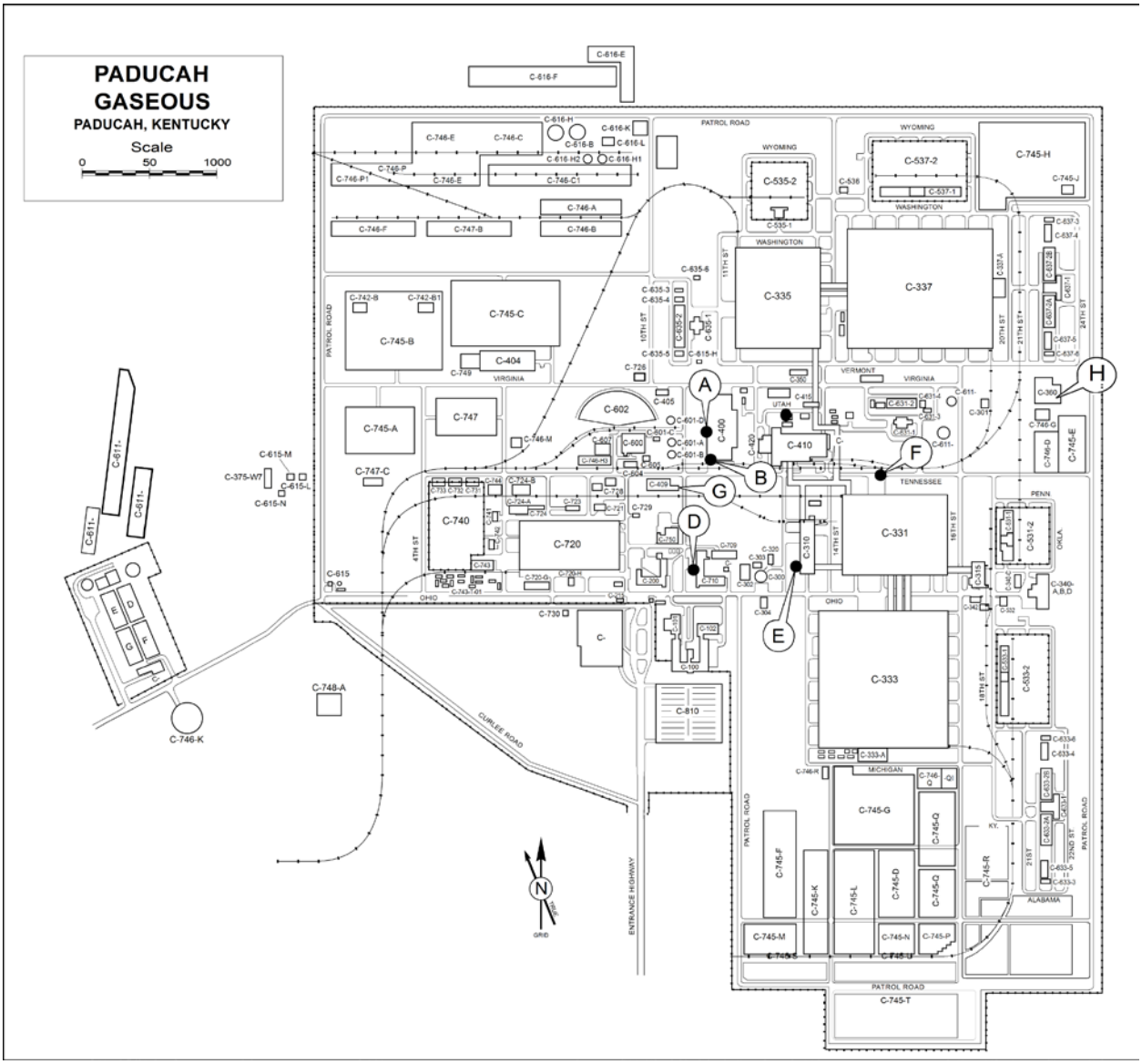

Figure 5.1-2. PGDP NESHAP air discharge groupings.

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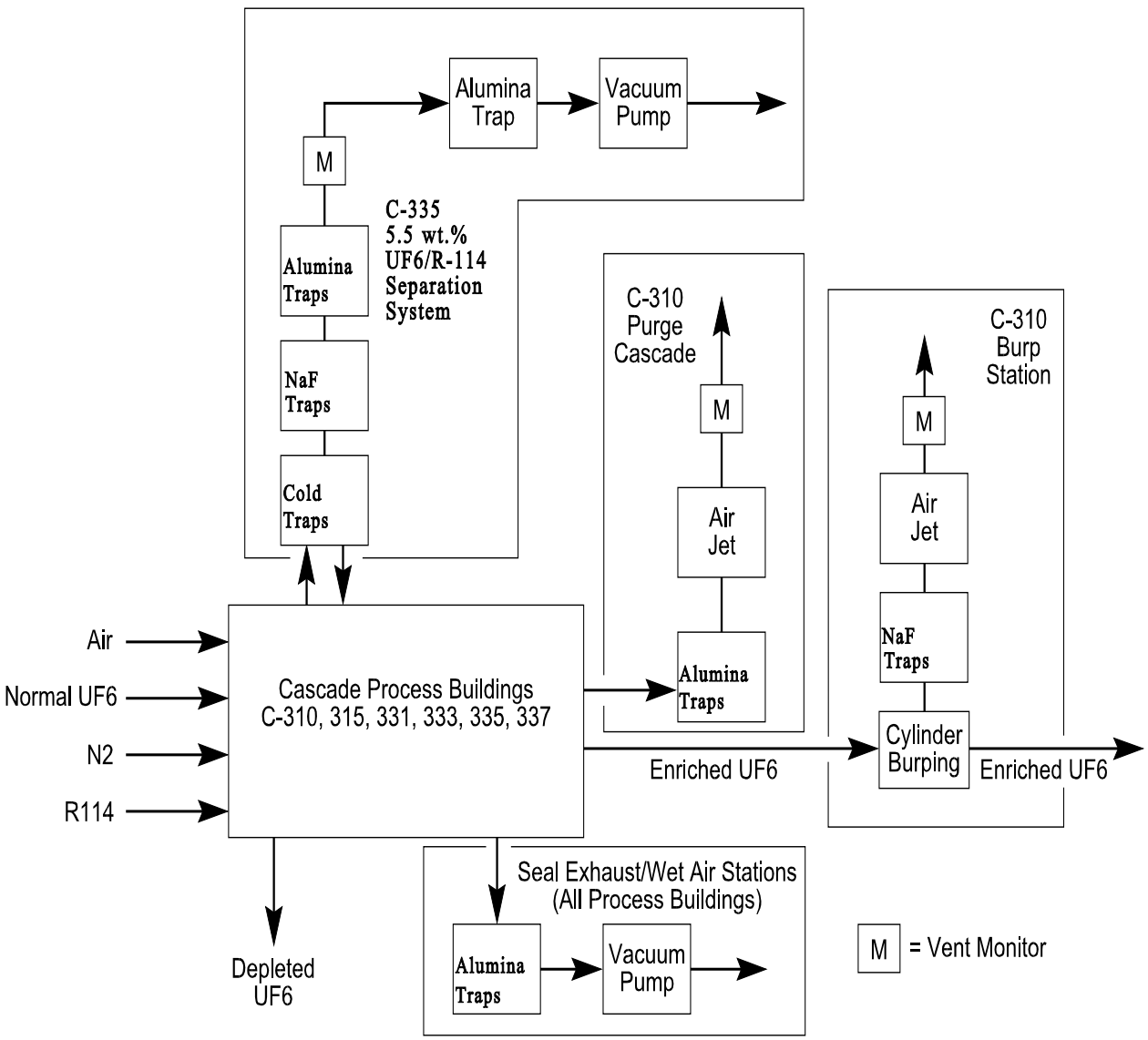

Figure 5.1-3. Cascade flow diagram.

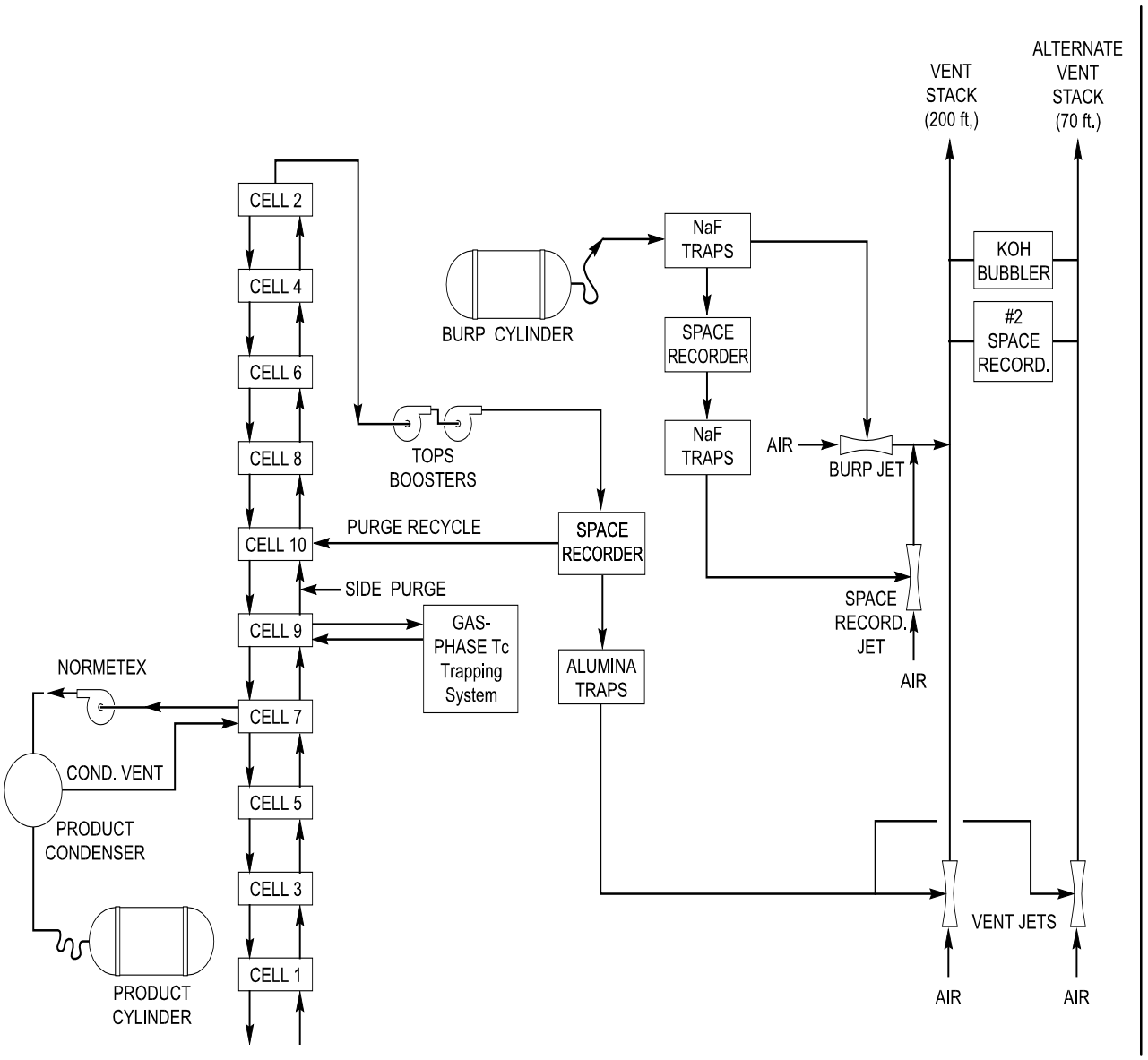

Figure 5.1-4. C-310 purge and vent flow diagram.

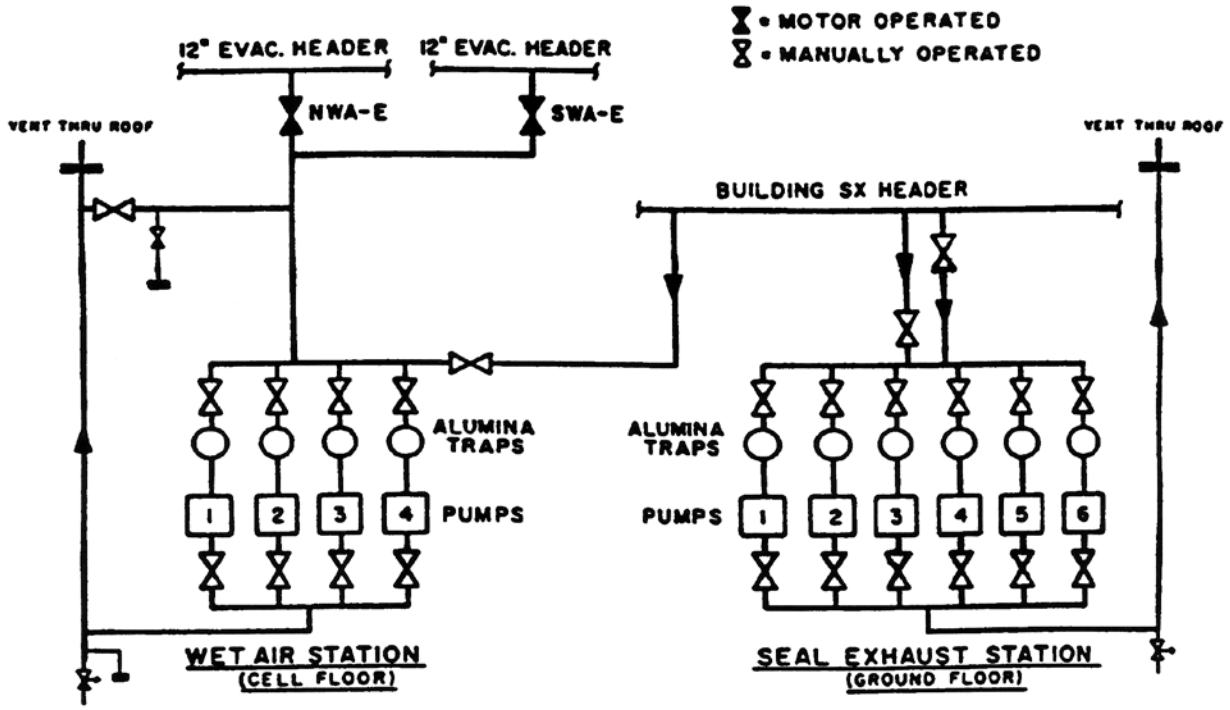

Figure 5.1-5. Seal exhaust/wet air system (typical).

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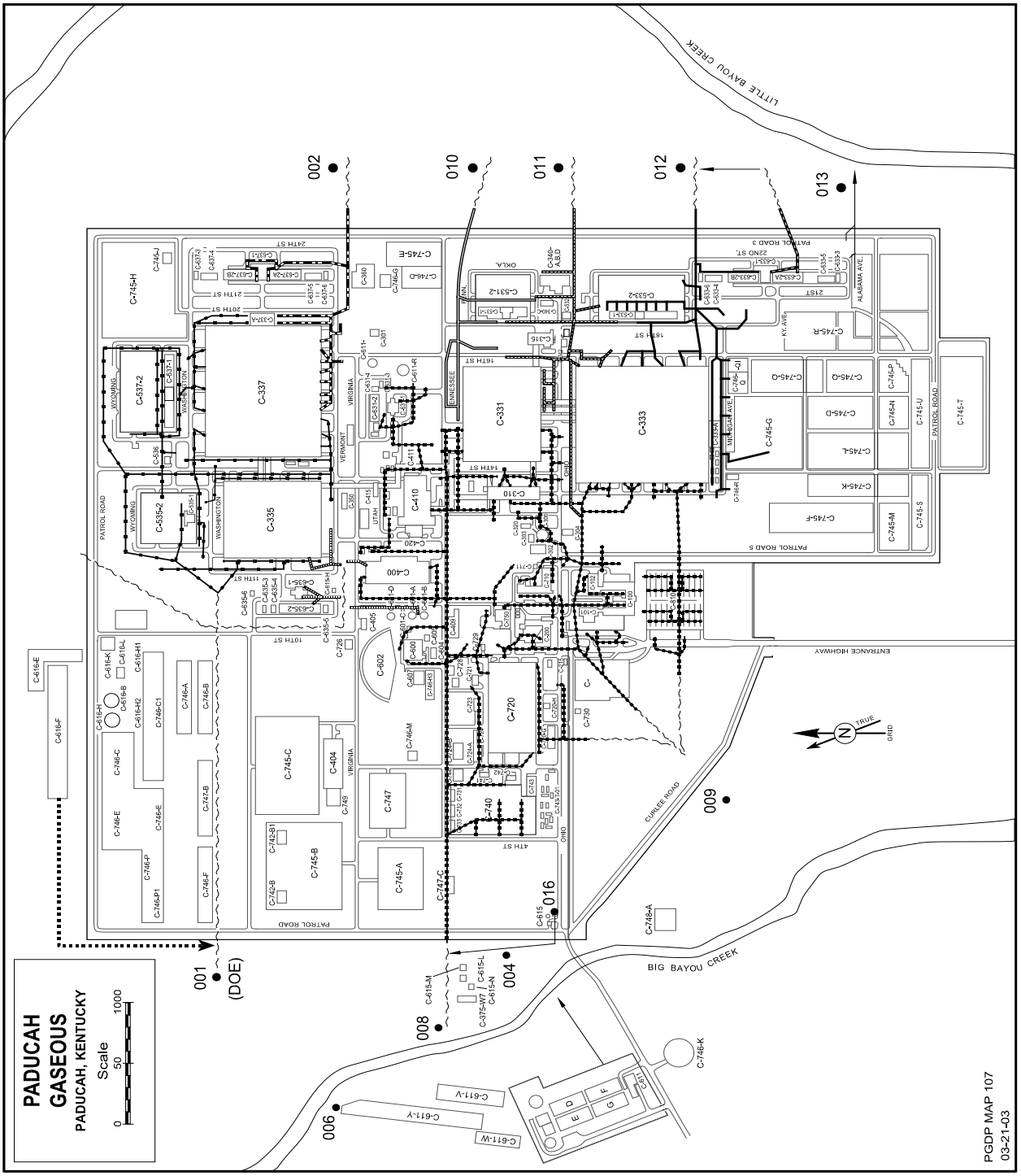

Figure 5.1-6. KPDES outfall locations at PGDP.

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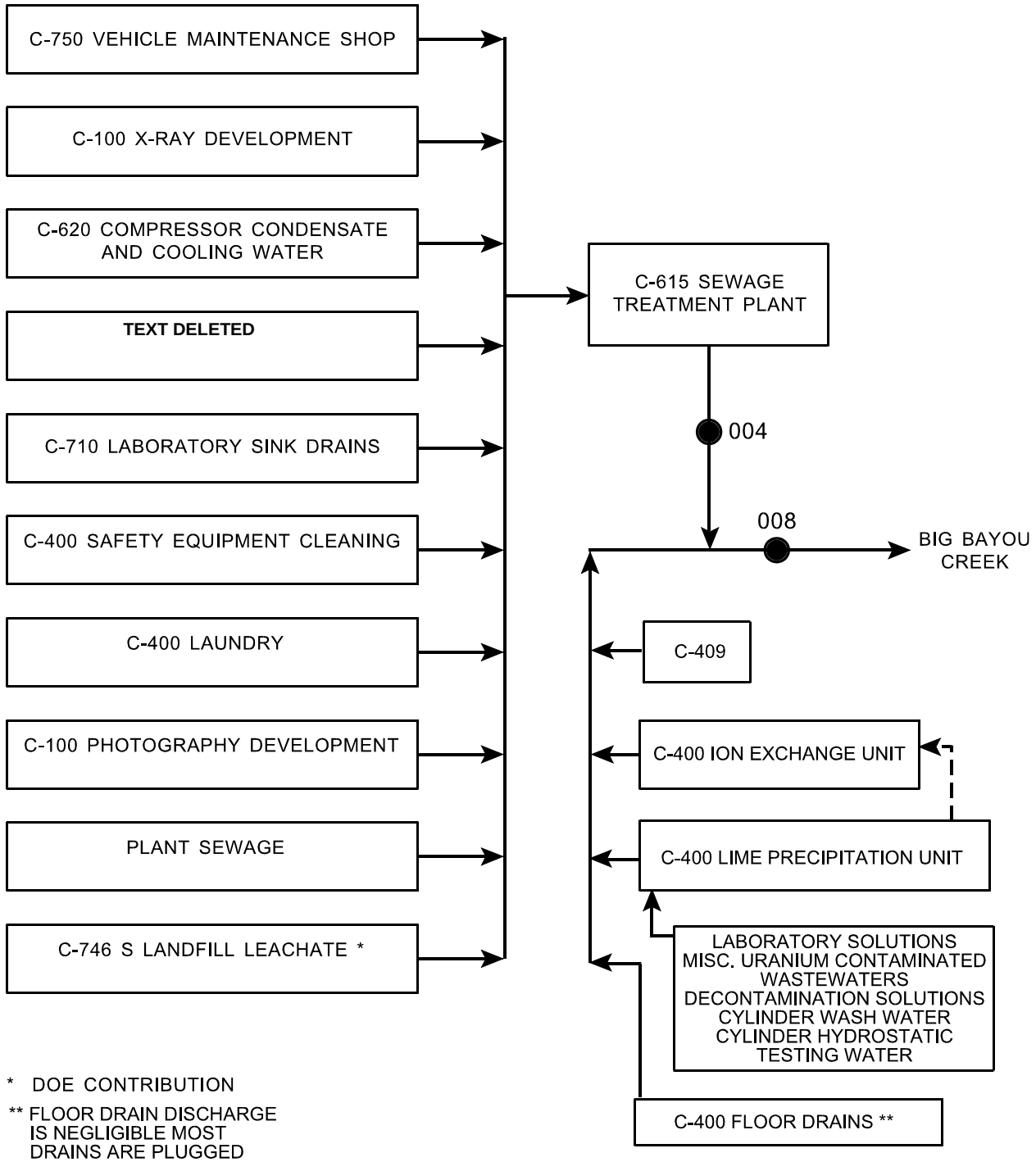

Figure 5.1-7. Outfall 004 Influents

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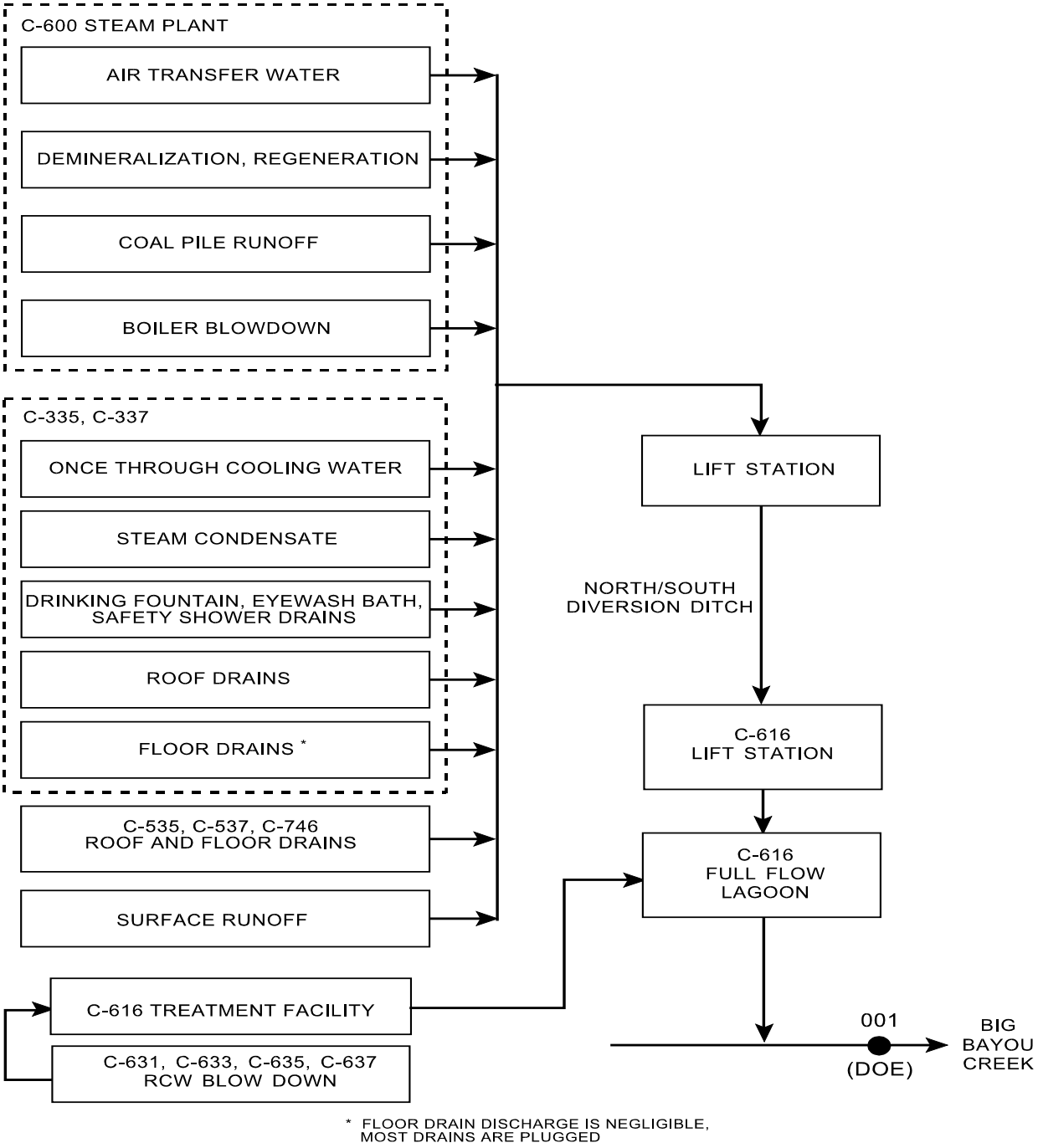

Figure 5.1-8. KPDES Outfall 001 influents.

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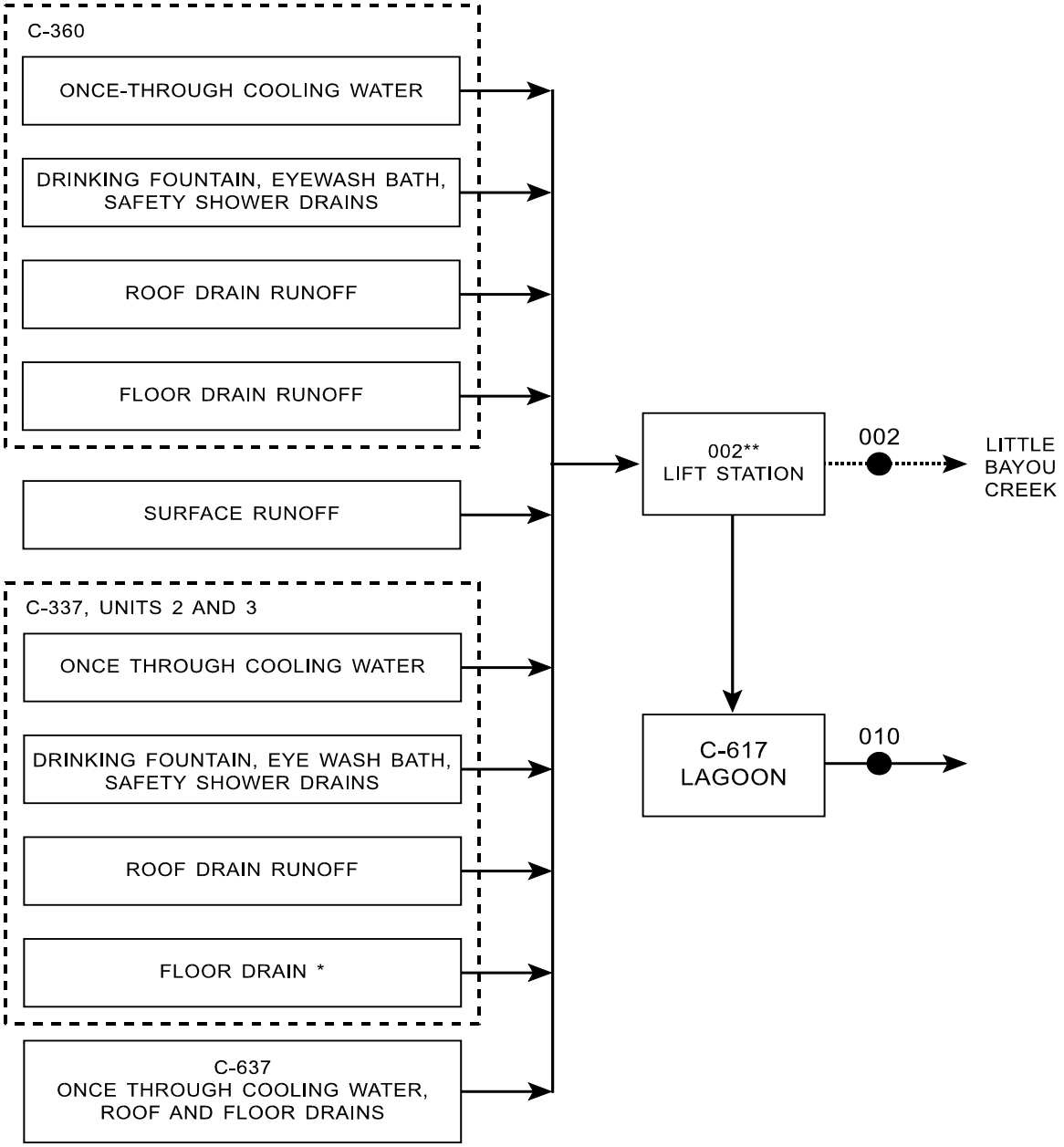

* FLOOR DRAIN FLOW NEGLIGIBLE, MOST DRAINS ARE PLUGGED

** LIFT STATION AND C-617 LAGOON BYPASSED DURING FLOODING CONDITIONS

Figure 5.1-9. KPDES Outfall 002 influents.

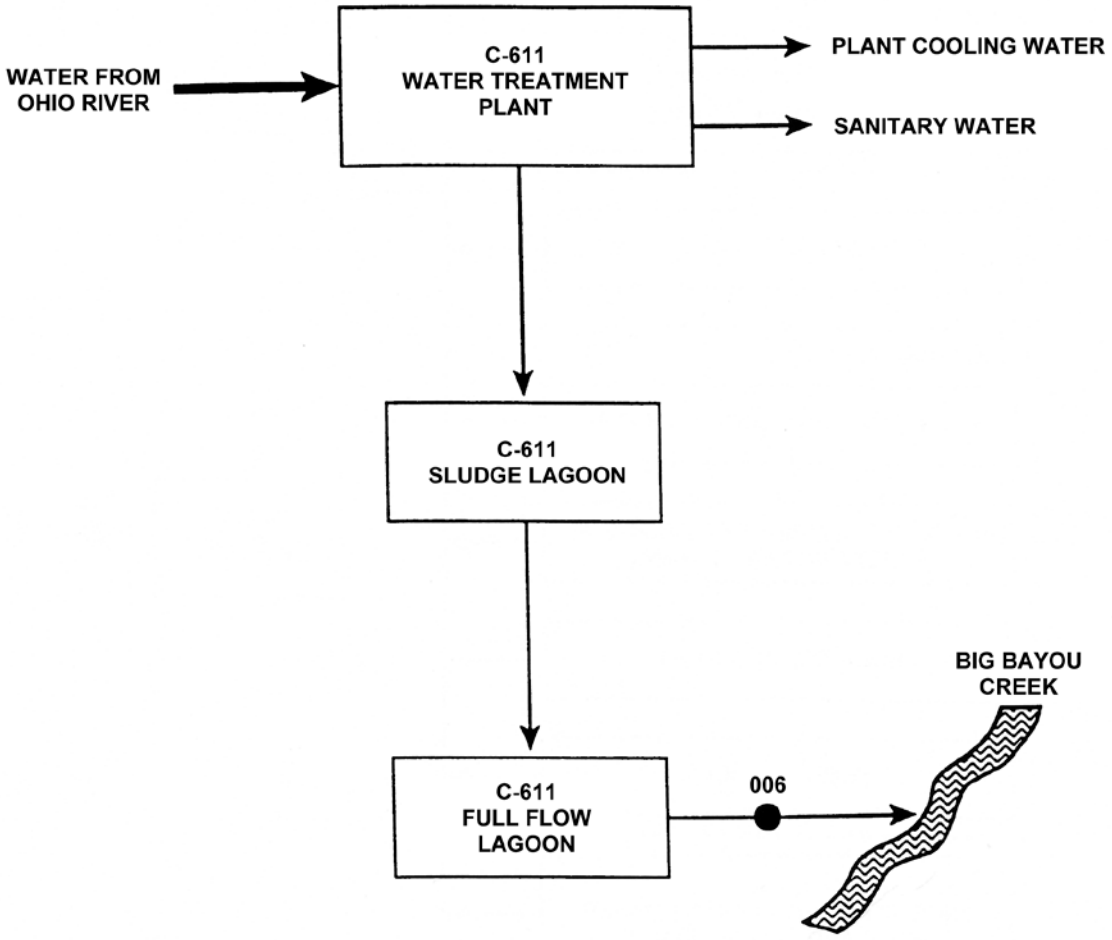

Figure 5.1-10. KPDES Outfall 006 influents.

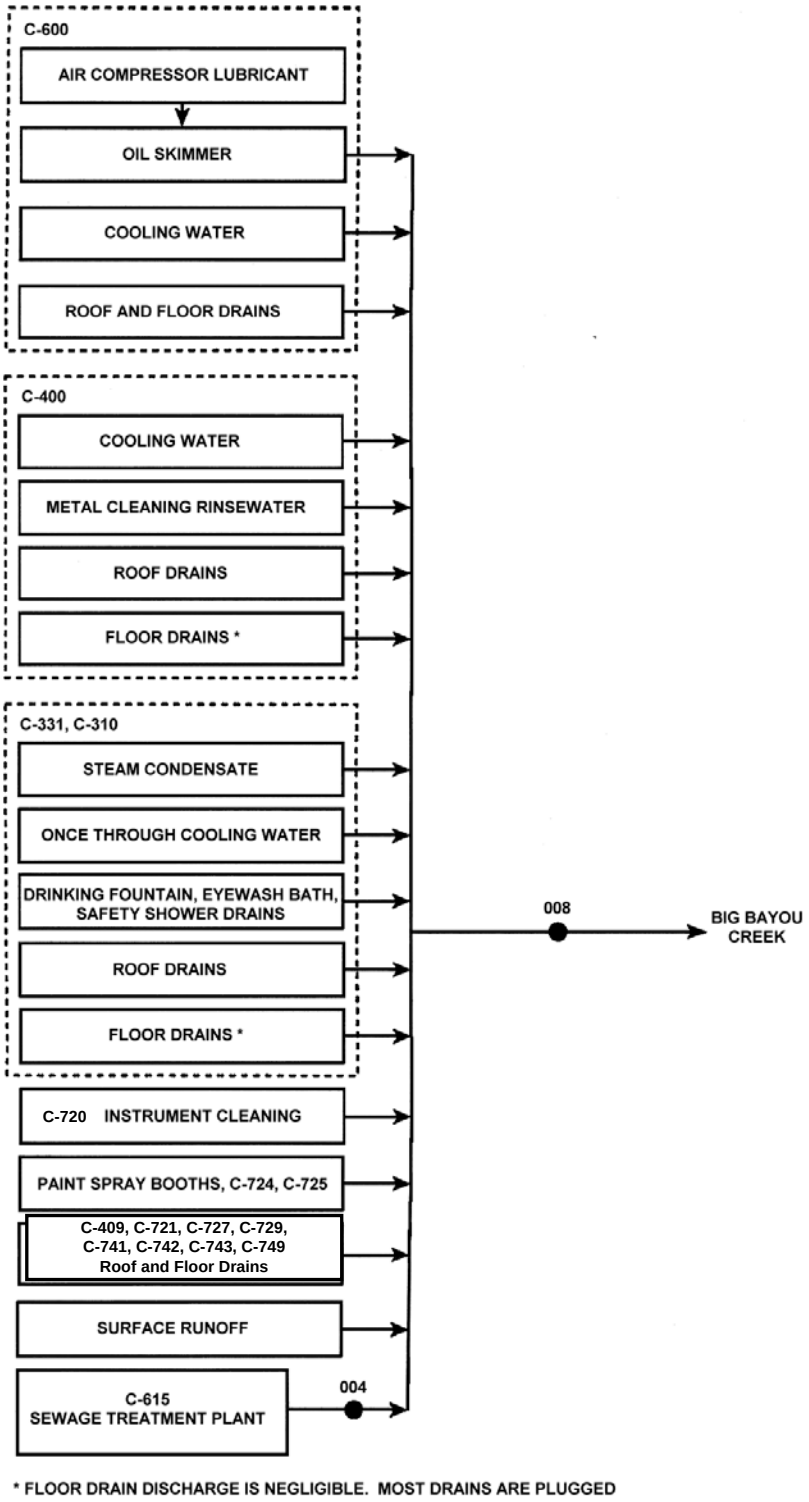

Figure 5.1-11. KPDES Outfall 008 influents.

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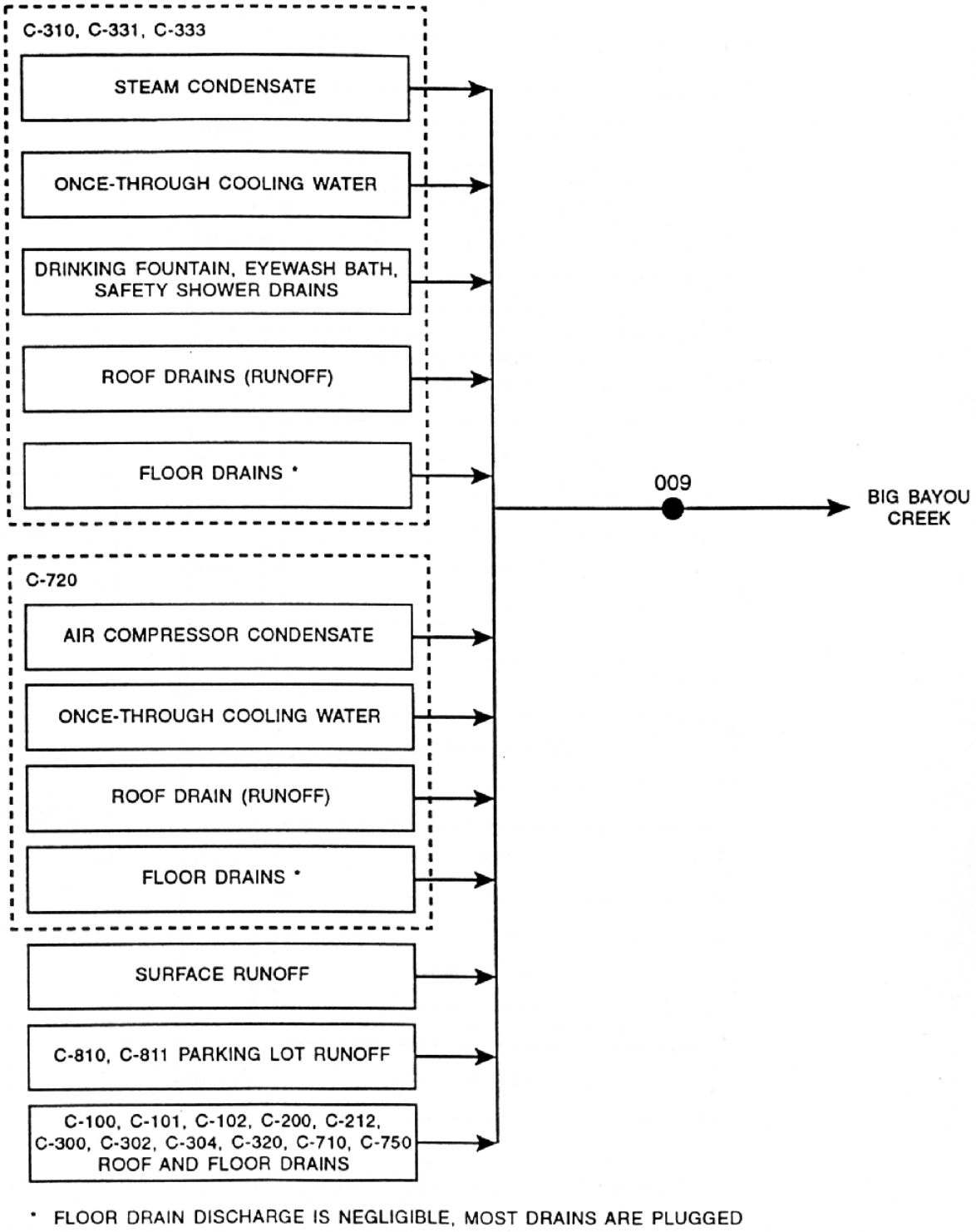
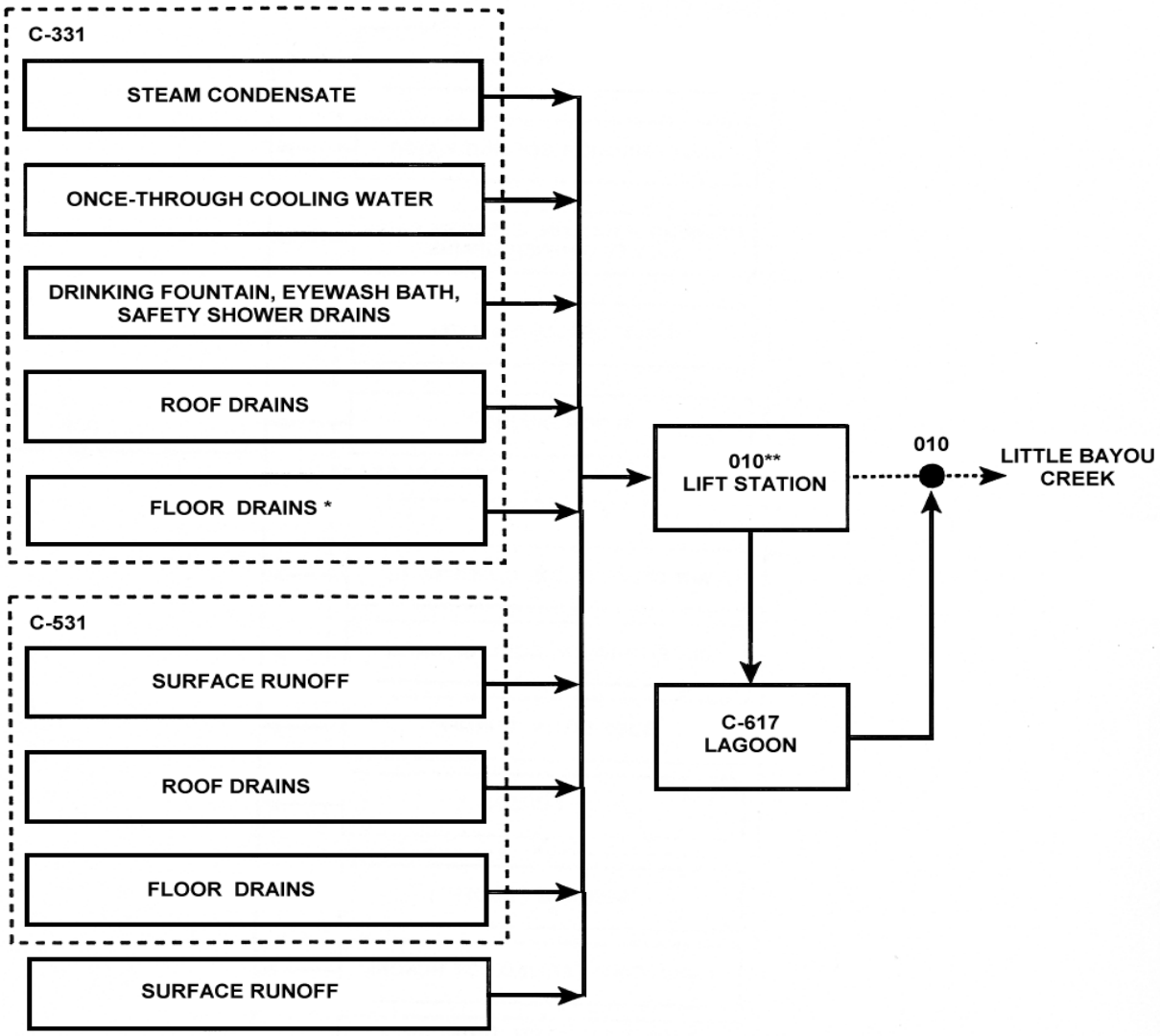


Figure 5.1-12. KPDES Outfall 009 influents.



* FLOOR DRAIN DISCHARGE IS NEGLIGIBLE, MOST DRAINS ARE PLUGGED

** LIFT STATION AND C-617 LAGOON BYPASSED DURING FLOODING CONDITIONS

Figure 5.1-13. KPDES Outfall 010 influents.

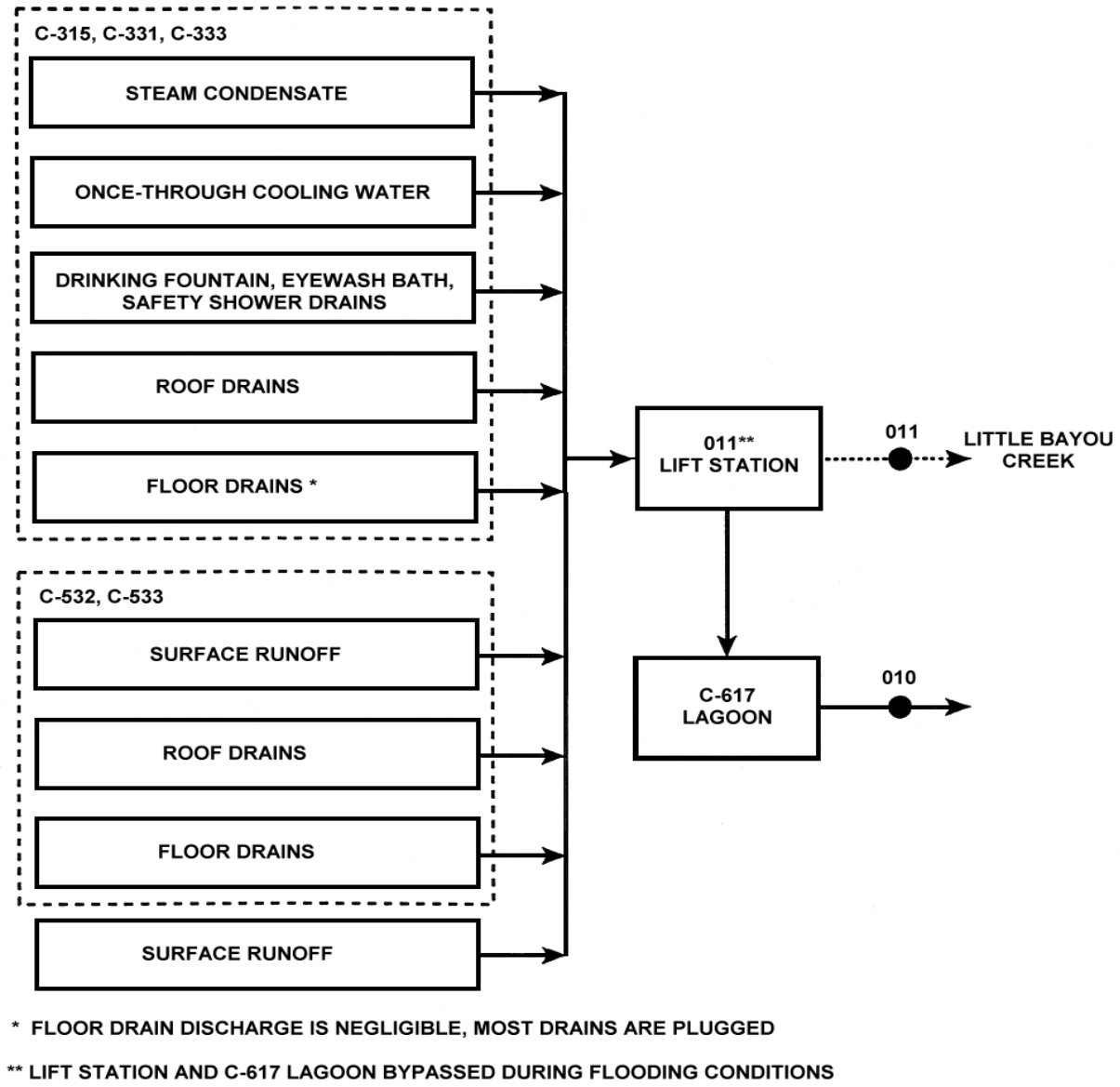


Figure 5.1-14. KPDES Outfall 011 influents.

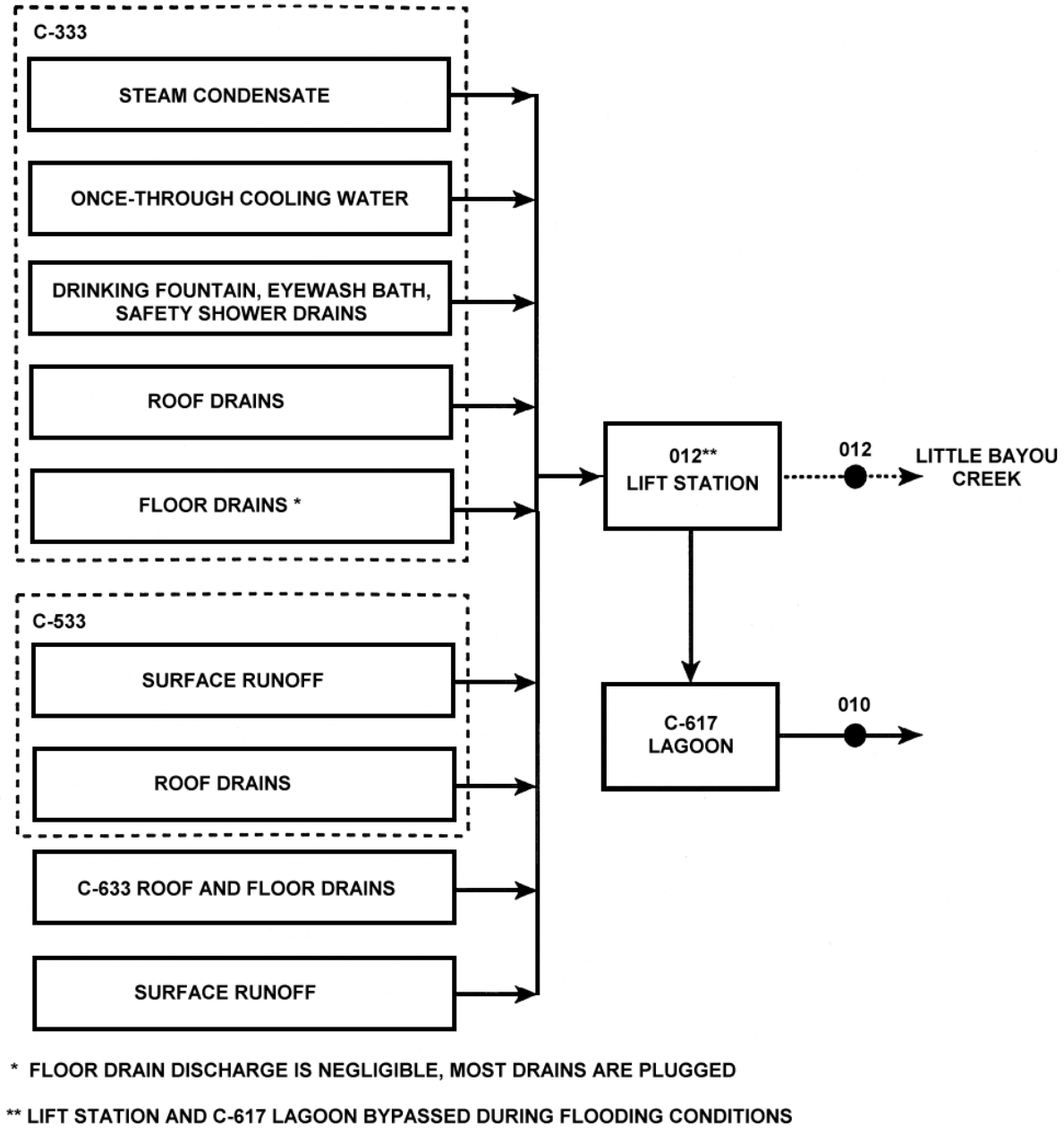


Figure 5.1-15. KPDES Outfall 012 influents.

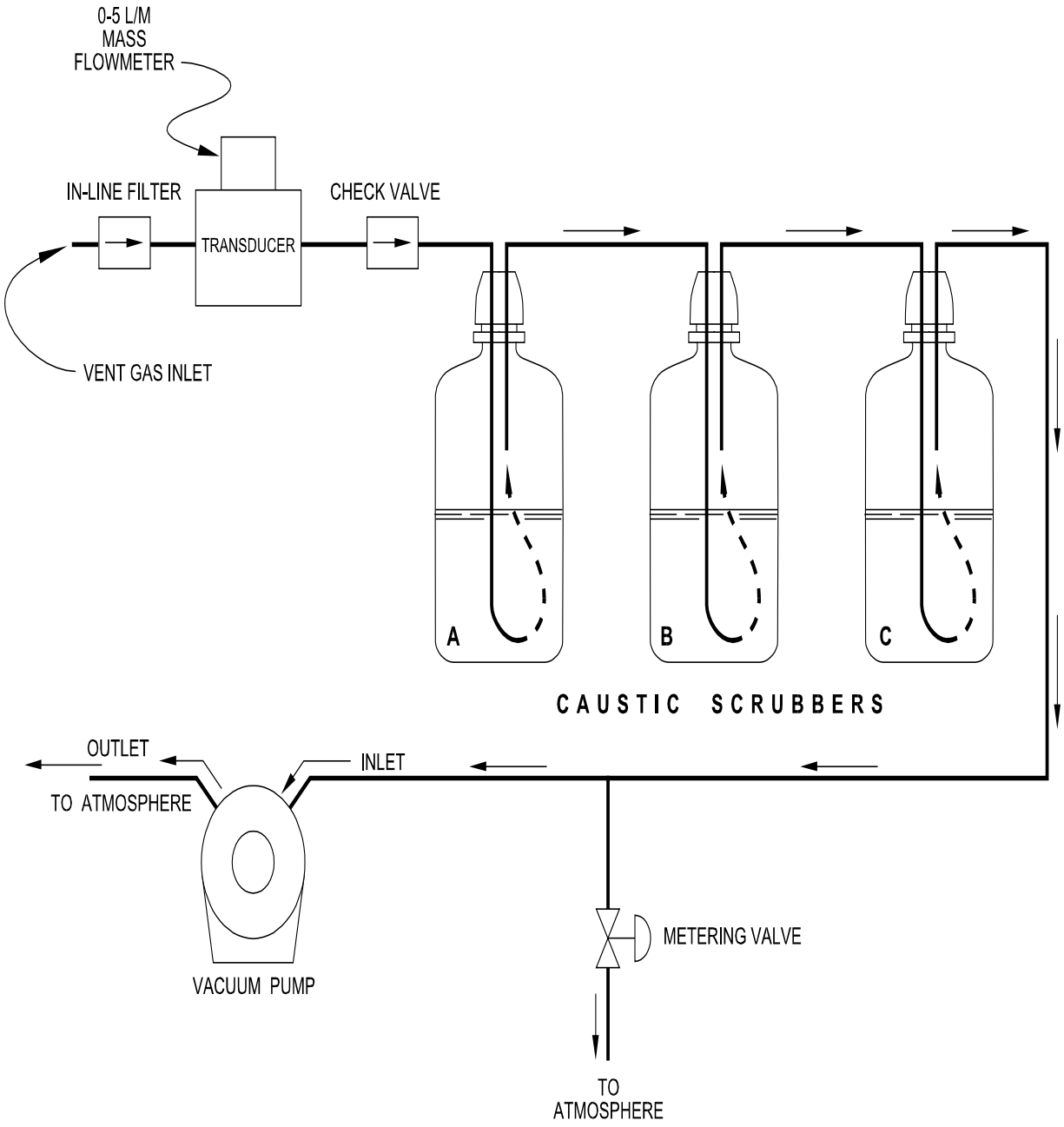


Figure 5.1-16. C-310 bubbler sampling system.

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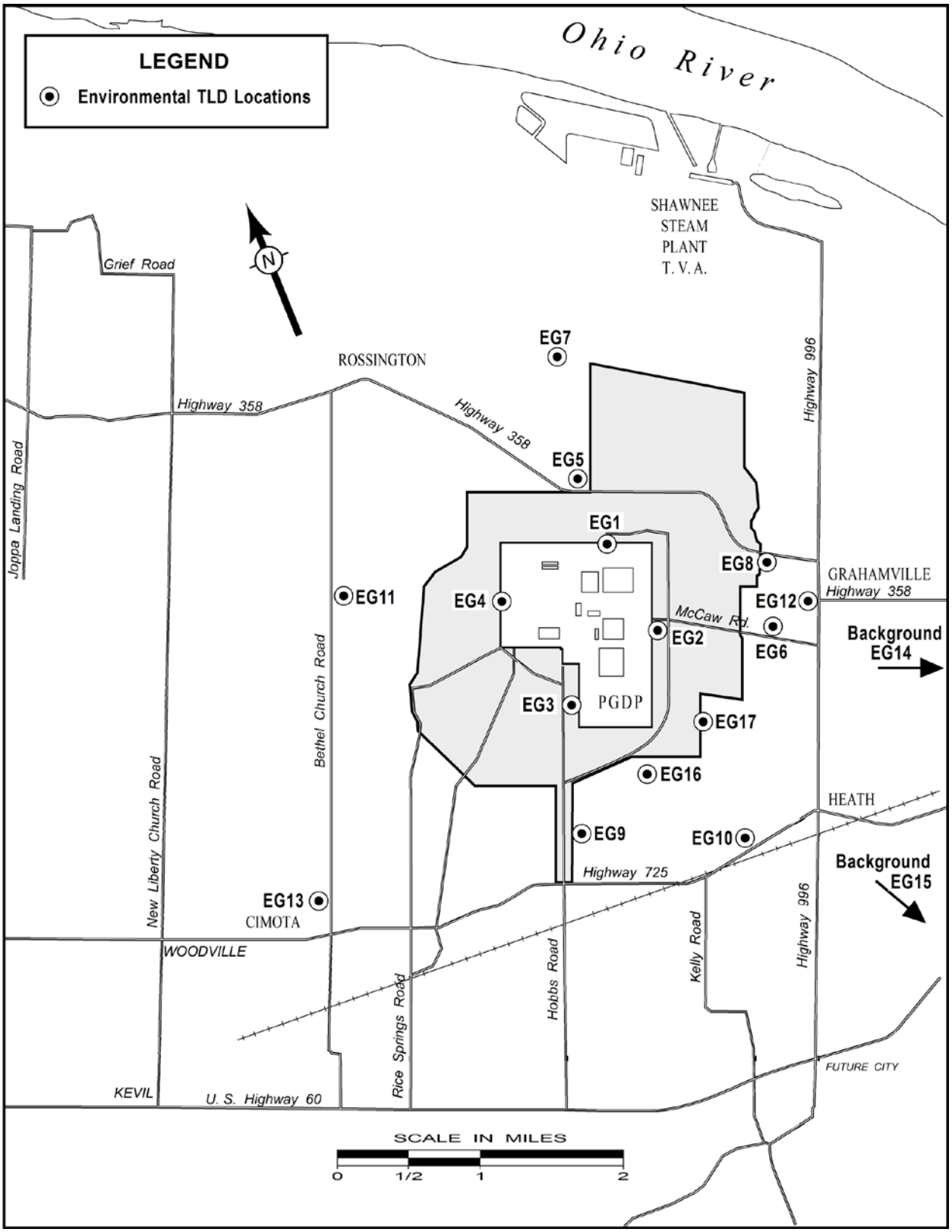

Figure 5.1-19. External gamma radiation sampling points.

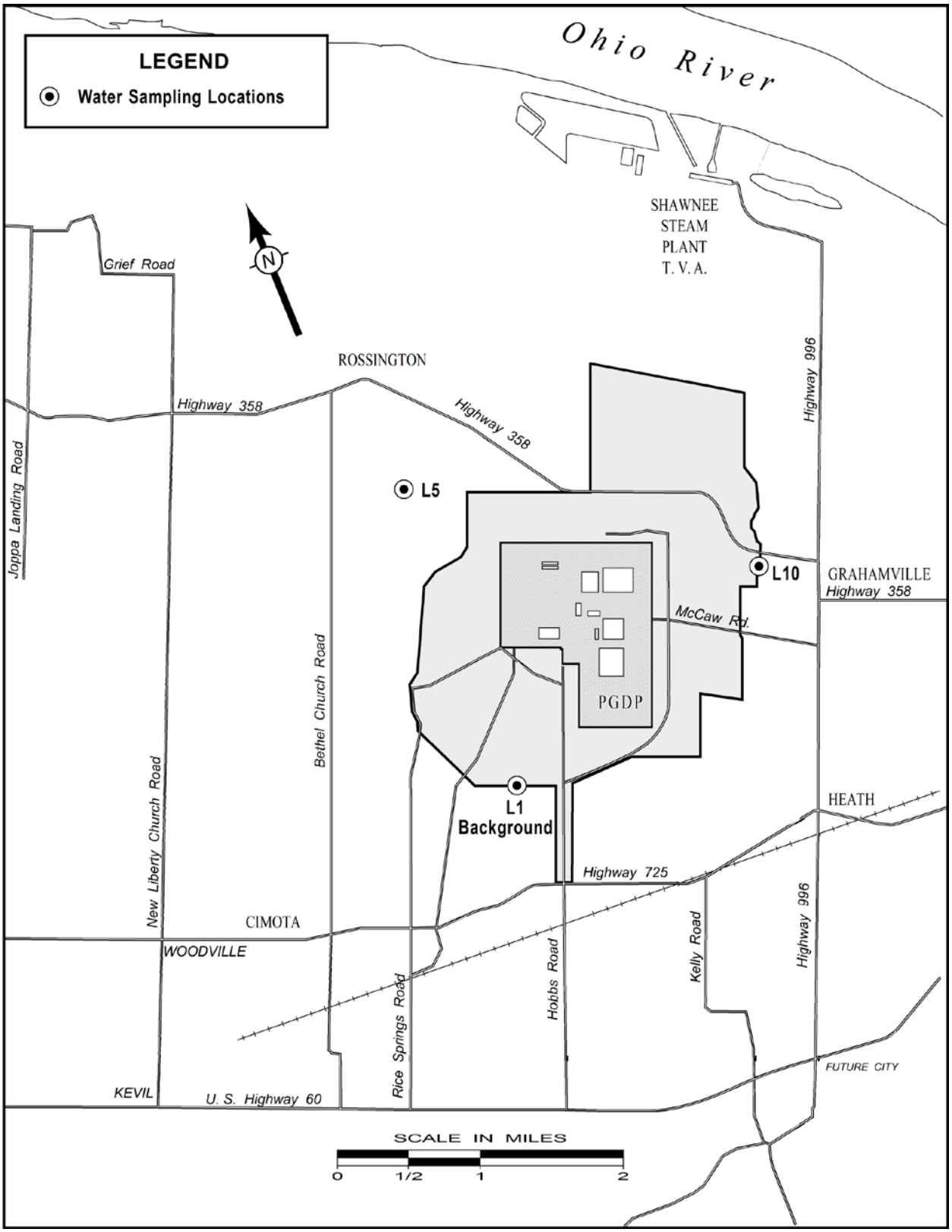

Figure 5.1-20. Surface water sampling locations.

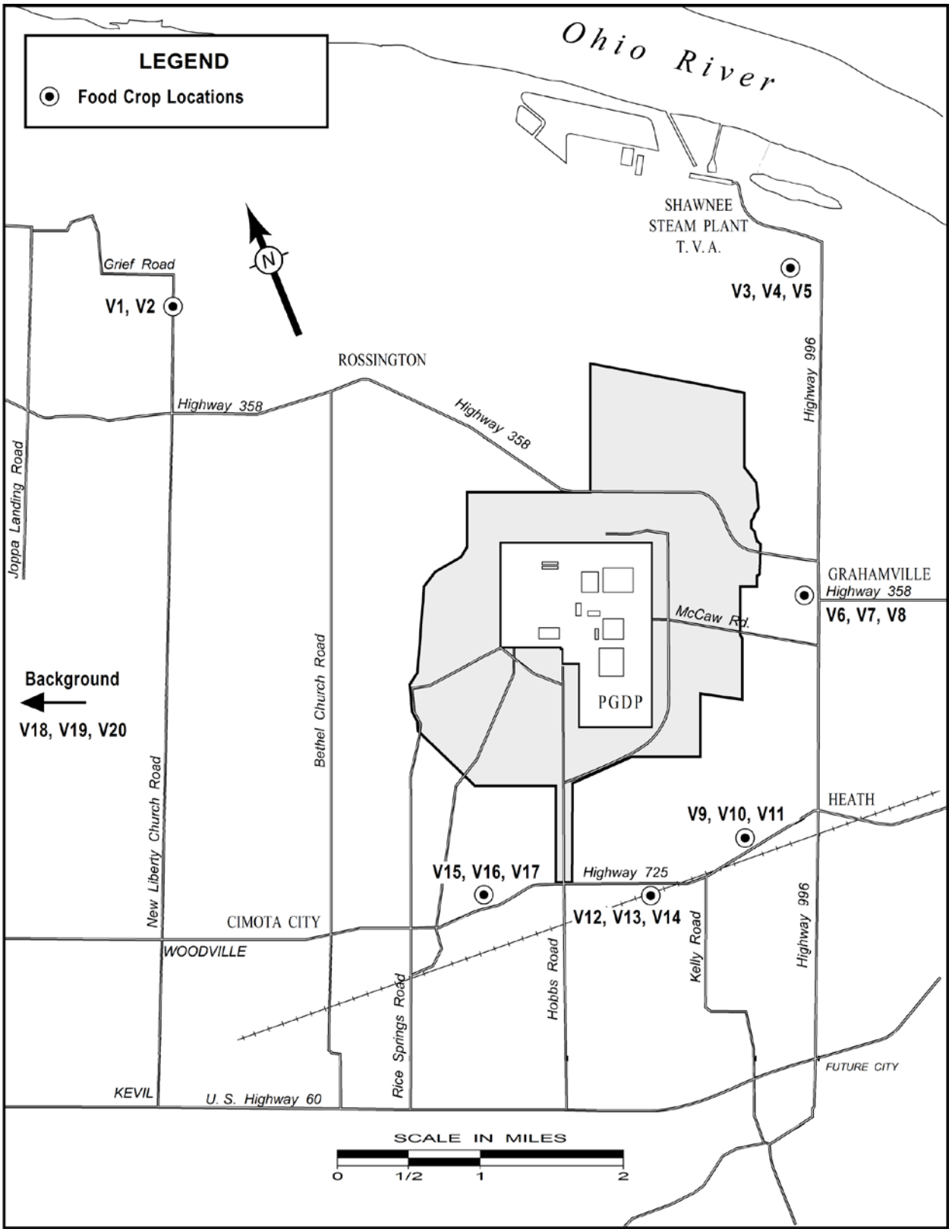

Figure 5.1-21. Food crop sampling locations.

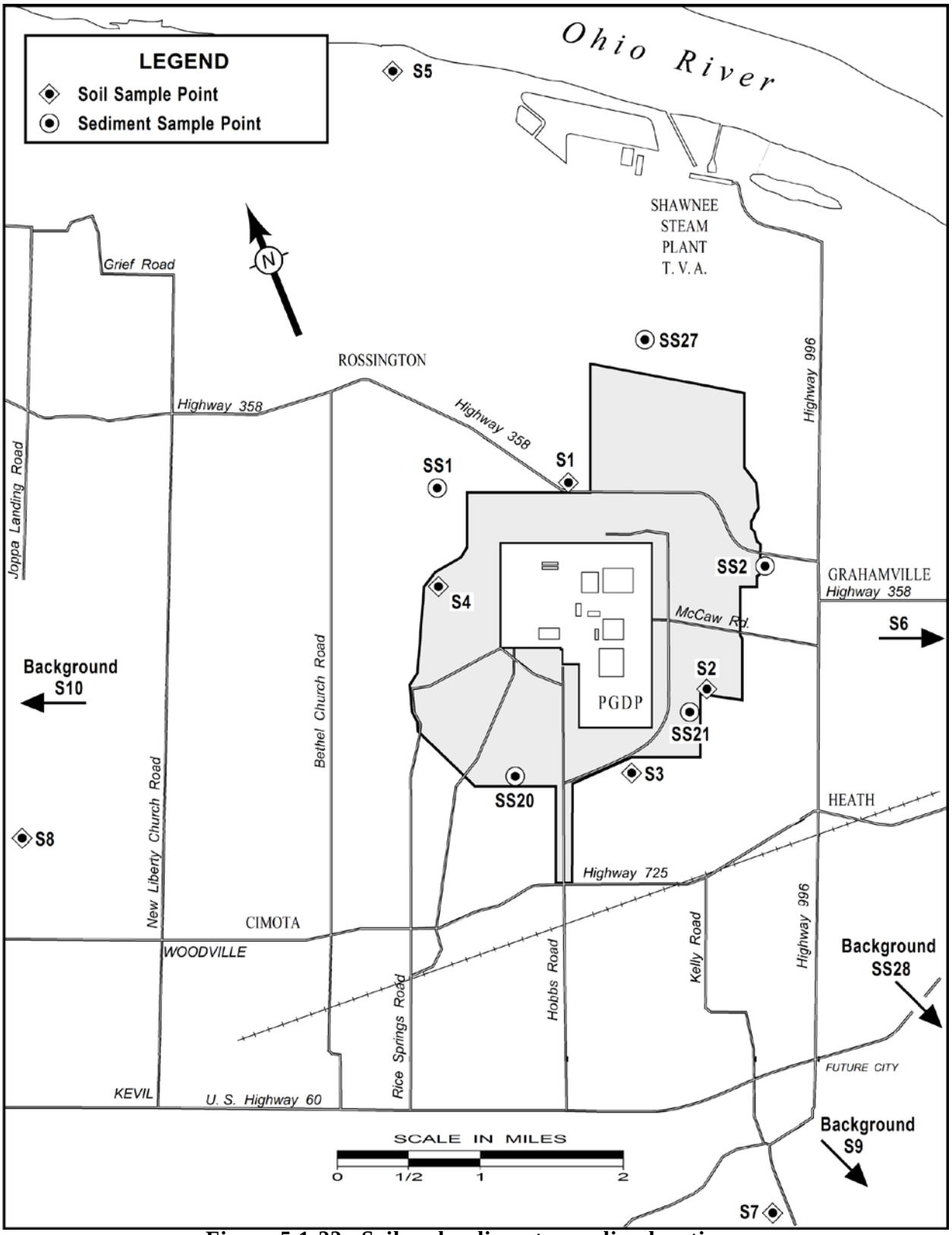

Figure 5.1-22. Soil and sediment sampling locations.

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5.2 NUCLEAR CRITICALITY SAFETY

5.2.1 Introduction

USEC, as part of its application for a certificate of compliance, is required by 10 CFR 76.35(a)(7) to provide a "description of the management controls and oversight program to ensure that activities directly relevant to nuclear safety . . . are conducted in an appropriately controlled manner that ensures protection of employee and public health and safety. . . . "In addition, 10 CFR 76.89 requires USEC to maintain and operate a criticality monitoring and audible alarm system. This section describes the basic criticality prevention and briefly discusses the monitoring provisions at the Paducah GDP. Section 3.12.6 discusses the Criticality Accident Alarm System (CAAS) in detail.

5.2.2 Program Elements

The nuclear criticality safety (NCS) program as defined in this section is implemented by the plant NCS procedures. These procedures reflect the requirements related to NCS as specified in this section.

5.2.2.1 Adherence With ANSI/ANS Standards

The nuclear criticality safety program has been developed to comply with ANSI/ANS 8.1-1983, 8.7-1975 and 8.19-1984. The issues which are not in full compliance with these standards are addressed in Section 5.2.4.

5.2.2.2 Nuclear Criticality Safety Responsibilities

The General Manager has overall responsibility for NCS and approves the implementation of Nuclear Criticality Safety Approvals (NCSAs). The General Manager assigns responsibility and delegates commensurate authority to all levels of management for the implementation and oversight of the NCS Program.

The organization managers (including maintenance) are responsible for ensuring that operations involving uranium enriched to 1 wt % or higher ^{235}U and 15 g or more of ^{-235}U are identified and evaluated for NCS prior to initiation of the operation. The organization managers are also responsible for ensuring NCS approvals are requested, and for ensuring implementation of the requirements contained in the approvals for these same operations.

First-line managers are responsible, in their respective operations, for ensuring that personnel are made aware of the requirements and limitations established by NCSAs either through pre-job briefings, required reading, and/or training (based on the complexity of the change). These same managers are responsible for ensuring any new fissile material operations which do not have approved NCSAs will not be performed until the necessary approvals have been obtained. First-line management is also responsible for removing fissile material handlers, who fail the test associated with the NCS training, from jobs which involve handling of fissile material.

Managers are trained in NCS and ensure all appropriate personnel (i.e., fissile material handlers) receive training as specified in the NCS procedure. This training provides personnel with the knowledge necessary to fulfill their respective NCS responsibilities. Section 6.6 discusses the training program in more detail.

The fissile material operators are responsible for conducting operations in a safe manner in compliance with operating procedures and are required to stop operations if unsafe conditions exist. Stop work and restart authority is discussed in more detail in Section 6.1.

The NCS Manager is responsible for the administration of the NCS program. This includes reviewing the overall effectiveness of the NCS program ensuring that NCS staff members are placed, trained, and qualified in accordance with written procedures and that NCS evaluations and NCS approvals are prepared and technically reviewed by qualified NCS engineers. The NCS staff members report to the NCS Manager who reports to the Regulatory Affairs Manager. Nuclear Criticality Safety is independent of organizations that require NCSAs. Section 6.1 gives more details related to plant organization.

The specific qualifications for the NCS Manager are discussed in Section 6.1.

Qualified NCS Group personnel are responsible for performing the following functions: (1) providing NCSAs for fissile material operations, (2) performing facility walk-throughs of facilities which handle fissile material and advising appropriate supervision of any NCS concerns, (3) participating in investigation of incidents involving NCS and in the determination of recommendations for eliminating such incidents, (4) assisting in plant emergency preparedness planning, (5) providing support to the Plant Operations Review Committee (PORC), and (6) participating in the review of procedures which involve fissile material operations to verify NCSA commitments have been effectively flowed down into operating procedures. As does any employee, the NCS Group personnel have the authority to halt any unsafe activity.

The responsibilities of senior NCS engineers performing technical reviews of NCSEs are specified in the Nuclear Criticality Safety Evaluation (NCSE) procedure. These responsibilities are verifying sufficient information is documented to allow independent analysis, verifying credible process upsets related to criticality safety are properly identified and evaluated, verifying compliance with the double contingency principle, checking for accuracy, and verifying applicability of the calculational methods.

5.2.2.3 Process Evaluation and Approval

Each operation involving uranium enriched to 1 wt % or higher ^{235}U and 15 g or more of ^{235}U is evaluated for NCS prior to initiation. The operation and related NCS requirements are documented in an NCSA. The evaluation is documented in a NCSE. The evaluation and approval process is governed by written procedures.

When a NCSA is needed for a particular operation, the requester completes a NCSA request form (Request for Criticality Safety Evaluation). This documents the request for NCS evaluation of the operation. This form is approved and signed by the manager of the requesting group/section or his/her designee. The form is then submitted to the NCS Group for analysis.

In response to the request, an NCSE is prepared to document the analyses performed as specified in the NCSE procedure. Techniques such as an NCS parameter checklist, What-If analysis, or Hazard and Operability Study are used to identify and document potential upset conditions presenting NCS concerns. The method selected is based on the complexity of the operation being considered. A Hazard and Operability Study is used when evaluating a complex operation involving multiple interacting systems which requires substantial input from operations, maintenance, and other subject matter experts to identify the possible process upset conditions. "What If" technique is used for less complex processes. An analysis for each identified process upset condition is performed to demonstrate double contingency.

The double contingency principle as stated in ANSI/ANS-8.1-1983, Section 4.2.2, is as follows: "Process designs should, in general, incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible." The PGDP NCS program applies this principle by implementing controls either on two different parameters or by implementing two controls on one parameter. Controls include passive barriers (e.g., structures, vessels, piping, etc.); active engineered features (e.g., valves, thermocouples, flow meters, etc.); reliance on the natural or credible course of events (e.g., by relying on the nature of a process to keep the density of uranium oxide less than a specified fraction of the theoretical), and administrative controls that require human actions to be taken in accordance with approved procedures, or by other means that limit parameters within specified values. If two controls are implemented for one parameter the violation or failure scenarios of the controls shall be independent. Application of this principle ensures that no single credible event can result in an accidental criticality or that the occurrence of events necessary to result in a criticality is not credible.

The basis for a parameter or process condition change that could lead to a criticality being unlikely must be documented in the NCSE. The basis may be an engineered feature, administrative control, the natural or credible course of events, or any combination of these or other means necessary to ensure the change is unlikely to occur. The parameters or conditions relied on and the limits must be specified in the NCSE and controlled.

Where the natural or credible course of events is relied upon in whole or in part to prevent a process condition change, the factors that influence the process must be described in sufficient detail in the NCSE as items related to NCS and programmatically controlled. For items which are established, maintained and implemented by non-NCS programs, credit for availability and reliability is established as described in SAR Section 6.3.5, Physical Plant Change Control and Configuration Management, without the necessity of establishment of additional NCS controls. For situations where the NCS-credited controls do not provide adequate assurance of availability or reliability (i.e., situations where non-NCS programmatic and physical plant changes could adversely affect the intended criticality safety function of the items relied upon for criticality safety), specific NCS controls will be established, maintained and implemented to ensure criticality safety.

Engineering judgement of both the analyst and the technical reviewer is used to ascertain independence of events and their likelihood or credibility. The basis for this judgement is documented in the NCSEs. Depending on the complexity of the operation, analytical methods such as Fault Tree and Event Tree Analyses are used in the evaluation process to examine potential accident scenarios. When the determination of the likelihood of an event is questioned, qualitative or quantitative estimates of event frequency are developed to support the determination.

The NCS evaluation process involves: (1) a review of the proposed operation and procedures, (2) discussions with the subject matter experts to determine the credible process upsets which need to be considered, (3) development of the controls necessary to meet the double contingency principle, and (4) identification of the assumptions and equipment (i.e., physical controls) needed to ensure criticality safety.

Once the NCSE is completed, a technical review of the evaluation is performed and documented. The NCS staff member who performs the technical reviews of NCS evaluations is a senior NCS engineer who has successfully met the requirements specified in the NCS qualification procedure. The minimum requirements for a qualified senior NCS engineer are: (1) complete the minimum requirements for a qualified NCS engineer; (2) perform a minimum of four technical reviews of nuclear criticality safety evaluations under the supervision of a qualified senior NCS engineer or the NCS Manager;

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(3) complete 1 year as a qualified NCS engineer and two years PGDP site-specific experience; and (4) be approved by the NCS Manager. The NCS Manager may modify the minimum senior NCS engineer qualification requirements for personnel who have worked for a minimum of five consecutive years at other facilities as a criticality safety engineer.

Qualified NCS Engineers meet the requirements specified in the NCS qualification procedure and must be approved by the NCS Manager. The minimum requirements for a qualified NCS Engineer are: (1) baccalaureate in engineering, mathematics or related science; (2) familiarization with the facility by completing a minimum of 1 year in a GDP NCS position; (3) complete Monte Carlo/Boltzmann transport code training course; (4) performing a minimum of four evaluations under the direction of a senior NCS engineer; (5) performing walk-through inspections under the guidance of a qualified NCS engineer; (6) receive NCS surveillance team training; (7) attend a nationally recognized criticality safety course; and 8) 1 year of organized training in the physics of nuclear criticality and in associated nuclear safety practices, if the trainee does not have a nuclear engineering or physics background. The NCS Manager may modify the minimum NCS engineer qualification requirements for personnel who have worked for a minimum of 3 consecutive years at other facilities as a nuclear criticality safety engineer.

The NCSA is prepared based on the results of the NCSE, and documents the conditions of approval (i.e., NCS requirements) for the operation. The conditions of approval include the process conditions which must be maintained to meet the double contingency principle or preserve the documented basis for criticality safety and restrict the modes of operation to those which have been analyzed in the NCSE. This may include development of a TSR in accordance with TSR Section 3.11.5 regarding double contingency. The requirements to be included in operating procedures and postings are identified.

The NCSA approval process first involves the acceptance of the NCSE and NCSA by the technical reviewer. The manager or designee of the operating group or section documents acknowledgment and agreement with the limits and controls specified. A 10 CFR 76.68 review will then be performed as described in Section 6.3.2 to determine whether prior NRC approval for the NCSA is required. If NRC approval is not required, the NCSE and NCSA are reviewed by the PORC and, if acceptable, approved by the General Manager. Editorial changes require only the approval of the NCS Manager. Editorial changes are defined as changes which do not change the technical basis of the NCSE/A. The PORC reviews the NCSE and NCSA to verify technical accuracy, ensure all credible process upsets have been identified and ensure consistency with other NCSAs and other potentially conflicting requirements or regulations such as OSHA and/or radiation protection requirements. Once approved by the General Manager, the NCS controls, limits, evaluation assumptions, and safety items are verified to be fully implemented in the field. This verification process is performed by the operations organization and NCS personnel. The documentation of this verification process is maintained as a quality record along with the NCS evaluation. The NCSA is then issued as a permanent or temporary document.

First-line management is responsible for implementing the conditions delineated in the NCSAs through the use of such tools as training, operating procedures, postings, and labels. First-line management ensures postings and labels are prepared and verifies that they are properly installed as required by the NCSA. The operating procedures are prepared or modified by first-line management to incorporate the NCSA requirements. First-line management is responsible for ensuring the employees understand both the procedures and NCSA requirements before the work begins.

Each completed NCSA is issued as a controlled document. The permanent NCSAs are maintained in a controlled manual which is issued to the personnel who need access to the NCSAs. The temporary NCSAs are issued to the appropriate personnel performing the temporary operation. Approved NCSEs/NCSAs are quality records and are handled according to the plant's Document Control and Records Management Program described in Section 6.10. The NCSA/NCSE process provides assurance that operations will remain subcritical under both normal and credible abnormal conditions. A summary of the NCS controls and parameters controlled as well as the Active Engineered Features based on approved NCSAs/NCSEs are also presented in Appendix A.

There are three operations which do not meet the double contingency principle. These are product cylinder operations, operation of the enrichment cascade, and removal of large cascade equipment (e.g., compressor, convertor, G-17 valve, etc). These operations have been evaluated to be safe; summaries of the accident scenarios and NCS controls associated with the operation of the enrichment cascade, the removal of enrichment cascade equipment, and UF_6 product cylinder operations are provided in Appendix A. Any operations that do not comply with the double contingency principle are documented in NCSEs and Appendix A.

There are TSRs to ensure controls are in place for those operations identified above which do not meet double contingency. Sections 2.4 and 2.5 of the TSRs list controls for operation of the enrichment cascade and for removal and maintenance of enrichment cascade equipment, respectively. Section 2.3 of the TSRs provides the controls associated with ensuring moderation control for the product cylinders. Section 3.12 of the TSRs also contains controls within the fire protection program for ensuring moderation control for the enrichment cascade.

New operations and operations other than those identified as not meeting the double contingency principle in Appendix A shall comply with the double contingency principle. In the event future operations are found to not comply with the double contingency principle, Appendix A will be modified to address this issue and will be reviewed and approved as described in Section 6.3.

Emergencies arising from unforeseen circumstances can present the need for immediate action. If NCS expertise or guidance is needed immediately to avert the potential for a criticality accident, direction will be provided verbally or in writing. Such direction can include a stop work order or other appropriate instructions. A NCSA or other form of documentation will then be prepared to justify the actions taken once the emergency condition has been stabilized. This documentation shall be prepared within 48 hours following the stabilization of the emergency condition.

5.2.2.4 Design Philosophy and Review

Designs of new fissile material equipment and processes must be approved by the NCS Group before implementation and will include the use of favorable geometry or engineered controls on mass, moderation, volume, concentration, interaction, or neutron absorption, as the preferred approach over the use of administrative controls. Advantage will be taken for the nuclear and physical characteristics of process equipment and materials provided control is exercised to maintain them.

The preferred design approach includes two goals. The first is to design equipment with NCS independent of the amount of internal moderation or fissile concentrations, the degree of interspersed moderation between units, the thickness of reflectors, the fissile material density, and the fissile material chemical form. The second is to minimize the possibility of accumulating fissile material in inaccessible locations and, where practical, to use favorable geometry for those inaccessible locations. The adherence to this approach is determined during the preparation and technical review of the NCS evaluation performed to support the equipment design. This preferred design approach is implemented through adherence to plant NCS procedures.

Fissile material equipment designs and modifications are reviewed to ensure that favorable geometry and engineered controls are used to advantage. Administrative limits and controls will be implemented in NCSAs to satisfy the double contingency principle for those cases where the preferred design approach cannot be met. The basis for the decision to use administrative controls in lieu of engineered controls shall be documented in cases where: 1) new fissile material equipment and operations are evaluated, and 2) existing fissile material operations are revised and engineered controls are replaced by administrative controls.

5.2.2.5 Criticality Accident Alarm System Coverage

A CAAS is provided to alert personnel if a criticality accident should occur. The system utilizes a distinctive audible signal to notify personnel in the affected area and initiate evacuation, thereby reducing personnel exposure to emitted radiation. Audibility is not provided in permit-required confined spaces, cell housings associated with cells that are running, and localized areas of inaudibility resulting from temporary activities that generate high noise levels. In these areas a "buddy system" is used to ensure personnel working in these areas are notified of alarms in order to evacuate.

At PGDP, the CAAS detects gamma dose rate. The system uses clustered detectors. Each cluster contains three scintillation detectors. Activation of any two of the three detectors in a cluster will initiate evacuation alarms. The failure of any major component of the system will result in a notification that indicates the need for corrective maintenance. A more detailed discussion of the physical function of the CAAS system is provided in Section 3.12.6.

Operations involving fissile material are evaluated for NCS prior to initiation. The need for CAAS coverage is considered during the evaluation process. Coverage is provided unless it is determined that coverage is not required and that finding is documented in the NCSE. For example, areas containing no more than 700 g of ^{235}U, 50 g of ^{235}U in any square meter of floor or ground area, 5 g of ^{235}U in any 10-liter volume, or areas having material that is either packaged and stored in compliance with 10 CFR 71 or specifically exempt according to 10 CFR 71.15, can be shown by evaluation not to require alarm coverage. Areas that do not contain any operations involving uranium enriched to 1 wt % or higher ^{235}U and 15 g or more of ^{235}U do not require an NCSE and are not required to have CAAS coverage. 10 CFR 76.89(a) authorizes USEC to "describe for the approval of the Commission defined areas to be excluded from the monitoring requirement." This submittal to the NRC "must describe the measures that will be used to ensure against criticality including kinds and quantities of material that will be permitted and

measures that will be used to control those kinds and quantities of material." USEC will submit, in accordance with the Compliance Plan, the analyses for alarm settings, detector placement and the analyses required by 10 CFR 76.89(a) to demonstrate that criticality monitoring and alarm coverage is not required in certain areas of the facility.

The CAAS provides detection and alarm coverage for postulated criticality events that would produce an absorbed dose in soft tissue of 20 rad of combined neutron and gamma radiation at an unshielded distance of 2 m from the reacting material within 1 minute. The detection criteria are met by setting PGDP detectors at 10 milliroentgen per hour above the background radiation rate for the area(s) of coverage.

The location of detectors and setpoints is based on results of dose calculations and detector tests performed at critical experiment facilities. These tests and calculations demonstrate that the CAAS will respond in accordance with the detection requirements specified in 10 CFR 76.89.

Additional details describing the criticality accident alarm system equipment, operation, testing, maintenance, and locations are provided in Section 3.12.6. Reference Section 5.3 for a discussion of the nuclear accident dosimeters.

5.2.2.6 Procedure Requirements

Operations to which NCS pertains shall be governed by written procedures. These procedures contain the appropriate NCS controls for processing, storing, and handling of fissile material. The NCSA requirements which require employee actions shall be incorporated into the operating procedure. NCSA requirements are identified by placing a "commitment stamp" in the left hand margin next to the appropriate procedure step. Identifying these requirements in this way ensures changes to these requirements are not made without review and approval by the NCS Group. The NCSA requirements are incorporated into the appropriate procedures as required by the NCS procedure.

New and modified procedures are reviewed by the appropriate safety organizations, including the NCS Group as specified in the procedure for procedure control. The NCS Group reviews the procedures to verify that the appropriate NCSA requirements have been incorporated and to verify that the proposed operation complies with NCS program requirements. Reference Section 6.11 for more details related to the procedure development and change control program.

5.2.2.7 Posting and Labeling Requirements

NCS limits and controls for areas, equipment, and containers are presented through the use of postings and labels as specified in approved NCSAs and procedures. Postings and labels are proposed, reviewed, and approved during the NCSA review and approval process. These limits and controls are posted on the Nuclear Criticality Safety Requirements signs as required by the plant NCS procedure. The design of labels are prepared by the operating organization and concurred with by the NCS Group as specified by procedure. Approved NCSAs specify the limits and controls for the postings. Limits and controls are printed in an appropriate size typeface and the postings and labels are placed in conspicuous locations determined by the line organization.

5.2.2.8 Change Control

Functional and physical characteristics of operations controlled for NCS are described in NCSAs and NCSEs. These components and features which are identified in the NCSAs and NCSEs are analyzed to determine the "boundary" of the system, encompassing those items that are essential to ensure operability. The boundaries are identified on system drawings and the safety function capability is verified during development and/or implementation of the NCSE/As. These components and features are documented in a manual for each facility. Each time a change to a facility is planned this manual is reviewed, by the individual (e.g., design authority, systems engineer, operations supervisor, etc.) planning the change, to determine if the change affects structures, systems, and components (SSC) relied on for safety. Section 6.3 specifies the organizations required to perform reviews of changes to SSCs. The required approvals are obtained before the change is implemented. If an item is relied on for the criticality safety of an operation, as a barrier for either double or single contingency, it will be identified through the work control process as an AQ-NCS SSC and NCS Group approval is required before implementing the change. The NCS Group reviews the NCSE for this specific operation and determines if the change affects the analysis performed and conclusions made in the NCSE. The change request will be approved by NCS only if the change does not impact NCS or once a revised NCSE has determined that the change is acceptable and meets NCS program requirements. In this way modifications to controlled operations are evaluated and approved prior to implementation. The items which require configuration change control are identified as Q or AQ-NCS. The configuration change control program is discussed in more detail in Section 6.3.

These components and features are reviewed during surveillances, assessments and walk-throughs of the facilities to verify unauthorized modifications have not been made. This surveillance program is discussed below in Section 5.2.2.9.

5.2.2.9 Operation Surveillance and Audits

In order to ensure that the NCS program is properly established and implemented, USEC utilizes surveillances, assessments, audits, and walk-throughs.

The NCS Group performs internal surveillances of the plant's implementation of NCS limits and controls in accordance with procedural requirements, need, and results of incident trending. The topics, scope, team members, and schedules for these surveillances are determined by the organization managers. Surveillance topics have included Criticality Accident Alarm Systems, Chemical Operations Facilities, Enrichment Cascade Facilities, Feed and Vaporization Facilities, Waste Management Activities, Product and Tails Withdrawal, NCS Validation of Computer Software, Laboratory Facilities, Maintenance Facilities, etc. Deficiencies identified during these surveillances are documented and reported to the appropriate levels of management in accordance with applicable procedures.

In addition to the NCS surveillances the operating organizations perform surveillances. At a minimum fissile material operations are reviewed for NCS on an annual basis (i.e., every 12 months not to exceed 15 months between surveillances). These surveillances are performed by the operating organization. NCS personnel are also present during these surveillances to provide NCS technical support as requested. These surveillances include the inspection of facility modifications, operating procedures, compliance with NCSAs, postings, and waste generation and handling. These surveillances are performed as specified by the NCS procedure.

PORC provides review of the NCS program in accordance with the Technical Safety Requirements.

Independent oversight is provided by internal audits of the NCS program conducted or coordinated by the Nuclear Safety and Quality Manager. Internal audits of the NCS program shall be conducted in accordance with Section 2.18 of the QAP. The purpose of these audits is to determine the adequacy of the overall NCS program. This includes the adequacy of the NCSEs, NCSAs, internal surveillances, and implementation of the NCS requirements.

NCS walk-throughs of facilities that may contain fissile material operations are performed by NCS personnel to determine the adequacy of implementation of NCS requirements and to verify that conditions have not been altered to adversely affect NCS. These walk-throughs are performed as specified by the NCS procedure on walk-throughs. For example, a walk-through inspection can be performed in response to trend data, at the request of the operations personnel, or due to concerns raised by employees or the NCS staff. As a minimum, these walk-throughs are completed for applicable areas biennially.

The results of these surveillances, audits, and walk-throughs are documented and reported to appropriate managers. Identified deficiencies are documented and corrected according to the problem reporting system described in Section 6.9 and the QAP Section 2.18.

NCS deficiencies are recorded and the data trended to monitor and prevent future violations. Deficiencies are grouped into categories such as organization, building, type of process, and type of deficiency. Corrective actions are taken for adverse trends in accordance with the Quality Assurance Program.

5.2.3 Technical Aspects

5.2.3.1 Application of Parameters

Moderation

Water and oil are considered to be the most efficient moderators commonly found on the plant site. When moderation is not controlled, either optimum moderation or worst credible moderation is assumed as the normal case when performing analyses. When moderation is controlled, credible abnormal process upset conditions shall determine the worst case moderated conditions. For example, it has been determined that the worst case moderation under process upset conditions for the oil in the Stokes-Pennwalt Pumps is an H/U ratio of 46.8. This value is based on the amount of uranium the oil can contain and still provide lubrication adequate for pump operation. The addition of more uranium will result in pump failure. Thus, the introduction of uranium into the pump oil is self-limiting.

Moderation control is applied to enrichment cascade equipment and product cylinders. Uranium enriched to 6 wt % or less, ^{235}U is considered to be incapable of supporting a nuclear chain reaction without the presence of moderation. The basis for this statement is provided in a NCSE.

The enrichment cascade is a closed system designed to process gaseous UF_6. This closed system prevents the introduction of moderation due to wet air inleakage. Also because UF_6 reacts chemically with moisture (a moderator) to produce solid uranium-bearing compounds which impedes the proper operation of the cascade, the entire enrichment cascade is designed to minimize introduction of moisture. This includes the use of R-114 for coolant rather than water.

Moderation control is the primary NCS control for product cylinders and is based upon maintaining the operating temperature and pressure ranges of the Product Withdrawal system so that hydrogen fluoride (HF) will not condense. This ensures the H/U ratio will remain below 0.088 since only a small, safe amount is dissolved in liquid UF_6.

Volume

Waste containers used at Paducah are maximum 32 gallon drums for uranium enriched to 2 wt %, maximum 5.5 gallon drums, maximum 21 liter carboys, and maximum 2.1-gal containers for uranium enriched up to 5.5 wt%. The bases for the container sizes are provided in each NCSE prepared for those operations requiring containers. Specific details of these bases can be obtained by referring to the particular NCSE of concern.

Interaction

Interaction is controlled by spacing items bearing fissile material when those items could result in a criticality accident if not properly spaced. The spacing, necessary to maintain a safe array of fissile material units, is determined in the NCSE performed for the array. The spacing requirements are documented in the NCSA for the operation. The amount of spacing needed between items is determined based on analysis of the normal and credible abnormal process upset conditions for the particular operation.

Geometry

Geometry control is applied by limiting equipment dimensions for those systems which depend on the geometry for criticality safety. The geometry is determined in the NCSE which is performed for each system and depends on the normal and credible abnormal process upsets conditions related to the specific system. For example, controlled geometry equipment used at PGDP included 5-in. deep pans and 10-in. schedule 40 pipe. Geometry controls are specified in the NCSAs and/or NCSEs.

Mass

Mass controls are applied on a case-by-case basis depending on the fissile material operation involved. The acceptable mass is determined based on the specific NCSE performed for the operation. The safe mass value depends on many factors including the geometry, the ^{235}U enrichment, composition, etc. The safe mass values are communicated to the operating personnel via the NCSAs.

One example of a mass control implemented at the PGDP is limiting waste storage drums to a maximum of 120 g of ^{235}U. Maximum 5.5 gallon waste containers are allowed to contain a maximum of 120 g of ^{235}U in any form without spacing or stacking restrictions. This limit of 120 g of ^{235}U was established based on a NCSE. This NCSE determined that 280 g of ^{235}U in each maximum 5.5 gallon drum, in an infinite array, optimally moderated, produced the most reactive subcritical multiplication factor (i.e., K_{eff} plus two standard deviations) of 0.9357. To account for double batching, 45% of 280 g was used to establish the acceptable mass limit for the drums (i.e., 120 g of ^{235}U).

Enrichment

Uranium-containing material on the plant site with ^{235}U enrichment $\leq$1 wt % is considered incapable of supporting a nuclear chain reaction, but interaction of such materials with materials of higher enrichment is taken into consideration in the specific NCSE for those operations which involve this material.

The ^{235}U enrichment of product UF_6 is 5.0 wt % with maximum ^{235}U enrichment up to 5.5 wt % at the PGDP. Small quantities of higher enriched uranium may be present on the plant site, within, or as samples from, contaminated spare parts received from other facilities and also as standards used for calibration purposes.

The maximum ^{235}U enrichment for each operation is established by the specific NCSE. The NCSA shall specify the maximum acceptable enrichment for each operation. Credible process upset conditions which could alter the ^{235}U enrichment shall also be considered in the NCSEs. For those operations which can be shown safe for an enrichment of 5.5 wt %, the NCS Group performs the NCSE assuming an enrichment of 5.5 wt %.

Density

The density of materials used in each specific NCSE are justified in the NCSE for the operation being considered. If the density must be controlled to maintain the double contingency principle, it will be documented in the specific NCSA for the operation.

UF_6 in the gaseous phase, at pressures and temperatures existing in the enrichment cascade equipment, is incapable of supporting a nuclear chain reaction even when intermixed with hydrogenous material (i.e., HF). The basis for this conclusion is documented in a NCSE. UF_6 in the gaseous phase in enrichment cascade equipment has low material density, and is not exposed to exotic reflecting materials (e.g., beryllium).

Heterogeneity

Heterogeneous configurations are considered for those operations which involve small fuel and moderator regions. The only operations currently performed at PGDP in which the fuel and moderator combinations result in an increase in reactivity due to a heterogeneous mixture are those operations involved with the handling, storing, and transporting of uranium samples. Based on the NCSE performed for the transportation of uranium samples at PGDP, heterogeneous mixtures are most reactive when the fuel and moderator dimensions are on the order of a few centimeters in thickness.

Concentration

Concentration controls are used on a case-by-case basis. When the criticality safety of an operation depends on the concentration of fissile material, the medium is sampled in accordance with the NCSA for the operation. If independent samples are required, the samples are either taken by two separate individuals, or are verified to be properly taken by a second individual. The two samples are independently analyzed as required by the NCSA for analyzing independent samples. Some of the operations which rely on concentration controls include C-400 uranium precipitation system, and liquid waste stored in large storage tanks and transported in tankers to disposal sites. The specific controls and details are documented in the NCSA for each operation which relies on concentration controls.

Reflection

Normal and credible abnormal reflection is considered when performing NCS evaluations. The possibility of full water reflection is considered when performing analyses. It is recognized that concrete can be a more efficient reflector than water and its potential presence is considered.

Neutron Absorption

When neutron absorbers are used as NCS controls, the intended distributions and concentrations under both normal and credible abnormal conditions are maintained in accordance with the requirements of the applicable NCSA. These requirements are: representative sampling of the neutron absorber, sampling at a frequency justified based on the environment the neutron absorber is exposed to, samples analyzed for all material attributes taken credit for in the NCSE, and periodic inspections of fixed neutron absorbers to ensure adequate distribution as specified in the NCSA. Before a neutron absorber is used, for the purposes of complying with the double contingency principle, the details specifying the neutron absorber control program shall be submitted to the NRC for review and approval.

An NCS evaluation can take credit for the neutron absorption properties of the materials (1) added specifically for the purpose of absorbing neutrons, and (2) of construction, provided an allowance has been made for manufacturing and dimensional tolerances, corrosion, chemical reactions, and uncertainties in the neutron cross-sections. The relevant physical characteristics of materials of construction credited in the criticality safety evaluation for their neutron absorption properties shall be verified as described in Section 5.2.2.3. The physical characteristics credited for criticality safety shall be designated as safety related items and be placed under change control as described in Section 5.2.2.8. Periodic surveillance shall be conducted for physical characteristics, such as material of construction and dimensions, which may credibly degrade over time.

5.2.3.2 Methods of Calculation

Experimental Data

Experimental data is not specific enough to allow evaluation of the operations performed at PGDP. The generic nature of the experimental data does not address all the variables present in the different operations. However, experimental data is used for validation of the computer code (e.g., KENO V.a) which is used to perform the calculations needed to support the development of NCSEs. The experimental data used is discussed in the code validation report.

Handbooks

Handbooks are also used in some cases when simple systems are being evaluated. Full advantage of these handbooks can not be taken since most of the operations performed at PGDP are too complicated to be adequately addressed by data in a handbook. When isolated operations are performed with small amounts of fissile material, referencing handbooks is useful for supporting the conclusions made in the NCSE. Examples of the handbooks used include, but not limited to, ARH-600 “Criticality Handbook” and LA-10860 “Critical Dimensions of Systems Containing ^{235}U, ^{239}PU, and ^{233}U.”

Hand Calculations

Single Units. Applicable methods for evaluating single units include: Modified Two Group Diffusion Equation (i.e., Critical Equation), Buckling Conversion, and Comparative Analysis.

Modified Two Group Diffusion Equation — This method is applicable to, and most widely used for, solution systems.

Buckling Conversion — The method of buckling conversion or shape conversion is applicable to all materials.

Comparative Analysis — This method involves direct comparison of the system configurations to subcritical data from NCS handbooks.

Arrays. Applicable methods for evaluating arrays include the Solid Angle Method and the Surface Density Method using unit shape factor.

Solid Angle Method — This method is applicable to solution systems. It is not useful if reflection is more effective than a thick water reflector located at the array boundary.

The conditions that must be satisfied in order to successfully apply the solid angle method are (1) k_{eff} of any unreflected unit does not exceed 0.80, (2) each unit is subcritical when completely reflected by water, (3) the minimum surface-to-surface separation between units is 0.3 m, and (4) the allowed solid angle does not exceed 6 steradians.

Surface Density Method using unit shape factor — This method can be used as an approximation for large arrays of identical units containing solutions and metals. This method determines the spacing and mass of units independently of the number of units. An important feature of the Surface Density Method is that it is equally applicable to more irregular geometries, including those typically associated with process equipment.

Computer Calculations

For those cases where adequate references are not available, NCS computational analyses are performed, which involve the calculation of k_{eff} to determine if the system will be subcritical under both normal and credible abnormal process conditions. Computer codes that simulate the behavior of neutrons in a process system or that solve the Boltzmann transport equation are used.

Computer calculations of k_{eff} provide a method to relate analytical models of specific system configurations to experimental data derived from critical experiments. A critical experiment is defined as a system which is intentionally constructed to achieve a self-sustaining neutron chain reaction or criticality. Critical experiments which have specific, well-defined parametric values and are adequately documented are termed benchmark experiments. Computer codes are validated using experimental data from benchmark experiments which, ideally, have geometries and material compositions similar to the systems being modeled.

Validation of the computer code determines its calculational bias or uncertainty as well as the effective margin of subcriticality. The PGDP validation involves the modeling of benchmark critical experiments over a range of applicability. Because the k_{eff} value of a critical experiment is essentially 1.0, the bias of the code is taken to be the deviation of the calculated values of k_{eff} from unity. Statistical analysis is employed to estimate the calculational bias, which includes the uncertainty in the bias and uncertainties due to extensions of the area of applicability, as well as the effective margin of subcriticality. Uncertainty in the bias is a measure of both the precision of the calculations and the accuracy of the experimental data. The validation of the computer code specifically defines the maximum acceptable k_{eff} used to determine subcriticality.

The margin of subcriticality used at PGDP shall result in a k_{eff} upper safety limit which will ensure that there is 95 percent confidence that 99.9 percent of all future k_{eff} values less than this value will be subcritical. The minimum margin of subcriticality of 0.02 in k_{eff} shall be used to establish the acceptance criteria (i.e., upper safety limit) for criticality calculations. The upper safety limit for PGDP calculations is established as 0.9634 which must be less than or equal to the value established in the validation report applicable to the particular code and computing platform used to perform the criticality calculations. Current validation reports shall be controlled documents.

The calculation of k_{eff} is accomplished by the use of computer codes which utilize Monte Carlo techniques or solve the Boltzmann transport equation to determine k_{eff} of a system. Computer models representing the geometrical configuration and material compositions of the system are developed for use within the code. The development of appropriate models based on both normal and credible abnormal process conditions is of primary importance in determining the potential reactivity of the system.

When nuclear criticality safety is based on computer code calculations of k_{eff}, controls and limits are established to ensure that the maximum k_{eff} complies with the applicable code validation for that type of system being evaluated.

Scoping and analysis calculations can be performed utilizing various unvalidated computer codes; however, computer calculations of k_{eff} used as the basis for NCS approvals are confirmed by, or performed using, configuration-controlled codes and cross-section libraries for which documented validations are performed with at least the same degree of conservatism as that presented in the validation report KY/S-221 and is in accordance with the American National Standards Institute (ANSI) standard ANSI/ANS-8.1-1983.

The configuration control program used to maintain the computer codes and cross sections used in performing k_{eff} calculations meets 10 CFR 76.68 change requirements and consists of the following elements. The Nuclear Criticality Safety Manager is responsible for controlling access to the software. Personnel who have access to this code must be approved by the NCS Manager. A semiannual (i.e., every 6 months not to exceed 7 months between confirmations) confirmation test is performed based on the validation test cases. A quarterly (i.e., every 3 months not to exceed 4 months between comparisons) bit-by-bit comparison of the production version against an archived production version is performed. Changes must be approved by the NCS Manager, System Administrator, Software Team Chairman and the Functional System Manager. This program is governed by the NCS software control procedure.

5.2.4 Items Addressed By Compliance Plan

Section deleted.

5.2.4.1 Adhere to ANSI/ANS Standard-8.1 1983

Section deleted.

5.2.4.2 Approval of NCSAs

Section deleted.

5.2.4.3 Document NCS Evaluation and Approval for All Fissile Material Operations

Section deleted.

5.2.4.4 Senior NCS Engineer Qualification Requirements

Section deleted.

5.2.4.5 NCS Engineer Qualification Requirements

Section deleted.

5.2.4.6 NCS Verification Process

Section deleted.

5.2.4.7 Maintain and Operate Criticality Accident Alarm System

Section deleted.

5.2.4.8 Develop Emergency Procedures

Section deleted.

5.2.4.9 Follow a Preferred Design Approach

Section deleted.

5.2.4.10 NCS Involvement in Labels

Section deleted.

5.2.4.11 Review Plant Changes Associated with Fissile Material Operations

Section deleted.

5.2.4.12 Surveillances

Section deleted.

5.2.4.13 Trend NCS Deficiencies

Section deleted.

5.2.4.14 Describe Basis for Criticality Incapability of 6 wt % ^{235}U

Section deleted.

5.2.4.15 Describe Basis for Criticality Incapability of Gaseous UF_6

Section deleted.

5.2.4.16 Validate Computer Calculations to 5.5 wt % ^{235}U

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Appendix A

Prevention of Inadvertent Criticality

Occurrence of a criticality accident is theoretically possible in a number of areas at the Paducah plant, but the probability is very low. In practice, a significant margin of safety is ensured by the nuclear criticality safety (NCS) program which is described in Section 5.2. Equipment and operations are evaluated to the double contingency principle. The double contingency principle is satisfied in all cases except for (1) the cascade including the major process equipment, (2) equipment removed with deposits exceeding the "safe" mass, and (3) product cylinder filling and handling. In those cases where double contingency is not met, specific controls are identified in the discussions below and are included in the TSRs to ensure single contingency protection.

This appendix summarizes material that is detailed in the NCS approvals (NCSAs) and evaluations (NCSEs) for the enrichment cascade, UF_6 handling facilities, chemical recovery and decontamination operations, laboratories, plant-wide operations, and maintenance. Representative criticality accident scenarios from the NCSEs are provided. This section is not intended to summarize every NCSA/E at the plant nor every fissile material operation. Rather, it provides a description of the types of fissile material operations and the type of NCS controls used to ensure criticality safety. The controls, including specific engineering controls such as Active Engineered Features (AEFs), operational limits, administrative controls and surveillances, are detailed in the NCSE/As that govern specific fissile material operations.

1.0 Enrichment Cascade Facilities

Equipment in the UF_6 enrichment cascade is evaluated in this section for criticality concerns.

1.1 Cascade Equipment

Administrative controls and passive engineering design features have been identified that prevent an inadvertent nuclear criticality in the operation and shutdown of the diffusion cascade. The NCS treatment of the diffusion cascade includes the cascade stages, purge and evacuation stations, UF_6 booster stations, and interconnecting piping. Uranium compounds in the cascade (primarily UF_6 and uranium oxy-fluorides) cannot achieve nuclear criticality at PGDP enrichment levels without moderation. Therefore, hazards are identified for NCS in terms of the degree of moderation that might be available with each initiating event. The detailed hazard analyses can be summarized in several basic categories:

- Large cascade breach from a fire or exothermic event
- Cooler deposits and concurrent moderation from RCW
- Large UF6 releases
- Wet air in-leakage and subsequent hydration of cascade deposits
- Moderation by external sources of water or oil, such as inadvertent sprinkler activation, or oil intrusion after bearing failure

The basic hazard categories are listed in order of risk, with the only singly contingent event listed first; large cascade breach from a fire or other exothermic event. The cascade equipment uses large quantities of lubricating oil to support compressor bearing operation. This oil could provide a source of fuel that makes very large fires credible. Likewise, the fluorine chemistry of the diffusion cascade is very complex and can lead to highly exothermic reactions, such as hot metal reaction, or exothermic reactions with the primary cascade coolant (CFC-114). It is unlikely, but credible, that such an initiating event

could cause a large breach in the process boundary, concurrent with exposure of the breach to water from sprinkler activation or emergency response, or oil/water from damaged piping. The UF_6 process boundary is robust and inherently fire resistant as controlled in the configuration management program under the AQ safety classification. Additionally, appropriate TSRs have been identified to demonstrate that this singly contingent scenario is sufficiently unlikely to occur. PGDP is required to maintain a Fire Protection Program, per TSR 3.12. That program minimizes the opportunity for a large fire to progress to the point of breaching cascade equipment. In addition to preventing fires from getting to a magnitude that could cause a breach in the process, the fire protection program minimizes the risk of direct water intrusion into the affected equipment during fire fighting activities. While these measures are expected to be effective at minimizing the risk of a large fire at PGDP, double contingency cannot be demonstrated for this scenario.

The second hazard category involves formation of a large deposit in a process gas cooler concurrent with moderation from RCW. Moderation would be credible in the form of interspersed moderation from RCW that might be present inside the cooler tubes, and interstitial moderation if excessive RCW leakage to the process were to occur. The primary control for this scenario is the geometry and physical properties of the gaseous diffusion process. These geometries and properties ensure subcriticality in the heat exchanger core of a process gas cooler even under the worst-case hypothetical loading and moderation of a process gas cooler. Those subcritical conditions include the cooler tubes being filled with water (RCW), the entire cooler being highly loaded with fissile material, and a large optimally moderated spherical deposit being present at the location of a proposed cooler leak. The primary control to prevent inadvertent criticality is the passive design of the process gas cooler heat exchanger cores. Moderation is controlled as the secondary barrier by ensuring that any RCW intrusion into the CFC-114 system will be detected and corrected before the RCW can reach the gas cooler and moderate a deposit beyond that analyzed and shown subcritical. Double contingency is provided for all scenarios involving internal moderation of cooler deposits.

It is normal case for some sections of the cascade to operate above atmospheric pressure. While common cascade design would lead to the highest pressures being at the feed points where the enrichment is typically non-fissile, it is common for some portions of the fissile cascade to operate above atmospheric pressure as well. This could lead to the potential for the release of large quantities of UF_6 to the cell floor environment in the unlikely event of a breach in the process barrier. The AQ safety classification for the primary process gas boundary as defined in Section 3.15 is used to ensure that equipment design and condition will be maintained to ensure that a large release of fissile material is unlikely to ever occur. In the event that such an event does occur, the analysis demonstrates that very large releases will remain subcritical, even in the presence of open containers of water, such as water wagons (these containers are considered present as part of the normal case). Additionally, the minimum activation temperature of sprinkler heads is controlled where needed to ensure a UF_6 release does not result in concurrent sprinkler activation. Double contingency is provided for all UF_6 release scenarios.

Since the majority of the process gas equipment operates below atmospheric pressure, leaks in the process boundary typically result in in-leakage of atmospheric air. This wet air in-leakage results in formation of uranium oxy-fluoride particulate or deposits. If wet air in-leakage progresses until the fluorinating environment has been consumed, then subsequent in-leakage can lead to hydration of existing uranium oxy-fluorides. The hydration of uranium oxy-fluorides has been studied and it has been shown that in the environment of the process buildings the hydration will not exceed a bulk $^{H}/_{U}$ of 4. The geometry of primary inter-stage components, such as compressors, converters, and coolers, ensure subcriticality under the worst expected loading at this level of moderation. When worst-case loading at an $^{H}/_{U}$ of 4 can not be shown to be subcritical and deposit mass is large or unknown (for example, in large piping outside the cell block valves) then moderation is limited by controlling the duration that the

deposit might be exposed to wet air, before a fluorinating or dry gas environment is re-established. Double contingency is provided for all wet air in-leakage scenarios.

The final hazard category is moderation of cascade deposits from external sources. The introduction of external bulk liquid moderator into the cascade system is unlikely, except for oil intrusion into a compressor following bearing failure. External sources of bulk liquid moderator from spills or spray include sprinkler activation, container spills, and leaking overhead RCW, HPFW, lube oil, or other piping. Protection for these events is provided by the AQ classification of primary process piping. Additionally, when process piping is open for maintenance and the piping is large enough to support a criticality when optimally moderated, administrative controls, such as requiring the equipment openings to be covered, are used to minimize the potential for liquid accumulation in the process equipment even if external moderators are present. Double contingency is provided for each of these events. Oil intrusion by failure mechanisms such as bearing failure, has occurred in the PGDP operational history and it is considered part of the normal case that catastrophic failure of the process seal could allow liquid oil to enter a compressor. However, the analyses have shown the worst expected compressor deposition to be subcritical even in the worst credible location/geometry in the compressor assembly under optimal moderation. Therefore, oil intrusion via a breached process seal is not a credible initiating event for an inadvertent nuclear criticality.

There are no AEFs specifically identified for the operation and shutdown of the cascade.

1.2 Contaminated Equipment Removed from the Cascade

Equipment such as convertors, compressors, and valves is removed from the cascade for maintenance as the equipment fails or wears out. Since this equipment is contaminated with uranium bearing material, the handling and storage operations related to the removal of contaminated equipment, reinstallation of equipment, and handling of equipment removed from the process gas system must be controlled.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the contaminated equipment removed from the cascade. The equipment, upon removal from the cascade, is categorized as either Planned Expeditious Handling (PEH) or Uncomplicated Handling (UH) based on a Non-Destructive Assay (NDA) mass determination, visual inspection, or favorable geometry. Equipment is labeled to indicate its handling category. For unfavorable geometry equipment independent non-destructive assay tests performed before and after removal are used to detect the presence of significant deposits. If the analysis indicates a deposit greater than a safe mass, the equipment is categorized as PEH. UH equipment larger than favorable geometry is reverified to be UH by an NDA or visual inspection within 24 hours. Large deposits in the remaining or adjacent system have been considered in the NCS analyses for the installed process equipment as discussed above in Section 1.1. PEH equipment is spaced from other fissile or potentially fissile material to reduce interaction effects. Remediation/decontamination of PEH equipment must also be performed in

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accordance with TSR time limits. Independent inspections verify the remediation of PEH equipment to UH levels. Mass, moderation, geometry, and interaction are the parameters controlled to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. For instance, the most likely upsets that could occur while the equipment is being moved or stored is a violation of the spacing requirements, or for some source of water to be introduced in the vicinity of the equipment. Moderation intrusion could occur from moist air, sprinkler activation, or a RCW leak while the equipment is unattended and uncovered, potentially leading to a criticality. Therefore, the double contingency principle is met for equipment with deposits less than safe mass. For equipment with deposits greater than safe mass, administrative controls for interaction and moderation are used to assure the safety of operations.

There are no AEFs identified for contaminated equipment removed from the cascade.

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1.4 Surge Drums and C-335 Bottom Surge Drums

In the context of this section, the cascade surge drums include the surge drums located in the four main process buildings and the C-335 bottom drums. The drums serve as a storage and evacuation volume in four primary functions:

- Cascade operational stability: Provide storage for large volumes of UF_6 or lights (e.g. N_2, O_2, and coolant mixtures),
- Cell maintenance: Provide evacuation and storage volume to support obtaining UF_6 negatives and storing purge gases,
- Cell Treatments: Provide storage volume for storing evolved UF_6 and various treatment by-product gases,
- Load follow: Provide storage volume to support planned and unplanned swings in cascade inventory and power changes.

The stored gases can be processed further (e.g. in the C-335 UF_6/R-114 separation system) or they can be returned to the cascade at a later time. The bottom drums in C-335 are typically used as a surge volume to ensure proper inventory control of the top overlap flow and the bottom of C-335. The surge drums and C-335 bottom drums are analyzed and controlled in the same manner for NCS; no differences in their typical use are credited.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the surge drums. Criticality is not credible at PGDP enrichment levels in the gaseous phase regardless of the gaseous moderation ratio. Criticality is also not credible at PGDP enrichment levels in the solid phase, unless the solid material is moderated. Moderation is considered credible from oil or water spills, wet air in-leakage, and possibly from HF condensation.

The robust mechanical design of the drums and passive design features for their mechanical mounting ensure that drum breach is unlikely to occur under anticipated normal operating conditions and credible process upsets. Sources of liquid moderator (i.e. hydrogenated oil and water) are independently controlled by facility design features and administrative controls to ensure that liquid moderator will not enter a drum even in the unlikely even that it is breached.

The NCS analysis assumes that non-volatile heel material (e.g. UO_2F_2) could always be present in a drum interior. When a drum is breached by planned or unplanned events, it will be exposed to some level of wet air in-leakage. Although the anticipated environment in the drum room(s) should be resistant to significant hydration due to typically high temperatures, it is considered credible for long-term exposure to wet air to lead to bulk hydration of non-volatile uranium deposits (e.g. UO_2F_2). Administrative controls are in place to limit the exposure time of drums and to ensure that breaches in the surge drum wall will be detectable by routine drum pressure monitoring. While significant hydration is credible over the course of months (if not years) the drums are controlled to ensure that hydration is limited to only surface hydrates, which

are easily removed with routine evacuation and use. When maintenance activities require excessive exposure times, drum deposition (if present) will be removed or a non-hydrating environment confirmed before returning the drum to service.

The final moderator of concern for surge drum operation is condensed HF. HF condensation requires the concurrent conditions of high total gas pressure, with a high HF partial pressure and low condensing temperature. For instance, even if the condensing temperature is assumed to be as low as 80°F, HF condensation of the UF_6•HF system will not occur unless the total pressure exceeds 20 psia with an HF partial pressure of at least 18 psia. It is unlikely that drum temperature in an operating facility would be as low as 80°F, and it is not considered credible that it would fall below 65°F. Drum pressure is routinely monitored to ensure it is controlled below atmospheric pressure, so that HF condensation will be unlikely even at the lowest credible drum temperature. The condensing conditions (80°F, 18 psia HF, and 20 psia total UF_6•HF) are not credible if the drum has been opened to atmosphere. Likewise, PGDP UF_6 compression systems such as stage or low-speed compressors have no significant compression ratio with high concentrations of light gases. Compressor systems such as high-speed purge and evacuation systems would also not be capable of reaching the condensing conditions for HF. However, even if the high-speed compression systems could reach the condensing pressures and temperature, the credible sources of sufficient HF inventory to be of concern in a surge drum would also include excessive concentrations of non-condensable gases which would vapor lock the closed-ended surge drum and prevent condensation.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is satisfied. There are no AEFs identified for the surge drums and C-335 bottom drums.

1.5 Freezer/Sublimers

The freezer/sublimer is designed to facilitate rapid cascade power changes by adding or removing UF_6 from the cascade. The freezer/sublimer consists of a shell which encloses a lattice of finned tubes through which R-114 is circulated which has been water-cooled in a separate heat exchanger. Water, a

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moderator, is isolated from the UF_6 in the freezer/sublimer by the R-114. The excess UF_6 from the cascade can be quickly frozen around the tubes in the shell side of the vessel or sublimed to the gaseous state for gradual return to the cascade.

Administrative controls, passive barriers, and one AEF have been incorporated to prevent a criticality from occurring in the freezer/sublimer. The freezer/sublimer is a large vessel that can contain significant quantities of low enriched UF_6. Moderation and assay are the primary parameters to be controlled to ensure safe subcritical operations. To reach a criticality with low-enriched uranium, a hydrogenous moderator must be present. UF_6 in the 10-MW or 20-MW freezer/sublimer vessels can be moderated by (1) condensation of HF as the UF_6 gas is freezing (desubliming), and/or (2) by the entrance of water into the vessel. For the assays allowed in the freezer/sublimers, criticality can not be achieved by water leaking into the finned tubes.

Some amount of HF is normally present in the process gas stream. However, in order for the HF condensation to occur at some minimum operating temperature (e.g. 90°F), the system pressure and HF partial pressure must be quite high, compared to cascade operating conditions. The current TSRs at PGDP limit the cascade high side pressure limit to 25 psia, which is artificially high to ensure instrument uncertainty will not result in TSR violations. At 25 psia total pressure, the HF partial pressure would have to exceed 22 psia for saturation to occur at temperatures below 90°F. RCW temperature at PGDP is always greater than 80°F if the cascade facilities are operating. Since RCW temperature is only a concern when rapidly freezing out UF_6, an RCW temperature of 75°F would relate to a condensing temperature greater than 90°F, and so HF condensation would be prevented even for a binary system. The RCW is not controlled because, 75°F is not a credible RCW temperature for an operating cascade at PGDP. Large amounts of water are not normally present within the freezer/sublimer coolant tubes. One objective is to prevent the entrance of water into the vessel (control of moderation). The principal source of water into the freezer/sublimer vessel would be from concurrent tube failures in both the freezer/sublimer and condenser-reboiler allowing recirculating cooling water to enter the vessel. Water entering a freezer/sublimer vessel that has failed (which contains a significant quantity of low enriched uranium) could produce a critical configuration. Excessive UF_6 within the freezer/sublimer could lead to bridging between the freezer/sublimer tubes. This bridging could lead to failure of the tubes due to UF_6 expansion when UF_6 is sublimed back to the cascade. The freezer/sublimer high-high weight trip shall close the UF_6 inlet B-line valve, preventing the mass within the freezer/sublimer from exceeding the UF_6 mass that may cause bridging. The hard-wired high-high weight trip constitutes an AEF.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met by controlling (1) the uranium enrichment, (2) the mass of material which can be contained in the vessels, and (3) the water content of the coolant.

The AEF identified for the freezer/sublimers is the Hard-Wired High-High Weight Trip. See Section 3.15 for details including safety classification.

1.6 5.5 Wt.% UF_6/R-114 Separation System

The 5.5 wt.% UF_6/R-114 Separation system is used to separate refrigerant, which enters the cascade through major process cooler leaks, and other light gases from UF_6. The separation

system removes the UF_6 from the gaseous mixture by freezing the UF_6 in the cold traps. Gas not held up by the cold traps is passed through NaF traps and Al_2O_3 traps. The light gases which pass through the traps go on to the seal exhaust pump station. The ability of the cold traps to operate in both the freeze and sublime modes allows the UF_6 trapped in the cold traps to be sublimed back to the cascade after processing the R-114 laden gas.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the 5.5 wt.% UF_6/R-114 Separation System. The cold trap and NaF traps used in the 5.5 wt.% UF_6/R-114 separation system are favorable geometry for 5.5 wt.% UF_6. Geometry is the primary control used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for the 5.5 wt.% UF_6/R-114 Separation System.

1.7 Seal Exhaust/Wet Air Pump System

The seal exhaust system is used to evacuate dry air and/or nitrogen leaking through process gas seals, thus preventing this inleakage from entering the UF_6 enrichment system. Vacuum pumps are used in the seal exhaust and/or wet air pump stations to remove wet air and/or nitrogen from the system in C-310, C-331, C-333, C-335 and C-337. Alumina traps, located on the suction side of each vacuum pump, remove traces of UF_6 which may be in the line due to seal leakage or from evacuating a cascade cell. The alumina traps prevent damage to the pumps from the process gas and are a barrier between the process gas and the environment. Because of the configuration of the cascade system, some traps (e.g. in C-310) can be expected to trap UF_6 that is enriched to the highest assay processed at PGDP. The alumina trap material is changed when it has been determined that it is saturated with uranium bearing compounds (UO_2F_2). This determination is made via periodic surveys conducted on each trap.

The vacuum pumps are down stream of the alumina traps. UF_6 that traverses the trap media and passes on to the vacuum pump will react with the oil forming UF_4 (solid) and HF (gas). This reaction significantly increases the viscosity of the oil/reaction mixture resulting in pump shutdown before sufficient uranium loading is achieved to pose a criticality concern.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the seal exhaust/wet air pump system. Occurrence of a criticality is possible as a result of the accumulation of enriched uranium in a seal exhaust/wet air pump system. In order to prevent a criticality from uranium and oil in the pump oil reservoir, the pumps have been modified to prevent the oil depth in the oil reservoir from exceeding a critically safe height in facilities which will operate above 1 wt % ^{235}U. An overflow volume with a favorable geometry has been added such that excess oil in the reservoir will overflow from the pump into the overflow volume and be contained separately from the

oil reservoir. The overflow volume is geometrically safe for an assay of 5.5 wt % ^{235}U. Additionally, the "hard piped" connection between the lube oil supply and the pump oil reservoir has been removed and an air-gap introduced. This modification was made in order to ensure that oil can only be added by hand, thereby limiting the amount of oil that could be available to react with UF_6. Enrichment, geometry, and interaction are the primary controls used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for seal exhaust/wet air pump system. NCS documentation establishes controls for performing maintenance activities.

1.8 Tops Purge Trapping System

The tops purge alumina trapping system is used to trap residual UF_6 from the light molecular weight gases that are removed from the top of the cascade exhaust system. Because of the location within the cascade system, these traps can be expected to trap UF_6 that is enriched to the highest assay processed at PGDP.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Tops Purge Trapping System. The traps in this trapping system are nominal 10-inch diameter traps with a fixed spacing which is of favorable design and configuration for criticality safety for assays up to 5.5 wt %. The spent alumina removed from the traps is handled as potentially fissile waste until characterized. This requires collection of the waste in favorable volume containers. Geometry and interaction are the primary controls used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for Tops Purge Trapping System.

1.9 Datum Systems

The operating pressures in the cascade are sensed by differential pressure transmitters and compared to reference pressure provided by the datum systems. The datum systems use the static lines to maintain controlled reference pressures of dry air to the stage differential blind multiplier transmitters.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the datum systems.

The datum pumps are safe in the installed configuration. Interaction between pumps during handling and transportation, or accumulation of uranium from decontamination and disassembly activities are the primary conditions which have the potential to cause a criticality accident. Volume, mass, and interaction are the primary controls used to maintain criticality safety of the datum pumps.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met.

1.10 Text deleted.

1.11 Cascade Building Process Gas Analyzers

This process involves the operation and maintenance activities of the following permanently installed process gas analyzers: Line Recorders; Assay Spectrometers; Infrared Analyzers, Ultraviolet Analyzers; Thermal Conductivity Systems; and a Gas Chromatograph (out of service).

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the process gas analyzers. Volume, geometry and interaction are the primary controls used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for process gas analyzers.

1.12 Standards and Sources

Standards are primarily used in C-709/C-710 and the cascade buildings, while sources are used throughout the plant site for calibrating instrumentation. These sources and standards involve very low masses, generally consisting of milligram quantities.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the standards and sources. Mass and interaction are the primary controls used to ensure criticality safety of the system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for standards and sources.

1.13 Sample and Calibration Buggies

Sample and calibration buggies generally consist of four types of equipment: a small vacuum pump, chemical traps, analytical apparatus, and the interconnecting piping and valves. The analytical apparatus may be any of several types of devices including sample collection tubes, infrared, and ultraviolet gas analyzers.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the sample and calibration buggies. Specific components of concern to criticality safety are the sample collection chamber, small chemical traps and the vacuum pump. However, while installed on the buggies themselves, do not present a criticality hazard due to the small size, spacing between the components, and the configuration of the buggies. Limits are in place to ensure that the size and spacing of buggies' components is maintained during use and all maintenance activities. Components removed from the buggies are handled and stored according to criticality safety limits. Additionally, the buggies are serviced such that the spent trapping media and waste oil are collected and treated as potentially fissile waste in accordance with the plant waste management program.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for sample and calibration buggies.

1.14 UF_6 Sample Tubes

The purpose of cell assay sampling is to determine the assay of the process gas at a particular point within the cascade. UF_6 sample tubes are utilized in the testing of UF_6 for ^{235}U enrichment, uranium density, organic contaminates, etc.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the UF_6 sample tubes. Volume, mass, and interaction are the primary controls used to ensure criticality safety for the operation. The total number of sample containers in a batch or which can be transported at one time is limited by NCS controls. Minimum spacing is required between sample batches and between sample batches and other fissile material.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for UF_6 sample tubes.

1.15 Sample Bulb Cleaning Operations

Sample bulbs (glass) and the associated hardware are cleaned in the cascade and C-360 facilities. The sample bulbs are used to collect cascade safety samples, and under normal operating conditions may contain small amounts of UF_6. However, the worst case credible mass accumulation of ^{235}U in the sample bulbs or cleaning apparatus is extemely small and the potential for an inadvertent criticality does not exist.

There are no AEFs identified for sample bulb cleaning operations.

1.16 Small Chemical Traps throughout the Cascade Process Buildings

Chemical traps are used in the space recorder system, for the cascade line recorders, in the cascade assay machines, and for the cascade buffer system. These chemical traps are used to remove residual UF_6 from a gas stream.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the small chemical traps. Geometry and interaction are the primary controls are used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for small chemical traps.

1.17 Psi (Ψ) Testing

The Psi tests are performed to measure the performance of the barrier. The Psi testing occurs on both the ground and cell floors of the process buildings. The test measures the UF_6 enrichment, temperature, and pressure of a given cell.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Psi tests. The primary accident scenario is the interaction of various vessels involved in the operation. Interaction controls are applied to this operation, as none of the vessels have an internal volume large enough to pose a criticality safety hazard without interaction with other vessels. The volumes of the individual vessels were shown to be safe.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for Psi tests.

1.18 UF_6 Process Equipment Received from Off Site

Equipment that has been exposed to process gas may be received from off site (e.g., from K-25 or Portsmouth). Shipment and receipt of used UF_6 process equipment is limited to NCS exempt shipments or equipment or groups of items that contain no more than a UH mass at a maximum enrichment of 5.5 wt.% ^{235}U.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the equipment received from off site. Double contingency is established to transition fissile equipment from DOT regulation to PGDP site control. Mass and interaction are the primary controls used to ensure criticality safety of the shipment.

Legacy equipment from off site is stored in specially marked storage areas. The enrichment of fissile material within this legacy equipment can exceed 90 wt. % ^{235}U. Mass and interaction are the primary controls used to ensure its criticality safety.

In order for a criticality to be possible, multiple contingent events would have to occur concurrently. The double contingency principle is met and there are no AEFs identified for equipment received from off site.

1.19 C-310 Gas Phase Technetium Trap System

The purpose of the gas phase ^{99}Tc trap system is to reduce the ^{99}Tc impurity concentrations in the purge cascade. Gaseous UF_6 may be diverted through traps from cell 5, cell 7, or cell 9 in the purge cascade. A small portion of the purge cascade cell flow is diverted to the traps and then returned.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in this system. Geometry and interaction controls are the primary controls utilized to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met, and there are no AEFs identified for the gas phase ^{99}Tc trap system.

2.0 UF_6 Handling Facilities

The equipment evaluated for criticality safety in these facilities includes the autoclaves, product cylinders, scale and elevator pits, oil interceptors, Normetex pumps, and various tanks.

2.1 Autoclaves (C-360 or Feed Autoclaves)

Analysis supports material with an assay up to 5.5 wt % ^{235}U being heated within the steam-heated autoclaves in C-360, C-333-A, or C-337-A as necessary for sampling/transfer or for feed to the cascade at an assay matching point. In order to feed material to the diffusion cascade under normal conditions, the Category A or B cylinder must be heated to transform the solid UF_6 to a liquid and then to gaseous state. For Category C cylinders, the cylinder is heated such that the pressure remains below 22 psia to prevent cylinder over-pressurization. Some Category C cylinders are not heated at all and are vaporized at ambient temperature. The UF_6 gas flows from the cylinder through connecting piping called a pigtail to UF_6 feed headers which deliver the gaseous feed material to appropriate assay points in the diffusion cascade. Should the pigtail fail or the cylinder rupture there is the possibility of a criticality from the mixing of UF_6 and the water inventory in an autoclave system. The cylinder is placed in the autoclave and connected to a manifold with a pigtail. After certain operational steps and conditions are met, steam can be introduced into the autoclave. After the heating/feed cycle is completed, the pigtail is disconnected and the cylinder is removed.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the autoclaves. Two major barriers are in place to meet double contingency and to prevent a nuclear criticality in an autoclave: (1) ensuring the integrity of the UF_6 system (a passive barrier), thereby precluding the intermixing of the UF_6 being heated and the steam/water providing the heat source, and (2) in the unlikely event that the UF_6 and water do mix, ensuring operability of the water inventory control system to minimize the amount of water available for reaction with the UF_6 and for neutron moderation. Various administrative controls and checks are used to verify the suitability of cylinders to be heated and confirm the integrity of UF_6 connections. Additionally, the autoclave steam pressure or UF_6 cylinder pressure is controlled to reduce the likelihood of a cylinder rupture. For normal heat cycles, the Autoclave Steam Pressure Control System is employed as an AEF to maintain a maximum steam pressure thereby limiting the amount of heat supplied to the cylinder and, hence, the internal pressure of the cylinder. Unlike during normal heating, controlled feeding does not require the ASPCS to be operational. For controlled feed heat cycles, the high cylinder pressure system is employed as an AEF to monitor the UF_6 cylinder pressure to maintain a maximum UF_6 pressure below the triple point.

Water inventory is of nuclear criticality safety concern once heat is applied to the cylinder. At the initiation of the heating cycle, the water inventory will be high due to the large amounts of condensate on the cooler surfaces. At the UF_6 triple point, the water inventory will be at its highest. However, the point in the heat cycle when the UF_6 is completely liquid and in steady state conditions represents a point when a majority of the activities such as normal feeding, sampling, and transferring take place in the autoclaves. Water inventory at this time, however, may be at its lowest. With the cylinder at steady state temperature, and steam demand limited to that required to replace the energy carried from the cylinder by the feed or sample flow, both steam and condensate available for reaction with (potential) UF_6 out-leakage are minimized.

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To assure the maximum allowable water inventory of the autoclave is not exceeded, dual condensate level probes are mounted at the same elevation in the condensate drain, slightly below the autoclave floor. Any abnormal accumulation of condensate in the drain line reaching the level of these probes automatically isolates the autoclave steam supply and prevents the addition of more water. These probes are therefore vital for insuring an acceptable water inventory to avoid an overpressure condition resulting in a release from the autoclave and to prevent a criticality when the autoclave is handling isotopically enriched UF_6 of up to 5.5 wt% ^{235}U. The Water Inventory Control System, an AEF, ensures that at the time the UF_6 is liquified there is not enough water in the autoclaves to support a criticality.

In the event of a release, reaction products of UF_6 and water are detected by a conductivity cell (not relied upon for criticality safety) and/or pressure instrumentation (an AEF), either of which effect containment by closure of isolation valves at the penetrations (with the exception of the autoclave relief line). During a release of UF_6 in an operating autoclave the pressure rises rapidly. Consequently, the autoclave isolation system is initiated by the pressure sensor for those releases having a large and rapidly rising pressure. The Autoclave High Pressure Isolation System constitutes an AEF.

Perhaps the most inopportune time for a UF_6 release to occur during any autoclave operation is during that portion of the sample or transfer operations when the autoclave must be open to operate the cylinder valve. Cylinder rolling is necessary to position the cylinder valve below the level of liquid UF_6. This is accomplished with the autoclave open. Administrative controls require the pigtail to be disconnected during rolling or tilting operations to prevent damage. The cylinder roll interlock system is an AEF which prevents the rolling of a cylinder while the pigtail is pressurized.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Two major barriers are in place to meet double contingency and to prevent a nuclear criticality in an autoclave: (1) ensuring the integrity of the UF_6 system, thereby precluding the intermixing of the UF_6 being heated and the steam/water providing the heat source, and (2) in the unlikely event that the UF_6 and water do mix, ensuring operability of the water inventory control system to minimize the amount of water available for reaction with the UF_6 and for neutron moderation. Operational and configuration controls of the autoclave system are the primary means to ensure prevention of the described scenario.

The UF_6 Release Detection System in C-337A isolates all autoclaves when any combination of four or more output signals are received from UF_6 detector head actuatations. This AEF provides a reliable means of detecting and isolating large UF_6 releases while minimizing undue thermal transients on the autoclave process equipment. This is used to control the mass of uranium released in the event of equipment failure. This system provides isolation of the autoclaves by activating the Autoclave Manual Isolation System. The components of this system include the UF_6 detector heads, alarm circuitry and detector circuit electrical power. Isolation components such as the UF_6 valves themselves are considered to be within the boundary of the Autoclave Manual Isolation System.

The AEFs identified for autoclave consist of the Autoclave Water Inventory Control System, the Autoclave High Pressure Isolation System, Cylinder Roll Interlock System, the Autoclave Steam Pressure Control System, the High Cylinder Pressure System, and the C-337A UF_6 Release Detection System. See Section 3.15 for details including safety classification.

2.2 Section Deleted

2.3 Product Cylinders

The product cylinders used at PGDP to store UF_6 vary in size. Under the right conditions it is possible to have a criticality resulting from a rupture of a cylinder and/or from the addition of moderating material to a cylinder containing enriched uranium.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in product cylinders. Three situations are postulated that could result in a critical configuration:

1. Withdrawal of a moderator in the form of HF along with UF_6 into a cylinder during the filling process could result in a criticality by exceeding the acceptable H/U ratio;

2. In the event of a leak or rupture of a cylinder, the addition of a large amount of water into the cylinder which reacts with the contents and results in a critical configuration;

3. Rupture of a cylinder which releases uranium compounds to atmosphere, and that material precipitates out of the atmosphere by rain or water spray and accumulates in solution in an unfavorable geometry outside the cylinder.

Double contingency cannot be demonstrated for large liquid-filled UF_6 product cylinders since moderation control is the only control to ensure subcriticality. The most likely moderating material to be encountered in a cylinder is HF that is fed to the withdrawal cylinder from the cascade. Moderation control for product cylinders is based on the UF_6 condensers being maintained under strict temperature and pressure controls to ensure HF will not condense. This ensures the H/U ratio will remain below 0.088 since only a small, safe amount is dissolved in UF_6.

The cylinders are filled with liquid UF_6. After the UF_6 has solidified, the cylinders are moved to the cylinder yard for interim storage. UF_6 cylinder handling activities include movement between the

buildings, storage at each location, and cylinder valve changes. The criticality safety of this process is assured through the general NCS programmatic controls identified elsewhere in this document. Appropriate limits and controls are provided in the specific NCSA governing the operation to maintain sufficient protection against an inadvertent criticality.

In order for a criticality to be possible, multiple events would need to occur simultaneously. Although, the double contingency principle is not met for liquid filled cylinders, administrative controls and passive barriers are used to assure the safety of operations.

There are no AEFs identified for filling product cylinders.

2.4 Normetex Pumps

Normetex pumps are used in both the product and tails withdrawal systems at PGDP; however, NCS focuses primarily on the pumps used for product withdrawal operations in C-310 since the incident of concern is an accidental nuclear criticality. Tails withdrawal does not involve material capable of a criticality.

Administrative controls, passive barriers, and AEFs have been incorporated to prevent a criticality from occurring in the Normetex pumps. The most likely scenarios are associated with a potential rupture of the barrier between the process gas and oil/wet air regions of the pump during operation. The events which could produce a failure of the barrier between the UF_6 and oil/wet air are: 1) rupture of the barrier on the low pressure side of the pump, which includes the bellows area and outer scroll region; and 2) rupture of the barrier on the high pressure side of the pump, which is comprised of the center scroll region.

The scenario initiated by rupture of the barrier between the UF_6 and oil/wet air on the low pressure side of the pump (from the suction line to outer scroll region) is not an NCS concern, since the process gas regions of the pump are of favorable geometry. Only with the concurrent, unlikely condition that the suction pressure is above atmosphere could the UF_6 be forced out of the process gas regions and potentially into the oil reservoir which is the primary accumulation point in this scenario.

A rupture on the high pressure side of the pump would allow material to escape from the process gas regions of the pump and enter the oil system regardless of the suction pressure. The worst potential consequences could allow unlimited quantities of gaseous UF_6 to accumulate in the pump oil reservoir. The UF_6 passing to the outside of the pump is gaseous based on the pressure decrease from 30 psia output line pressure to atmospheric pressure in the pump housing and oil sump. Gaseous UF_6 passing into the oil sump can react partially with the oil surface. Reaction of the UF_6 with oil results in higher oil viscosity which severely limits the ability of the UF_6 and oil to mix. Two pump trips are employed as AEFs to limit the amount of UF_6 that can mix with the oil. These AEFs are the High Oil Pressure Trip and the Low Oil Flow Trip.

Much of the UF_6 entering from the rupture is expected to react with water vapor in air and be exhausted out the oil sump vent. Release of UF_6 or UO_2F_2 and HF from the oil sump vent will activate the UF_6 detection system (an AEF) and general building alarms. The UF_6 detection system for the pump installation will automatically shutdown the pump and isolate the system from the downstream high pressure UF_6 source. Although not all pump trip systems on the Normetex pump are credited as AEFs, the Normetex discharge block valve closure that is activated due to a pump trip is credited as an AEF. When a signal is sent to the pump to trip the pump, the discharge block valve is required to close to isolate the pump from backflow of high pressure UF_6 into the pump. The backflow of UF_6 into the pump could challenge the integrity of the internal bellows and allow UF_6 to enter the pump oil reservoir.

The Normetex pumps effectively satisfy the double contingency principle for nuclear criticality safety. Two NCS parameters, moderation and mass, associated with operation of the Normetex pumps are controlled to maintain subcriticality. Moderation is controlled by maintaining the integrity of the UF_6/oil barrier in the pump. The pump is designed such that the process gas and oil regions are separate. A failure of this barrier will result in the potential for mixing the uranium with a moderating material. The uranium mass is controlled in this operation through the actions of the automatic and manual pump shutdown and isolation systems (AEFs). In the event of a rupture of the barrier, these systems will function to stop and isolate the pump, thus limiting the amount of uranium which can be released.

The AEFs identified for Normetex pumps are the High Oil Pressure Trip, Low Oil Flow Trip, the C-310 Normetex Pump Discharge Block Valve Closure or pump trip and the UF_6 Leak Detection System. See Section 3.15 for details including safety classification.

2.5 Product Withdrawal Accumulators

The two liquid UF_6 accumulators which serve the product withdrawal system are located in C-310A. The accumulators provide a surge volume for the UF_6 product withdrawal process.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the product withdrawal accumulators. Moderation control, as described above for the product cylinders, is the primary barrier to criticality in the accumulators. Uranium enriched to 6 wt % ^{235}U or less cannot achieve criticality unless moderation is present. Since UF_6 readily reacts with moisture to form UO_2F_2 and HF, it is necessary to keep the cascade free of moisture. Therefore, the system design preclude introduction of moisture into the cascade. The only mechanisms for moisture to enter the system are for the moisture to come through the product withdrawal pumps from the cascade, for the system to leak (wet air inleakage), or for purge gas (N_2 or air) laden with moisture to be misdirected into the UF_6 product header. An evaluation of moderation intrusion via plant air or nitrogen used as a purge gas has shown that this is not a credible pathway to criticality.

The temperature and pressure in the withdrawal system are maintained to keep the HF concentration low enough that the H/U ratio in the system is low. This is assured through administrative controls and passive design features.

There are no AEFs identified for filling product cylinders.

2.6 Sampling Station at Product Withdrawal

The sampling cabinet located in the product withdrawal room provides a safe method of sampling liquid UF_6. Samples are withdrawn from the cylinder fill line into small favorable geometry 2S cylinders or sample tubes. The 2S cylinders or sample tubes are then transferred to the laboratory for analysis. The 2S cylinders and sample tubes may be re-fed to the cascade.

There are no AEFs identified.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occuring during product withdrawal samping operations. Volume, geometry, mass, moderation, and interaction are the primary controls used to ensure criticality safety.

In order for the criticality to be possible, multiple failures would need to occur simultaneously. Therefore, the double contingency principle is met.

2.7 Cylinder Burping/Sodium Fluoride Traps

After the liquid UF_6 product has cooled and solidified, the cylinder is connected to a manifold at the C-310 burping station or to the product withdrawal station to exhaust remaining light gases from the cylinder. The gases pulled from the cylinder can be exhausted to either the cascade purge system or to the NaF traps. The sodium fluoride traps in C-310 are used to remove UF_6 in evacuated gases originating from product cylinders. Impurities, which can be a mixture of nitrogen, hydrogen fluoride, intermediate gases, R-114, etc., are entrained in the liquid UF_6 as it is withdrawn into the product cylinders. This material is evacuated (burped) from the cylinders through NaF traps or back to the cascade. The small quantities of UF_6 evacuated with the impurities are absorbed by the NaF pellets in the traps until pellet saturation occurs. The NaF pellets are then regenerated by heating the traps and using a sweeping purge to evacuate the UF_6 and return it to the C-310 cascade.

In C-360, solid 30B cylinders are pressure checked to determine if cylinder pressure is within shipping pressure requirements. If pressure exceeds requirements, cylinder burping occurs to meet specifications. Burping in C-360 involves connecting the solid 30B cylinder to a manifold at the burping station to exhaust non-condensible gases from the cylinder to the evacuation drums or directly to the cascade evacuation system via a tie line.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the cylinder burping operation in C-310 and C-360 and for the sodium fluoride traps in C-310. Enrichment, geometry and interaction are the primary controls used to maintain criticality safety of the C-310 burping operation and sodium fluoride traps. Trap geometries are safe for specified enrichments. Moderation and mass control are the primary control used to maintain criticality safety on the C-360 burping operation.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for cylinder burping and use of the sodium fluoride traps.

2.8 C-360 Scale/Elevator Pits

There are several large pits in C-360 used to house various scale and lift components. They include the hydraulic lift pit, the upstairs scale pit, the basement scale pit, the elevator pit, two oil interceptor pits, and two valve pits.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-360 scale and elevator pits. None of these pits are of favorable geometry. Water that collects in the pits either drains out or must be pumped out. The pipes in the drain systems of C-360 have a nominal diameter of 4 inches. At an enrichment of 5.5 wt % ^{235}U, the minimum critical diameter of a cylinder is much greater than 10 inches. Therefore, the 4-inch diameter pipe is a favorable geometry.

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Before a critical configuration can exist in any of the pits, a well moderated uranium solution would have to accumulate to an unsafe depth. Thus, the criticality accident of concern for pits in C-360 is from an accumulation of uranium and moderator, most likely in the form of water, in one of the pits. For such a scenario to occur, a large release of UF_6 would have to happen and that uranium would have to reach the pits. Second, sufficient moderator would have to be present in the pit. In order for the water to be in the pit, the sprinkler system would have to release water or the water would have to already be in the pit when the uranium arrived.

Uranium could enter the pits through a release of UF_6 in an autoclave, cylinder, or process piping and componenets (See discussion of controls and AEFs, in Section 2.1 and 2.14 of this appendix, that mitigate such releases) or through a handling incident in or around the scales or elevator. Two release detection systems, UF_6 release detection systems (zones 2 and 3), and UF_6 refease detection system (zone 4) detect UF_6 releases and will stop the elevator pit sump form running when they detect a UF_6 release. This prevents pumping a fissile solution to an unsafe geometry. In addition, the UF_6 release detection system (zone 4) initiates closure of two transfer isolation valves and the cylinder valve at the transfer station. This AEF stops the flow of liquid UF_6 from the parent cylinder to the daughter cylinder. The elevator pit water and oil sensor and alarm system is in place in the elevator pit to detect the presence of a liquid accumulation prior to achieving an unsafe depth. If water/oil is detected in the pit, an audible alarm is actuated and immediate action is taken to remove the accumulated liquid. A quarterly inspection of all the pits and drains is performed to verify that no uranium deposits are accumulating and to verify that the pit drains are operational.

Two oil interceptors are in C-360 so that all of the floor drain lines to the storm sewer must pass through them. During a UF_6 release, it could be possible to introduce uranium into these interceptors which could contain moderator in the form of oil and water. To prevent more than minor quantities of uranium from directly entering the interceptors, the interceptor pits are covered and sealed. The only other credible mechanism for introducing uranium into the interceptors is by washing fissile material from a UF_6 release into the C-360 drains by a source of water. Sources of water identified are water from sprinkler activation following a UF_6 release and water backing up through the drain system. Controls are implemented to ensure that it is unlikely for water to back up through the drain. An inadvertent sprinkler activation is also an unlikely event. Thus, two unlikely events (UF_6 release and source of water on the C-360 floor) would have to occur to wash uranium into the C-360 pits and produce a criticality.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. For instance, a uranium release must occur simultaneously with the presence of moderator in the pits. Therefore, the double contingency principle is met.

AEFs specifically identified for the sump pump trip function of the C-360 pits are the UF_6 release detection system (zones 2 and 3).and the sump pump trip function of the UF_6 release detection systems (zone 4). As referenced above, Sections 2.1 and 2.14 of this appendix discuss additional controls and AEFs that contribute to this operation. These AEFs include the autoclave water inventory control system, autoclave high pressure isolation system, autoclave steam pressure control system, UF_6 release, detection system (zones 1), autoclave cylinder roll interlock system, interlock switch between C-360 elevator and scale cart system, cylinder scale cart movement prevention system, elevator key lock

interlock on elevator door, and the isolation valve closure function of UF_6 release detection systems (zone 4). See Section 3.15 for details including safety classification.

2.9 C-310 Scale Pits

The scale pits in the C-310 product withdrawal system are approximately 8 feet wide by 12 feet long for stations 3 and 4, and 8 feet wide by 9 feet 4 inches long for station 5 and are located beneath each product withdrawal station. Before a critical configuration can exist in the scale pits, a uranium solution would have to accumulate to an unsafe depth. This represents a significant quantity of uranium and moderator.

Administrative controls, passive barriers, and an AEF have been incorporated to prevent a criticality from occurring in the C-310 scale pits. Accumulation of uranium in the scale pit could result from rupture of a product cylinder or from a broken pigtail. Automatic valves (safety systems) shut off UF_6 to the cylinder when a release is detected as part of the Product Withdrawal UF_6 Leak Detection System (an AEF). The cylinder valve will also be closed by an automatic system upon detection of a UF_6 release. The automatic closure of valves during a release prevents the accumulation of uranium should a pigtail break.

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The Scale Cart Movement Prevention System prevents moving a scale cart with a pressurized pigtail attached. This AEF provides mass control. The Product Withdrawal UF_6 Release Detection and Isolation System mitigates a release and acts as a mass control.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met.

Two AEFs, the Product Withdrawal UF_6 Leak Detection and Isolation System and the Scale Cart Movement Prevention System are identified for C-310 scale pits. See Section 3.15 for details including safety classification.

2.10 Cylinder Weigh Scales in C-333A and C-337A

The cylinder weigh scales are used to determine the UF_6 cylinder mass.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-333A and C-337A cylinder weigh scales. Only solidified or empty UF_6 cylinders are allowed to be placed on the weigh scales to preclude the potential of accumulation during a postulated cylinder breach. Accumulation of uranium in the unfavorable geometry scale pit could potentially produce a criticality. Cylinder integrity (providing mass control) is the primary control used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for the C-333A and C-337A cylinder weigh scales.

2.11 C-360 Evacuation and Relief Drums

The relief drums are used to contain the overflow material in the event of a manifold high pressure incident which ruptures the rupture discs. The evacuation drums are used to collect gaseous UF_6 during C-360 operations.

The Autoclave Water Inventory Control System is designated as a safety system for the toll transfer and sampling facilities. This system's primary function is to limit the amount of water in the autoclave. The limiting of water is a criticality control by limiting the amount of moderation to the evacuation and relief drums should the UF_6 cylinder lose its integrity, for example, by a pigtail rupture. Two condensate level probes are mounted in the three-inch drain pipe slightly below the autoclave shell. If the sonic signal from either of the probes detect high condensate level or any other reason, the two steam supply isolation valves and thermovent line block valve close to limit the total water in the autoclave.

The Autoclave Steam Pressure Control System controls the steam pressure and its associated saturation temperature in order to limit the vapor pressure and liquid volume of the UF_6 within the cylinder, preventing over-pressurization and loss of ullage. When the steam pressure set point is reached, an alarm is sounded and two steam supply isolation valves and the thermovent line block valve are closed. This limits moderation of the evacuation and relief drums. The components of this system include pressure switches; the dual block valves; and associated relays, solenoids, and other electrical components.

The Autoclave High Pressure Isolation System is actuated by the pressure rise within the autoclave and initiates autoclave isolation by closure of the block valves on all lines penetrating the autoclave head. This provides moderation control for the evacuation and relief drums following a postulated pigtail rupture. The components of the safety system include the pressure switches, two isolation valves on lines penetrating the autoclave head; and associated relays, solenoids, and other electrical components.

Administrative controls, passive barriers, and AEFs have been incorporated to prevent a criticality from occurring in the C-360 evacuation and relief drums. Temperature and pressure controls are maintained to preclude the desublimation of UF_6 and condensation of HF (moderation). Moderation and interaction are the primary controls used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met. Three AEFs, the Autoclave High Pressure Isolation System, the Autoclave Water Inventory Control System and the Autoclave Steam Pressure Control System are identified for the C-360 Evacuation and Relief Drums. See Section 3.15 for details including safety classification.

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2.12 C-333A, C-337A Autoclave Air Capture Systems

The autoclave air capture systems in the C-333A and C-337A feed facilities are used to capture airborne UF_6 and its UO_2F_2 and HF reaction products. The use of the systems as industrial vacuums is not approved.

Administrative controls and passive barriers are implemented to prevent a criticality from occurring in the autoclave air capture systems. There are no AEFs in use for these systems. The limiting upset for the use of the autoclave air capture systems is the breach of a liquid-filled UF_6 cylinder. This event can be caused by an operational failure (e.g., failure to close the cylinder valve before removing the pigtail) or the loss of the physical integrity of the cylinder valve. Geometry is the primary parameter controlled to maintain criticality safety of the autoclave air capture systems.

In order for a criticality to be possible, multiple independent events would have to occur simultaneously; therefore, the double contingency principle is met.

2.13 Fixed High Efficiency Filter Systems (HEFS)

The HEPA filters in the fixed (i.e., in-place) HEFS remove airborne uranium particulate produced by a UF_6 release.

Administrative controls, and passive barriers have been incorporated to prevent a criticality from occurring in the fixed HEFS. The criticality accident scenario associated with the C-310 and C-360 HEFS involves deposits of fissile material greater than a subcritical mass. Mass, moderation, and interaction are the controls used to ensure criticality safety. Administrative controls, such as visual inspection or non-destructive assay analysis, are used to ensure criticality safety in the C-310 and C-360 fixed HEFS.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met, and there are no AEFS.

2.14 Sampling, Transfer, and Refeeding Operations in the C-360 Toll Transfer and Sampling Facility

The C-360 Toll Transfer and Sampling Facility provides systems for the receiving, sampling, transferring and shipping of UF_6 cylinders. Samples are withdrawn from the UF_6 cylinders into small, volume controlled 2S cylinders or sample tubes. The samples are then transferred to the Laboratory for analysis. Once the analysis is complete, the samples and metal cold traps associated with the mass spectrometry equipment are returned to the C-360 facility for refeeding to the cascade. 1S cylinders may also be refed to the cascade.

The liquid UF_6 handling equipment is relied on to prevent a liquid UF_6 release which could result in a criticality if sufficient water was able to react with the fissile material.

The levelator and scale cart are designed with a minimum capacity of 20 tons. The interlock switch between the levelator and the scale cart air supply prevents movement of the cylinder if the levelator is not in its full upright position. The rail stops on the levelator prevent rolling the scale cart and the cylinder off the end of the lift.

The UF_6 Release Detection System - C-360 Laboratory Area (Zone 1) provides for detection of UF_6 and isolation of autoclave containment valves upon detection of UF_6 in the laboratory at one of two detectors. The UF_6 release detection system in zone 4 provides for detection of UF_6 and closure of two transfer block valves and the cylinder valve upon detection of UF_6 at the transfer station. This AEF stops the flow of liquid UF_6 from the parent cylinder to the daughter cylinder. These AEFs limits a liquid UF_6 release to acceptable levels.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-360 sample, transfer, and refeeding operations. Volume, geometry, mass, moderation, and interaction are the primary controls used to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met. The Liquid UF_6 Cylinder Handling Equipment, Levelator/Scale Cart Interlock UF_6 Release Detection System - Laboratory (Zone 1) and transfer station (zone 4) are identified as AEFs. See Section 3.15 for details including safety classification.

2.15 C-360 ^{99}Tc Trapping System

The purpose of the ^{99}Tc trapping system is to reduce ^{99}Tc impurity concentrations to within customer defined limits. Liquid UF_6 may be diverted through the traps during transfer to a daughter cylinder.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occuring in this system. Geometry and interaction controls are the primary controls utilized to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met, and there are no AEFs identified for the ^{99}Tc trapping system.

3.0 C-400 and C-409 Chemical Recovery/Precipitation and Decontamination Operations

Some of the C-400 and C-409 decontamination and uranium recovery equipment has the possibility for criticality. Therefore, controls are implemented to prevent criticality accidents. The equipment analyses are presented in the following sections.

3.1 C-400 Spray Booth

The C-400 spray booth is used to clean contaminated equipment. The cleaning system uses high-pressure process water to rinse surface contamination from equipment to be decontaminated. The system consists of a spray booth with a drain; nominal 10-inch diameter wash solution storage tanks; supply and return pumps; filters; a high-pressure jetwash system; a ventilation system; and associated piping and spraying fixtures. Solution stored in nominal 10-inch diameter solution storage tanks is eventually sent to a uranium recovery system.

Administrative controls, passive barriers, and AEFs have been incorporated to prevent a criticality from occurring in the C-400 Spray Booth.

The contaminated wash solution in the tanks is transferred to a uranium recovery/precipitation system periodically. The two systems available are the C-400 uranium recovery and the C-409 uranium

precipitation systems. Transfer to the C-400 receiving and storage system may be done after two independent representative samples have shown that the uranium enrichment of the contaminated wash

solution is less than or equal to 1.5 wt % ^{235}U and that the concentration is less than 100 g U/liter for any solutions greater than 1.0 wt % ^{235}U (up to and including 1.5 wt % ^{235}U). All higher enrichment solutions are transferred to C-409. Inadvertent transfer of solutions greater than 1.5 wt % ^{235}U to the unfavorable geometry tanks in C-400 is administratively controlled by requiring independent keylock operation of the transfer valve by two persons. This Key Interlock for Solution Transfer is an AEF.

The floor basin associated with the spray booth is of favorable geometry for up to 5.5 wt.%, less than a safe slab depth, for criticality safety. Solution depths greater than 4.25-inch are prevented by design since the excess material would run out of the booth into the building floor. The solution storage tanks

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are nominal 10-inch diameter and are also of favorable geometry for up to 5.5 wt. %. Additional stringent administrative controls on system operation, particularly the mass of uranium contained in equipment to be decontaminated and on the placement of equipment to be decontaminated, are used to ensure criticality safety for spray booth operations.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met.

There is one AEF identified for C-400 Spray Booth. This is the Key Interlock for Solution Transfer. See Section 3.15 for details including safety classification.

3.2 C-400 Uranium Recovery Unit

The primary mission of the C-400 Uranium Recovery System is the processing of uranium contaminated solutions that have low enrichment. The C-400 uranium recovery process involves the storage and transfer of contaminated solutions generated by the C-400 spray booth and the C-400 cylinder wash facility. In addition, solutions in portable containers may be transferred to this facility for processing in accordance with applicable NCS controls.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-400 Uranium Recovery System. Solution with an enrichment equal to or greater than 1.0 wt % must be isotopically diluted prior to transfer to the No. 5 dissolver unit. A criticality accident could occur if a solution with an enrichment greater than 1.5 wt % were inadvertently transferred to the C-400 uranium recovery system's nominal 20-inch diameter receiving tanks. To meet double contingency requirements, duplicate, independent samples are required prior to any solution transfers.

Another accident scenario involves the transfer of solution from the nominal 20-inch diameter storage tanks in the C-400 uranium recovery system to the No. 5 dissolver unit which is not criticality safe for uranium enriched to equal or greater than 1.0 wt % ^{235}U. Current operations provide for the isotopic dilution of solutions at the acidifying facility to less than 1.0 wt % ^{235}U. Based on the results of criticality analyses, the potential for criticality exists in the uranium recovery system only if there is a loss of assay control within the system. Two scenarios were identified which bound the potential for criticality in the uranium recovery systems. These scenarios are: (1) uranium with an assay equal to or greater than 1.0 wt % ^{235}U accumulating in sufficient quantities in an unfavorable geometry; or (2) ^{235}U enrichments greater than the permissible limits are introduced to the uranium recovery system.

A combination of limits on enrichment, mass, concentration, and the use of favorable geometry are used to ensure the nuclear criticality safety of the C-400 uranium recovery system. Uranium mass is controlled indirectly through a concentration limit of 100 g U/liter in accordance with applicable NCS controls. Enrichment is controlled by sampling prior to transferring.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met.

3.3 C-409 Uranium Precipitation System

The primary mission of the C-409 Uranium Precipitation System is the processing of the uranium contaminated solutions that have enrichments equal to or greater than 1.0 wt % ^{235}U that can not be processed by the C-400 Uranium Recovery System. The C-409 uranium precipitation systems includes a solution acidifying and storage tank system, a precipitation tank system, a rotary vacuum precipitation system, and a filtrate tank system.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-409 Uranium Precipitation System. The solution acidifying and storage tanks are nominal 10-inch diameter and are by design and arrangement of favorable geometry for nuclear criticality safety for handling uranium solutions containing 5.5 wt % ^{235}U or less.

All storage, acidifying, precipitation, and filtrate tanks share a common overflow and vent line. If a tank should overflow, the overflow is discharged onto the stainless steel floor pan. The vent line also exhausts near the floor pan. The potential for voids to be formed under the floor pan is similar to that discussed for the C-400 Uranium Recovery Unit. To ensure the floor integrity is maintained, visual inspection of the floor pan for degradation, corrosion, or other damage is implemented.

The precipitation system tanks are nominal 10-inch diameter and are favorable geometry by design and arrangement for uranium solutions containing 5.5 wt % ^{235}U or less. Each of the tanks is equipped with two liquid level sensors. Should the liquid level reach these switches, the solution storage transfer pump, the slurry transfer pump, and the filtrate pump will trip off and a visual and audible alarm will sound. An upper level switch also actuates a visual and audible alarm.

A combination of limits on concentration/density and the use of favorable geometry is used to ensure the nuclear criticality safety of the system. Concentration/density is used as a control for NCS in one portion of the system. The transfer of filtrate to storage systems is limited to ensure that the

solution transferred out of the system does not require further NCS controls. The majority of the system is fabricated of pipe that is of favorable geometry for 5.5 wt % ^{235}U. The drum filter unit is designed to be safe at enrichments up to 5.5 wt % ^{235}U. Components of the system that are not favorable geometry have specific NCS controls.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met. There are two AEFs identified for C-409 Uranium Precipitation System. These are the Filtrate Receiver High-Level Actuation System for the filtrate pump and the Filtrate Receiver High-Level Shutoff System for the vacuum pump. See Section 3.15 for details including safety classification.

3.4 C-400 Cylinder Wash

The C-400 Cylinder Wash Facility consists of a cylinder wash operation and a hydrostatic testing operation. The cylinder wash operation provides a means to maintain the cleanliness of 10 and 14 ton UF_6 cylinders and to remove the residual uranium heels. The hydrostatic testing operation provides a test facility to perform the required periodic hydrostatic pressure testing recertification.

Administrative controls and passive barriers have been incorporated to prevent an inadvertent criticality in the C-400 cylinder wash and hydrostatic testing operations. The cylinder wash can be operated at two different assay ranges. To avoid heel mass limits, the operation can be limited to less than 1.0 wt % ^{235}U. Also the operation can be operated at less than 2.0 wt % ^{235}U. Since the 48 inch cylinders are not favorable geometry for optimally moderated 2.0 wt % ^{235}U in water, administrative controls must be utilized. The administrative controls for C-400 cylinder wash activities limit the assay and mass of the residual heel material remaining in the cylinders to be washed. Spacing is also controlled administratively and through passive barriers designed into the cylinder wash stand. The wash solution storage tanks are nominal 16-inch diameter tanks which are geometrically safe for 2.0 wt % ^{235}U. The drain pan for wash solution has a depth of approximately 8 inches, which is geometrically favorable for 2.0 wt % ^{235}U.

When operated to less than 1.0 wt % ^{235}U the mass of the heel is not controlled since an entire full cylinder could not become critical even under optimum moderation conditions. Instead of controlling the mass, multiple controls are placed on the assay of the heel left in the cylinders.

The C-400 hydrostatic test facility can also be operated with two different assay limits. The test facility can be limited to less than 1.0 wt % ^{235}U to avoid controls, which are necessary for enrichments above this value. In addition, the test facility can be operated at at assays up to 5.5 wt % ^{235}U. The hydrostatic storage tanks are not favorable geometry for 1.0 wt % ^{235}U or greater. The administrative controls associated with the C-400 hydrostatic testing operation include verification that all visible uranium-bearing material has been removed from the cylinders prior to connecting them to the hydrostatic testing system. Preventing the introduction of uranium to the system, along with additional controls limiting the number of cylinders that can be tested with a given batch of hydrostatic test solution, ensures that only negligible concentrations uranium-bearing material exist within the hydrostatic testing system. The cylinders are verified to be free of water (i.e., moderator) prior to being returned to service.

When the hydrostatic test facility is operated to to less than 1.0 wt % ^{235}U the inspection for visible uranium is no longer required. This inspection is no longer needed since an entirely full cylinder could not become critical even under optimum moderation conditions. Therefore, instead of looking for

signs of uranium, multiple controls are placed on the uranium assay that has been placed in the cylinders.

The C-400 cylinder wash and hydrostatic testing operations remain subcritical for normal operations and maintain double contingency to remain subcritical for credible process upsets.

There are no AEFs identified for the C-400 cylinder wash and hydrostatic testing operations.

3.5 C-400 and C-409 Floor Drains and Containment Pans

The C-400 and C-409 buildings are the primary decontamination facilities, which house several fissile material operations involving fissile solutions generated as a result of decontamination activities. Floor drains located near these fissile material operations which have the potential to accumulate an unsafe mass of fissile material have been sealed.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-400 and C-409 floor drains and containment pans. The potential for a criticality occurring is primarily due to accumulation of uranium in potentially unfavorable geometries. Potential fissile solution volumes (tanks, process equipment, transfer piping, storage containers/drums and containment pans) associated with these operations are evaluated. The accumulation of solutions in the containment pans, associated with these operations, cannot exceed the depths specified in NCS controls. Geometry is controlled for these facility aspects.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. The double contingency principle is met and there are no AEFs identified for the C-400 and C-409 floor drains and containment pans.

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3.6 Disassembly and Decontamination of Small Vacuum Pumps and Datum Pumps in C-400

The small vacuum pumps are stored and decontaminated in C-400. Following the disconnection from the system, the pumps are moved to C-400 for disassembly and decontamination of the pump parts and surfaces.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the disassembly and decontamination of small vacuum pumps and datum pumps in C-400. The main criticality concern involves the accumulation of large quantities of uranium in the oil and having a large volume of this oil accumulate in an unfavorable geometry. A criticality accident is possible if the oil is placed into the wrong size container, if spacing requirements are violated, or if the containment pan has a depth greater than specified by NCS controls.

Volume, geometry and interaction are the controls used to ensure criticality safety. The size of waste containers is controlled. A minimum spacing is required between the waste containers and between the waste containers and all fissile bearing equipment (except between a waste container and the pump during removal of the oil), between the pumps on different shelves, and between the rack and other fissile material. The number of small pumps or datum pumps that can be in a batch or that can be on a shelf is limited by NCS controls.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the disassembly and decontamination of small vacuum pumps and datum pumps in C-400.

3.7 Disassembly and Decontamination of the Seal Exhaust/Wet Air Pumps in Building C-400

The Seal Exhaust/Wet Air vacuum pumps are decontaminated in C-400. Following the disconnection from the system, the pumps are moved to C-400 for disassembly and decontamination of the pump parts and surfaces.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the disassembly and decontamination of the seal exhaust/wet air pumps in C-400. The main criticality concern involves the accumulation of large quantities of uranium contaminated oil in an unfavorable geometry. A criticality accident is possible if the free flowing or slugged oil is placed into the wrong size container, if the spacing requirements are violated or if the containment pan has a depth greater than specified by NCS controls.

Volume and interaction are the controls used to ensure criticality safety. The size of waste containers is controlled for oil. A minimum spacing is required between the waste containers and between the waste containers and all fissile bearing equipment, except between a waste container and the pump during removal of the oil.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the disassembly and decontamination of seal exhaust/wet air pumps in C-400.

3.8 Operation and Maintenance of the C-400 Dry Honer

The Dry Honer utilizes small glass (SiO_2) beads carried by a high velocity air stream inside a closed glovebox to decontaminate small parts.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the operation and maintenance of the dry honer. The dry honer vessel cleaning operation has the potential to accumulate significant amounts of fissile material. Mass and interaction are the primary controls used to ensure criticality safety for the operation. The mass is controlled by the use of batch limits and visual inspections of accumulation points.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for dry honer.

3.9 C-400 Compressor Disassembly Pit

The Compressor Disassembly Pit is used for maintenance of cascade axial compressors.

Compressors are characterized and removed from the cascade as described in Section 1.2.

Administrative controls and passive barriers are in place to prevent a criticality from occurring during the disassembly of fissile compressors in the C-400 Compressor Pit. The main criticality concern is the moderation of a PEH deposit from firewater/sprinkler activation or oil from hydraulic equipment located in the compressor pit. The double contingency principle is met for compressors containing deposits that are less than a safe mass. However, compressors classified as PEH are singly contingent with moderation and interaction controlled to assure the safety of the operation.

There are no AEFs specifically identified for the C-400 Compressor Disassembly Operation.

3.10 C-409 Cylinder Wash Operation

Prior to washing a cylinder, a series of prewashing checks are performed which include weighing the cylinder, verifying the assay of the cylinder and cylinder inspection. The cylinder is then secured to the cylinder wash stand. Water and if necessary any cleaning agents are mixed in the solution makeup tank. Once the proper cleaning solution mixture is obtained, a 5-gallon batch is pumped from the solution makeup tank to the wash solution container. The wash solution container is moved to the cylinder wash stand and connected to the cylinder valve. The wash solution container valve and the cylinder valve are then opened allowing the vacuum in the cylinder to draw the wash solution into the cylinder. After the solution has drained out of the wash solution container and pressure has equalized with the atmosphere, the HF scrubber system is connected and turned on. The wash solution container is disconnected from the cylinder and moved out of the way. The cylinder can be rotated and tilted using the roll and tilt drive mechanism to allow the solution to react with the heel inside the cylinder. The cylinder is then positioned so that the solution can be evacuuated from the cylinder using the vacuum

pump and evacuation tank. Once all the solution is drained into the evacuation tank its volume can be determined. Additional washings will be performed until the cylinder is cleaned. The solution from the evacuation tank and HF scrubber system will be drained into 21-liter poly bottles. Once the cylinder is sufficiently cleaned, it is visually inspected. If no visible uranium is detected, then a steam wand can be used to remove additional residue. All solution generated by the steam cleaning will be collected in 21-liter poly bottles or the evacuation tank.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-409 Wash Operation. Since the large UF_6 cylinders are not safe geometry, both the amount of wash solution and the heel mass are administratively controlled. The wash solution container and systems tanks are safe geometry for 5.5 wt. % enriched uranium.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and one AEF "Cylinder Wash HF Scrubber Recycle Pump Shutdown" is required for this operation. Reference Section 3.15.10.3.5 for more details related to this AEF.

4.0 Laboratory

Since the Laboratory provides analyses on product assay uranium, a potential for criticality exists in the Laboratory phase of PGDP operations. Discussed below are the NCS controls implemented to prevent criticality accidents at the C-710 facility.

4.1 Liquid Uranium Salvage

Liquid uranium salvage or "liquid salvage" solutions are the result of the sampling process at PGDP. The mass of uranium required for criticality is extremely large compared to the quantity of

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material typically handled in the Laboratory. However, a criticality may be possible if liquid uranium salvage is improperly handled during storage or processing.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in liquid uranium salvage. When sampling UF_6 vapor, cold traps are used in some processes to collect excess UF_6 which is hydrolyzed with water to stabilize the uranium into a nonvolatile compound (UO_2F_2) so the uranium can be stored for recovery. The total mass of UO_2F_2 in the cold traps in the storage areas is restricted since the storage areas are an unsafe volume. The total mass is controlled by limiting the number of cold traps. A maximum enrichment of 5.5 wt % ^{235}U is assumed. Limiting the number of cold traps ensures the system is subcritical without spacing restrictions between traps.

UO_2F_2 solution generated as part of the laboratory activities is placed in polybottles, or carboys. Other laboratory processes generate uranium-contaminated solutions which are also collected in the carboys or maximum 5.5 gallon drums. These carboys of "liquid salvage" solutions can be heavily contaminated with uranium and require criticality controls. The carboys are held on wheeled carts in each lab until they are full. The liquid salvage carboys are kept in their carts when not being handled. The carts help ensure safe spacing between carboys, as well as provide secondary containment for the carboy in case of leaks. Each carboy cart is designed to store only one carboy.

The Inductively Coupled Plasma (ICP) lab uses maximum 5.5 gallon drums to collect uranium-contaminated solutions. The drums are stored in secondary containment pans that ensure safe spacing between drums, as well as provide secondary containment in case of leaks.

The full containers of liquid salvage solutions are treated as fissile material and are placed in a sampling area until the solution assay and/or uranium concentration are determined. If the solution has an assay of less than 1 wt % ^{235}U, no criticality controls are required for the carboy or the waste drum which is used for collection of the material. If the solution in the container has an assay greater than or equal to 1 wt % ^{235}U, isotopic dilution may be conducted until the assay is below 1 wt % ^{235}U. Carboys which have an assay greater than 1 wt % ^{235}U may be transferred to Waste Management, transferred to a maximum 5.5 gallon drum and then turned over to Waste Management, or transported to a receiving facility for processing or storage. ICP drums which are not diluted below 1.0 wt % are turned over to Waste Managemant as fissile waste.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for liquid uranium salvage.

4.2 Solid Uranium Salvage

Solid uranium salvage is a waste stream of uranium contaminated solids. The C-710 laboratory facility handles solid uranium salvage waste in a Generator Staging Area (GSA) which is in a ventilated hood. The GSA has two maximum 5.5-gal collection drums for solid uranium salvage. The material in either of these drums can become contaminated with fissile material and as a result require criticality controls.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the solid uranium salvage. Geometry, volume, and interaction are controlled to ensure criticality safety. The drums are kept in two rings fixed to the floor to maintain a set spacing between them. Spacing is required between the salvage drums and other fissile or potentially fissile material. When the drums are full, samples of the contents are analyzed.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for solid uranium salvage.

4.3 Sampling Laboratory

The Sampling Laboratory in C-710 is used for subsampling uranium compounds (mainly UF_6), sample container preparation, and salvaging excess uranium materials. UF_6 samples are received in 2S cylinders or smaller containers. Liquefaction of the UF_6 by placing the sample cylinders in a steam bath is required for subsampling. Liquid sampling manifolds transfer metered samples of liquid UF_6 from the sample cylinders to smaller sample tubes.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Sampling Laboratory. To ensure criticality safety in the laboratory, batch limits have been established to limit the quantity of material which can be stored, handled, or processed at one time. No spacing is required between cylinders in a single batch; however, spacing is required between batches and between a single batch and other fissile material. Spacing requirements provide interaction control. Mass and volume controls are used in batch limits.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the Sampling Laboratory.

4.4 Uranium Analysis Laboratory

The Uranium Analysis Laboratory in C-710 prepares and analyzes various uranium samples for a number of chemical measurements including uranium, toll UF_6 specifications and process control. A U_3O_8 beaker is also located in this area of operations.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Uranium Analysis Laboratory. Nuclear criticality safety controls ensure that uranium quantities are limited to less than a safe batch, measured by either volume or mass, and that a minimum spacing is provided between batches for interaction control.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the Uranium Analysis Laboratory.

4.5 Accumulation and Storage of Low Level, Low Uranium Density Waste

Low Level, Low Uranium Density Waste (LLLUD) is a heterogenous waste stream consisting of paper, plastic, absorbent media used to clean up spills, and metal (e.g. sample planchettes). LLLUD drums are used in the laboratory and are transported to a Fissile Control Area (FCA) for storage.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the accumulation and storage of LLLUD. Accident scenarios involve the accumulation of uranium in LLLUD waste drums, involve a spacing violation between a LLLUD drum and another source of fissile material, and the introduction of a liquid into the LLLUD drum. The LLLUD drums require a minimum safe spacing from each other and from any other fissile/potentially fissile material. Geometry and interaction are the controls used to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the accumulation and storage of LLLUD.

4.6 UF_6 Standard Storage and Handling

The Isotopic Analysis Lab is used to prepare working standards of various enrichments. Working standards are prepared by blending calculated amounts of material from base standards into a sample cylinder.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring with UF_6 standard storage and handling. Mass, moderation, interaction and favorable geometry are the controls used to maintain criticality safety. A limited number of cylinders are allowed in any cylinder storage cabinet. The process piping and the cylinders are of favorable geometry.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the UF_6 standard storage and handling.

4.7 Gas Source Mass Spectrometer Stations

The gas source mass spectrometer equipment is used for analyzing a wide range of gas samples.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the gas source mass spectrometer stations. Geometry, volume, and interaction are the controls used to ensure criticality safety. In order to preclude a potential critical configuration through the effects of interaction, only one carboy shall be moved at a time in these areas such that no two are adjacent to the mass spectrometer at the same time. The maximum subcritical mass is controlled by limiting the number of UF_6 sample tubes and standards, cold traps, mechanical vacuum pumps, and HEPA filters.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the gas source mass spectrometer stations.

4.8 Uranium-Contaminated Waste Oil Handling

The uranium-contaminated waste oil collection facility provides collection services for uranium-contaminated waste oil generated by the laboratories.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the uranium-contaminated waste oil handling. A combination of limits on mass, concentration and interaction are used to ensure criticality safety. Oil contaminated with uranium to such an extent that the oil will not flow freely and violations of the spacing requirements between waste oil containers and liquid salvage carboys are the primary scenarios for a criticality accident. There are no single event initiators that would be necessary and sufficient to create conditions conducive to a nuclear criticality.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for uranium-contaminated waste oil handling.

4.9 C-409 RCRA Laboratory

Section deleted.

4.10 ICP Laboratory

The ICP Laboratory receives various samples to process and analyze for metal impurities.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the ICP Laboratory. Mass is the primary control used to ensure criticality safety in the ICP lab. The only process upset that has the potential to lead to a criticality accident is if the accumulation of ^{235}U exceeds the limit specified in NCS controls. Administrative controls ensure the number of samples allowed in the lab are controlled.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the ICP Laboratory.

4.11 Radiochemistry Laboratory

Small samples are received in the lab from the subsampling and environmental compliance lab for determination of isotopic contents. A small portion of these samples are labeled potentially fissile (PF).

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Radiochemistry Laboratory. A combination of limits on volume, geometry and interaction are used to ensure criticality safety in the lab. The criticality concerns are spacing of PF samples on the workbench and storage of PF samples in the cabinet. Sample container volume and the number of sample containers per batch are limited as specified in NCS controls. A minimum safe spacing is required between PF sample batches being handled and used on the workbenches and tables and between sample batches and other fissile/potentially fissile material during transportation.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the Radiochemistry Laboratory.

4.12 Process Infrared and Process Gas Chromatography Laboratory

The principle function of the process gas chromatography lab is to prepare line recorder standards. The primary uses of the infrared lab are to detect the presence of hydrocarbons in UF_6 samples and the presence of drying gases and UF_6 in other samples.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the Process Infrared and Process Gas Chromatography Laboratory. All of the process upsets identified for these labs have been shown to be subcritical. Volume, geometary, and interaction are the primary controls used to ensure criticality safety in the labs.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the Process Infrared and Process Gas Chromatography Laboratory.

4.13 Drain System in the C-710 Facility

Most of the laboratories which involved significant quantities of uranium are housed on the first floor of the building. The main lines used for the first floor drains lead into the C-712 neutralization pit, commonly known as the acid pit.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-710 drain system. The floor drains in the areas that handle fissile/potentially fissile material are sealed. The acid pit ties directly into the sanitary sewer, through an overflow system built into the acid pit. The drain openings of concern are the floor drains in the laboratories; cup drain located in the fume hood; sink drains in the labs; and various pieces of automatic washing equipment. These pathways are only a concern when they are located in rooms which handle fissile/potentially fissile material or when automatic washers are used to clean items which have fissile/potentially fissile material and/or samples.

Concentration is controlled to ensure the C-712 pit never reaches a uranium concentration that would pose a criticality hazard. This is accomplished by controlling the mass and the total amount of water discharged to the pit for each sample tube and cylinder cleaned. Visual inspections of the integrity of the floor drain seals are performed and documented on a regular basis.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the C-710 drain system.

4.14 Section Deleted

4.15 Handling, Transporting, and Storage of Small Vacuum Pumps, Room 144

Small vacuum pumps are handled, transported, and stored in Room 144. The small vacuum pumps are used to supply vacuum to a large assortment of operations which have the potential of contaminating the pump with uranium.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the handling, transporting, and storage of small vacuum pump in Room 144. The primary parameters used to ensure criticality safety are interaction and geometry. The main concern from a

criticality standpoint is the interaction between fissile systems. One set of equipment such as the vacuum pumps may be subcritical by themselves but when placed next to one or more pieces of equipment containing fissile material, a criticality could occur. There are no single event initiators that would be necessary and sufficient to create conditions conducive to a nuclear criticality.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the handling, transporting, and storage of small vacuum pumps in Room 144.

5.0 Plant-Wide Operations

The following plant-wide operations have the potential for criticality. Therefore, NCS controls are implemented to prevent criticality accidents.

5.1 Field Decontamination

Field decontamination is performed for clean up of areas where significant amounts of fissile material may be encountered in the plant. The exact nature of the work varies from area to area, but two basic methods are used: the dry cleaning method or the soda ash solution method. The dry cleaning method is used wherever possible. This method makes use of floor sweep, brooms, scoops, and vacuum cleaners equipped with secondary HEPA filters. The soda ash solution method is used when necessary. A soda ash in water solution is used with sponges, rags, and floor sweepers to clean up an area.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the field decontamination. For both cleaning methods, maximum 5.5-gal drums or maximum 5.5-gal vacuum cleaners are required as a nuclear criticality safety volume control on all jobs where materials are enriched to 1.0 wt % ^{235}U or higher. Each vessel such as a maximum 5.5-gal drum or HEPA vacuum cleaner containing contaminated waste is moved one at a time and interaction control is provided by requiring a minimum spacing during all storage and handling operations. Geometry, volume, and interaction are controlled to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for field decontamination.

5.2 Handling and Storage of Contaminated Waste

As part of normal operations of the cascade and its many supporting operations, contaminated fissile uranium or potentially fissile wastes are generated. These wastes are handled and stored according to the criticality safety and waste management practices described below.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in handled and stored contaminated waste. Criticality is possible as a result of violating the double contingency controls associated with fissile waste handling operations. Criticality could result due to several scenarios including violation of safe spacing requirements, or mishandling a container due to

an error in characterization. PGDP uses favorable volume and spacing controls during the containerization and handling of potentially fissile waste streams. Characterization of waste container contents for ^{235}U mass and enrichment is performed to ensure application of appropriate nuclear criticality safety controls. Potentially fissile waste streams are characterized by using duplicate, independent measurements.

Containers of potentially fissile waste are handled under NCS controls until characterized. If the waste is determined to contain less than an always safe mass of ^{235}U for the specific container, then the container may be moved to a permanent low level waste storage area without NCS spacing controls. If the waste is determined to be less than 1.0 wt. % ^{235}U, the waste may be treated and handled as non-fissile. If the waste contains in excess of the always safe mass of ^{235}U, for the specific container size, the waste container contents may be mass reduced (material split into one or more containers) and the waste containers re-characterized until each container contains less than an always safe mass or the waste container may be relocated to a permanent criticality storage area covered by a NCSA. Physical and procedural controls are utilized to satisfy double contingency requirements for waste management operations. Administrative controls include the use of independent verification of drum handling actions, sampling activities, and uranium content calculations.

Experience has demonstrated that some waste streams from Fissile Control Areas and contamination areas with open uranium systems have an extremely low probability of entraining significant uranium contamination. These waste streams include Boundary Control Station waste and NCS exempt waste. Boundary Control Station waste is disposable personnel protective equipment, wipes, respirator cartridges, tacky mats, tape, plastic, paper, and dirt cleaned from personnel monitors. NCS exempt waste includes other waste that, based on historical sampling data and process conditions, does not have the potential to accumulate fissile material. NCS exempt waste specifically includes materials such as scrap metal, insulation, miscellaneous liquids, process equipment lubricating oil, chemicals, and water not used for radiological decontamination. These materials do not require generation or identification as potentially fissile waste.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for handling and storage of contaminated waste.

5.3 Text Deleted

5.4 Operation and Maintenance of the Negative Air Machines

The Negative Air Machines (NAMs) are utilized to provide control and containment of hazardous compounds (UO_2F_2, HF, and other particulates and fumes in the air) to minimize personnel exposure and maintain hazardous materials in the smallest volume/area possible. The NAMs are utilized to remove both radioactive and non-radioactive particulates.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the operation and maintenance of NAMs.

Mass and interaction are the primary controls used to ensure criticality safety of the NAM system and handling of used NAM filters. Minimum spacing is required between the NAMs and other fissile material and between a batch of filters and other fissile/potentially fissile material. The number of filters per batch is limited by NCS controls. Administrative controls are in place for using only NCS approved filters and for storing containers of fissile/potentially fissile NAM filters. Inspections are performed before and after the filters are removed from the NAMs to ensure the safe mass is not exceeded during filter storage. Visual inspections and differential pressure checks are performed to identify proper operation of the system and any build-up deposits of uranium material.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the operation and maintenance of NAMs.

5.5 Spent NAM/Fixed HEPA Filter Storage Containers

Spent NAM/Fixed HEPA filters are placed in B-25 or similar "strong tight" storage containers for storage and subsequent off-site shipment.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in spent NAM/Fixed HEPA filter storage containers. Each container is restricted in mass and

required to be spaced from other similar containers and other fissile/potentially fissile material. Accumulation of an unsafe mass is the primary criticality concern. Mass and interaction are the primary controls used to ensure criticality safety of the system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for spent NAM/Fixed HEPA filter storage containers.

5.6 HEPA Filtered Vacuum Cleaners

High efficiency particulate air (HEPA) filtered vacuum cleaners and wet-vacs are used at PGDP to clean up spills or accumulations of contaminated materials, to maintain equipment, and housekeeping in general. The vacuum cleaners typically employed for fissile material have capacities ranging up to 5.5 gal.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the HEPA filtered vacuum cleaners. The criticality concerns associated with use of the vacuums are the potential for use of a vacuum for fissile material that is larger than favorable volume or the creation of a potentially critical configuration due to the interaction of several vacuums containing fissile material. Volume, geometry, and interaction are the primary controls are used to maintain criticality safety for the vacuum cleaners. All vacuum cleaners to be used with fissile material are limited in capacity. The waste emptied from the vacuum canisters and the spent HEPA filters are handled as potentially fissile waste in accordance with the waste management program.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the HEPA filtered vacuum cleaners.

5.7 Trap Media Vacuum Cleaners

The trap media vacuum cleaners are used for removing alumina (Al_2O_3) and NaF media from traps throughout the cascade. The trap media serves to remove uranium, generally in the form of UF_6 or UO_2F_2, from process gas streams.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the trap media vacuum cleaners. Geometry, volume and interaction are the primary controls used to ensure criticality safety of the system similar to the HEPA filtered vacuum cleaners discussed above.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the trap media vacuum cleaners.

5.8 Transfer, Handling, and Storage of Fissile/Potentially Fissile Material Samples

Fissile/potentially fissile material is sampled to identify the actual uranium assay/content of the material. In general, the liquid samples are from the cylinder wash system, spray booth, and uranium recovery system. Solid samples are removed from chemical traps from cascade process buildings.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the transfer, handling, and storage of fissile/potentially fissile material samples. Volume, geometry, moderation and interaction are the controls used to ensure criticality safety. For all batch sizes, the volume of the sample containers is controlled and the limit specified is the volume of the sample containers. Minimum spacing is required between the batches of samples, and between the batch samples and other fissile material. Storage racks are restricted to the number of storage positions and require a minimum safe spacing between the positions.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the transfer, handling, and storage of fissile/potentially fissile material samples.

5.9 Selection Deleted

6.0 Maintenance

The following maintenance operations have the potential for criticality. Therefore, NCS controls are implemented to prevent criticality accidents.

6.1 Centrifugal Pump Disassembly

Operation of the UF_6 enrichment cascade periodically requires routine repair of centrifugal pumps. This equipment is contaminated with uranium bearing materials with varying enrichment levels. These pumps are removed from the cascade to be repaired or replaced.

Upon removal from the cascade the pumps are categorized as either Planned Expeditious Handling (PEH) or Uncomplicated Handling (UH) based on a Non-Destructive Assay (NDA) analysis, or visual inspection. If the analysis indicates a deposit greater than the safe mass, the equipment is categorized as PEH. See Section 1.2 of this appendix, Contaminated Equipment Removed from the Cascade, concerning PEH and UH handling requirements.

Mass, moderation, and interaction are the controls used to ensure criticality safety. Minimum spacing is required between fissile material and any pump containing deposits of uranium. Spacing requirements are also required between the maximum 5.5-gal waste drums and other fissile material.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for centrifugal pump disassembly.

6.2 Disassembly and Repair of Process G-17 Valves in C-400 and C-720

Operation of the UF_6 enrichment cascade periodically requires routine repair of process G-17 valves from the cascade. Since this equipment is contaminated with uranium bearing material, the handling and storage operations of these valves must be controlled. Typically the disassembly and decontamination of these valves occurs in C-400 and reassembly occurs in C-720.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the disassembly and repair of process G-17 valves. These valves are categorized as either PEH or UH based on an NDA analysis. If the analysis indicates a deposit greater than a safe mass, the equipment is categorized as PEH. Double contingency requirements are not met for the process G-17 valve disassembly operations when the equipment is designated as PEH. The mass of the uranium deposit within the valves may be greater than a safe mass value so that with the addition of a moderator, a critical configuration is possible. See Section 1.2 of this appendix, Contaminated Equipment Removed from the Cascade, concerning PEH and UH handling requirements.

Volume, moderation and interaction are the controls used to ensure criticality safety. Minimum spacing is required between fissile material and any valve containing deposits of uranium as specified in NCS controls. The number of PEH valves to be in the disassembly and decontamination area at one time is limited.

In order for a criticality to be possible when handling UH valves, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for disassembly and repair of process G-17 valves.

6.3 Repair and Handling of Converters in C-720C

Operation of the UF_6 enrichment cascade periodically requires the repair of converters. The converters have been in the cascade and exposed to process gas for a number of years which means they are contaminated with uranium bearing material.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the repair and handling of converters. The converters, upon removal from the cascade, are categorized as either PEH or UH based on an NDA analysis. If the analysis indicates a deposit greater than a safe mass, the equipment is categorized as PEH. See Section 1.2 of this appendix, Contaminated Equipment Removed from the Cascade, concerning PEH and UH handling requirements.

Moderation is the primary control applicable to a converter which has been classified as PEH. Volume controls are used in the storage and collection drums for waste generated from remediation of the converters. Interaction between pieces of stored equipment containing large deposits as well as between stored and operating equipment is controlled.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for repair and handling of converters.

6.4 Disassembly, Decontamination, and Repair of Expansion Joints

Operation of the UF_6 enrichment cascade periodically requires the repair of expansion joints. The expansion joints may be contaminated with uranium bearing material.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the disassembly, decontamination, and repair of expansion joints. Prior to removal, the uranium deposit mass is quantified by an NDA analysis. The expansion joints upon removal from the cascade are categorized as either PEH or UH. If the analysis indicates a deposit greater than a safe mass, the equipment is categorized as PEH. See Section 1.2 of this appendix, Contaminated Equipment Removed from the Cascade, concerning PEH and UH handling requirements. Other criticality concerns involve undetected uranium deposits, improper disposal of waste, and violations of spacing requirements. Moderation and interaction are the controls used to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for disassembly, decontamination, and repair of expansion joints.

6.5 Seal Change, Transportation, Disassembly, and Decontamination

The seal handling operations involve removal of the contaminated seals from the cascade compressors, storage, transportation, disassembly, and decontamination of the contaminated seals. Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the operations.

The primary criticality safety hazard associated with seal removal, handling, storage, and transportation is the accumulation of an unsafe mass in seal cans and interaction with other fissile material. Mass and interaction are controlled to maintain criticality safety of this operation.

The primary criticality safety hazard associated with seal disassembly and decontamination is the accumulation of an unsafe quantity of uranium or accumulation of uranium in an unsafe geometry. Mass, geometry, and interaction are controlled to maintain criticality safety of this operation.

6.6 Maintenance of the Normetex Pump in C-720

Normetex pumps can be removed for maintenance due to equipment failure or routine maintenance. The pump will only be slightly contaminated since it is evacuated of UF_6 before it is removed from the withdrawal station. Even if the pump was not evacuated of UF_6 before removing it, the maximum UF_6 that could remain in the pump is well below a safe mass.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the maintenance of Normetex pumps. Interaction is the primary control used to ensure criticality safety. Interaction between fissile material and the fissile material in the pump could make conditions favorable for a criticality. Criticality is also possible if there is uranium loading in the pump oil. The pump oil reservoir is an unfavorable geometry. A minimum spacing is required between the Normetex pump and items containing fissile material. A minimum spacing is also required between the waste drums containing fissile/potentially fissile material and any other material containing fissile/potentially fissile material. The number of waste drums which can be handled at a time in the Normetex pump maintenance area is limited.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for maintenance of Normetex pumps.

6.7 Process Motor Repairs

Due to the potential of uranium to be on the motors, repair of process motors will take place in either a contamination control zone or a contamination area.

Administrative controls have been incorporated to prevent a criticality from occurring in the repair of process motors. The primary criticality accident scenario is the potential accumulation of uranium material resulting from the process. Mass and enrichment are the controls used to ensure criticality safety. Uranium contaminated waste generated will be disposed of in a maximum 58-gal drum and labeled as "NCS Spacing Exempt" waste.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met. There are no AEFs identified for repair of process motors.

6.8 General Machining of Contaminated Process Equipment in C-720

Process equipment is removed from the cascade if it fails or for other reasons needs repair or routine maintenance.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the machining of contaminated process equipment. At the time equipment larger than favorable geometry is removed from the cascade, the mass of fissile material contained within the equipment is determined either by NDA measurement or estimated by visual inspection. The process equipment is categorized as either PEH or UH. If the analysis indicates a deposit greater than a safe mass, the equipment is categorized as PEH. See Section 1.2, Contaminated Equipment Removed from the Cascade, concerning PEH and UH handling requirements.

Potential accident scenarios involve accumulation of fissile material in unfavorable volume/geometry, machining equipment with significant contamination on a single component, or interaction between fissile material. A combination of limits on mass and interaction are used to ensure criticality safety.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for machining of contaminated process equipment.

6.9 Section Deleted

6.10 C-335 HEPA Vacuum Cleaner Servicing Area

The C-335 HEPA vacuum cleaner servicing operation is used to temporarily store and empty vacuum cleaners that have been used to vacuum fissile material. There are regular HEPA vacuum cleaners which are exposed to fissile material and HF HEPA vacuum cleaners which are used in situations where UF_6 and subsequently HF could be released.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the HEPA vacuum cleaner servicing area. The vacuums are cleaned in a glovebox and the contents are placed into a maximum 5.5-gal drum. Criticality can occur due to interaction of fissile materials, accumulation of fissile material in the glovebox (which is not a geometrically safe vessel), unsafe masses of fissile material, and introduction of a moderator. Geometry and interaction are the primary controls used to ensure criticality safety. Geometry is controlled by limiting the servicing and storage of vacuums to those approved for fissile use and limiting the volume and diameter dimensions of the waste drums. The number of HEPA vacuums and waste drums that can be stored in the glovebox at one time are limited. Minimum spacing is required between vacuums and waste drums. Various tags are used to identify in-process and emptied vacuums.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the HEPA vacuum cleaner servicing area.

6.11 Seal Test Buggy Calibration and Repair in C-720

Seal Test Buggies are brought to the C-720 instrument shop for calibration and repair. These buggies are used to test the efficiency of seals in cascade operations.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the calibration and repair of Seal Test Buggies. The buggies contain small components that can accumulate only small amounts of uranium. Criticality safety during calibration and repair is maintained through the control of volume and interaction of any waste generated during this process. Volume is controlled through the use of waste containers with a maximum volume of 5.5 gal. Interaction

is controlled through the use of secondary containment devices which provide a minimum safe spacing between the waste containers in these devices.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for calibration and repair of Seal Test Buggies.

6.12 Pressure Transmitter Cleaning Operations

The pressure transmitters are used to monitor pressures at many locations throughout the plant. In many cases these transmitters are not exposed to uranium contamination systems, however some of the uses are related to processes which have the potential of contaminating the transmitter with uranium.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the pressure transmitter cleaning operations. The criticality concern with the cleaning of these transmitters is the accumulation of the uranium contaminated solution from the cleaning operation in a large unsafe volume or geometry. The worst case scenario involves water highly contaminated with uranium from a number of collection cylinders placed in a waste drum other than the required maximum 5.5-gal waste drum. Another scenario involves the violation of spacing requirements. The cleaning station and waste containers must have minimum spacing between each other. The maximum volume of cleaning solution allowed in the cleaning station is controlled.

Volume and interaction are the controls used to ensure criticality safety. In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the pressure transmitter cleaning operations.

6.13 C-331 Instrument Maintenance Shop

The C-331 instrument maintenance shop maintains a variety of equipment, including valves, vacuum pumps and instruments.

Administrative controls and passive barriers have been incorporated to prevent a criticality from occurring in the C-331 instrument maintenance shop. There are several operations performed in the shop which have the potential to involve fissile material. No single piece of equipment brought into the shop has the potential to be contaminated with a critical mass of fissile material. Controls focus on the prevention of the accumulation of material from multiple instruments into a critical configuration. Geometry, volume, and interaction are the primary controls are used to maintain criticality safety of this system.

In order for a criticality to be possible, multiple contingency events would need to occur simultaneously. Therefore, the double contingency principle is met and there are no AEFs identified for the C-331 instrument maintenance shop.

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5.3 RADIATION PROTECTION

As a condition of certification, 10 CFR 76.60(d) requires that USEC "comply with the applicable provisions of 10 CFR Part 20, 'Standards For Protection Against Radiation,' not later than the date of the Director's decision on the initial application and/or as specified in an approved plan for achieving compliance." This section describes USEC's Radiation Protection (RP) Program for keeping occupational radiation exposures and radioactive contamination as low as is reasonably achievable in accordance with the requirements set forth in 10 CFR 20.

5.3.1 Radiation Protection Program

5.3.1.1 ALARA Policy

In accordance with 10 CFR 20.1101, USEC has established an RP Program designed to protect personnel entering the USEC-leased spaces from unnecessary exposure to ionizing radiation and radioactive materials. This program is based upon the following principles:

1. Personnel radiation exposures and the release of radioactive effluents shall be maintained in accordance with the As Low As Reasonably Achievable (ALARA) principle.

2. No individual shall receive a radiation dose in excess of any regulatory limit.

Responsibility for oversight and adherence to this policy rests with the Vice President, Operations. The General Manager has the overall responsibility and authority for the ALARA program at PGDP. The Radiation Protection (RP) Manager (or designee) is responsible for implementing the ALARA program.

5.3.1.2 Radiation Protection Committee

The Radiation Protection Committee (RPC), is an independent advisory group to the General Manager, Plant Manager, and the PORC on radiation protection issues, including the ALARA Program. It functions to (1) monitor selected operational radiation protection issues; (2) advise plant management on radiation protection concerns; (3) review proposed designs, work practices, selected suggestions, and selected projects with regard to contamination control and/or ALARA.

Membership and Structure

Membership consists of persons from various functional disciplines of the plant who have the necessary competence and experience to perform the functions of the committee. Standing committee members are the Radiation Protection Manager (RPM) who serves as the chair, the vice-chair who is appointed by the RPM, the Engineering Manager, the Environmental, Safety, and Health Manager, Operations Manager, Maintenance Manager, and the bargaining unit representative(s). Participation from other functional disciplines may vary depending on the issue of concern. The committee chair, or designee, is responsible for requesting appropriate functional representation. Committee members may designate an alternate to attend committee meetings in their place.

Quorum

The quorum consists of five standing committee members or their alternates.

Authorities

Committee authority is limited to reviews and recommendations. The committee has no approval, stop, or start work authority. Ad hoc subcommittees may be established for special studies or reviews pertinent to committee-related issues.

Meeting Frequency

The committee meets at least quarterly and as directed by the chair.

Responsibilities

The RPC chair ensures that the functions of the committee and tasks which may be assigned by, but are not limited to, the General Manager, Plant Manager, and PORC are properly executed. Minutes are made available to the General Manager, the Plant Manager, and the PORC. Special reports are prepared upon request of the General Manager, the Plant Manager, or the PORC chair, or when the RPC chair determines issues warrant attention.

The RPC reviews matters that have or may have an impact on contamination control and/or ALARA. These include, but are not limited to the following: (1) technologies for selected buildings and/or job tasks; (2) current work practices and completed tasks which have/had contamination control or ALARA concerns; (3) radiation protection violations; (4) lessons learned; (5) trends and resulting impacts on contamination control and/or ALARA; (6) establish annual contamination control and exposure goals; and (7) review BEQs as required by SAR Section 5.1.

Minutes and Records

Minutes are issued that identify RPC members and/or alternates in attendance, agenda items, a summary of decisions made, and action items. Copies are provided to the General Manager, the Plant Manager, the PORC, and the RPC members.

5.3.1.3 Radiation Protection Program Elements

The RP Program[1] described in this Section 5.3 includes the following elements:

1. Policy statements;
2. Approved, written, and controlled procedures that implement the RP Program;
3. Personnel radiological training, including General Employee Radiological Training (GERT);
4. Surveys and evaluations of radiological and soluble uranium's toxicological conditions;
5. Access controls;
6. Administrative radiation and soluble uranium's toxicological dose control levels with provisions for management review and concurrence;
7. A self-assessment function designed to monitor personnel adherence to established procedures and radiological controls;
8. Use of protective clothing and personal protective equipment;
9. Inspections and audits;
10. Personnel radiation and soluble uranium's toxicological exposure monitoring;
11. Recordkeeping;
12. Reports; and
13. ALARA Program.

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1. Nonoccupational Radiological Protection monitoring programs are described in Chapter 5.1, Environmental Protection - Radiological.

In accordance with 10 CFR 20.1101(c), the radiation protection program content and implementation as described in this Section is reviewed annually. The RP Manager is responsible for this annual review and preparation of a report documenting the results of the review. The report is then reviewed by the Radiation Protection Committee. Revisions to the RP program as described in this Section, if required, are initiated by the RP Manager and submitted to the PORC as part of the annual review.

5.3.1.4 Radiation Protection Organization

The Health Physics (HP) organization provides radiological protection support to the facility, is independent of the organizations responsible for production or remediation, and has an equivalent reporting level. The HP organization provides oversight and control of the technical aspects of the program elements that affect radiological protection.

The RP Manager directs the HP organization, is responsible for establishment of the RP Program, and has the authority to request the General Manager to deny access to radiological areas for personnel who do not adhere to radiological protection requirements. The RP Manager has technical oversight of all radiological protection procedures with the authority to oversee, stop work, or subcontract the services, as necessary, to maintain the integrity of the radiological protection program. For radiological control matters, the RP Manager has direct access to the General Manager and the Plant Manager. The RP Manager's position in the organization is shown in Figure 6.1-1. Responsibilities of the RP Manager described in this section will be carried out by the RP Manager or his/her designee. The designee will meet the qualifications of the RPM.

The RP Manager is required to have the technical competence and experience to establish radiological protection programs and the supervisory capability to direct the implementation and maintenance of radiological protection programs. The minimum qualifications for the RP Manager are identified in Section 6.1. Certification by the American Board of Health Physics is desired.

RP support personnel who provide HP and radiological engineering, dosimetry, bioassay, independent oversight, and instrumentation and calibration functions are required to have technical qualifications pertinent to their assigned duties.

HP technicians and their supervisors perform the functions of assisting and guiding workers in the radiological aspects of the job. HP technicians and their supervisors are qualified and trained in accordance with an approved qualification and training program (see Section 5.3.1.8).

HP technicians and supervisors have the responsibility and authority to stop radiological work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of approved radiological protection requirements.

5.3.1.5 Radiological Protection Procedures

USEC maintains approved written procedures to implement requirements of the RP Program as described in this Section. These procedures are prepared consistent with the requirements of 10 CFR 20 and are approved, maintained, and adhered to

for operations involving personnel radiation exposure and toxicological exposure to soluble uranium. These procedures will be prepared, maintained and made available to appropriate personnel at the plant as described in Section 6.11. The RP Program as described in this Section is reviewed annually as described in Section 5.3.1.3.

5.3.1.6 Radiological Work Permits

Radiological work permits (RWPs) are required for work activities in Contamination, High Contamination, Airborne Radioactivity, Radiation, and High Radiation Areas. HP may require the use of RWPs to control other radiological work. The RP Manager designates HP personnel who are authorized to approve, issue, update, revise, and close RWPs.

The limits established for contamination control (surface and airborne) are based on the toxicity of uranium. The contamination control program, of which RWPs are a part, is designed to ensure that the inhalation or ingestion of uranium are below limits. Therefore, the RWPs as well as other aspects of the contamination control program are based on the toxicity of uranium.

RWPs implement radiological safety requirements for activities involving exposure to radiation or radioactive materials, and are a primary mechanism by which radiological controls are established in the facility. RWPs are prepared, issued, and closed in accordance with approved procedures. The individual requesting work in an area requiring an RWP notifies HP and provides a description of the work in sufficient detail for HP to adequately assess the radiological conditions applicable to the task. HP assesses the radiological conditions and includes information on the RWP concerning protective clothing, and special instructions such as radiological hold points, approves, and issues the RWP. Radiological surveys that supplement RWPs provide information regarding radiation and contamination levels. HP closes the RWP upon being notified that the work is completed; after the RWP has expired, or; as deemed necessary by HP due to changing radiological or job conditions.

An RWP may be issued for any period of time up to one year, based on the stability and predictability of changes in the radiological conditions of the work area. HP may close a particular RWP at any time.

Radiological surveys are routinely reviewed to evaluate the adequacy of RWP requirements. RWPs are updated or closed and reissued if radiological conditions change to the extent that protective requirements need modification.

RWPs are closed upon completion of the job, and HP personnel evaluate the area to ensure that the area has been returned to an acceptable condition (trash and equipment removed). An evaluation is performed to determine if the area should be decontaminated to release the area based on area posting prior to the start of the job.

HP management reviews the RWP closure package to ensure appropriate actions have been taken.

Technical work documents, such as procedures, work packages (information prepared for onsite maintenance work), or job or research plans, may be used to control hands-on work with radioactive materials. When used in lieu of RWPs, these technical work documents will contain radiological protection requirements normally specified in RWPs. Radiological Control Hold Points are incorporated into technical work documents for steps that require action by HP to prevent exposures to radiation and radioactive material in excess of action levels, high airborne radioactive material concentrations, or the release of radioactive material to the environment.

Technical work documents used to control radiological work activities receive the same review and approval as an RWP. Technical work documents or continuous HP coverage may be used in lieu of RWPs when approved by the RP Manager. Qualified HP technicians are authorized to provide continuous radiological coverage in lieu of an RWP for short duration (less than one shift) non-complex tasks. When continuous HP coverage is used, requirements normally specified on an RWP are communicated to the worker.

5.3.1.7 Posting and Labeling

Caution signs for Radioactive Material Areas (RMAs), Airborne Radioactivity Areas (ARAs), Radiation Areas (RAs), and High Radiation Areas (HRAs) are maintained as required by 10 CFR 20.1901, 20.1902, 20.1903, 20.1904, and 20.1905, with the interpretation that RMAs located within a posted Contamination Control Zone (CCZ), Contamination Area (CA), High Contamination Area (HCA), ARA, RA, HRA or other posted radiological area are not required to be posted as an RMA since a higher level of control is already required. In addition, the following exemptions to the applicable 10 CFR 20 requirements apply (also see Section 1.8):

1. Containers located in Radiological Areas within the USEC leased area are exempt from container labeling requirements of 10 CFR 20.1904, as it is deemed impractical to label each and every container. In such areas, one sign stating that every container may contain radioactive material will be posted. By procedure, when containers are to be removed from contaminated or potentially contaminated areas, a survey is performed to ensure that contamination is not spread around plant site.

2. Feed, product, and depleted uranium cylinders, which are routinely transported inside the site boundary between facility locations and/or storage areas at the facility, are readily identifiable due to their size and unique construction, and are not routinely labeled as radioactive material. UF_6 cylinders are constantly attended by qualified Radiological Workers during movement.

5.3.1.8 HP Technician Training and Qualifications

HP technician qualification consists of the standardized core course training material,[2] facility-specific information, on-the-job training, and passing final comprehensive written examinations (written examinations may be waived for personnel with National Registry of Radiation Protection Technologists (NRRPT) certification). The training program ensures personnel are proficient in radiation measurements, characterization of radiological conditions, release monitoring, and personnel monitoring. Formal remediation protocols have been established.

Entry level prerequisites are established to ensure that HP technicians meet minimum standards for physical condition and education. Task qualification for entry level positions may be used until formal training is completed.

Following initial qualification, HP technicians are requalified every two years through participation in continuing radiological training programs. Personnel who maintain qualifications as HP technicians satisfy the requirements of Radiological Worker training.

HP technician supervisors will maintain qualifications as HP technicians and participate in continuing radiological training programs.

The RP training programs will be delivered consistent with the training procedures. Training is used to develop the skills necessary to perform assigned work in a competent manner. The training consists of initial, on-the-job, and continuing training. Instructors will meet the minimum qualifications required by Section 6.6.4.

5.3.2 Personnel Exposure Control and Measurement

5.3.2.1 Administrative Control Levels

An Administrative Control Level (ACL) of 500 mrem per year total effective dose equivalent (TEDE) per person has been established for radiological workers at PGDP. The ACL may not be exceeded without approval of both the RP Manager and the General Manager. If any individual exceeds an action level of 50% of the ACL in any quarter, or the ACL in a calendar year, an investigation will be performed by the RP Manager or his designee to determine the types of activities that may have contributed to the worker's external exposure. This investigation may include, but need not be limited to, procedural reviews, work practices, work locations, and job assignments.

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2. Health Physics Technician Course Curriculum training modules are listed in Table 5.3-1.

Depending upon the conclusions of the investigation, the individual may be allowed to continue radiological work, however, work restrictions may be imposed on individuals whose exposure exceeds published ACLs. Approval for continued work is documented in the evaluation described in the preceding paragraph which requires approval by the General Manager. Investigations to determine cause, assess the exposure, and document the results are specified by procedure.

5.3.2.2 Radiation Exposure

Both NRC- and DOE-regulated sources of radiation and radioactive material are interspersed at PGDP. There is also frequent moving of personnel from a USEC contractor or subcontractor staff to a DOE contractor or subcontractor staff. Individual subcontractors may move back and forth repeatedly during the year. This situation makes separation of personnel exposure between NRC and DOE regulated sources difficult. However, the low cumulative exposures for the site make it feasible not to separate the exposures for personnel being monitored under the USEC certificate.

To comply with the personnel monitoring requirements of 10 CFR 20.1502 and the reporting requirements of 10 CFR 19.13, 20.2106, and 20.2206 within the purposes and scope stated in 10 CFR 19.1, 19.2, 20.1001, and 20.1002, PGDP tracks exposures for personnel issued a NVLAP-accredited TLD by USEC regardless of whether the exposure is from an NRC- or DOE-regulated source. This applies to internal as well as external exposure. Whenever worker notification is required by 10 CFR 19.13, the individual's “total exposure” while at PGDP is reported without differentiating between exposure from NRC-regulated sources and DOE-regulated sources. USEC will comply with the requirements of Regulatory Guide 8.13 (Rev. 2), “Instructions Concerning Prenatal Radiation Exposure.”

To comply with the reporting requirements of 10 CFR 20.2206, PGDP site submits personnel information for the Radiation Exposure Information Reporting System (REIRS) report based on the personnel exposure database. Dose reports are completed as required for personnel monitored in accordance with 10 CFR 20.1502(a).

The occupational exposure received by USEC employees, subcontractors, and visitors will not exceed the 10 CFR 20 Subpart C limits. USEC requires current year exposure history of any occupational worker as required by 10 CFR 20.2104. Personnel declaring they are pregnant will be advised to keep radiation exposure to an embryo or fetus in accordance with the ALARA principle during the entire gestation period.

Persons entering an HRA are monitored for beta/gamma radiation. HP personnel will specify other dosimeters such as finger rings and direct-reading dosimeters where the standard TLDs cannot provide the desired information or are not practical. Self-reading or alarming dosimeters are used upon entry into HRAs.

The primary means of detecting radiation exposure due to a criticality event is the criticality accident alarm system (CAAS) for those areas that require CAAS coverage. Alarming electronic personal dosimeters (EPDs) are required in areas with inoperable CAAS, for personnel involved in planned expeditious handling equipment transportation, or those involved in response to a fissile cylinder breach.

The established personnel monitoring program consists of the following:

1. Establishment of administrative exposure limits that are lower than (10% of limits) 10 CFR 20 Subpart C limits and in consideration of the chemical toxicity of soluble uranium, limit intake to 10 mg/wk;
2. Provision for dosimeters to measure the external exposure of personnel; and
3. Analysis of personnel occupational exposure and maintenance of exposure records.

A network of Fixed Nuclear Accident Dosimeters (FNADs) is situated around the leased area. In the event of a criticality, TLDs in the FNADS are processed by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited TLD reader. Personal TLDs can also be evaluated for neutron dose. In addition, site-issued badges contain an indium foil that can be evaluated for neutron activation. If the indium foil indicates exposure to a neutron flux, the TLD can be read and biological materials of personnel may also be evaluated.

5.3.2.3 Internal Dosimetry

The chemical characteristics and retention times of soluble uranium processed at the GDPs are such that renal toxicity limitations are the limiting conditions for health effects. Since 1989, experience at PGDP indicates that exposure derived from low level acute and chronic exposure is less than 2 percent of the annual radiation exposure limits specified in 10 CFR 20.1201. Since Paducah will not handle uranium enriched above 5.5 percent, the chemical toxicity for soluble uranium takes precedence over the radiological hazard for soluble uranium.

A bioassay program is employed to confirm the results of radioactive material contamination control and respiratory protection programs. Bioassay results are the primary means of calculating internal doses. Air sampling data is used to trigger special bioassay sampling.

The Committed Effective Dose Equivalents (CEDE) per unit of intake by inhalation from *Federal Guidance Report No. 11*, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," may be utilized in calculating internal dose. Invivo lung counting may also be employed as determined by the RP Manager. The biokinetic model in ICRP 30 is used for internal dose calculations. The use of this model is in agreement with Regulatory Guide 8.34, Monitoring Criteria and Methods to Calculate Occupational Radiation Doses (7/92). The radionuclide specific data in NUREG/CR-4884 is also used in internal dose calculations.

In the event the potential to exceed an intake of 10 mg/week of soluble uranium exists, appropriate measures are employed to assess exposure. Inductively Coupled Plasma (ICP) Mass Spectrometry analysis is routinely used for urinalysis but analytical methods such as radiochemical separations, beta scintillation, fluorometry, and alpha spectroscopy may also be used to assess the extent of the intake and determination of exposure. Uranium analysis by ICP Mass Spectrometry has a reliable detection limit of 0.5 μg per liter. Table 5.3-2 gives a program description and the analytical methods employed at PGDP.

The routine bioassay program considers the exposure potential to personnel by work location and work activity. The routine sample submission frequencies and administrative control levels are listed in Table 5.3-4. Because chemical toxicity can be limiting when dealing with Class "D" uranium, the uranium action levels have been selected to limit an individual's chronic intake to 10 mg of soluble uranium per week. Evaluations are performed when intakes are confirmed to exceed 1 mg of soluble uranium per week.

Participants in the routine confirmatory urinalysis program are selected from personnel whose duties require routine entry into Restricted Areas. Personnel who work in Restricted Areas and have the potential to receive intakes resulting in a CEDE greater than or equal to 0.1 rem CEDE in a year or intakes of 1 mg of soluble uranium in one week are included in the routine bioassay program. Personnel submit bioassay samples, such as urine or fecal samples, and participate in Invivo monitoring as required by the bioassay program.

Table 5.3-3 gives the predicted bioassay results following a 10-mg acute intake of soluble uranium for different sampling times after the intake. These can be compared to the evaluation, control, and work restriction levels for the PGDP bioassay program stated in Table 5.3-4. Calculations assuming a chronic intake of 10 mg/week would yield a projected bioassay result of 391 μg/liter for personnel on a 4-week sampling frequency using the UF_6 biokinetic model. Table 5.3-3 also shows a comparison of the ICRP 30 standard Class D uranium model along with a comparison of the UF_6 model based on PNL-8723, "Internal Dosimetry Technical Basis Manual for Portsmouth and Paducah Gaseous Diffusion Plants," for internal dosimetry calculations.

Bioassay results are used to assign internal dose. PGDP collects "spot" urine samples from personnel rather than 24 hour urine samples. Confirmatory follow-up bioassay results or information obtained during intake investigation are used to support intake assignments. Based on air sampling and loose contamination survey data, uranium is the dominant nuclide at the plant. Isotopic analysis of fecal samples and 24-hour urine sampling are not routinely performed at PGDP, however, these analyses will be considered when dose assessments exceed 500 mrem CEDE. Because the sensitivities of lung counting systems are poor compared with urinalysis for Class D uranium, lung counting is only considered when intake estimates exceed 500 mrem CEDE.

Personnel participate in follow-up bioassay monitoring when their bioassay results exceed the administrative control levels or as determined by HP. Special bioassay studies are performed as necessary to evaluate the extent of actual personnel exposure in the event of a confirmed release, breakdown of radiological controls, evidence of failure of respiratory protective equipment, or other incidents in which an intake exceeding 0.8 DAC-hr or 1 mg of uranium is suspected. Personnel are selected to submit special urine samples of ^{99}Tc analysis based on job analysis or air sample data.

PGDP has some UF_4 areas remaining within the leased area where the potential for exposure to Class W uranium exists. During maintenance activities in areas containing Class W uranium personal protective

equipment is required to be worn and special bioassay samples are collected. The standard ICRP uranium biokinetic model will be used to assess dose from intakes of Class W uranium.

Urinalysis results are reviewed by HP to determine unusual trends. If bioassay sample results indicate an internal exposure that exceeds action levels, additional analyses and removal of the individual from further exposure are considered.

5.3.2.4 External Dosimetry

Persons requiring radiation exposure monitoring per 10 CFR 20.1502(a) will be issued and will be required to wear beta-gamma-sensitive dosimeters (TLDs) that are processed and evaluated by a processor holding current accreditation from the NVLAP of the National Institute of Standards and Technology (NIST). These personnel exposure monitoring dosimeters will be exchanged at least quarterly (± 2 weeks). The beta-gamma dosimeters may be supplemented, as appropriate, by other types of dosimeters (e.g., finger rings, direct-reading dosimeters, and neutron dosimeters), and by radiation measurements made with radiation survey instruments. Self-reading or alarming dosimeters will be used for entry into HRAs.

The primary means of detecting radiation exposure due to a criticality event is the criticality accident alarm system (CAAS) for those areas that require CAAS coverage. Alarming electronic personal dosimeters (EPDs) are required in areas with inoperable CAAS, for personnel involved in planned expeditious handling equipment transportation, or those involved in response to a fissile cylinder breach.

External dosimetry results are reviewed by HP to determine any unusual trends or exposures. If the external exposure status of an individual is uncertain, the individual is removed from further exposure until HP determines the exposure status and advises management of any special controls or restrictions to be applied.

5.3.2.5 Radiological Surveys

The radiological survey program consists of routine surveys, work support surveys, and material release surveys. Surveys are conducted to support facility activities in a manner that ensures radiological hazards associated with each activity are properly identified and relative radiation levels and concentrations of radioactive material are determined. Routine survey frequencies are established based on the stability of operation as demonstrated by the consistency of survey results. Radiological surveys for the purposes of evaluating the need for personnel protection equipment or for posting requirements are performed by qualified HP personnel.

The routine survey program involves surveys of the facility to determine workplace radiological conditions, effectiveness of contamination control measures, and proper identification and posting of radiological hazards. Areas within the facility will be categorized and scheduled for survey commensurate with their relative radiological hazard and contamination potential. Survey frequencies are based on area occupancy, potential for spread of contamination, and process knowledge. The routine survey program is reviewed annually by the RP Manager and documented, maintained, and modified to reflect changes in radiological conditions.

Due to the large physical size of each process building (as much as 60 acres under each roof) and the facility design (control rooms and locker rooms are located inside the Restricted Area), the primary focus of the routine survey program is to quickly identify any breakdown in contamination control. Areas

having the highest survey frequency are those that serve as the boundary between areas of different radiological conditions or are adjacent to radiological areas and permit personnel activities where the spread of radioactive material is likely to occur.

Large area wipes may be used to supplement standard smear techniques. If an evaluation indicates that an area wiped is contaminated, a thorough contamination survey is performed. Large area wipes are reported in units of activity/swipe (i.e., <200 dpm/wipe alpha). If the results of a large area wipe are less than detectable for the instrument used, the results of the large area wipe are documented as less than the minimum detectable activity of the instrument.

Actions for cleanup of the various areas are listed below:

1. Contamination Areas — In the event removable contamination exceeding 100 times the levels as specified in Table 5.3-6 is identified on accessible surfaces, the area will be re-posted as a High Contamination Area. If access is required to the area and additional personnel protective equipment will be required for entry, decontamination of the area will be initiated as soon as practical with consideration of ALARA principles. Decontamination will commence after the evaluation of the associated hazard is complete. The recommendation to decontaminate will come from the evaluation which considers the remaining work evolutions and personnel access requirements.

2. Contamination Control Zones (CCZs) — In the event removable contamination is identified on accessible surfaces exceeding the levels specified in Table 5.3-6, when averaged over an area of one square meter or more, the area will be re-posted as a Contamination Area or High Contamination Area and actions taken to locate the source of contamination and an evaluation of the radiological hazards posed by the contamination conducted. If access is required to the area, decontamination of the area will be initiated as soon as practical with consideration of ALARA principles.

3. Noncontaminated Areas — In the event removable contamination is identified exceeding the levels specified in Table 5.3-6, the area will be re-posted as a Contamination Area or High Contamination Area and actions taken to locate the source of contamination and an evaluation of the radiological hazards posed by the contamination conducted. If access is required to the area, decontamination of the area will be initiated as soon as practical with consideration of ALARA principles.

Work support surveys are a fundamental element of the RWP process. In-process surveys are conducted as necessary to verify radiological conditions at various points in the work activity and to ensure exposure potentials are maintained in accordance with the ALARA principle. When required by work activities, surveys are conducted to support decontamination efforts and the release of tools, equipment, and waste material from the work area. Work support surveys are performed either by RP personnel or by other workers who are qualified to perform them.

Shipments of radioactive materials arriving at the USEC site are surveyed by qualified personnel in accordance with 10 CFR 20.1906. Outgoing shipments of radioactive materials are surveyed by qualified personnel and packaged in accordance with 10 CFR 71 and 49 CFR 173.

In the event that radiological surveys indicate radiation levels above the posted limits for the area, the area is re-posted and the cause of the increased radiation investigated.

5.3.2.6 Work Area Air Sampling

To the extent practical, radioactive materials are contained and/or confined during processing, transfer, and storage as necessary to maintain intake of such materials by personnel in accordance with the ALARA principle. As appropriate, operations involving readily dispersible forms of radioactive materials are accomplished within enclosures (e.g., process equipment, glove boxes, glove-port hoods, and laboratory type hoods). Portable ventilation units may be used in work areas where large portions of process system surfaces are exposed for maintenance.

The air sampling program includes portable low-volume, high-volume, and lapel air samplers. Continuous air monitors (CAMs) may be used on occasion to supplement the program. A combination of low-volume, high-volume, and lapel air samplers are used for job coverage and general area air sampling. Low-volume air samplers are used for routine air sampling.

Routine low-volume air sampling stations are located throughout the PGDP to measure and permit trending of workplace airborne radioactivity. As a minimum, air sample stations are located where it could be conceivable that airborne radioactivity concentrations may reach or exceed 10% of the derived air concentration (DAC), as listed in Table 5.3-11, when averaged over an 8-hr period. Specific sampling locations are chosen based largely on operating experience, air flow studies, and locations where process equipment is operated and maintained. The routine low-volume sample station locations are reviewed annually by HP to determine if any locations need to be added, deleted, or changed.

The frequency of exchanging and analyzing sample media for work area samplers is based on the potential for dust loading, area occupancy rates, and environmental conditions. Routine low-volume air sample filter media are changed at least once a week. The routine air sample filter media may be exchanged sooner if needed to evaluate process work, potential release situations, or at the direction of the RP Manager. Air samples are routinely held for 3 days to allow for decay of naturally occurring radionuclides. Health Physics reviews low-volume air sampling trend charts and notifies Facility Managers when conditions warrant further attention. Filter media samples have appropriate correction factors applied for alpha and beta particles based on duration of sampling period and environmental conditions of the area being sampled.

Flow rates through air samplers, as measured by in-line flow rate instrumentation, are checked and documented at the beginning and end of each sampling period. Flow rate instrumentation is calibrated at least annually to be within ±20% of the standard.

High volume air sampler placement is based on specific job evolutions, environmental conditions, the potential dust loading, and area occupancy rates. High volume samples are taken as a means of assessing workplace conditions and whether radioactive material is becoming airborne. Grab samples are analyzed in a counter calibrated for the sample geometry.

The administrative control levels for job-coverage air samples is 10 percent DAC and 0.8 DAC-hour/sample. Special bioassay sampling is required when air samples exceed 0.8 DAC-hours and

10 percent DAC. Adjustment for respirator use is considered in determining bioassay monitoring. (Table 5.3-11 summarizes the GDPs airborne radioactivity posting levels and their basis.)

In the event of unexpected or abnormally high airborne radioactivity results (airborne radioactivity concentrations exceed 10 percent of the DAC listed in table 5.3-11 averaged over 8 hours), investigations are undertaken to verify the validity of the result, identify the source of the condition, assess the associated impact, prompt bioassay sampling to determine personnel dose, and if practical, prevent reoccurrence.

5.3.2.7 Physical and Chemical Characteristics of Radioactive Materials Encountered in the Workplace

Activities at GDPs often involve the breach of systems and components containing radioactive material. These systems and components also at times have some amount of removable contamination on their exterior surfaces as a result of the failure of a particular component or other system breach. The amounts of radioactive material on the external surfaces present little hazard from an external radiation standpoint because the major material is uranium which is predominantly an alpha-emitting radionuclide, and ^{99}Tc which is a weak beta emitter.

The primary alpha radiological concern at the GDPs is the internal dose component from inhalation of uranium during a UF_6 release. While the dose per unit of intake is minimal a large intake (10 mg) would result in an estimate of between 20 and 280 mrem CEDE assuming Class D uranium and 0.5% TRU. ^{234}U alpha energy is 4.8 MeV.

The primary beta radiation is from uranium daughters, ^{234}Th/^{234m}Pa at 2.28 MeV E_{max} and ^{99}Tc at 0.29 MeV E_{max}. The exposure pathway for beta is during skin contamination events which yield approximately 0.002 mrem/hour per dpm/cm^2.

Bremsstrahlung and direct gamma radiation are the primary exposure pathways for external dose at the GDPs and are essentially confined to situations dealing with UF_6 cylinders (full and newly emptied) and calibration of instruments. Gamma calibration sources are listed in Chapter 1. Bremsstrahlung radiation is primarily generated when high energy beta radiation interacts with high atomic number atoms, such as uranium in UF_6.

Neutron exposure is confined to areas where large quantities of uranium cylinders are stored. The neutron dose rate in these areas is between 0.1 and 0.3 mrem/hour at 30 cm.

The primary hazard in a GDP is acute exposure of operating personnel to a major release of Class D uranium in the form of UF_6 from the process equipment. Low-level/chronic exposure is possible in certain phases of the process, such as in feed and withdrawal areas and during process maintenance activities. The airborne radioactivity hazard tends to be the greatest concern although the feasible dose from inhalation of class D uranium is quite low. The principle radionuclide of concern at GDPs is uranium in the chemical form of UF_6. The chemical characteristics of UF_6 result in the formation of HF and UO_2F_2 when introduced to atmospheric conditions. This is an easily visible, irritating buoyant cloud.

The olfactory warning properties of airborne exposure are significant because of strong respiratory tract irritation due to HF.

The HF odor is detectable by personnel at very low concentrations (between 0.03 and 0.13 ppm, depending on reference) making an unknown 10 mg intake of soluble uranium unlikely at a GDP facility. Based on stoichiometric calculations, a 1.0 ppm concentration of HF would result in an airborne uranium concentration of approximately 2.43 mg/m^3. A 1-hr exposure to an atmosphere 8 to 30 times the threshold detection limit for HF would result in an intake of approximately 2.9 mg of uranium, assuming the standard man breathing rate of 1.2 m^3/hr.

The hazards from uranium are twofold — chemical toxicity and radiation. Fortunately, the warning properties and low specific activity combine so that large intakes are unlikely except during inadvertent releases. The chemical toxicity limit is limiting in the lower assay end of the cascade due to the decrease in ^{234}U. The specific activity of depleted uranium is about 0.4 μCi/g. The specific activity of reactor feed at 4% enrichment is still only 2 μCi/g.

^{234}U is the uranium nuclide with the highest dose. The DAC for the uranium isotopes present in the GDPs (^{234}U, ^{235}U, ^{236}U, and ^{238}U) varies only from 5E-10 μCi/ml to 6E-10 μCi/ml. ^{234}U is also the predominant isotope in terms of total alpha radioactivity in all areas (except at the tails withdrawal points or the process equipment immediately up gradient from that point). ^{238}U produces slightly more than half the total activity only in process equipment near "tails." ^{235}U, enriched to as much as 2% of the mass, is never a significant contributor to the total alpha activity. To determine the actual composition of the uranium, isotopic determinations would have to be performed on nearly every sample. Since ^{234}U is limiting in terms of the DAC and ALI, all uranium is assumed to be ^{234}U for dose compliance purposes as a conservative measure.

Nuclides other than uranium are present at PGDP (^{99}Tc, ^{241}Am, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{230}Th). Outside of the technetium and uranium, these nuclides are not routinely detected in removable contamination and airborne samples and are only present in trace quantities within certain areas of the plant. A formal site characterization has been completed at PGDP to determine isotope composition and isotope ratios within areas of the plant. Wipe and air samples obtained within the plant and containing significant activity may be analyzed for these nuclides. Experience reveals uranium or technetium to be the dominant nuclide with other isotopes not being routinely detected.

Air sampling data specific to intakes detected on urine bioassay above action levels are evaluated along with bioassay for various nuclides in an effort to determine the radionuclides involved in the intake. In accordance with 10 CFR 20.1204(a) and (g), radionuclides contributing significant internal dose are included in the internal dose assessment.

5.3.2.8 Respiratory Protection

The Respiratory Protection Program follows the requirements of 29 CFR 1910.134 and 10 CFR 20 for use, issuance, training, and qualifications for respirator users. Respiratory radiological protection requirements are specified in RWPs or procedures.

Respiratory protection may be used to limit internal exposures when engineering and administrative controls, including access restrictions and the use of specific work practices, are not practical. The selection and use of respirators for radiological protection are in accordance with 10 CFR 20.1703. Qualifications for individuals permitted to use respiratory protection include an annual physical examination by a physician, respiratory protection training, and fit testing.

The Respiratory Protection Program is administered by Industrial Hygiene (IH). RWPs specify respiratory protection requirements to prevent inhalation of uranium or other radioactive material. HP coordinates respiratory protection requirements with IH prior to specifying the requirements on the RWP.

Use of respiratory protection will be considered under any of the following conditions:

1. Entry into posted Airborne Radioactivity Areas;

2. During breach of contaminated systems or components;

3. Work in areas or on equipment with removable contamination levels greater than 100 times the values in Table 5.3-6; and

4. During work on contaminated surfaces with the potential to generate airborne radioactivity.

In specific situations, the use of respiratory protection may be contraindicated due to physical limitations, such as heat stress, or the potential for significantly increased external exposure with approval of the RP Manager. In such situations, stay time controls to limit intake are established and continuous workplace airborne monitoring is provided along with expedited analysis of results.

Respirator use is considered for activities where an individual may be exposed to soluble uranium that may exceed 0.8 DAC-hours or an intake of 1 mg soluble uranium during a work shift.

5.3.2.9 Occupational Exposure Analysis

As stated in SAR 5.3.2.2 “Radiation Exposure,” an annual report of personnel monitoring information is submitted to the Radiation Exposure Information Reporting System (REIRS) Project Manager based on the PGDP personnel exposure database. Since NRC certification, records show that TEDE doses at PGDP are normally less than the monitoring requirements of 10 CFR 20.

5.3.2.10 Ventilation

Process building ventilation systems are described in Section 3.3.5.11.

When portable units equipped with differential pressure (DP) gauges are used for radiological protection purposes, HEPA filter differential pressure will be checked when the unit is placed in service or daily when running continuously. A reading greater than 5 inches water across the HEPA filter shall require a shutdown for inspection or filter change. Vacuum units not equipped with DP gauges will have

proper performance ensured through ANSI N510-1989, Section 8 flow parameter testing every eighteen months. Portable HEPA filter units are DOP tested every eighteen months to ensure HEPA filter integrity.

For HEPA systems that are relied upon for personnel protection or to meet environmental emission limits, periodic testing will be performed in accordance with Sections 5, 8, 10, 11 and 15 of ANSI standard N510-1989, with two exceptions. The absorber bank in-place leak test (Section 11 of the standard) will be performed with an alternative, but equivalent, Halide gas, and the laboratory testing of adsorbent (Section 15 of the standard) will test for HF loading instead of radioiodine since HF is the gas of concern at the GDPs. Recommended test frequencies in this standard will be used.

In addition to general ventilation systems, portable ventilation units may be employed for short duration jobs when the unprotected worker could potentially exceed 0.8 DAC-hours of exposure. These portable ventilation units are equipped with high efficiency particulate air (HEPA) filters, and are designed to recirculate and discharge room air at low velocities. Activities where these units may be employed are also subject to approval by NCS.

The average air velocity through openings in uranium sampling and handling hoods containing readily dispersible uranium is a minimum of 100 linear ft/min (lfpm). The face velocity of laboratory fume hoods is evaluated annually. If not within specification, repairs are initiated by plant maintenance personnel or by vendors, as required.

5.3.3 Contamination Control

5.3.3.1 Areas Restricted for Purposes of Radiological Control

Radiological control is provided by controlling access to areas or facilities where radiation or radioactive material may be encountered, and by requiring that each person who enters those areas or facilities receives the appropriate level of radiological worker training.[3] Depending upon the type and extent (or amount) of radioactive material present, the areas identified include Radioactive Materials Areas (RMAs), CCZs, CAs, HCAs, Fixed Contamination Areas, Soil Contamination Areas, ARAs, RAs, or HRA. Access and departure requirements are specified by procedure. Radiological posting is used to alert personnel to the presence of radiation and radioactive materials, and to aid them in minimizing exposures and prevent the spread of contamination. Contamination controls are implemented where contamination is present.

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3. Personnel are trained commensurate with the hazard per 10 CFR 19; details concerning Visitor Orientation, General Employee Training, and Radiological Worker Training programs are described in Section 6.6.

Controlled Areas

Controlled Area means an area, outside of a restricted area but inside the site boundary, to which access can be limited by USEC for any reason. At PGDP, the Controlled Area is the area within the reservation boundary.

Restricted Areas

Each restricted area is conspicuously identified. Unescorted access to Restricted Areas requires, as a minimum, the successful completion of the appropriate level of radiological worker training and , if required, a personnel monitoring device (TLD). (External dosimetry monitoring requirements are stated in SAR 5.3.2.4.) Depending upon the type and extent (or amount) of radioactive material present, Restricted Areas are identified as RMAs, CCZs, Fixed Contamination Areas, Soil Contamination Areas, CAs, HCAs, ARAs, RAs, or HRAs. Restricted Areas are not required to be posted "Restricted Area."

Radioactive Material Areas

Areas or rooms that contain an amount of radioactive material exceeding 10 times the quantity specified in Appendix C to 10 CFR 20.1001-20.2401 for that material will be conspicuously posted "Caution, Radioactive Material." As noted in Section 5.3.1.7, RMAs located within other posted radiological areas are not required to be posted as "Radioactive Material Area" because a higher level of control is already required.

Contamination Control Zones

CCZs provide a boundary to minimize the spread of contamination. CCZs are areas where removable contamination levels are maintained at less than the levels specified in Table 5.3-6, but where discrete instances of contamination are likely to be encountered due to the physical size and historical operation of the facility. CCZs are conspicuously posted "Caution, Contamination Control Zone."

Unescorted access to CCZs requires, as a minimum, the successful completion of radiological worker training. Equipment and material are monitored prior to exit from CCZs. Personnel exiting CCZs are required to monitor themselves for contamination at the boundary control station except as noted in Section 5.3.3.5.

Fixed Contamination Area

Areas with removable contamination levels below Table 5.3-6 values but with surfaces exceeding the values of Table 5.3-6 for total contamination will be controlled as Fixed Contamination Areas (FCA). If the radiation levels exceed 0.05 mrem/hr at 1 meter the area will be posted as a "Fixed Contamination Area."

Soil Contamination Areas

If surveys of soil surfaces conducted in USEC-controlled spaces, indicate surface contamination greater than the total contamination levels shown in Table 5.3-6, the area is posted as required by approved procedures. Prior to and during excavation, surveys are taken of the sub-surface soil to determine extent of contamination. These soil contamination areas are typically a legacy of past DOE operations and considered DOE waste.

Contamination Areas

CAs are areas where removable contamination level averaged over an area of approximately 1 m^2 (see Table 5.3-6, footnote b for limitations) has been identified as being greater than the levels specified in Table 5.3-6 but not greater than 100 times the levels in Table 5.3-6. CAs are conspicuously posted "Caution, Contamination Area" with the exception of some areas, enclosures, structures, or equipment on Cell Floors. Personnel access is subject to RWP requirements. Unescorted access to CAs requires, as a minimum, the successful completion of Radiological Worker Training and an appropriate personnel monitoring device (TLD). Due to the large physical size of the Cell Floors (up to approximately 25 acres) and evidence that current contamination control practices are effective in protecting personnel from unnecessary exposure to contamination, the Cell Floors will normally be posted as CCZs and additional information will indicate that unposted CAs are present and an RWP is required for any access. Unposted CAs on the Cell Floor will only be permitted for easily described, generic locations out of the normal walk ways such as motor ends, cell housings, specific compressor components, etc. The areas that may be allowed to exist unposted will be specified in approved procedures. High Contamination Areas will not be allowed to be unposted. Contamination Areas associated with job specific tasks will not be permitted to be unposted. General RWPs for non-job-specific access to the Cell Floors will contain sufficient information to enable radiation workers to avoid contacting unmarked contaminated surfaces. The General RWPs for such areas shall contain sufficient information to meet the requirements of 10 CFR 19.12 that states, "All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area . . ." Unescorted access to CAs and Cell Floors requires, as a minimum, the successful completion of Radiological Worker training.

With the exception of Cell Floor CCZs described in the preceding paragraph, personnel exiting CAs are required to monitor themselves for contamination after removing their protective clothing and prior to leaving the step-off area except as noted in Section 5.3.3.5. Those personnel excepted above will perform a whole body frisk when exiting the CCZ. Equipment and materials will be monitored prior to removal from CAs. If contaminated, the equipment and materials will be decontaminated prior to removal from the CA or will be contained and controlled as radioactive material.

High Contamination Areas

HCAs are areas where contamination levels have been identified as greater than 100 times the levels specified in Table 5.3-6. In addition to the requirements specified for contamination areas, HCAs will be conspicuously posted "Caution, High Contamination Area," and personnel access is subject to RWP requirements.

Airborne Radioactivity Areas

ARAs are areas where airborne radioactivity may be reasonably expected to exceed 10% of the DAC sampled over 8 hours, or a peak concentration of 1 DAC sampled over no more than 1 hour, or soluble uranium concentration exceeds 50 $\mu g/m^3$ averaged over 8 hours. In addition to the requirements specified for contamination areas, ARAs are conspicuously posted "Caution, Airborne Radioactivity Area," and personnel access is subject to RWP requirements.

Radiation Areas

RAs are areas accessible to personnel in which radiation levels could result in a person receiving a dose equivalent in excess of 5 mrem/hr at 30 cm. These areas will be posted "Caution, Radiation Area" and personnel access to these areas is subject to RWP requirements. Unescorted access to RAs requires, as a minimum, the successful completion of radiological worker training and an appropriate monitoring device, if required. The RP Manager may exempt the requirement for an RWP in certain RAs as specified in approved procedures.

At USEC facilities, the primary radiation concern is the cylinder yards. When feed cylinders are emptied, short-lived radionuclide daughter products of uranium remain in the cylinder. This residual material is called the "heel." After the cylinder is emptied, it can exhibit a dose rate exceeding 100 mrem/hr at 30 cm for a short period of time. Since the "heel" forms at the bottom of the cylinder and the cylinder is stored on or near the ground, the area where the dose rate exceeds 100 mrem/hr at 30 cm is not accessible. Cylinders are surveyed after being emptied and placed on the scale cart. Any cylinders with dose rates exceeding 100 mrem/hr at 30 cm will not be moved or raised after being placed in the storage area, without continuous coverage by a HP technician with a survey meter.

Freshly emptied cylinders will be surveyed and segregated to areas posted as "Radiation Areas" to allow them to decay. Work and entry in these areas will be performed by qualified radiological workers under the guidance of an RWP.

High Radiation Areas

HRAs are areas accessible to personnel in which radiation levels could result in a person receiving a dose equivalent in excess of 100 mrem/hr at 30 cm from the radiation source or 30 cm from any surface that the radiation penetrates. These areas will be posted "Danger, High Radiation Area" or "Caution, High Radiation Area."

There are cases when radiation levels exceeding 100 mrem/hr at 30 cm may be anticipated. Selected examples include instrument calibration, C-360 technetium traps, and freshly emptied cylinders. The residual material (i.e., heels) remaining in freshly emptied cylinders contain short-lived daughter products that can temporary cause radiation levels to exceed 100 mrem/hr. The general inaccessibility of the affected portions of cylinders allows the empty cylinder storage area to be controlled as a radiation area. Very High Radiation Areas are not anticipated at PGDP. Physical and/or administrative controls to prevent inadvertent or unauthorized access to HRAs will be maintained. Minimum requirements for unescorted entry into HRAs includes the following:

1. Radiological Worker training;
2. RWP;
3. Personnel TLD and supplemental dosimeter;
4. Survey meter or dose rate indicating device available at the work area;
5. Periodic radiation surveys performed by HP in accordance with the applicable RWP.

Access to HRAs will be controlled in accordance with 10 CFR 20.1601 requirements with the exception of freshly emptied cylinders. In the event that accessible temporary HRAs are created by the "heels" of freshly emptied cylinders, they will be controlled by posting the area around the cylinder as an HRA and including additional wording to require HP approval prior to entry, provided that:

1. The HRA does not exist for more than 3 days;

2. The dose rate at 1 m from the external accessible surface of the cylinder does not exceed 10 mrem/hr; and

3. The cylinder is stored away from normally occupied areas.

[This is an exception to the requirements of 10 CFR 20.1601(a) and (b) but similar to 10 CFR 20.1601(e).]

5.3.3.2 Contamination Control Boundaries

CCZs, CAs, and HCAs are delineated by a clearly identifiable physical boundary, except as noted in Section 5.3.3.1 under "Contamination Areas." Personnel monitoring is performed at step-off areas except as noted in Section 5.3.3.5.

5.3.3.3 Surface Contamination

Loose surface contamination controls include posting areas, use of RWPs, protective clothing, surveys, and training of personnel. Whenever normally accessible areas of loose surface contamination are found to be above the levels specified in Table 5.3-6, the area is re-posted and, when appropriate, decontaminated.

5.3.3.4 Protective Clothing and Equipment for Contamination Control

Protective clothing is provided for personnel entering contaminated areas. The type(s) of clothing required are consistent with the individual's work assignment and are dependent upon the type and level of contamination anticipated. With the exception of emergency evacuations, protective clothing is removed prior to exiting the BCS, as specified in Radiological Worker Training, RWP, or area posting. During emergency evacuations, personnel report to designated assembly points and monitoring stations where protective clothing is removed and contamination monitoring is performed.

The protective clothing requirements are specified in the applicable RWP, approved procedures, or area posting; for example, during routine inspection activities, gloves and shoe covers may be the only protective clothing specified. Lab coats are available for use during more detailed inspection activities. Most normal operating and maintenance assignments require shoe covers, coveralls, and gloves. Industrial safety equipment, such as face shields, goggles, and acid suits are available. In addition, full-face negative pressure respirators and full-face positive pressure respirators are available. Other NIOSH and MSHA approved devices may also be utilized for respiratory protection.

Laundered Anti-C clothing are required to meet the following criteria prior to reuse:

1. Beta-gamma radioactivity less than 20,000 dpm/100 cm^2;
2. Alpha radioactivity less than 1,000 dpm/100 cm^2; and
3. TRU alpha radioactivity less than 1,000 dpm/100 cm^2.

Protective clothing requirements for accident conditions are specified in the Emergency Plan.

5.3.3.5 Personnel Surveys

Personnel survey instruments (except as noted below) are located at step-off areas for use, as needed, by personnel leaving areas controlled for removable surface contamination to areas not controlled for removable contamination. Table 5.3-10 describes typical instrumentation available. Personnel exiting these areas will be required to survey themselves after removing their protective clothing and prior to leaving the step-off area unless background radiation is too high or environmental conditions such as high heat and moisture in the air interfere. In those cases the individuals are directed to proceed promptly to an alternate area for monitoring.

The action levels for personnel monitoring of skin and clothing are the total contamination levels stated in Table 5.3-6. HP and management are notified if contamination is found. Clothing contaminated above the action level is not released unless it is decontaminated to below these levels. If individuals are contaminated above the action level, personnel decontamination is performed as indicated in Section 5.3.3.6. The requirement for monitoring prior to leaving an area may be preempted during emergency evacuations, but monitoring will be required at designated assembly points.

5.3.3.6 Personnel Decontamination

HP personnel respond to personnel contamination incidents, assess the consequences, and supervise field decontamination efforts. If contamination is not readily removable, contaminated personnel are decontaminated by qualified personnel in accordance with approved procedures. Bioassay sampling may be required based on HP evaluation of the incident. Contaminated individuals may be released when it has been determined by the plant medical director (or designee) and RP Manager that the remaining contamination does not require further treatment and further decontamination may be detrimental to the individual involved. Emergency medical treatment will take precedence over radiological considerations.

5.3.4 Radioactive Material Control

5.3.4.1 Control of Radioactive Material

Containers and equipment or items contaminated by radioactive material are surveyed, tagged, or labeled in accordance with 10 CFR 20.1904 and 1905 except as specified in Section 5.3.1.7. Approved procedures govern the requirements and methods for identifying and labeling radioactive material.

5.3.4.2 Radioactive Source Control

Sealed Sources

The Radioactive Source Control Program maintains administrative and physical control of sealed radioactive sources. The Source Control Program establishes source custodians and requires semiannual leak testing, accountability, and control of sealed radioactive sources.

Each sealed source containing more than 100 μCi of beta- and/or gamma-emitting material or more than 10 μCi of alpha emitting material, other than Hydrogen-3, with a half-life greater than 30 days and in any form other than gas, will be tested for leakage and/or contamination at intervals not to exceed 6 months. In the absence of a certificate from a transferor indicating that a test has been made within 6 months prior to the transfer, the sealed source will not be put into use until tested.

The test will be capable of detecting the presence of 0.005 μCi of contamination on the test sample. The sample will be taken from the source or from appropriate accessible surfaces of the container or from the device where the sealed source is mounted or stored in which one might expect contamination to accumulate. Records of leak test results are in units of activity (dpm or μCi) and maintained for inspection by the NRC.

Leak testing will be conducted by HP. If the test reveals the presence of 0.005 μCi or more of removable contamination, USEC will immediately withdraw the sealed source from use and cause it to be decontaminated and repaired by a person appropriately licensed to make such repairs or to be disposed of in accordance with NRC regulations. Within 5 days after determining that any source has leaked, USEC shall file a report with the Division of Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, describing the source, test results, extent of contamination, apparent or suspected cause of source failure, and corrective action taken. A copy of the report will be sent to the Administrator, USNRC, Region II, and the USNRC Resident Inspector for Paducah.

The periodic leak test required by this condition does not apply to sealed sources that are stored and not being used. The sources excepted from this test will be tested for leakage prior to any use or transfer to another person unless they have been leak tested within 6 months prior to the date of use or transfer.

Plutonium Alpha Sources

Each plutonium alpha source containing 0.1 μCi or more of plutonium, when not in use, will be stored in a closed container adequately designed and constructed to contain plutonium that might otherwise be released during storage.

At least once every 3 months, USEC will test the sources for loss of plutonium in one of the following ways using radiation detection instrumentation capable of detecting 0.005 μCi of alpha contamination: (1) by measurement of the source of potential alpha contamination through surveys of the storage container and areas in which the source is used; or (2) by wiping thoroughly the external surfaces of the source mount, other than the radioactive surface of the source, with a piece of filter paper of high wet strength and low porosity moistened with a solution that will not attack the mount, and after the paper is allowed to dry, measuring the radioactivity on the paper. Records of test results will be kept in units of activity (dpm or μCi) and maintained for inspection by the NRC.

If any survey or measurement performed as required above discloses the loss of more than 0.005 μCi of plutonium from the source, or if a source has been damaged or broken, the source will be deemed to be losing plutonium. USEC shall immediately withdraw it from use and cause it to be decontaminated and repaired by a person appropriately licensed to make such repairs, or to be disposed of in accordance with NRC regulations. Within 5 days after determining that any source has leaked, USEC shall file a report with the Division of Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, describing the source, test results, extent of contamination, apparent or suspected cause of source failure, and corrective action taken. A copy of the report will be sent to the Administrator, USNRC, Region II, and the USNRC Resident Inspector for Paducah.

5.3.4.3 Release of Materials, Equipment, and Facilities

Materials and equipment will not be released for unrestricted use unless the contamination levels are less than the levels specified in Table 5.3-6. Contamination surveys are performed on materials, equipment, and facilities to be released from radiological protection requirements.

Use histories may be employed to supplement surveys of materials or equipment that have inaccessible surfaces. Use histories are summaries of the operational history of the item. Use history information includes the function, location(s) where the item was used, and other relevant evidence to assess the item's potential for internal contamination.

Total radioactivity levels for bulk, aggregate materials, or waste to be released for unrestricted use or disposal are specified in the Radioactive Waste Management Program Document.

5.3.5 Radiological Protection Instruments and Equipment

Radiation dose rate and contamination survey instruments are selected to measure the types and energies of radiation encountered with gaseous diffusion operations. The source term associated with the

enrichment process is simple and consistent with little radiological exposure consideration except when skin contamination occurs. As such, there is little need for a wide range of instruments.

Uranium toxicity hazard takes precedence over the radiological hazard. The survey instruments used are adequate to detect all applicable action levels in Table 5.3-6, and these action levels are adequate to also ensure worker protection against the chemical toxicity of soluble uranium.

The primary complement of instrumentation includes alpha/beta count rate and scaler instrumentation plus ion chambers used to evaluate shallow dose and deep dose equivalent readings. Table 5.3-10 describes typical instrumentation available to support the operation of the facility. Survey instruments capable of supporting radiography operations will also be maintained in inventory.

The RP Manager will be responsible for maintaining adequate quantities of calibrated radiation detection and measurement instruments.

Radiological instruments will be calibrated based on specifications derived from the applicable vendor manuals or other nationally recognized guidance as appropriate (e.g., NCRP 112). The standards found in American National Standards Institute (ANSI) N323 (1978) will be followed except for Sections 4.6 and 5.1(3). The following requirements apply to all such equipment and instruments:

1. Portable radiation detection and measurement instruments will be inspected, maintained, and calibrated at least annually, or removed from service. The techniques include the use of radioactive calibration sources.

2. Instruments will be calibrated following any maintenance, modification, or repair deemed likely to affect operation before being returned to service.

3. Calibration sources and equipment will be within ±10% of the stated value and have documented traceability links to the NIST.

4. Portable RP instruments that are in use but do not have a built in automatic functional test feature are source checked daily prior to noon that day, or prior to using the instrument if not used on a daily basis. Instruments with the automatic functional test feature that are in use are checked once a week (e.g., hand and foot monitors and half-body monitors).

5.3.6 Records and Reports

Radiological protection records demonstrate the effectiveness of the overall program and document personnel exposure. Records are maintained in the form required by 10 CFR 20.2110, and are retained

as required by 10 CFR 20.2101 through 20.2106. Section 6.10 provides additional information on the records management and document control program.

5.3.7 Items Addressed by Compliance Plan

Section deleted.

5.3.7.1 Radiation Protection Procedures

Section deleted.

5.3.7.2 Posting of Radioactive Materials and Areas

Section deleted.

5.3.7.3 Nuclear Accident Dosimeters (NADs)

Section deleted.

5.3.7.4 Radioactive Calibration Sources

Section deleted.

5.3.7.5 Operational Check of HEPA Filters on Local Ventilation Units

Section deleted.

Table 5.3-1. Health Physics technician course curriculum.

Core Academics
Basic Mathematics and Algebra
Unit Analysis and Conversion
Physical Sciences
Nuclear Physics
Sources of Radiation
Radioactivity and Radioactive Decay
Interaction of Radiation with Matter
Biological Effects
Radiological Protection Standards
ALARA
External Exposure Control
Internal Exposure Control
Radiation Detector Theory
Site Academics
Radiological Documentation
Communication Systems
Counting Errors and Statistics
Dosimetry
Contamination Control
Airborne Sampling Program/Methods
Respiratory Protection
Radiological Source Control
Access Control and Work Area Setup
Radiological Work Coverage
Shipment and Receipt of Radioactive Material
Radiological Incidents/Emergencies/First Aid
Personnel Decontamination
Radiological Considerations for First Aid
Radiation Survey Instrumentation
Contamination Monitoring Instrumentation
Air Sampling Equipment
Counting Room Equipment
Chemical Toxicity of Soluble Uranium Compounds

Table 5.3-2. Bioassay program for PGDP.

Urine Bioassay Capabilities	PGDP
Number of workers currently participating in urine bioassay program (approximate)	585
Workers participation	Selected based on work tasks
Normal Urine Sample Collection Time	End-of-shift (Later part of week)
Frequency of Urine Monitoring	Monthly or Quarterly
Routine Urine Sample Volume	60 ml
Primary Uranium Analysis Method	ICP Mass Spectrometry
ICP Mass Spectrometry MDA	0.5 µg/l
^{99}Tc Analysis (gross beta)	Beta Scintillation Counting
Technetium (gross beta) Detection Level	10 dpm/ml
Additional Analytical Capabilities	
Alpha Spectroscopy (through off-site support)	0.03 dpm/sample
Transuranic Analysis Performed (through off-site support)	When urine action levels are exceeded
Transuranic/Analysis Method Alpha Spectroscopy (through off-site support)	0.03 dpm/sample
Fluorometric Mass Analysis	3 ug/l

Table 5.3-3. 10 mg acute intake of uranium demonstration.

Time after Intake (days)	UF_6 Intake Retention Fraction *	Predicted Result Following a 10 mg Intake (µg/l) *	Time after Intake (days)	ICRP 30 Intake Retention Fraction	Predicted Result Following a 10 mg Intake (µg/l)
0.17	3.85e-01	3852.0	0.17	2.02e-01	2022.0
0.25	3.16e-01	3163.0	0.25	1.82e-01	1820.0
0.33	2.55e-01	2554.0	0.33	1.63e-01	1633.0
1.00	5.37e-02	536.7	1.00	7.42e-02	741.5
7.00	2.21e-03	22.1	7.00	6.47e-03	64.7
14.00	1.20e-03	12.0	14.00	3.51e-03	35.1
28.00	5.09e-04	5.1	28.00	1.32e-03	13.2
42.00	3.14e-04	3.1	42.00	6.48e-04	6.5
56.00	2.35e-04	2.3	56.00	3.67e-04	3.7
70.00	1.91e-04	1.9	70.00	2.20e-04	2.2
84.00	1.61e-04	1.6	84.00	1.34e-04	1.3
98.00	1.41e-04	1.4	98.00	8.29e-05	0.8

* UF_6 model based on PNL-8723

Table 5.3-4. Internal dosimetry action levels. [1, 2]

Bioassay Technique	Current Frequency [3]	Action Level	Actions to Be Taken [4]
Routine Uranium Urinalysis	Monthly or Quarterly	5 µg U/liter	Resample to confirm result and determine intake.
		20 µg U/liter	Follow-up urinalysis, investigation of probable cause, and additional exposure to individual is limited. Restrict individual if > 0.1 ALI or 10 mg U in a week.
		40 µg U/liter	Individual is placed on restriction until follow-up sample < 5 µg U/liter. Investigate to determine probable cause.
Special Uranium Urinalysis	2 – 6 Hours After Intake	5 µg U/liter	Resample to confirm result and determine intake.
		300 µg U/liter	Restrict individual and resample to determine intake.
	16 – 30 Hours After Intake	5 µg U/liter	Resample to confirm result and determine intake.
		50 µg U/liter	Restrict individual and resample to determine intake.
Special Tc-99 Urinalysis	16 – 30 hours after intake	6,000 pCi/liter	Resample to confirm result and determine intake.
		60,000 pCi/l	Restrict individual and resample to determine intake.

1. Uranium action levels are for soluble uranium.
2. Internal dose is evaluated for all personnel whose average routine bioassay sample result exceeds 2.0 µg U/liter.
3. Routine sample frequencies determined by evaluation of work location and duties performed. In addition, personnel may be assigned a special frequency if deemed necessary by HP.
4. When intake is confirmed to be > 1 mg uranium, an investigation is performed to identify the source of the exposure, and if practical, a means to prevent reoccurrence.

Table deleted.

Table 5.3-6. Summary of contamination levels.

Nuclide[a]	Removable (dpm/100 cm^2)[b,c]	Total (Fixed + Removable) (dpm/100 cm^2)[b]
U-nat, ^{235}U, ^{238}U, and associated decay products, Transuranics ≤ 2% by alpha activity, ^{99}Tc, and beta-gamma emitters	1000	5000
Transuranic modified materials containing > 2% and < 8% transuranics by alpha activity, Th Nat, ^{232}Th, ^{223}Ra, ^{224}Ra, and ^{232}U	200	1000
^{226}Ra, ^{228}Ra, ^{230}Th ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I, and transuranics ≥ 8% by alpha activity	20	500

a. The values in this table apply to radioactive contamination deposited on, but not incorporated into, the interior of the contaminated item. Where contamination by both alpha and beta-gamma-emitting nuclides exists, the levels established for the alpha and beta-gamma-emitting nuclides apply independently.

b. The levels may be averaged over 1 m^2 provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface will be considered to be above the activity guide G if: (1) from measurements of a representative number (n) of sections, it is determined that $1/n \sum_n S_i \geq G$, where S_i is the dpm/100 cm^2 determined from measurements of section i; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds 3G.

c. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with a dry filter or soft absorbent paper or cloth, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on an estimate of the actual area and the entire surface should be wiped. Except for transuranics ≥ 8% by alpha activity, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination is within the levels for removable contamination.

Table 5.3-7. ***Table Deleted***

Table 5.3-7. ***Table Deleted***

Table 5.3-7. ***Table Deleted***

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Table 5.3-7. ***Table Deleted***

Table 5.3-8. Table Deleted

Table 5.3-9. *Table Deleted*

Table 5.3-10. Typical radiological protection instrumentation.

Instrument Type	Radiation Detected	Purpose	Typical Range	Minimum Calibration Frequency
Count Rate	α, β, γ	Contamination Monitoring	0 - 500,000 cpm	Annually
Dose Rate	β, γ	Radiation Monitoring	0.2 mR/hr - 5 R/hr 0.1 mR/hr - 1000 R/hr	Annually
Scaler	α, β, γ	Radioactivity Analysis	N/A	Annually
Count Rate	α, β, γ	Personnel Contamination Monitor	N/A	Annually

Table 5.3-11. DAC and airborne radioactivity posting levels.

Nuclide (See Note 1)	DAC	Posting Level (See note 2)
Gross Alpha based on Class D ^{234}U and 2% Class W ^{230}Th	1×10^{-10}	1×10^{-11}
Gross Alpha based on Class D ^{234}U and 8% Class W ^{230}Th	3×10^{-11}	3×10^{-12}
Gross Alpha Class W ^{230}Th	3×10^{-12}	3×10^{-13}
Gross Beta-Gamma (^{234}Th Class Y)	6×10^{-08}	6×10^{-09}

Notes:

1. All values are listed with units of μCi/ml.

2. Posting Levels are 10 percent of DAC.

3. DAC - Derived Air Concentration's listed are for the more limiting of 5 rem Committed Effective Dose Equivalent or 50 rem tissue or organ limit.

4. The values above are assumed as worst case, i.e., ^{230}Th is present in each mixture at the highest concentration per category as described.

5. Area may be posted based on calculated DAC's from actual airborne radioactivity concentration data.

6. The OSHA PEL (chemical toxicity level) for soluble uranium is 50 μgram/m^3 which equates to 2×10^{-11} μCi/ml for depleted uranium.

5.4 FIRE PROTECTION

Pursuant to 10 CFR 76.35(a)(6) and 76.87(c)(4), this section provides a description of the fire protection facilities and equipment used to protect health and safety and limit danger to life or property from fires. This section also provides an overview of the plant's fire protection program.

5.4.1 Program

The fire protection facilities and equipment are designed to detect, contain, and suppress fires. The major physical components of the fire protection system (e.g., the water supply system, pumps, sprinkler systems, fire alarms, and other fire-fighting equipment) are described in Section 3.9.

The fire protection program is under the direction of the Fire Chief. An experienced fire professional has been assigned as the Authority Having Jurisdiction (AHJ) with the responsibility for the interpretation and application of applicable fire codes and standards. The AHJ is a fire protection engineer who is a graduate of an engineering curriculum, who has engineering experience similar to the eligibility requirements as Member grade in the Society of Fire Protection Engineers. AHJ duties may be performed by contracted AHJ support or by the Portsmouth Plant AHJ.

The GDP fire protection programs have been developed in accordance with DOE requirements. These requirements draw heavily on National Fire Protection Association (NFPA) codes and standards and result in fire protection programs that have provided an acceptable level of fire safety.

The fire protection program will comply with the following standards for modifications to the plant following certification: NFPA 10-1990, Portable Fire Extinguishers; NFPA 13-1989, Sprinkler Systems; NFPA 15-1990, Water Spray Systems; NFPA 24-1992, Private Fire Service Mains; and NFPA 30-1990, Flammable Liquids. Any areas where full compliance with these standards will not be observed will be documented and justified by the AHJ. Any deviations found during future modifications will be documented and justified by the AHJ or corrective action will be taken.

The Plant Operations Review Committee (PORC) provides an oversight and review role in fire protection. The charter of the PORC Committee includes the responsibility to review nuclear safety issues related to the administrative plans, programs, procedures, and changes thereto for programs such as fire protection. This includes procedures and issues that relate to the Technical Safety Requirements (TSRs) for fire protection. See Section 6.2.

5.4.1.1 Description of Fire Hazards

The major buildings at PGDP (Buildings C-331, -333, -335, -337, -310, and -315) are constructed of heavy unprotected steel frame, concrete floors, mostly noncombustible exterior walls, and a built-up metal deck roof assembly. Each building is a single fire area; sprinkler coverage is provided except for cell housings and surge drum rooms. The sprinkler and water systems are described in Section 3.9. Combustible loading is low (except for the lube oil) and the fire hazards are limited to normal industrial activities. Any exceptions to this are identified during building surveys or by the building custodian. These include such things as switch gear and transformers, fork lift trucks, maintenance welding/hotwork activities, rotating electrical equipment with oil lubricated bearings and

some hydraulic systems. Lightning protection is not installed on the major buildings. The buildings are, however, heavily grounded, and lightning has not been a problem for these structures. The power systems are designed to handle lightning.

There are two major fire potentials in the process buildings. The first is the quantity of lube oil used in the process buildings. This oil is pumped to roof level tanks and gravity fed via piping to the rotating equipment and gravity drained (in pipe) to ground floor storage tanks and pumps. The oil used has a flash point of greater than 400°F and the interior roof level tanks as well as the ground level tanks are sprinklered and diked. The second major fire hazard is the roof deck. The construction is a typical metal deck roof assembly with a combustible vapor barrier/adhesive, insulation board, built-up tar and felt covering, covered with ballast gravel. Sprinklers are provided throughout the buildings primarily in response to the fire hazard of the combination of lube oil use and combustible roof assembly. This is discussed in Chapter 4.

Process buildings and UF_6 handling buildings are single fire areas. None of these buildings are divided into fire areas by fire doors. Building separation is used as a method of limiting fire spread.

There is no fixed fire detection or suppression in the cell housings. The only sources of combustibles in a cell housing are hydraulic oil lines that operate stage control valves in Building C-333 and C-337. Due to the high flash point of this oil and the lack of ignition sources in the cell housing, the probability of a fire in the cell housing is very low. However, if a hydraulic line did rupture, then pressure indicators as described in Section 3.3.5.10.2 could alert operators to the problem. Also, in the unlikely event of a fire, the UF_6 detectors described in Section 3.3.5.9.5 could detect the smoke generated from the fire in the areas where detectors are required.

If the fire was generated from a source exterior to the cell housing, such as a lube oil fire at a process motor, other process alarms would alert operators to the problem. These alarms include failure of the motor bearings resulting in compressor deblades, power surges and fluctuations, cascade flow alarms, and seal exhaust alarms. These alarms are described in Section 3.3.

Operators walking the cell floor would also notice the smoke in either type of fire and notify the control room who subsequently would notify the central control facility who notifies Fire Services. If in the unlikely event that the fire was to exist without detection for an extended time, the building fire suppression system would activate, control the fire, and notify Fire Services with water flow alarms as described in this section and Section 3.3.5.12. The consequences of a cell housing fire are bounded by a lube oil fire. The fire suppression systems in the process buildings are discussed in more detail in Sections 3.3.5.12 and 3.9.2.5.

An assessment was performed in 1997 to determine the combustible loading in process buildings C-310/C-310-A, C-315, C-331, C-333, C-335, and C-337 and the adequacy of the sprinkler systems in these buildings. It concluded the lube oil fire scenarios discussed in SAR Chapter 4 were still the most challenging to the capabilities of the sprinkler systems. It further concluded the lube oil fire scenarios would conservatively bound fires involving the other combustibles if certain administrative controls were implemented. The recommended controls included limitations on the height of permanent bulk storage of combustibles and separation of the permanent bulk storage locations from various systems and equipment containing combustible liquids. These recommended controls have been procedurally implemented.

Outside of the process buildings there are three areas where liquid UF_6 is routinely handled. These are C-333A, C-337A, and C-360. In each of these buildings cylinders are heated by steam in enclosed autoclaves to liquify UF_6. The autoclaves have some hydraulic controls, but the hydraulic fluid has a flashpoint of greater than 400°F. Combustible loading in these noncombustible buildings is low and the buildings are sprinklered. Other fire hazards are limited to typical industrial equipment.

There are no significant quantities of flammable liquids used in the process. The incidental use of these liquids are primarily for maintenance and support activities and they are handled using procedures that are based on the guidance of NFPA 30.

Hot work operations are normal in the maintenance activities associated with the operation of the process. These operations are controlled by a hot work program.

The cable tunnels connect the switch houses, process buildings, and central control facility. The tunnels at PGDP were evaluated in September, 1966 and again in May, 1970 and were determined to be low risk installations, as described below. No major modifications and changes have occurred in these tunnels since the evaluations were performed. The tunnels are approximately seven feet wide and seven feet high and contain approximately 75 cables mainly for control and communications, though some 440 V AC and 250 V DC circuits do exist. All cables are insulated for 600 volts except for communications cables that are located in a separate low voltage tray. All cables have neoprene or PVC jackets which are considered flame retardant. The vast majority of the cables carry negligible currents and do not produce measurable heat. There are very few cable splices.

Cell control functions are located in the ACR, the LCC and the CCF and are redundant. Therefore, the effect of a loss of cables due to a fire in a cable tunnel would be at most an operational inconvenience. All circuits are protected by fuses or circuit breakers where concern exists for short circuits. All materials of construction used in the tunnels are noncombustible including twelve (six on each side) solid transite cable trays on about one foot spacing. These trays have been maintained clean and free of debris and/or combustibles. Transient combustible loadings are small and limited in magnitude. The only reasonable source of ignition is electrical in origin and its probability is very small.

5.4.1.2 Hazard Evaluation

Fire hazards for major buildings are surveyed annually (listed in Section 5.4.1.1) by fire protection engineering staff and are documented in a building survey. The fire hazard evaluation activity consists of two major parts — the annual building survey and the Chapter 4 accident analysis. The survey is an inspection and analysis with a focus on fire protection. These surveys provide for a formal review and periodic evaluation of the occupancy and the fire protection of a given facility.

The building survey includes a review of the emergency egress paths for the facility. The review of the emergency egress paths is accomplished using the intent of NFPA 101, Life Safety Code as guidance. Process buildings do not comply with the travel distances due to the size of the building. A technical study has indicated that exit arrangements are adequate because of the low occupancy levels, large number of exits, large building volumes, and fixed fire protection in the buildings.

Completing a building survey consists of these elements:

- Identify building construction.
- Define fire areas.
- Evaluate fire cutoffs or barriers.
- Determine exposures to the structure or facility.
- Describe building function including occupancy classification.
- Assess ordinary building hazards such as ventilation and heating systems.
- Discuss processes including any special equipment or special operation.
- Assess special hazards, such as flammable liquid processes, high piled storage, and classified electrical installations.
- Review fire protection and installed detection equipment as well as special features of fire protection in the building.
- Develop a list of issues or recommendations for the facility manager regarding fire protection issues. These are tracked to resolution.
- Review emergency egress paths

Survey elements involving building design, construction, and operation are reviewed annually by the Fire Protection Engineering staff, but are not included in the survey report unless changes have occurred from the baseline survey.

Chapter 4 contains these elements:

- Accident analysis, including major fire scenarios.
- The effect of the fire protection system in controlling the fire scenarios.
- Toxic and radiological hazards from a release regardless of the initiator.

Hazard evaluations performed in this manner have served the site's fire protection program satisfactorily in the past by identifying issues and problems facilitating the continuation of a successful and safe fire protection program.

5.4.1.3 Pre-fire Planning

Pre-fire plans have been developed for major buildings (listed in Section 5.4.1.1). Each pre-fire plan indicates the locations of connections to sprinkler systems, sprinkler control valves, and fire hydrants. Special hazard areas are also identified. These plans are reviewed by Fire Services annually.

5.4.2 Fixed Fire Suppression and Fire Detection Systems

The plant fire alarm system monitors fire alarms in all important buildings and structures (a listing of these is maintained by Fire Services) and provides alarm indication to the C-300 Plant Control Facility, the C-200 Fire and Guard Building, and the C-303 Supervisory Control and Data Acquisition Building. The C-300 facility is manned by Operations personnel around the clock and is one of the fire alarm monitoring locations. If either the C-200 building or C-303 building is used in lieu of C-300, then that fire alarm panel will be continuously monitored, and have the capability to be in contact with the C-300 facility. These alarms include: waterflow alarms from the sprinkler systems; manual pull stations located throughout the site; and other special detection systems such as smoke, heat, and CO_2 discharge. Annual testing of a sprinkler system (see Section 5.4.4) includes the actuation of a water flow alarm by the sprinkler system alarm valve. This alarm valve will only initiate the alarm on sustained water flow due to a time delay. The time delay feature “filters” out flow pulses, which might be caused by short-lived pressure transients in the system, and thus only alarms on a valid water flow. The time delay settings meet the 90-second response criteria consistent with NFPA 25 and 72. All alarms can be received and acknowledged at the primary and both of the backup monitoring locations. This provides for prompt dispatch of emergency response

personnel, as necessary, to investigate and resolve the alarm condition. Alarms caused by non-fire conditions, such as spurious water flow alarms from pressure surges, are reviewed by Fire Services and identified for maintenance as needed. These are trended under the Assessment and Tracking Report system, but are not considered as reportable events as described in Section 6.9. (There is no process-related flammable gas or flammable vapor detection needed, and no alarms of this type are provided.)

Manual pull stations are located throughout the site. These pull stations initiate an alarm indication at the C-300, C-200, and C-303 buildings. Typically this alarm is not announced locally. The process buildings have evacuation alarms that are initiated from a central location.

Fixed automatic fire suppression systems provide the primary means for the detection, control, and suppression of fires at the plant. These systems, primarily sprinkler systems, are installed in most of the buildings on the plant site, including those building areas containing systems designated as Q as defined in Section 3.15. These fixed fire suppression systems are inspected, tested, and maintained on a regular basis (see Section 5.4.4).

A reliable water supply system with water storage, pumps, and underground piping is provided. This is a looped, gridded system to provide for minimum outage potential. Fire pumps and water supplies are separated to provide for maximum reliability. It would require multiple failures to render the fire water system inoperable. This system also has sectional valves to permit isolation in the event of a pipe break and split pumping capacities to provide greater reliability and redundancy.

Details of these systems are contained in Section 3.9.

Emergency response is provided by the on-site Fire Services and the Plant Emergency Squad. Fire alarms are not transmitted off-site to the area fire departments. The site Fire Services currently has mutual aid agreements with other fire departments in the county. These agreements are tested during periodic exercises held by Emergency Management.

5.4.3 Mobile and Portable Equipment

Mobile fire equipment is provided and maintained on-site to support firefighting activities and backup the fixed fire suppression systems. This equipment is manned by Fire Services personnel and includes a minimum of one 1,000-gpm pumper, one truck with HAZMAT, radiological, and rescue equipment, and one ambulance. This equipment is housed indoors and equipped with the necessary hose, nozzles, breathing apparatus, meters, detection equipment, rescue equipment, and other related equipment. Hose carts are also provided for the larger process buildings to facilitate manual fire suppression efforts.

Self-contained breathing apparatus (SCBA) is provided for use by trained personnel in connection with emergency activities including firefighting. Breathing air used in SCBAs meets a minimum quality of Grade D and is checked quarterly.

Portable fire extinguishers are available throughout the plant including the process areas. Primarily, the extinguishers in the process areas are Class ABC dry chemical type and Class BC CO_2 type. Size, spacing and specific type of extinguisher for placement is determined using NFPA 10, Standard for

Portable Fire Extinguishers as the guidance document. These extinguishers are inspected on a monthly basis. Extinguishers used in the balance of the plant consist primarily of dry chemical, CO_2, and pressurized water types.

5.4.4 Testing and Inspection

The inspection and testing of fire protection equipment is performed by or overseen by Operations or Fire Services personnel. The testing and inspection of equipment is completed in accordance with procedures which include test frequencies that have been developed by DOE-Oak Ridge over the past 40 years. The DOE-Oak Ridge program was based on NFPA inspection frequencies modified to the special situations at the site (such as controlled access, specially trained workforce, supervised systems, on-site Fire Services section and engineering staff, and extensive operating experience).

The major elements of the inspection program and their associated frequencies are:

- Every 3 years:

  Trip test the dry pipe sprinkler systems.
  Hydrostatically test fire hoses located/stored in process buildings (unless new hose which will be tested within 5 years of purchase)

- Annually:

  Flow test the fire pumps
  Flow test the wet pipe sprinkler systems
  Inspect and flush the fire hydrants
  Flow test at least one HPFWS hydrant adjacent to each process building to verify acceptable distribution pipe flow
  Test the manual fire alarms (pull stations)
  Test the sprinkler waterflow alarms
  Test supervisory alarm devices or ensure valve seals are installed for control valves in the required flow paths
  Test low air pressure alarms
  Flow test the pumper trucks
  Test SCBA
  Operate sprinkler systems control and sectionalizing valves
  Test special fire alarm indicators, such as heat and smoke detection systems
  Inspect major buildings to evaluate housekeeping, check fire emergency equipment and exit pathways.
  Hydrostatically test fire hoses on pumper trucks.
  Inspect and refold fire hoses located/stored in process buildings.
  Test fire alarm receipt and acknowledgment capability in the C-300, C-200, and C-303 buildings.
  Inspect exterior of fire water storage tank(s)

- Monthly:

  Start test the fire pumps
  Inspect the wet pipe sprinkler systems risers
  Inspect portable fire extinguishers.
  Verify diesel fuel supply to diesel fire pumps
  Verify fire water storage tank and water basin level
  Assure control and sectionalizing valves to required sprinklers are properly aligned

5.4.5 Staffing and Training

Fire emergency response is primarily handled by an on-site fire department (Fire Services). This is a fully staffed Fire Services section with fire officers and firefighters. Emergency response to the entire site is provided by this group under the incident command of the Plant Shift Superintendent (PSS) or his designee. Response capability of Fire Services includes, among other things, fire, rescue, emergency medical, process problems, spills, and confined space problems.

Fire Services personnel provide emergency response services and redundant firefighting capability to back up the automatic fire detection and suppression systems installed throughout the site. The normal minimum scheduled shift staffing is four personnel. In addition to their response functions, Fire Services personnel are responsible for conducting (or witnessing) the testing and inspection of fire protection systems and related equipment.

Fire Services is organized with fire officers and firefighters. The fire officers are first-line managers responsible for daily management of the firefighters including the testing program, training, alarm receiving, and emergency response. Fire officers have at least five years experience in fire service with management and leadership training.

Fire Services personnel are on-site at all times and are trained and equipped to handle anticipated types of emergencies. Firefighters receive training that meets requirements for state certification. Emergency medical response personnel meet requirements for state certification as emergency medical technician (these are usually also firefighters).

Training Development Administrative Guides (TDAG) are maintained that describe training provided to emergency response personnel. Training needs are reviewed annually and the training program modified to meet identified needs. The identification of changes needed to the Fire Services training program comes from the result of drills and exercise feedback, the acquisition of new equipment, or new techniques that come to light through the on-going professional development of staff personnel. Training records are kept of the training activities. Training is based on national standard emergency response methodology with site specific training on issues unique to the site. Qualified instructors provide a range of classroom and hands-on training to maintain standards of performance for all response personnel.

Specific training activities include firefighting, hazardous material response, confined space rescue, emergency medical response, radiological emergencies, and rescue. There is a live fire training facility on-site to augment firefighting training. Drills are conducted quarterly as part of the plant emergency plan.

Additional support for Fire Services personnel includes an on-site Plant Emergency Squad as described in the Emergency Plan. The on-site Plant Emergency Squad is on call for response to assist at emergency scenes. They receive training for the type of activities they may be called upon to perform. In addition, there are mutual aid agreements with off-site local fire agencies. Plant employees receive initial and biennial fire safety training as part of general

employee training. This includes emergency reporting, facility evacuation, and fire extinguisher familiarization.

5.4.6 Fire Investigation, Permits, and Procedures

5.4.6.1 Impairment Control

Valves on the water system supplying the fire suppression systems are controlled through a written permit system. This permit system is controlled by Fire Services and therefore Fire Services is notified of the impairment of fire suppression systems. Only groups authorized by Fire Services may operate fire protection valves.

This permit system provides for the notification of the facility custodian (for fire watch), the reason for the impairment, the supervisor authorizing valving, system restoration time, and supervisor responsible for restoring the system. Compensatory actions will be initiated when TSR-identified process building sprinkler systems are out of service. Fire protection systems taken out of service for scheduled/unscheduled maintenance are returned to service as soon as the maintenance is completed.

5.4.6.2 Fire Protection Engineering

A fire protection engineer is available on staff to evaluate the fire hazards of changes to maintenance and process systems, provide in-house consultation, and also perform the building surveys of major process buildings as described in Section 5.4.1.2.

The fire protection engineer also assists in the development of project design criteria, performs designs reviews, establishes specification requirements, participates in some fire investigations, and conducts routine engineering consultation as necessary. The fire protection engineer is part of project design teams and routinely reviews project design packages to ensure applicable fire safety issues are addressed, including construction, egress, facility protection, separation of fire areas, detection systems, and special hazard protection.

5.4.6.3 Hot Work Program

A hot work program is in place to ensure that cutting, welding, and other hot work conducted in areas not designed or approved for such processes will be done in a manner that is consistent with industry fire prevention practices. This includes procedures, permits, pre-job inspections, fire watcher standby during hot work, and post-job fire watches to prevent delayed ignition of any combustibles. Fire watchers receive training and hands-on fire extinguisher practice. First-Line managers are trained on fire safety and are authorized to write hot work permits. Open hot work permits are tracked. The information is used to determine where hot work would need to be suspended during sprinkler system outages. The information is also used by Fire Services to conduct field surveillances of work during routine building inspections and when concerns or unusual circumstances exist.

5.4.6.4 Fire Investigations

All reported fires are investigated using a graded approach. This includes investigations by fire officers, the fire protection engineer, or a multi-discipline team as warranted. Results of investigations are considered for distribution throughout the plant to prevent future reoccurrences.

Fire Services staff conduct investigations of fires or other emergency incidents that meet one of the following criteria:

- Determined to be reportable to NRC or DOE.
- Determined to have a suspicious origin.
- Involves noncompliance with a NRC or DOE regulation.
- Involves noncompliance with plant policy and/or procedures.
- Results in major impairment of any fixed or mobile fire protection systems, equipment, or appliance.
- Results in a property loss >$5,000.00.
- Involves a serious injury.
- Involves a fatality.

Fire Services staff prepares a written investigation report.

5.4.7 Process Building Sprinkler Systems Covered by TSRs

The sprinkler systems in the process buildings are designated as AQ in Section 3.15. Although these systems are designated as AQ systems, they are controlled by the fire protection program herein described; the fire protection program provides the level of control necessary to support the accident analysis. The configuration of fire protection systems has been maintained through the use of a plant procedure. This procedure prescribes the requirements for configuration management of fire protection systems and ensures that modifications and repairs to these systems are under the control of the AHJ. In addition, procedures are in place for the operation, testing, inspection, and impairment control of fire protection systems. Together, these procedures and practices have provided adequate assurance that fire protection systems and features will perform their intended functions. These procedures will continue to be used to ensure configuration management of fire protection systems.

The fire protection program is controlled by the Fire Chief and the fire protection engineer. These individuals have oversight of the fire protection systems. System modifications are reviewed by a fire protection engineer for compliance, or equivalent, with the guidance listed in the standards and the particular situation.

Fire protection engineers review plans for system modifications for compliance with the guidance in applicable standards (final approval authority rests with the AHJ). Modifications and repairs are coordinated between maintenance, contractors, and Fire Services personnel to ensure proper system work is completed. Repairs to a system are done with recognized and approved parts that are commercially available. Repair parts/replacement parts are specified and controlled by Engineering.

Permits for outages and the actual outage of any system are approved by Fire Services. Maintenance is requested through Fire Services, and post-maintenance testing is done or overseen by members of Fire Services.

The operability of the process building sprinkler systems are addressed in applicable TSRs.

5.4.8 Nuclear Criticality Safety Aspects of Firefighting

Firefighting activities involving fissile material warrant special precautions to ensure a criticality does not result. Each building containing fissile material has a Pre-Fire Plan established that specifies safe firefighting practices. This involves techniques such as using a fine spray pattern, using minimal amounts of water, and avoiding direct streams into a suspected open breach or where it could change geometry.

5.5 TRANSPORTATION

10 CFR 76.60(g) applies the requirements of 10 CFR Part 71 to USEC. The packaging and transportation of radioactive materials are conducted in accordance with 10 CFR Part 71. 10 CFR 71 grants general licenses to transport radioactive material in NRC-approved packages and DOT specification containers pending certain conditions. One condition is that the licensee have a quality assurance program approved by the NRC that satisfies the provisions of 10 CFR 71, Subpart H. USEC's Radioactive Material Packaging and Transportation Quality Assurance Program satisfies the provisions of 10 CFR 71, Subpart H, and is provided separate from this application. Plant procedures governing transportation activities ensure that the conditions of 10 CFR 71 are satisfied.

5.5.1 Items Addressed By Compliance Plan

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5.6 CHEMICAL SAFETY

United States Enrichment Corporation (USEC) operations at PGDP require radioactive, hazardous, and toxic chemicals to support the basic process of uranium enrichment. The enrichment process uses, consumes, combines, and manufactures various hazardous, flammable, reactive, and toxic chemicals. Pursuant to 10 CFR Part 76.87(c)(11), the Technical Safety Requirements (TSRs) include appropriate references to address chemical safety. The Safety Analysis Report (SAR) describes the technical basis program requirements for chemical safety, the integration of chemical safety with uranium enrichment operations, and describes the management systems used by PGDP for chemical safety. The TSRs identify those requirements for control of chemicals and commit to the chemical safety controls described in this section.

5.6.1 Introduction

The PGDP chemical safety controls are limited to non-radiological materials. Radiological materials, safety analyses, and the toxicity of uranium are addressed in Chapter 4 and Section 5.3.

Chemical safety at PGDP consists of the integration of environmental, safety, and health management systems to address chemical safety. Chemical safety controls are designed to mitigate the adverse effects of the toxic materials used in the enrichment process to workers, the public, and the environment. To achieve this objective, safety analyses, process hazard analyses, and industrial hygiene and safety programs are utilized. Chemical safety utilizes existing plant programs rather than developing new or specifically tailored programs. These referenced programs may or may not contain direct references to chemical safety.

The basis for the application of the different controls, commensurate with risk, begins with the identification of chemicals under OSHA standards. Further review in the 10 CFR 76.68 review process is performed as necessary. Thus, for some chemicals, very specific Q controls may be deemed necessary and other chemicals, under a graded approach, are deemed not to require even the application of AQ controls.

Section 6.1 identifies the roles and responsibilities for the Safety and Health program, including Chemical Safety, receipt and control of hazardous materials, environmental matters, and fire protection. Chemical safety incorporates technical and administrative controls to manage risk. In Section 5.6.13, the chemical safety control strategy is discussed further and the additional controls and requirements utilized to protect workers and the general public from chemical hazards are identified.

5.6.2 Section Deleted

5.6.3 Operating Procedures

Plant procedures are prepared in accordance with the requirements of a formal procedure system. The procedure process and program, described in Section 6.11, is applicable to all plant procedures. The procedure program controls the development, review and approval, revision process, distribution, and procedure configuration management.

Alarm response procedures are written for those alarms that alarm remotely in addition to locally. All the alarms are present to aid in the detection and mitigation of releases for production purposes only, but they are not credited with that function for the purposes of the accident analysis.

5.6.3.1 Sitewide Safety Program Procedures

Safety and health program procedures, applicable to the entire site, are processed in accordance with the plant procedure program discussed in Section 6.11. The industrial hygiene and safety programs used for chemical safety and implemented by sitewide program procedures include:

- Lockout/TagOut (LO/TO) Program
- Confined Space Entry Program
- Safety and Health Work Permit Program
- Hot Work Program
- Personnel Protective Equipment (PPE) Program
- Signs/Labeling/Tagging Program
- Safety Training Programs

These safety and health programs apply to chemical safety as described in the program implementation documents.

5.6.4 Training

Employee training is conducted by a dedicated training organization. The plant training programs, as described in this section and Section 6.6, apply to chemical safety. The Training group provides basic plant entry training, general employee training, and technical job specific training as required by plant operations.

Cascade operators, chemical operators, maintenance, management, and emergency response personnel have pre-requisite training requirements needed for initial job qualification. Personnel who operate, maintain, manage, handle, and have emergency response duties for the chemicals covered by

PSM, and addressed in Section 5.6.13.3, are adequately trained for the particular chemical system or related activity. This training supplements the plant training program and occurs at the job-specific level.

Non-PGDP contractor (typically construction) personnel receive plant access training and plant-specific safety training by PGDP personnel prior to starting work. The contractor or the contractor-designated Safety and Health Officer has the contractual responsibility for internal contractor employee training. This training, performed by the contractor, is supplemented by PGDP approval of the contractor's Safety and Health Plan. If construction activities interface with chemical systems, appropriate training and guidance will be required. This training and job review is provided by PGDP representatives.

5.6.5 Maintenance and Inspection

Maintenance and inspection programs are summarized below and described in detail in Section 6.4, Section 6.3, and in the QA Program description.

Maintenance and inspection requirements and criteria for chemical systems are developed by the Engineering group in conjunction with the specific facility maintenance organizations, the manufacturer's recommendations, and the SAR. These chemical safety requirements are based on the TSRs, the SAR accident analysis, and/or the Process Safety Management (PSM) program requirements for a particular chemical system and the manufacturer's recommendations.

5.6.5.1 Calibration and Inspection

Specific calibration and inspection requirements are based on operating characteristics, past operating experiences, system operating environments, and manufacturer's recommendations.

Maintenance, including calibration and inspection, of chemical systems that affect the assumptions or conclusions of the accident analysis is implemented in accordance with the TSRs and/or accident analysis conditions for a particular system.

Maintenance of chemical systems is performed in accordance with the facility maintenance programs that include the PSM Mechanical Integrity program requirements for those systems covered under PSM. These facility programs are based upon calibration and inspection requirements from operational experiences and characteristics of the system.

Facility maintenance personnel are responsible for calibrating to the tolerances and inspection criteria identified by the TSRs, the PSM Mechanical Integrity program, and the maintenance work package requirements.

5.6.5.2 Maintenance Work Packages

Maintenance work packages are prepared to provide the necessary technical and safety guidance for maintenance activities as described in Section 6.4. These work packages are applicable to chemical

systems and equipment. Supporting maintenance procedures are subject to the requirements of the plant procedure program described in Section 6.11.

5.6.5.3 Preventive Maintenance and Quality Considerations

Manufacturer's recommendations are used as guides for preventive maintenance on specific chemical systems and equipment. If operational experiences or system characteristics indicate a need for a different preventive maintenance schedule, the preventive maintenance baseline can be changed after appropriate review and approval. Equipment installed or maintenance services provided by contractors for chemical systems are tested and inspected by the contractor as required by the contract for that project. Independent inspection and testing is also performed by PGDP personnel.

Independent overview of maintenance activities on chemical hardware and requirements are addressed by the QA Program and Configuration Management (CM) programs, as applicable. These independent overview programs include:

- Procurement Quality Requirements
- Construction Inspection
- Testing and Pre-operational Inspection
- Pressure Vessel Inspection
- Crane Inspection
- Operational Readiness Review and Pre-Startup Safety Review Programs
- Plant Operations Review Committee (PORC)

The operational readiness review process is conducted in accordance with program implementing procedures utilizing a graded approach. The scope of the readiness review is decided by the readiness review committee depending on the issue and system being reviewed and the safety concerns present.

Deficiencies associated with maintenance activities are dispositioned in accordance with the QA Program requirements, and include Problem Reports, when required.

5.6.6 Configuration Management

The CM program is described in Section 6.3 and is applicable to chemical systems. These systems are specifically identified and the structures, systems and components (SSCs) are classified utilizing a graded approach as described in the QA Program. Engineering, as the design authority for the plant, administers the CM Program. The plant CM Program includes an organizational structure and administrative processes and controls to ensure that accurate, current design documentation is maintained that matches the plant physical configuration.

Revision or modification to a chemical system is initiated via an Engineering Service Order that initiates the design process and includes a 10 CFR 76.68 screening. In accordance with 29 CFR 1910.119(i), a pre-startup safety review is performed for new or modified facilities when the change is significant enough to require a change to process safety information. The pre-startup safety review is an independent review to address the readiness of the system hardware, associated hazard controls, personnel (including required training), and procedures. If the change does not require a change to process safety information, a pre-startup safety review will not be performed.

5.6.7 Emergency Planning

Emergency Planning is performed by emergency management personnel within Environmental, Safety and Health. The PGDP Emergency Plan applies to chemical safety concerns. Section 4 of the Emergency Plan outlines the roles and responsibilities of personnel during an emergency and Section 5 describes the emergency response measures in detail, including onsite and offsite protective actions.

Operators, in compliance with the PGDP "See and Flee" policy, are not expected to participate in emergency response activities for chemical releases. The policy is for employee prompt movement to a safe location. If facility procedures direct an employee response to a minor release, an employee can respond appropriately after "See and Flee" policy requirements have been met.

5.6.8 Incident Investigation

The Incident Investigations program and process, as described in Section 6.9, applies to chemical safety. Incident investigations are conducted in accordance with plant procedures. The level of investigation is based upon severity and significance of the event and regulatory requirements.

Occupational injury and illness investigations related to chemical safety are part of industrial hygiene and safety programs. Investigations are conducted in accordance with Occupational Safety and Health Administration (OSHA) PSM program requirements.

5.6.9 Audits and Inspections

Formal plant audit responsibilities are assigned to the QA organization. In addition, internal organizations have monitoring programs, assessments, and reviews as required by program implementation procedures. The PGDP audit and assessment program is described in Section 6.8 and is applicable to chemical safety.

5.6.10 Quality Assurance

Chemical safety is addressed by the QA Program utilizing a graded approach.

5.6.11 Human Factors

Human factors design responsibility for facility and system design at PGDP is assigned to Engineering with specific technical assistance from the Health and Safety group. The process hazard analysis, prepared for OSHA PSM regulated chemicals, includes ergonomic considerations at the specific work site.

5.6.12 Detection and Monitoring

Technical descriptions of the methods and equipment used for detection and monitoring of releases are discussed in Chapters 3 and/or in the process hazard analyses prepared for the OSHA PSM standard for the specific facility or system evaluated for chemical safety. For chemical systems, the functional descriptions are contained in Chapter 3.

5.6.13 Chemical Safety Control Strategy

The chemical safety control strategy at PGDP first requires that the chemicals used be identified and the listing of chemicals used kept current. Then, the chemicals are categorized by potential chemical risk. In order of decreasing risk and decreasing significance, the chemical hazards are addressed by the Chapter 4 accident analyses, by the Process Safety Management program, and by the industrial hygiene and safety programs for chemical hazards.

5.6.13.1 Identification and Inventory Control

Three processes are used to identify hazardous or toxic chemical use at PGDP.

The first process identifies and inventories chemicals used on the PGDP site. This process ensures that chemicals used on site are appropriately addressed for safety. The process includes:

- Purchase requisition reviews.
- A listing of chemicals used by PGDP.
- Material Safety Data Sheet (MSDS) library, upgrades, and distribution services to the site.
- Identification of new chemicals for the review process.

The second process is the formal Engineering Service Orders (ESOs) required for modifications to existing systems. The ESO process provides a mechanism that identifies new or revised usages of chemicals, chemical processes, and/or associated possible logistics that require engineering involvement. An ESO may not be required unless physical modifications or updated engineering evaluations are needed. If any changes to hazardous chemical inventories or locations exist as a result of an ESO for a new, modified, or decommissioned facility, process, or storage location, appropriate chemical safety review will be applied to address regulatory requirements. Any physical change to the plant, including inventory limits and changes of location for hazardous chemicals, will be evaluated in accordance with the requirements of 10 CFR 76.68.

The third process is associated with contractors on site. When work is to be performed by contractors, a review of the contractors' safety and health program is conducted to identify the presence of hazardous and toxic materials to be brought onsite by the contractor. MSDS for these chemicals are provided by the contractor, and the chemical is entered into the plant centralized listing.

The three processes described above identify chemicals to be evaluated and controlled at the PGDP.

5.6.13.2 Chemicals Addressed By Accident Analysis

The Chapter 4 accident analyses address radiological and non-radiological chemicals having a potential risk. The analyses identify engineered and administrative controls required for safety. The chemicals and chemical mixtures that have potential significant chemical risk and have safety significance are described in Chapters 3 and 4.

Uranium hexafluoride (UF_6) is the most abundant hazardous material on site. Chapter 4 provides an evaluation of accidents that involve the release of UF_6. The accident analysis considers both radiological and toxicological hazards from the UF_6 releases. The HF which evolves from a UF_6 release is considered as one of the effects of a UF_6 release and as such is addressed in Chapter 4.

5.6.13.3 Chemicals Addressed by Process Safety Management

A number of chemical processes are used at PGDP that are managed in accordance with the requirements of 29 CFR 1910.119. The PSM Program manages these hazardous chemicals in a manner that prevents impacts to workers or the public. PGDP has several chemicals on-site that are listed in the OSHA PSM standard including Cl_2, F_2, and ClF_3. Only Cl_2 and F_2 are used in amounts above the threshold quantity necessary to require implementation of the elements of the PSM standard. The facilities that are covered under PSM are listed below along with the nominal quantities present at each location.

- C-611-B Pre-chlorination Room (Cl_2) 8000 lbs.
- C-611-S Post-chlorination Room (Cl_2) 4000 lbs.
- C-631, C-635 RCW Pump Houses (Cl_2) 4000 lbs.
- C-633, C-637 RCW Pump Houses (Cl_2) 8000 lbs.
- C-745-A Cylinder Storage Yard (Cl_2) 16,000 lbs.
- C-410-D/K Complex (F_2) 2,490 lbs.
- C-745-A Cylinder storage Yard (F_2) 1,800 lbs.
- C-745-B Cylinder Storage Yard (F_2) 1,800 lbs.

In addition to the accident analysis described in Chapter 4, PSM Process Hazards Analyses (PHAs) are used to identify and manage chemical risks and impacts. Specific job-related risks and the technical and administrative control used for risk management are addressed in the PHAs.

Previously undisclosed or newly revealed chemical safety concerns identified by the PHA preparation process are processed through a 10 CFR 76.68 review for disposition of the concern. This 10 CFR 76.68 review will determine if new TSRs need to be developed.

5.6.13.4 Industrial Hygiene and Safety Program Managed Chemicals

Hazardous and toxic chemicals, not covered by the programs discussed in Sections 5.6.13.2 and 5.6.13.3, are effectively managed using industrial hygiene and safety (IHS) programs. For IHS program managed chemicals, there is no "threshold quantity" qualifier. To address these chemicals, the

IHS programs provide the necessary protective barriers and controls enabling safe use of these chemicals.

Commercial chemicals have varying toxicity and hazardous ranges and categories. Because chemicals can be used across the site in various manners, the IHS program applications to chemical safety are general in nature and based on industry accepted standards and regulatory requirements for controlling occupational exposures. To address the potential exposure risks associated with IHS program managed chemicals, PGDP uses chemical review programs, program procedures, and Material Safety Data Sheets (MSDSs). Implementation of these IHS programs provide employee protection from hazardous chemicals during daily operations and emergency response.

5.6.14 Multi-Occupancy of the PGDP Site

The creation of USEC resulted in a lease agreement with the Department of Energy (DOE). USEC leases from the DOE certain operating segments and certain support facilities of the original Gaseous Diffusion site. The remaining site sectors are used by DOE environmental restoration contractors and sub-contractors. Under article 5 of the lease, the DOE assumes liability for accidents and events caused by operations under their control. DOE has no obligation to inform USEC about hazardous chemicals under their control. DOE provides information through established communication channels regarding hazardous chemicals used by third parties present at PGDP that could impact PGDP nuclear operations.

5.6.15 Items Addressed by Compliance Plan

Section deleted.

5.7 ANALYTICAL SUPPORT

5.7.1 Laboratory Mission and Organization

The primary missions of the Laboratory are to supply quality analytical services, to provide process support for existing equipment and systems, and provide technology recommendations for new equipment and system requirements in support of the gaseous diffusion plant(s).

In addition, the Laboratory may provide analytical services as they relate to materials that are not of diffusion plant(s) origin under the Cabinet for Health Services Commonwealth of Kentucky Radioactive Material License. These services are provided to the DOE and other off-site customers under contract agreements.

Organizationally, the laboratory is divided into sections according to functional responsibilities. The sections may be subdivided into laboratories to further define specific areas of responsibilities. Laboratories provide a wide range of analytical services including organic, inorganic, spectrochemical, and radiochemical analyses to plant customers including support of nuclear safety and environmental radiological protection activities.

Radiochemistry laboratories provide laboratory-based radioanalytical measurements for both activity determination and specific radionuclide identification. Sample matrices include waters, soils, air filters, smears, solids, liquids, sludges, oils, and bioassay. Analytical techniques include gamma spectroscopy, alpha spectroscopy, liquid scintillation beta counting, and gross alpha/beta counting.

Precise UF_6 isotopic measurements are provided for cascade control, uranium accountability, and barrier performance evaluation. Minor isotope (^{234}U and ^{236}U) analyses are performed for process inventory and uranium shipments. Services include container preparation for process samples, representative subsampling from bulk sample quantities for laboratory analysis, a uranium salvaging process from excess sample material, and coordination and monitoring the disposal of waste from the laboratory in accordance with applicable regulations.

Inorganic analysis laboratories perform a variety of both classical wet and instrumental analyses. Wet methods include volumetric, gravimetric, and colorimetric determinations. Instrumentation includes ion chromatography, selective ion electrode, fluorometry, Inductively Coupled Plasma Spectrometry (ICP) and Inductively Coupled Plasma-Mass Spectrometer (ICP/MS). These laboratories are responsible for the analysis of urine for uranium content in support of the Health Physics personnel monitoring program.

5.7.2 Laboratory Personnel Training and Qualification

Personnel assigned to the Laboratory fall into one of two general categories. The first category, professionals, including managers and supervisors, provide a foundation of technical expertise and guidance to the laboratory operation. They have a minimum of a bachelor's degree in a physical science or technical field. The second category, laboratory or engineering technicians, have a minimum of an associate degree or a bachelor's degree with a minor in a science or technical field. Pertinent training and/or experience may be substituted for education requirements for both professional and technician level positions.

On-the-job training and qualification requirements are defined in the Training Development and Administrative Guide (TDAG) for Laboratory Technicians. Laboratory skills training is conducted primarily as on-the-job training (OJT). New or inexperienced employees are assigned appropriate safety and technical reading material, including technical procedures and required recordkeeping related to the method or procedure to be learned. An experienced technician or laboratory supervisor works with the trainee until proficiency in the method or procedure is observed as defined in the TDAG. Where applicable, qualification includes acceptable performance on control samples. Qualification records are maintained for each analyst.

Supplementing the lab OJT program is required reading. This provides an administratively controlled means of conveying pertinent information to laboratory personnel.

The Laboratory has a safety training program for employees. Annual refresher training on safety topics for individuals performing laboratory operation is required. Personnel working in the laboratories follow standard safe laboratory practices. Regulatory requirements for laboratory chemical safety are covered in 29 CFR 1910.1450, "Occupational Exposures to Hazardous Chemicals in Laboratories." As required by the standard, a chemical hygiene plan is in place and a chemical hygiene officer has been appointed to implement the provisions of the Chemical Hygiene Plan.

Laboratory practices involving fissile operations are covered by laboratory Nuclear Criticality Safety Approvals (NCSAs). Laboratory personnel performing tasks for which NCSAs apply participate in training covering specific requirements for the applicable NCSAs prior to performing such tasks independently.

5.7.3 Control of Analytical Process

Systematic control of the processes involved in analyzing the samples is required in order to generate reliable results. To achieve the desired level of competence, the Laboratory uses the following major types of planned and systematic controls:

- Analyst training and qualification (previously discussed).
- Implementation of sample tracking and accountability and/or chain-of-custody procedures to ensure traceability and integrity of samples and data.

- Use of National Institute of Standards and Technologies (NIST) or other certified standards for instrument calibration and day-to-day quality control.
- Implementation of routine and special internal control.
- Calibration and maintenance of analytical instrumentation.
- Implementation of standard operating procedures and standard analytical methods.
- Minimization of cross contamination.
- Participation in external controls programs.
- Participation in certification and/or accreditation programs.
- Statistical evaluation and control charting.
- In-house surveillance, problem reporting, and corrective actions.

5.7.3.1 Chain of Custody/Accountability

For environmental, safety, and health samples, chain-of-custody protocols are implemented from the point of sampling and are maintained after samples are relinquished to laboratory personnel and subsequent storage until disposal or customer pickup. Appropriate protocols are likewise implemented to track accountability samples from the point of origin through the analytical process and through disposal. The laboratory information system is used for sample tracking.

Samples that meet the acceptance criteria are officially transferred to the laboratory by signature on chain-of-custody/record-of-receipt. Acceptance criteria are prescribed in procedures. The samples are logged onto the laboratory information system and distributed to the appropriate laboratories. Samples that do no meet acceptance criteria are returned to the customer or analyzed and the results reported with qualifying statements. Uranium accountability samples are transferred to the laboratory on accountability documents.

5.7.3.2 Traceability of Standards

Standards used to calibrate instruments and for quality control for analytical sample batches are generated using materials traceable to NIST or other industry-recognized materials.

5.7.3.3 Laboratory Quality Assurance/Quality Control

Analytical methods require quality control samples to be analyzed with each batch of samples. Quality control samples may consist of blanks, duplicate/replicate samples, matrix spikes, matrix spike

duplicates, and/or performance evaluation samples as appropriate to the method. Methods and related quality control/quality assurance activities are documented in approved procedures.

In addition to such known quality control samples included with routine analyses, blind and double-blind quality control samples are analyzed as further performance checks. (A blind quality control sample is one in which the analyst is aware that the sample is a control but does not know the analyte concentration. A double-blind quality control sample is one in which the analyst is not aware that the sample is a control.)

5.7.3.4 Calibration, Calibration Verification, and Maintenance of Instrumentation

Instrumentation is controlled according to the plant's Calibration Program. Control of measuring and test equipment meets the requirements specified in Section 2.12 of the Quality Assurance Program where applicable.

Analytical instrumentation that requires calibration is calibrated or a calibration verification is performed per batch or daily when the instrument is in use according to documented methods or protocols. Critical analytical balances as defined in the calibration program are calibrated and serviced annually using NIST-traceable checkweights. Subsequently, the calibration of balances is verified daily when used with NIST-traceable checkweights. Automatic pipettors are calibrated/verified according to approved procedures.

Where applicable, material from independent sources is used to calibrate and to verify the calibration of an instrument. Laboratory procedures document calibration/calibration verification frequencies for radiological analyses. The laboratory is required to maintain maintenance documentation for each piece of analytical equipment and to note both routine and special maintenance given to each instrument.

Routine cleaning, maintenance, and other minor repairs are performed by laboratory personnel, when the actions are within the skill of the technician. Where required, instrument maintenance personnel and/or vendors provide assistance. Instruments are calibrated or the calibration verified after maintenance and repair events.

5.7.3.5 Standard Operating Procedures

Analyses are performed according to documented approved procedures. As applicable procedures are developed based on regulatory methods such as Environmental Protection Agency (EPA) or National Institute of Occupational Safety and Health (NIOSH) and/or nationally-approved methods (ASTM), or industry-recognized methods.

5.7.3.6 Minimization of Cross Contamination

Samples with potential for contamination are identified when delivered to the laboratories. Acknowledging the possibility of cross-contamination laboratories utilize good laboratory techniques to minimize cross-contamination of samples. These practices include glassware cleaning techniques, analysis of blanks and other quality control samples, storage and preparation of contamination samples in designated areas, and contamination control activities. Specific practices are documented in approved procedures.

5.7.3.7 Participation in External Controls

The laboratories participate in several performance evaluation programs including the Proficiency Analytical Testing (PAT) Program administered for the NIOSH by the American Industrial Hygiene Association (AIHA); the Mixed-Analyte Performance Evaluation Program (MAPEP) administered by DOE; and commercial quality programs administered by Environmental Resource Associates (ERA). Participation in these programs is dependent on the types of samples analyzed, regulatory requirements, and program availability.

5.7.3.8 Participation in Certification and/or Accreditation Program

The laboratory is accredited and/or certified for non-NRC regulated analyses by various agencies based on analyses being performed and regulatory requirements. Accreditations and/or certifications involve regular onsite inspections by the concerned agencies and acceptable performance on designated control programs.

5.7.3.9 Statistical Evaluation and Control Charting

Laboratory personnel prepare statistical evaluations of quality control data which form the basis for control charts. The laboratory tracks daily balance calibration verifications, laboratory check standard recoveries, and relative percent difference data, among others, as part of its overall process control.

5.7.3.10 Internal Surveillance, Problem Reporting, and Corrective Action Tracking

Among the important checks and balances of laboratory performance are the internal surveillance program, assessment tracking reports (ATRs), and corrective action tracking. Surveillances of laboratory operations (analytical procedures, personnel qualification records, waste disposal activities, etc.) are performed by in-house surveillance groups. Problems noted require a corrective action response by the

appropriate group. Corrective actions are tracked until completed. Unacceptable performance in a QC program is investigated and documented according to procedures.

5.7.4 Laboratory Support to Radiological Monitoring and Radiological Protection

The laboratory provides support to the radiological protection program including environmental radiological analyses, personnel-related radiological analyses and analyses in support of nuclear criticality safety/uranium accountability.

The laboratory performs environmental radiological analyses, analysis for uranium by various methods and analysis for fluoride. Samples are taken by the site's sampling personnel. The laboratory also performs radiological analyses in support of site personnel radiological safety programs: the bioassay (urine) program, the personal air monitoring program and the health physics survey program. Matrices involved in these programs are urine, air filters and wipes (smears). Precision, bias, and minimum detectable values are updated on an ongoing basis as specified by procedure and are maintained in the laboratories for review.

5.7.5 Items Addressed by Compliance Plan

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6. ORGANIZATION AND OPERATING PROGRAMS

6.1 ORGANIZATION AND RESPONSIBILITY

Under the Energy Policy Act of 1992, the Nuclear Regulatory Commission (NRC) was required to establish a certification process to ensure that USEC complies with the standards established by NRC for the GDPs under 10 CFR Part 76. The Energy Policy Act provides that the requirement for a certificate of compliance shall be in lieu of any requirement for a license for the GDPs and that USEC shall apply for a certificate of compliance. The Act also requires that USEC and any contractor operating the GDPs for USEC provide the NRC with ready access to the facilities, personnel, and information that the NRC considers necessary to carry out its responsibilities for certification.

USEC is committed to conducting operations in a manner that protects the health and safety of workers and the public, protects the environment and provides for the common defense and security. In order to meet these commitments, as well as others required for operation of the uranium enrichment enterprise, USEC has issued an operations policy manual which contains statements of policy and procedures to guide the day-to-day business and provide direction to USEC employees. The USEC policy with respect to nuclear safety, safeguards and security states in part:

> "USEC is responsible for, and is committed to, safe operation, maintenance, modification, design, fabrication, and testing of the Portsmouth Gaseous Diffusion Plant ... and the Paducah Gaseous Diffusion Plant ... and is committed to conducting operations in a manner that protects the health and safety of workers and the public, protects the environment and provides for the common defense and security ... USEC has provided the management structure to ensure that the safety/safeguards policy is effectively implemented."

The operations organization is responsible for the safe operation of the GDP. Programs and staff organizations are established for safety, safeguards, quality, environmental and health areas and are provided with sufficient resources to support safe operation of the GDP.

USEC has established management systems with associated policies, administrative procedures, and management controls to ensure: the GDP equipment, facilities and procedures; the staff (including training and qualifications); and the programs provide for the protection of the health and safety of workers and the public, protection of the environment, and for the common defense and security. Management controls have been established to maintain the safety/safeguards basis of the GDP as described in this application. Organizations with environmental, health, safety, safeguards and quality responsibilities have been established with a reporting chain, independent from the operations

organizations, to a senior manager, (Vice President, Operations for Corporate Headquarters or General Manager for plant organizations).

The integration of the plant operations and the various programs and requirements is accomplished through a variety of management practices. Where frequencies are identified below, they represent current normal business practice but can be adjusted by the manager responsible for the meeting.

- Vice President, Operations, periodic officers and staff meeting, daily phone call with General Managers to discuss the overall status of the plants, problem and event reports, the daily production report, future plans, and other pertinent subjects.
- General Manager meets weekly with Plant Manager and Organization Managers to discuss issues and policy implementation.
- Monthly review of plant performance indicators.
- The Plant review and approval systems [particularly the function of the Plant Operations Review Committee (PORC)] for procedures, training, modifications/changes to the physical plant and/or plant programs as described in this application, provide for the integration of the various requirements and controls.
- Plant work permit systems provide the integration in the field of various health, safety, and environmental program requirements and hazard evaluations.

Figure 6.1-1 shows the USEC organization for operation of the GDPs. Managerial positions that have responsibilities important to safety and safeguards are described in this chapter; other managerial positions are described in those portions of the application where applicable, particularly in the Quality Assurance Program Description, Radioactive Waste Management Program Description, Emergency Plan, Fundamental Nuclear Material Control Plan, Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance, and the Security Plan for Classified Matter. Typically “Organization Managers” report to the Plant Manager or General Manager; “Group Managers” report to Organization Managers; and “Section Managers” report to Group Managers.

Section 6.1.1 describes the organizational commitments, relationships, responsibilities and authorities for the overall management system to assure the protection of the health and safety of the workers and the public, protection of the environment, and provide for the common defense. This section includes the qualifications, functions, responsibilities, and authorities of the positions in the organization assigned functions related to environmental, health, safety, safeguards and quality.

Section 6.1.2 describes the management controls for maintaining the environmental, health, safety, safeguards and quality programs, and the administrative systems to control relationships and interfaces between programs.

6.1.1 Organizational Commitments, Relationships, Responsibilities, and Authorities

USEC is committed to the safe operation of the GDP and has provided the management structure to ensure that the safety/safeguards policy is effectively implemented. The management structure provides for line responsibility for safe operations with sufficient staff support to develop, communicate, and provide technical programs for various environmental, health, safety, safeguards and quality areas. The organization of various support staff are provided in the description of the environmental, health, safety, safeguards and quality areas.

USEC provides direction and management of GDP operations. Policy and program direction is provided through the Director, Regulatory Affairs. The Environmental, Safety and Health Manager, who provides direction for the site environmental programs, and the safety and health programs, has direct access to the General Manager for matters relating to those programs. These individuals are independent from day-to-day production, plant operating cost, and production scheduling considerations. Also, the Nuclear Safety and Quality Manager (located on-site) who reports to the Vice President, Operations, provides oversight and assurance that corporate policies and procedures are being followed in operation of the plant.

The General Manager directs and oversees site activities to ensure safe, reliable, and efficient operations. The Plant Manager reports to the General Manager and directs and coordinates the production plant operation in accordance with policies as reflected in plant procedures and practices. The production line organizations and related support and services organizations report to the Plant Manager and have responsibilities for implementation of safety and safeguards policies and procedures in daily operations. The on-duty PSS reports to the Shift Operations Manager and provides direction and coordination for shift operations. The Shift Operations Manager reports to the Operations Manager. The staff and support organizations report to the General Manager and provide program direction and support to the production line in implementing safety and safeguards requirements.

Personnel minimum qualifications, functions and responsibilities for key staff positions are described below. Throughout this section, equivalent technical experience means the substitution of 2 years of nuclear industry experience for each year of college up to a total of 3 years. Additionally, 30 semester hours or 45 quarter hours from an accredited college or university may be substituted for the remaining 1 year of baccalaureate education. Individuals who do not possess the formal educational requirements specified in this section or do not meet the equivalent technical experience defined above shall not be automatically eliminated where other factors provide sufficient demonstration of their abilities to fulfill the duties of a specific position. These other factors must clearly demonstrate proficiency in the technical area for which the position will be responsible, for example, a license or certification, documented completion of relevant training, or previous experience in the same position at another facility. These other factors shall be evaluated on a case-by-case basis, documented, and approved by the General Manager or appropriate Headquarters management, with the consultation of the human resources organization.

6.1.1.1 Section Deleted

6.1.1.2 Vice President, Operations

The Vice President, Operations, reports to the Senior Vice President, Uranium Enrichment.

The Vice President, Operations, has overall responsibility for safe operations of the GDPs including implementation responsibilities for packaging and transportation of radioactive material. The Vice President, Operations, is authorized to direct the General Manager to take any specific action, including but not limited to, placing all or any portion of one or both GDPs in a safe condition, in order to ensure health and safety of workers and the public, protection of the environment, safeguards (nuclear material control and accountability), security and to achieve or maintain compliance with applicable regulatory requirements. In addition, the Vice President,

Operations, must concur with the decision of the General Manager to restart any operation that was directed to be shut down by the Vice President, Operations, or by the Nuclear Safety and Quality Manager.

The Vice President, Operations, has implementation responsibility for all activities within the GDP organizations, including the functions of operations, maintenance, plant support, engineering, security, transportation, and industrial, radiological, and nuclear safety.

The Vice President, Operations, is responsible for both the Quality Assurance Program (QAP) and the Packaging and Transportation Quality Assurance Program (PTQAP), and for determining the status, adequacy, and effectiveness of the QAP as described in Section 2.2.5 of the QAP and the PTQAP.

The Vice President, Operations, has implementation responsibility for packaging and transportation activities within USEC. The Vice President, Operations, is responsible for final approval of the design of packaging and design changes to packaging used for radioactive material shipments.

The Vice President, Operations, shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, six years nuclear experience, and ten years management experience (which may be concurrent with the nuclear experience).

The Vice President, Operations, is appointed by the USEC Board of Directors.

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6.1.1.3 Director, Regulatory Affairs

The Director, Regulatory Affairs, located at headquarters, reports to the Vice President, Operations.

This position has responsibility for the management of nuclear regulatory functions and the corporate policy system. This individual is also responsible for development and management of corporation-wide environmental and waste management policies. This individual is the primary day-to-day interface with the NRC Office of Nuclear Materials Safety and Safeguards (NMSS) and has overall responsibility for management of activities related to certification of the GDPs. Although this individual works closely with the General Manager and key plant personnel, he/she is independent from production, plant operating cost, and production schedule concerns, and has the authority to stop work if there is a failure to adhere to regulatory requirements within his/her area of responsibility. The plant Regulatory Affairs Manager reports to the General Manager but is governed by and must adhere to policies established by the Director, Regulatory Affairs.

This position shall have as a minimum a bachelors degree or equivalent technical experience, and four years of nuclear management experience. This individual is appointed by the Vice President, Operations.

6.1.1.4 Section Deleted

6.1.1.5 Director, Corporate Security

The Director, Corporate Security, located at headquarters, reports to the Senior Vice President, Human Resources and Administration.

This position has responsibility for USEC Corporate Security requirements, policy, and flowdown of security requirements and policies to the protective force/security organizations. This position is independent from production, plant operating costs, and production schedule concerns and has stop work authority if there is a failure to adhere to regulatory requirements within the security area.

This position shall have as a minimum a bachelor's degree or equivalent technical experience and four years of security management experience. This individual is appointed by the Senior Vice President, Human Resources and Administration.

6.1.1.6 Section Deleted

6.1.1.7 Nuclear Safety and Quality Manager

The Nuclear Safety and Quality Manager, located at the plant, reports to the Vice President, Operations.

The Nuclear Safety and Quality Manager has the responsibility to exercise oversight of plant operations to ensure that the health and safety of the public and workers are adequately protected, to ensure compliance with safety, safeguards, and quality requirements, and to ensure implementation of policies, procedures and management expectations. The Nuclear Safety and Quality Manager is also responsible for nuclear material control and accountability and quality control, including receipt inspection of material and inspection of other selected safety-related activities.

The Nuclear Safety and Quality Manager is independent from production, plant operating cost, and production schedule concerns, and has authority to shut down operations and/or stop work when

necessary to ensure protection of public and worker health and safety and provide for common defense and security and to ensure regulatory or quality compliance. This manager has access to all information at the site related to safety, safeguards and quality. This manager interacts directly with the General Manager, other managers, and key plant personnel and participates, as desired, in any evaluations or discussions related to safety, safeguards and quality. This manager informs the Vice President, Operations and the General Manager about safety, safeguards, and quality issues and compliance. This manager manages the Nuclear Safety and Quality Office and directs plant quality assurance functions involving audits and oversight of plant operations as well as a nuclear safety assurance function.

The Nuclear Safety and Quality Manager primarily works the office shift, but periodically observes plant operations performed on backshifts. This manager is on-call and is notified by the Plant Shift Superintendent's office of reportable events per plant procedures. This notification occurs on all shifts.

The Nuclear Safety and Quality Manager shall have as a minimum a technical degree and 15 years nuclear experience with 3 years of management experience in quality assurance, nuclear safety oversight, engineering and technical support, or regulatory affairs. Either the Nuclear Safety and Quality Manager or a management position responsible for quality assurance that reports to the Nuclear Safety and Quality Manager shall have a minimum of one year quality assurance experience or one year experience implementing quality assurance program requirements.

The Nuclear Safety and Quality Manager is appointed by the Vice President, Operations.

6.1.1.8 Section Deleted

6.1.1.9 General Manager

The General Manager reports to the Vice President, Operations.

The General Manager is responsible for the safe operation of the plant, for compliance with all applicable NRC regulatory requirements, and for adherence to applicable policies. The General Manager is responsible for production, training, procedures, emergency management, fire services, medical services, records management and document control, engineering, transportation, materials handling and storage, shared site programs, and occupational, environmental, security, and nuclear safety.

Day-to-day authority and accountability for production, production support, and, fire services activities is assigned to the Plant Manager. The General Manager has responsibility for the primary day-to-day interface with NRC on matters of adequate safety/safeguards and regulatory compliance, and may delegate responsibility for that interface to the Regulatory Affairs Manager.

The General Manager has overall responsibility for plant security and compliance with applicable security regulatory requirements.

The General Manager has shut down and stop work authority for all or any portion of the plant (leased facilities). The General Manager shall be responsible to authorize restart of shutdown operations and must obtain concurrence of the Vice President, Operations, for any operations that were directed to be shut down by the Vice President, Operations or by the Nuclear Safety and Quality Manager.

The General Manager shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, six years of nuclear experience, and six years of management experience (which may be concurrent with the nuclear experience).

The General Manager is appointed by the Vice President, Operations.

6.1.1.10 Plant Manager

The Plant Manager reports to the General Manager.

The Plant Manager is responsible for the day-to-day production activities at the site including operations, maintenance, work control process, fire services, and production support. The Plant Manager shall be responsible for authorization of restart of shutdown operations but must seek concurrence from the General Manager for any operation that was shutdown by the General Manager, the Vice President, Operations or the Nuclear Safety and Quality Manager.

The Plant Manager shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, six years of nuclear experience, and six years of management experience (which may be concurrent with the nuclear experience).

The Plant Manager is appointed by the General Manager with concurrence by the Vice President, Operations.

6.1.1.11 Operations Manager

The Operations Manager reports to the Plant Manager.

The Operations Manager is responsible for the operation of the enrichment cascade, plant utilities, chemical services, feed and product facilities, shift operations, and fire services. This includes activities such as ensuring the correct and safe operation of the UF_6 processes; proper receipt, storage, handling and on-site transportation of UF_6; providing electric power, steam, compressed air, nitrogen, plant and sanitary water, waste water treatment for the cascade and support facilities; and providing chemical cleaning, and

decontamination services. In the absence of the General Manager and Plant Manager, the Operations Manager may be delegated the responsibilities and authorities of the General and/or the Plant Manager. This manager shall have the authority to stop work and/or shut down operations in any part of the operation for which he/she has responsibility.

The Operations Manager shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience with at least six months in a gaseous diffusion plant.

The Operations Manager is appointed by the Plant Manager with concurrence by the General Manager and the Vice President, Operations.

6.1.1.12 Maintenance Manager

The Maintenance Manager reports to the Plant Manager.

The Maintenance Manager is responsible for providing safe and reliable performance of preventive, predictive, and corrective maintenance and support services on plant facilities and equipment. This includes workplanning, troubleshooting, maintenance of logs and records, interfacing with Scheduling to initiate, screen, evaluate, prioritize, and schedule maintenance work, and coordinating shop maintenance. The manager shall have the authority to stop work and/or shut down operations in any part of the operation for which he/she has responsibility.

The Maintenance Manager shall have as a minimum a bachelor's degree in engineering or the physical sciences or equivalent technical experience and four years of nuclear experience with at least six months in a gaseous diffusion plant.

The Maintenance Manager is appointed by the Plant Manager with concurrence by the General Manager and by the Vice President, Operations.

6.1.1.13 Section Deleted

6.1.1.14 Radiation Protection Manager

The Radiation Protection Manager reports to the Environmental, Safety, and Health Manager.

The Radiation Protection Manager is responsible for the implementation, maintenance, and effectiveness of the health physics, radiation protection, and environmental sampling programs. These duties include training personnel in the use of radiological program support equipment, controlling radiation exposure of personnel, determining the radiological status of the facility, determining the need for issuing and closing out radiation work permits, conducting the radiological occupational monitoring and environmental sampling programs. The Radiation Protection Manager has direct access to the General Manager and the Plant Manager concerning radiation protection matters and has stop work authority for activities not being conducted in accordance with radiation protection requirements and policies.

The Radiation Protection Manager shall have as a minimum a bachelors degree in engineering, health physics, radiation protection, or the physical sciences or equivalent technical experience, and four years experience in radiation protection including six months at a uranium processing facility.

The Radiation Protection Manager is appointed by the Environmental, Safety, and Health Manager with concurrence by the General Manager.

6.1.1.15 Text deleted.

6.1.1.16 Shift Operations Manager

The Shift Operations Manager reports to the Operations Manager.

The Shift Operations Manager coordinates the activities of the Plant Shift Superintendents, Cascade Coordinators, and the Fire Chief, and provides technical and administrative support.

The Shift Operations Manager shall have as a minimum a bachelors degree or equivalent technical experience and four years nuclear experience, with at least six months at a GDP.

The Shift Operations Manager is appointed by the Operations Manager with concurrence by the Plant Manager, General Manager, and the Vice President, Operations.

6.1.1.17 Plant Shift Superintendent

The Plant Shift Superintendent reports to the Shift Operations Manager.

As the senior manager on shift, the Plant Shift Superintendent represents the General Manager and has the authority and responsibility to make decisions as necessary to ensure safe operations, including stopping work and placing the plant in a safe condition. The Plant Shift Superintendent is responsible for accumulation and dissemination of information regarding plant activities, serving as or designating the incident commander during plant emergencies and making notification of events.

The Plant Shift Superintendent is authorized to stop operations when system operability or the overall safety of operations is in question. The Plant Shift Superintendent is also authorized to initiate restart after shutdown for non-routine reasons. For shutdowns that are directed by the Vice President, Operations; Nuclear Safety and Quality Manager; the General Manager, or the Plant Manager; the Plant Shift Superintendent may authorize restart only after obtaining the approval of the Plant Manager (who will in turn obtain the necessary concurrence as described in Section 6.1.1.9).

The Plant Shift Superintendent shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience and 4 years experience at a GDP, or a high school diploma plus 12 years experience at a GDP.

The Plant Shift Superintendent is appointed by the Shift Operations Manager with concurrence by the Operations Manager, Plant Manager, and General Manager.

6.1.1.18 Engineering Manager

The Engineering Manager reports to the General Manager.

The Engineering Manager is responsible for engineering activities in support of operations, including project management, design, fabrication, and construction of plant modifications; systems engineering; and the configuration management program. The Engineering Manager has stop work authority for any activity that would be or is in violation of the plant safety basis, the Technical Safety Requirements, or the requirements and assumptions of the accident analyses.

The Engineering Manager is the design authority for radioactive material packaging and transportation structures, systems, and components. As such, the Engineering Manager is responsible for the following:

1. Evaluation of supplier's technical capabilities and approval of technical dispositions, and technical evaluation of supplier-generated nonconforming material, equipment, or services.

2. Providing measures which ensure the proper selection, application, methods of acceptance, and use of commercial grade items when applicable.

3. Specifying requirements for handling, storage, shipping, cleaning, packaging, and on-site movement of S.C. items in specifications, drawings, instruction, procedures, procurement documents, and/or other appropriate documents.

4. Determining applicable special processes, providing technical requirements, review, and concurrence for special process procedures including the utilization and application of nondestructive examination procedures.

5. Providing technical criteria for testing and the evaluation and resolution of test deficiencies.

6. Providing documented technical justification for nonconforming items dispositioned "use-as-is" or "repair" and ensuring as-built records reflect accepted deviations as required.

The Engineering Manager shall have as a minimum a bachelors degree in engineering or the physical sciences and four years of nuclear experience with at least six months in a gaseous diffusion plant.

The Engineering Manager is appointed by the General Manager with concurrence by the Vice President, Operations.

6.1.1.19 Nuclear Criticality Safety Manager

The Nuclear Criticality Safety Manager reports to the Regulatory Affairs Manager.

The Nuclear Criticality Safety Manager is responsible for developing and implementing the nuclear criticality safety program for the facility. These duties include technical oversight of nuclear criticality safety; nuclear criticality safety training; evaluation and approval of current and proposed changes to process conditions, equipment, and procedures involving fissile material operations; and conducting assessments of program implementation. The Nuclear Criticality Safety Manager has direct access to the General Manager concerning nuclear criticality safety matters and has stop work authority for any activity that could cause a criticality concern.

The Nuclear Criticality Safety Manager shall have as a minimum a bachelors degree in engineering or physical sciences, and four years nuclear criticality experience or nuclear engineering experience (e.g., core load design, fuel design, reactor engineering) with at least six months at a uranium processing facility where nuclear criticality safety was practiced.

The Nuclear Criticality Safety Manager is appointed by the Regulatory Affairs Manager with concurrence by the General Manager.

6.1.1.20 GDP Procurement and Materials Manager

The GDP Procurement and Materials Manager is responsible for packaging and transportation and for receipt, delivery, storage, control, and on-site movement of packaging and transportation SSCs and hazardous chemicals under his cognizance to the point of issuance. This manager interacts directly with the General Manager, other managers and key plant personnel and participates as desired in any discussions related to procurement and materials management. The GDP Procurement and Materials Manager is appointed by and reports to the USEC Director of Procurement and Contracts.

6.1.1.21 Selection Deleted

6.1.1.22 Security Manager

The Security Manager reports to the General Manager.

The Security Manager is responsible for plant police services and security. The Security Manager is governed by and must adhere to the policies established by the Director, Corporate Security. The Security Manager has stop work authority for activities not being conducted in accordance with applicable regulatory requirements. The General Manager is authorized to direct the security resources assigned to plant security by the Security Manager, as necessary, to ensure safe operation of the plant.

The Security Manager shall have as a minimum a bachelors degree or equivalent technical experience and four years security experience or four years nuclear experience.

The Security Manager is appointed by the General Manager with concurrence by the Director, Corporate Security.

6.1.1.23 Fire Chief

The Fire Chief reports to the Shift Operations Manager and is governed by, and must adhere to, policies established by the General Manager.

The Fire Chief is responsible for plant fire services and has stop work authority for activities not being conducted in accordance with applicable fire protection requirements. The Fire Chief is the senior site fire protection officer.

The Fire Chief shall have as a minimum a bachelors degree or equivalent technical experience, four years of fire protection experience, and 6 months of nuclear experience.

The Fire Chief is appointed by the Operations Manager with concurrence by the Plant Manager and the General Manager.

6.1.1.24 Production Support & Product Scheduling Manager

The Production Support & Product Scheduling Manager reports to the Plant Manager. The Production Support and Product Scheduling Manager is responsible for the technical functions in direct support of production activities. This includes laboratory operations, and materials and process technology.

The Customer Service & Product Scheduling Manager is responsible for the management of groups and personnel in several significant functions for customer order filling and scheduling production maintenance work. Scheduling of production maintenance work includes managing daily work control activities, developing an integrated work schedule, and coordinating development of work control guidelines. The Production Support & Product Scheduling Manager also serves as USEC's primary point of contact with the DOT and implements applicable NCS controls for Production Support & Product Scheduling field activities.

The Production Support & Product Scheduling Manager shall have as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, four years of management experience and five years of nuclear experience with at least six months in a gaseous diffusion plant.

The Production Support & Product Scheduling Manager is appointed by the Plant Manager with concurrence by the General Manager and Vice President, Operations.

6.1.1.25 Regulatory Affairs Manager

The Regulatory Affairs Manager reports to the General Manager. The Regulatory Affairs Manager is governed by and must adhere to policies established by the Director, Regulatory Affairs.

As delegated by the General Manager, the Regulatory Affairs Manager is responsible for the day-to-day interface with NRC on matters of regulatory compliance; event investigations, and reporting; and regulatory commitment management. As delegated by the Director, Regulatory Affairs, the Regulatory Affairs Manager has responsibility for coordinating certification related and certificate renewal-related activities. The Regulatory Affairs Manager is also responsible for providing plant management with data to assure the plant's corrective actions and commitments are properly addressed and managed to facilitate compliance with the implementing policies and procedures, for the operating experience review program, for administration of the problem reporting systems, and for alerting plant management to adverse trends as noted for identified deficiencies. In addition, the Regulatory Affairs Manager is the senior site manager responsible for establishment and oversight of the Nuclear Criticality Safety and Nuclear Safety programs (including implementation of the unreviewed safety question determination program and conducting assessments of program implementation), and has stop work authority for any activity that would be or is in violation of the plant safety basis, the Technical Safety Requirements, or the requirement and assumptions of the accident analyses.

The Regulatory Affairs Manager is responsible for preparation, presentation, and recording of employee orientations and for technical and qualification training programs' development and implementation. The Regulatory Affairs Manager is also responsible for the development and implementation of the procedures program and for the records management and document control (RMDC) program.

The Regulatory Affairs Manager shall have as a minimum a bachelor's degree in engineering or the physical sciences or equivalent technical experience, and four years nuclear experience.

The Regulatory Affairs Manager is appointed by the General Manager with concurrence of the Director, Regulatory Affairs.

6.1.1.26 Operations and Maintenance First-Line Managers

First-line operations and maintenance managers report to Group or Section Managers.

First-line operations managers shall meet the employment qualifications as an Operator and have as a minimum one of the following:

1. A high school diploma or satisfactory completion of the General Educational Development (GED) test and 3 years of plant operations experience with at least 6 months in a gaseous diffusion plant.
2. A four year degree with at least two years gaseous diffusion plant experience in an operational, maintenance, or engineering assignment.
3. A two year degree with at least three years gaseous diffusion plant experience in an operational, maintenance, or engineering assignment.
4. A high school diploma or satisfactory completion of the General Educational Development (GED) test and five years of gaseous diffusion plant experience in a maintenance or engineering assignment.
5. A high school diploma or satisfactory completion of the General Educational Development (GED) test and two years Military experience in a technical field and 18 months of experience in an operational, maintenance, or engineering position with at least 6 months in a gaseous diffusion plant.

First-line maintenance managers shall have as a minimum a high school diploma or satisfactory completion of the GED test and 3 years of maintenance-related plant experience with at least 3 months in a gaseous diffusion plant or 11 years maintenance experience in a gaseous diffusion plant. As an equivalent alternative, a first-line maintenance manager may have a four year technical degree with at least two years gaseous diffusion plant experience in an operational, maintenance, or engineering assignment.

First-line operations and maintenance managers are appointed by Group or Section managers with concurrence by the Organization managers.

First-line operations managers can authorize the restart of equipment that has been shutdown in a routine fashion when the prerequisites and limitations of the associated operating procedure are met.

6.1.1.27 Environmental, Safety and Health Manager

The Environmental, Safety and Health Manager reports to the General Manager.

The Environmental, Safety and Health Manager is responsible for oversight functions in the areas of environmental, safety, health and medical services, emergency management, and waste management. The Environmental, Safety and Health Manager is the senior site manager responsible for establishment and oversight of the site environmental protection programs and the environmental monitoring program described in Section 5.1. This manager appoints a site program manager for the Chemical Safety Program.

The Environmental, Safety, and Health Manager is the senior site manager responsible for establishing and implementing the health physics and environmental sampling programs at the facility. This manager shall have the authority to stop work and or shutdown operations in any part of the operation for which he/she has responsibility.

The Environmental, Safety and Health Manager shall have as a minimum a bachelors degree or equivalent technical experience and four years of nuclear experience with at least six months at a GDP.

The Environmental, Safety and Health Manager is appointed by the General Manager.

6.1.2 Management Controls

The management controls established by USEC include policies and directives, management systems, and administrative procedures. USEC establishes policies which are communicated to the plants. Policies related to the protection of health and safety of workers and the public, protection of the environment, and providing for the common defense are discussed in pertinent sections of this application.

Management systems and programs are described in Chapters 5 and 6, the Technical Safety Requirements, and in several program plans and descriptions (notably, the Emergency Plan, Quality Assurance Program, Radioactive Waste Management Program, Fundamental Nuclear Material Control Plan, and Security Plans. The commitment tracking and corrective action management systems are integrated to prioritize plant actions consistent with their safety and safeguards significance. Where safety or safeguards might be adversely impacted by cost or schedule considerations, it is the policy of USEC to subordinate cost and schedular considerations to ensure adequate treatment of safety and safeguards.

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The interface and coordination of the elements of safety and safeguards programs are accomplished through the management systems described in this chapter and are manifest in the line direction of plant operations. Additionally, oversight of the integration of various program elements is provided by the Nuclear Safety and Quality Manager. From a technical perspective, the Plant Operations Review Committee (PORC) and its associated subcommittees provide the mechanism for evaluating and integrating safety and safeguards program elements from a plant design and program change perspective.

6.1.3 Items Addressed by Compliance Plan

Section deleted.

Management Controls

Section deleted.

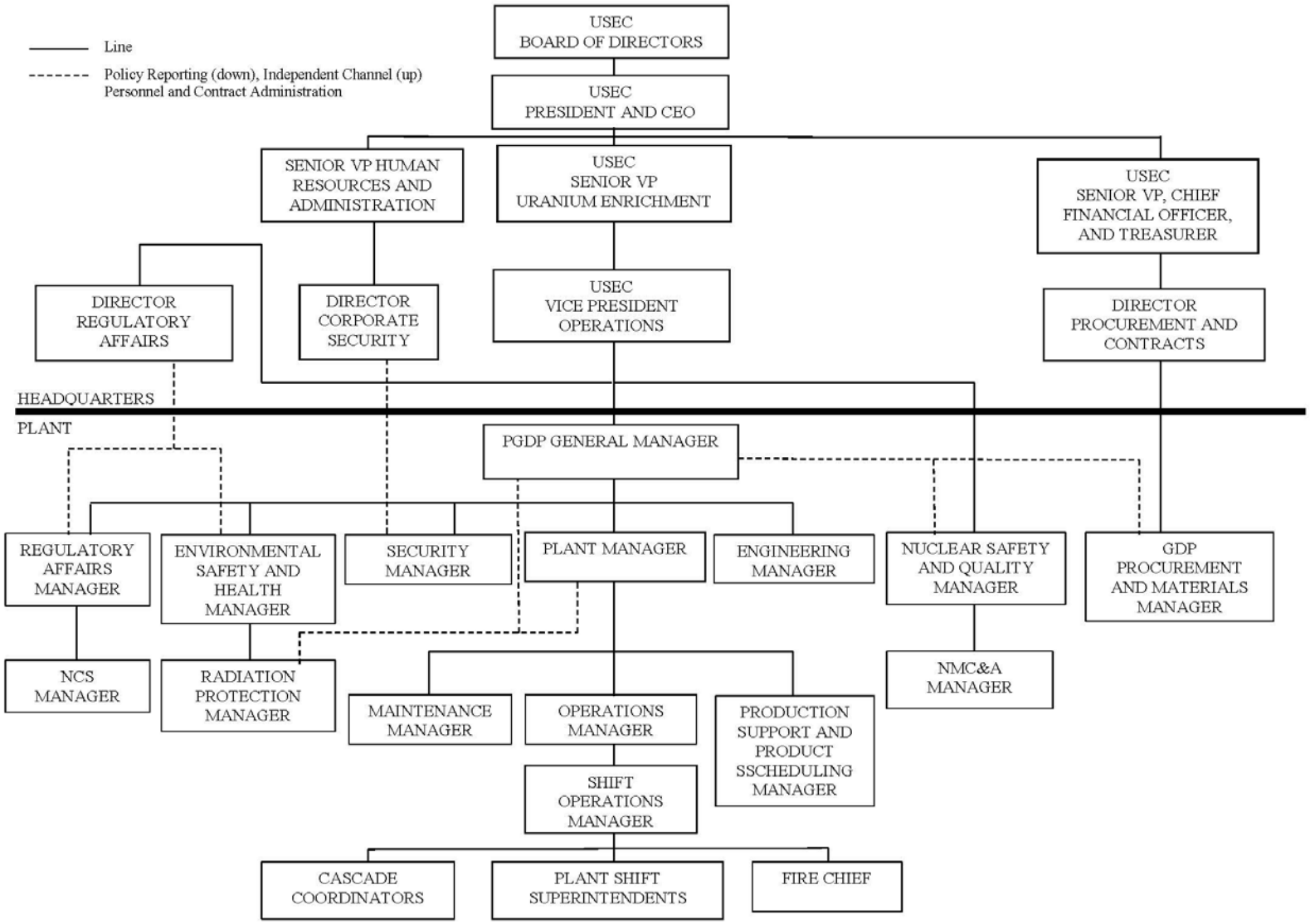

Figure 6.1-1. Uranium Enrichment Facilities Organization Chart

Figure 6.1-2 deleted

6.2 SAFETY COMMITTEES

The United States Enrichment Corporation (USEC) has established a Plant Operations Review Committee (PORC) that provides the review of the gaseous diffusion plants (GDPs) activities as required by 10 CFR 76.68(a). The membership, qualifications, meeting frequency and quorum, functions, responsibilities, and required records are as described in TSR 3.10. The PORC advises the General Manager on matters related to nuclear safety. The General Manager approves the procedure implementing the PORC activities described in TSR 3.10. Auditing and oversight of PORC activities is the responsibility of the Nuclear Safety and Quality Manager.

Subcommittees may be established by the PORC chair to provide assistance in conducting reviews and assessments as described in the PORC procedure. The PORC chairperson approves the subcommittee procedures, membership, and member qualifications. The PORC maintains the overall responsibility for all required review responsibilities.

6.2.1 Deleted

6.2.2 Deleted

6.2.3 Items Addressed by Compliance Plan

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6.3 PLANT CHANGES AND CONFIGURATION MANAGEMENT

In accordance with 10 CFR 76.68, USEC is permitted to make changes to the plant or to the plant's operations as described in the Safety Analysis Report (SAR) in accordance with specified requirements. In addition, USEC may apply for amendments to any certificate of compliance in accordance with 10 CFR 76.45 and may modify programs and plans in accordance with the criteria set forth in this application. This section describes the mechanisms used to provide for control and approval of such changes. In addition, this section describes the plant systems for controlling the configuration of plant programs and systems in accordance with this certification application, including the SAR and Technical Safety Requirements (TSRs).

6.3.1 Technical Safety Requirements and Certificate of Compliance Conditions

Proposed changes to the plant or the plant's operations including physical modifications, changes to procedures and training, and changes to programs and plans are reviewed relative to the TSRs and the conditions of the certificate of compliance.

USEC will not make any changes to the TSRs (except the Basis Statements) or to any conditions of the certificate of compliance, unless prior approval for such change is granted by the NRC in accordance with 10 CFR 76.45. USEC may make changes to the Basis Statements without prior NRC approval. Changes to the Basis Statements will be included in revisions to the TSRs and will be submitted annually to the NRC. The revised pages of the TSRs will be marked and dated to indicate each change.

Proposed changes to the TSRs, TSR Basis Statements, and any conditions of the certificate of compliance are authorized by responsible management and approved by the Plant Operations Review Committee (PORC) (see Section 6.2).

Regulatory Affairs (RA) controls documentation and coordinates implementation of approved changes to the TSRs and conditions of the certificate of compliance, controls documentation of changes to TSR Basis Statements, and maintains records of changes and change control documentation.

6.3.2 Safety Analysis Report

Proposed changes to the plant or to the plant's operations, including physical modifications, changes to procedures and training, and changes to programs and plans, are reviewed relative to the description of the plant and plant operations in the SAR.

In accordance with 10 CFR 76.35, the Safety Analysis Report is comprised of Volumes 1 and 2 of the Certification Application and includes:

Chapter 1 - Introduction and General Description of the Facility
Chapter 2 - Site Characteristics of the Paducah Gaseous Diffusion Plant
Chapter 3 - Facility and Process Description
Chapter 4 - Accident Analysis
Chapter 5 - Nuclear Safety Programs
Chapter 6 - Organization and Operating Programs

USEC may make changes to the plant or to the plant's operations, as described in the Safety Analysis Report, without prior NRC approval, provided all the following provisions of 10 CFR 76.68(a) are met:

1. USEC shall conduct a written safety analysis which demonstrates that the changes would not result in undue risk to public health and safety, the common defense and security, or to the environment;

2. The changes must be authorized by responsible management and approved by the PORC as described in Section 6.2;

3. The changes may not decrease effectiveness of the plant's safety, safeguards, and security programs;

4. The changes may not involve a change in any condition to the certificate of compliance;

5. The changes may not involve a change to any condition to the approved compliance plan;

6. The changes may not involve an unreviewed safety question.

If USEC determines that a proposed change would not meet one of the above provisions, USEC shall not make the change unless prior approval for such change is granted by the NRC in accordance with 10 CFR 76.45.

USEC will evaluate any as-found conditions that do not agree with the description of the plant or plant operations as described in the SAR (including programs, plans, policies, and operations) in accordance with the above provisions. Any revisions required to reflect the as-found conditions will be submitted annually as specified in 10 CFR 76.36 or at a shorter interval as may be specified in the certificate.

Changes will be submitted to the NRC annually pursuant to the requirements of 10 CFR 76.36. The revised pages of the SAR will be marked and dated to indicate each such change. RA is responsible for the maintenance and control of the SAR and maintains records of changes and change control documentation.

6.3.3 Programs and Plans

RA is responsible for maintaining the program plans and documentation of changes as discussed in the following subsections.

6.3.3.1 Programs and Plans Requiring Evaluations

Proposed changes to the Emergency Plan, Quality Assurance Program, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance, Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance, Security Plan for the Protection of Classified Matter, and the Fundamental Nuclear Material Control Plan shall be evaluated by USEC to determine whether the proposed change would decrease the effectiveness of the program. USEC shall

not make a change to these plans or program descriptions that would decrease the effectiveness of the program unless prior approval of such change has been granted by the NRC in accordance with 10 CFR 76.45. These changes shall be authorized by responsible management and approved by the PORC (as described in Section 6.2).

RA is responsible for maintaining the program plans and documentation of changes. Proposed changes to the plant or to the plant's operations including procedures and training, plant programs, or the plant physical configuration are reviewed relative to the program descriptions and plans.

Those changes to the program descriptions and plans that are determined not to decrease program effectiveness may be made without prior NRC approval with notification of the NRC of changes made as follows:

1. Changes to the Quality Assurance Program will be submitted annually;

2. Changes to the Emergency Plan will be submitted to the NRC and to affected off-site organizations within 6 months after the change is made;

3. Changes to the Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance, Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance, Security Plan for the Protection of Classified Matter and Fundamental Nuclear Material Control Plan will be submitted to the NRC within 6 months after the change is made;

The revised pages of the program description or plan will be marked and dated to indicate each change.

6.3.3.2 Changes to Other Plans and Information

USEC may change the Radioactive Waste Management Plan, Depleted Uranium Management Plan, Decommissioning Funding Plan, Environmental Compliance Status Report, and Supplemental Environmental Information without prior NRC approval. Changes to these plans and information will be authorized by responsible management and approved by the PORC (as described in Section 6.2). Revisions to these documents reflecting such changes will be submitted annually to the NRC. The revised pages will be marked and dated to indicate each change.

RA is responsible for maintaining the program plans and documentation of changes. Proposed changes to the plant or to the plant's operations including procedures and training, plant programs, or the plant physical configuration are reviewed relative to the program descriptions and plans.

6.3.4 Records of Plant Changes

Records of changes described in Sections 6.3.1 through 6.3.3, including their safety analysis and documentation, are maintained in accordance with 10 CFR 76.68(c) and as described in Section 6.10.

6.3.5 Physical Plant Change Control and Configuration Management

The control of changes to the physical plant and control of the physical plant configuration are managed by the Design Authority (Engineering). The following paragraphs describe the plant Configuration Management (CM) Program mechanisms used to control changes and maintain the plant configuration as described in this certification application, including the SAR and TSRs. The evaluation of changes relative to the application is as described above relative to the particular section of the application involved. As noted, changes affecting the application are incorporated by the RA organization.

6.3.5.1 Overview

6.3.5.1.1 Objectives

The CM Program has been developed and documented in a site procedure and is being implemented to ensure that changes from the plant's baseline configuration are controlled to prevent degradation of safety or safeguards. The program includes (1) identification of the structures, systems, equipment, components, and design features credited for safety and safeguards, (2) organizational descriptions of duties and responsibilities, and (3) administrative controls, procedures and polices, to implement and document activities that maintain the plant's baseline for safety and safeguards.

This program includes organizations and administrative processes and assessments to ensure accurate, current design documentation that matches the plant's physical configuration while complying with applicable requirements.

6.3.5.1.2 Safety Benefits

CM Program results in:

1. Performance of design activities in accordance with the Quality Assurance Program (QAP) that produces technically sound designs to meet or exceed regulatory and industrial code/standards requirements and preserve or increase design margins of safety.

2. Establishment and enforcement of controls that ensure the integrity of the design and design documentation are maintained throughout the plant life, including the development and implementation of modifications.

3. Assurance that coordination of the intent of the design documents with operating and maintenance procedures accompanied by appropriate training of personnel to support plant changes is accomplished.

4. Effective communication of boundaries and systems, structures, and components (SSCs) as described in Section 3.15.

6.3.5.1.3 Program Elements

The elements of the program consist of the following:

1. Program Management;
2. Design Requirements;
3. Records Management and Document Control;
4. Change Control;
5. Assessments; and
6. Training.

6.3.5.1.4 CM Structure

Key responsibilities and functional interfaces are illustrated in Figure 6.3-1.

6.3.5.2 Program Management

6.3.5.2.1 Policy Statement

The configuration of important safety and safeguards features of facilities, activities, processes, and experiments must conform to approved design and administrative requirements. In addition, decisions affecting safety, quality, and other important functions must be documented and changes must not lead to violation of established requirements.

Important features are structures, systems, components, computer hardware or software, communications networks, instructions or procedures, or other designated physical or administrative items that protect the health and safety of workers and the public; protect the environment; ensure compliance with applicable laws, orders, or regulations; or provide safeguards and security.

6.3.5.2.2 Organization

CM is a primary responsibility of the Design Authority, although numerous organizations are tasked with implementation responsibilities as illustrated in Figure 6.3-1.

Features (SSCs) controlled by the CM Program include Q and AQ items (see Section 3.15).

AQ items require CM controls as identified in Appendix A of the QAP. CM requirements are reflected in QA and CM procedures.

CM requirements for Q items are addressed in subsequent subsections and paragraphs of this section.

6.3.5.2.3 Key Responsibilities

1. Regulatory Affairs

   a. Performs analyses and evaluations in support of the SAR.

   b. Performs reviews of plant change reviews (PCRs) for proposed facility modifications and procedure changes, requiring a written safety analysis, unreviewed safety question determination, or decreased effectiveness evaluations.

2. Engineering

   a. Obtains information derived from the SAR to be used in the development of the Q item database.

   b. Is the Plant Design Authority (DA) responsible for establishing the design requirements, ensuring design output information (documents and data) appropriately reflects the design input, and for maintenance of the plant's safety basis;

   c. Manages the CM Program;

   d. Identifies and defines the boundaries for Q systems.

   e. Performs design/modification processes that implement the design control and design change control requirements established in the QAP which includes controls for design inputs, design verification (including analysis software), design changes, design interfaces, and design documentation and records;

   f. Issues the documentation that defines boundaries for SSCs in the CM Program; and

   g. Establishes and maintains a controlled database for Q items.

   h. Maintains system awareness by reviewing logs, data, work control packages and observes operations and performs system walk-downs;

   i. Identifies system/component problems and ensures resolution;

   j. Evaluates surveillance test results;

   k. Monitors PM program and calibration frequencies;

l. Reviews design proposals and modifications;

m. Ensures that appropriate documents and procedures are updated to be consistent with modifications; and

n. Assists in work control package preparation and identification of post-maintenance test requirements.

3. Records Management and Document Control – Regulatory Affairs

a. Develops and operates a records management and document control (RMDC) program that controls and issues designated documents and acts as the repository with retrieval capabilities for controlled documents and records necessary to maintain the plant's design history; and

b. Maintains an index of documents that are required to be controlled.

4. GDP Procurement and Materials

a. Develops procedures in accordance with the QAP for procurement and control of item;

b. Purchases Q items and replacement parts only from authorized organizations and to requirements and technical specifications as identified by Engineering;

c. Ensures that only inspected and accepted items are stored and issued for work; and

d. Maintains items in a manner that complies with Engineering issued requirements.

5. Maintenance

a. Develops and implements procedures to execute a controlled work procedure that provides for verification of data, performance, or documentation where specified by the DA; documentation of material used for identification and to ensure traceability if required; post maintenance testing to ensure design specifications are met; and a process for maintaining equipment history records;

b. Ensures maintenance personnel are knowledgeable of requirements for working on Q systems/items;

c. Performs work only after receiving an approved maintenance work package; and

d. Identifies and furnishes to Documents and Records those work history and traceability requirements for Q items.

6. Operations

   a. Ensures no modifications are made to design or operational configuration without proper review and approval;

   b. Performs and documents operational, post-maintenance tests/checks and post-modification tests to assure items are operating as intended;

   c. Issues work orders or other authorizations prior to maintenance, testing or modifications activities; and

   d. Records the occurrence of tests, calibrations and maintenance activities.

7. Training and Procedures Groups – Regulatory Affairs

   a. Establishes a procedures control program to ensure technical, operations, maintenance and administrative procedures used to apply the CM Program processes are properly developed, received, approved, revised and controlled.

   b. Provides training support to Operations and Maintenance organizations to ensure personnel training is updated to support plant changes.

8. Nuclear Safety and Quality

   a. Assists in the development and implementation of the commercial grade dedication process for Q items;

   b. Assists in the acceptance process for non-commercial grade Q items;

   c. Verifies that Design Authority supplied acceptance criteria is met and that accepted items are appropriately identified;

   d. Establishes a program for in-process inspection of maintenance work packages in accordance with acceptance criteria contained in maintenance procedures or provided by the Design Authority;

   e. Provides oversight of the problem reporting and resolution program of the Regulatory Affairs Organization,; and

   f. Conducts audits and surveillances of processes that implement the CM Program.

6.3.5.2.4 General Modification Process

1. A request for engineering assistance is reviewed by Design Engineering Management to determine that:

    a. The proposed change is acceptable based upon scope, applicability, justification and/or technical merit.

    b. The change is a substitution and grants approval to continue the substitution process.

    c. The change may proceed through the design process in accordance with engineering procedures and with approval by the Design Authority and may require additional review by the PORC.

    PORC approval is required for changes to the plant as described in the SAR. See Section 6.2.

2. The engineering design modification process involves:

    a. The assignment of an engineering group to process the engineering request;

    b. The assignment of a design/project team by engineering management. This team is comprised of design/project personnel from Engineering, Nuclear Criticality Safety, Safety, and Maintenance as appropriate;

    c. A field verification for Q and AQ systems/items that design documentation agrees with as-found configurations. This allows for a technically accurate assessment of the modification's impact on the system;

    d. A 10CFR 76.68 Plant Change Review performed by qualified personnel (NCS evaluations are described in Section 5.2);

    e. Identification of design documents, procedures, training, post-modification, etc. required to support the modification; and

    f. The approval of appropriate personnel prior to implementation (e.g., DA, PORC).

6.3.5.3 Design Requirements

The SAR, process hazard analyses, and NCSAs are developed based on the plant's known configuration. A reasonable spectrum of postulated accidents that could potentially affect the health and safety of the public and on-site workers are identified and evaluated to determine the risk involved. These evaluations are used to identify the SSCs credited for safety and to identify the boundaries of these systems.

Utilizing the boundary definitions and the identification of components responsible for a safety function, the Engineering organization:

1. Conducts a field walk-down, prior to modification, and design document comparison for Q and AQ systems/items to verify the design baseline;

2. Resolves any variances, including the processing of a USQD if appropriate, and generate approved, as-built design documentation; and

3. Utilizes the verified design baseline for future modifications.

6.3.5.4 Document Control

Procedures, documents, and records control programs provide for centralized control and issuance of documents critical to the maintenance of the plant design configuration and provide a repository for records to verify this maintenance.

6.3.5.4.1 Procedures

The procedure control program ensures that procedures are generated, reviewed, approved, and distributed in a controlled manner. Reference Section 6.11 for details and clarification.

6.3.5.4.2 Records Management and Document Control

A document control program ensures that changes to approved controlled documents are updated in a timely manner, distributed to controlled copy holders, and maintained available to support daily work activities.

Controlled documents in support of the CM Program are identified in the procedures that generate the documents and include, but are not limited to, such documents as:

1. Procedures addressing activities affecting SSCs and design features credited with preventing or mitigating accidents as identified in the SAR or other regulatory hazard analyses required by the SAR or QAP.

2. Design documents (e.g., drawings, analyses and calculations).

3. Q item database.

4. Engineering specification data sheets which include the technical requirements, vendor data requirements and the commercial grade dedication requirements.

5. SAR, TSR, Nuclear Criticality Safety Approvals (NCSA) and other hazard analyses.

6. Procedures and plans addressing emergency operating and response plans.

7. Controlled documents to support maintenance and verification of the design baseline are required by procedures that generate records such as:

   a. Design modification packages;

   b. Acceptance records for receipt of material, shop and field inspection of work processes supporting maintenance, repair, and testing records;

   c. Maintenance, repair, and modification construction and installation work packages; and

   d. Documentation used by Operations to record verification, test, and traceability data.

   Reference Section 6.10 for details and clarification.

6.3.5.5 Change Control

A change control process is documented, which meets the requirements of the QAP and which requires that:

1. Facility modifications, additions, or changes have a 10 CFR 76.68 review performed in accordance with the requirements specified in Section 6.3.2. Information utilized in the 10 CFR 76.68 review includes the following as appropriate:

   a. Systems Requirement Document;
   b. Feasibilities studies;
   c. Conceptual design descriptions;
   d. Drawings/specifications;
   e. Other documentation providing a project description; and
   f. Changes in the project.

2. Modifications be evaluated for any required changes or additions to the facility's procedures, personnel training, testing programs, or regulatory documents.

3. Critical repair parts for Q and AQ-NCS items be identified, described, and controlled.

4. Modifications, as appropriate, be evaluated and documented for radiation exposure to minimize worker exposure in keeping with the facility ALARA program, criticality, and worker safety requirements and/or restrictions. Other areas of consideration in evaluating modifications may include: modification costs, similar completed modifications, QA aspects, potential operability or maintainability concerns, constructability concerns, environmental considerations and human factors.

5. Proposed facility modifications receive an independent, technical review which considers the technical feasibility and merit of the proposed change and the identification of appropriate interfaces for inclusion in the change package (e.g., procedures, training, safety).

6. A final review prior to release for operation is conducted which verifies that:

   a. The safety analysis documentation is complete and approved;
   b. Operational procedure changes are completed and other supporting procedure changes have been initiated;
   c. Operational training and qualification changes have been completed;
   d. Design changes are completed and any as-built changes are identified and approved;
   e. Document changes are completed; and
   f. Post-modification testing has been successfully completed.

6.3.5.6 Assessments

The assessment program systematically evaluates the development and effective implementation of the CM Program processes. It assesses the adequacy of the implementation of administrative requirements on configuration items and their documentation. The assessment program contains the elements of:

1. Field verification of design requirements and documentation. This activity description includes the field verification directed toward the SAR system boundaries and their specific SSCs;

2. Surveillance testing as identified in the TSR and reflected in Operations/Maintenance procedures;

3. Post-modification testing;

4. Administrative procedural audits/surveillances;

5. Activity monitoring; and

6. Problem reporting and corrective action.

6.3.5.7 Training

A training and qualification program has been established for workers relied upon to operate, maintain, or modify items where required as defined in the SAR. Reference Section 6.6 for details and clarification.

6.3.6 Items Addressed by Compliance Plan

Section deleted.

6.3.6.1 Program Management

Section deleted.

6.3.6.2 Design Requirements

Section deleted.

6.3.6.3 Document Control

Section deleted.

6.3.6.4 Change Control

Section deleted.

6.3.6.5 Assessments

Section deleted.

6.3.6.6 Training

Section deleted.

6.3.7 Flowdown of Certification Application Commitments

In accordance with 10 CFR 76.35(a)(7), USEC is required to provide a description of the management controls and oversight program to ensure that activities directly relevant to nuclear safety and safeguards and security are conducted in an appropriately controlled manner that ensures protection of employee and public health and safety and protection of the national security interests. One of these management controls involves the flowdown of certification application commitments into implementing documents.

Implementing documents utilized in the flowdown process shall be controlled in accordance with SAR Section 6.10.2, Document Control Program. Regulatory commitments contained in an implementing document shall be identified and noted as commitments within that document. Changes to an implementing document that contains a commitment are reviewed in accordance with 10 CFR 76.68.

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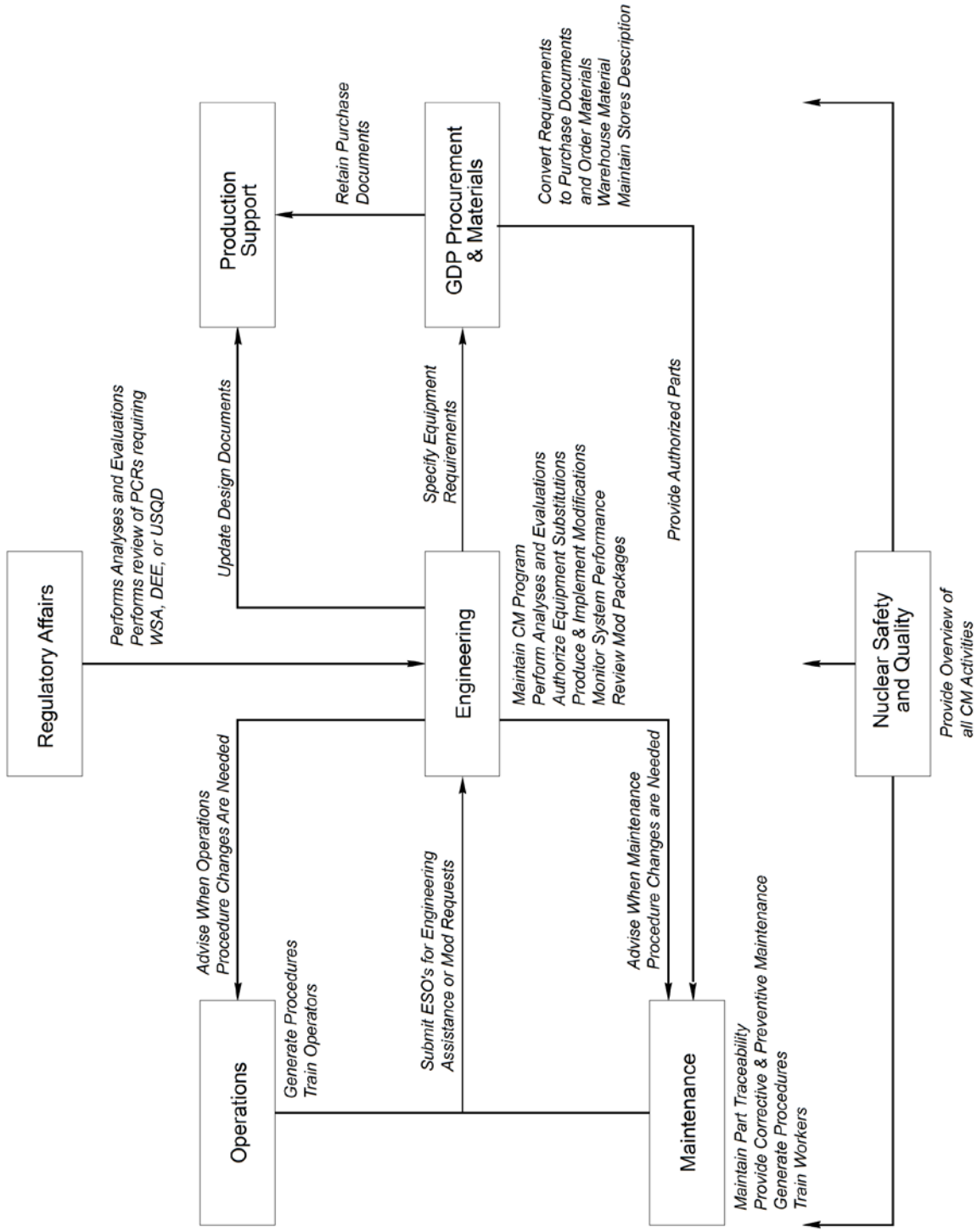

Figure 6.3-1. Configuration management functional relationships.

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6.4 MAINTENANCE

The PGDP Maintenance and Production Support & Product Scheduling organizations provide for the safe, reliable, and cost-effective maintenance of the gaseous diffusion plant. Maintenance for the plant is performed in accordance with Quality Assurance Program and Configuration Management requirements. The maintenance program consists of a mix of corrective maintenance (CM) and preventive maintenance (PM), including instrument calibrations. Trend analysis is used to monitor the effectiveness of the program. Managers have roles and responsibilities that are periodically revised based on corporate goals. Personnel evaluations include the effectiveness of implementation of their responsibilities.

6.4.1 Maintenance Program Coverage

The PGDP maintenance program described in this section applies to those Q and AQ-NCS structures, systems, and components (SSCs) as identified by the design authority in accordance with Section 6.3, described in Section 3.15 and covered by the Quality Assurance Program (QAP). Routine maintenance work is identified, prioritized, planned, scheduled, executed, and closed out in accordance with the work control process.

AQ SSCs are also identified by the design authority in accordance with Section 6.3, described in Section 3.15 and covered by the QAP. Identifying, planning, prioritizing, scheduling, and closing out of AQ SSC maintenance is accomplished in accordance with the work control process. For each AQ SSC, the maintenance requirements that must be followed are established based on the impact on the health and safety of the public and workers, and the environment of specific SSCs. The specific graded requirements for the execution of maintenance on each AQ SSC are developed taking into consideration as appropriate: (1) the requirements of applicable regulations, codes, and standards; (2) the complexity or uniqueness of an item (or activity) and the environment in which it has to function, as determined by specification, design, or fabrication methods; (3) the history of the item in service; (4) the degree to which functional compliance may be demonstrated or assessed by testing, by inspection, and PM methods applied; and (5) the consequence of failure. The configuration management program provides for the identification of AQ SSCs.

6.4.2 Maintenance Organization and Administration

Assuring effective maintenance on GDP identified SSCs requires the following elements:

- Developing policies and procedures for installing, maintaining, and repairing of identified SSCs;
- Performing PM and CM;
- Performing post maintenance testing;
- Performing periodic surveillance activities;
- Identifying required spares, material, and replacement parts in support of maintenance activities;
- Providing planning and technical support for maintenance activities;
- Maintaining the maintenance data system;
- Performing measurement and test equipment maintenance; and
- Implementing on-the-job training (OJT) programs for maintenance personnel.

Implementing these elements is the responsibility of the organizations as described below.

6.4.2.1 The Maintenance Organization

The Maintenance Organization plans and conducts corrective and preventive maintenance including calibrations on identified GDP SSCs. Maintenance activities are performed in the following areas: mechanical, electrical, instrument, calibrations, electronics, support shops, and plant services (e.g., maintenance of site vehicles, cylinder handling, janitorial, etc.). Each group manager is accountable to the Maintenance Manager for the correct and timely maintenance within his scope. The Maintenance Manager reports to the Plant Manager.

The Maintenance Manager provides oversight of enrichment plant maintenance implementation through self-assessments. The self-assessment program is described in SAR Section 6.8.

6.4.2.2 Scheduling Group

The Scheduling Group of the Production Support & Product Scheduling Organization provides scheduling functions for maintenance activities. They also provide Computerized Maintenance Management System (CMMS) oversight and support, PM scheduling and tracking support, and TSR surveillance scheduling and tracking support.

6.4.2.3 Engineering

Engineering provides the technical basis for PM, develops predictive maintenance techniques, evaluates equipment history, tracks and trends performance of designated SSCs, supports root cause analysis of equipment failures, support reliability studies, provides design criteria, provides acceptance criteria and provides post maintenance testing requirements for identified SSCs. Engineering is also responsible for configuration management and technical support to the Maintenance organization.

6.4.2.4 GDP Procurement and Materials

GDP Procurement and Materials is responsible for provisioning including requisitioning, receipt, storage, and issuance of repair materials and components. They verify that catalog numbers and descriptions of identified SSCs are consistent with the latest Engineering Specification Data Sheet (ESDS) revision, ensuring that all identified SSCs have been inspected by appropriate personnel, tagged with a serviceable tag, and placed in a segregated controlled area. This organization also ensures that identified SSCs are stored in a way that will ensure integrity and availability and that they are maintained according to engineering specifications.

6.4.2.5 Other Support Groups

The Environmental, Safety and Health, Nuclear Criticality Safety, and Health Physics groups provide personnel safety and radiological control requirements needed to perform work safely.

The Quality Control group within Nuclear Safety and Quality performs inspections that are specified in work packages and procurement documents.

6.4.3 Training of Maintenance Personnel

Section 6.6 describes the system approach to training methodology used for initial and continuing training.

6.4.4 Maintenance Facilities

Section 3.13 describes PGDP maintenance facilities and specialized equipment.

6.4.5 Procedures

Procedures fall into two broad categories. Administrative procedures (including Scheduling and Maintenance) define the processes for identifying, scheduling, prioritizing, and coordinating maintenance,as well as prescribing the development of work packages and how maintenance is to be conducted. Technical maintenance procedures or work instructions appropriate for the circumstances are developed for repair, calibration, and testing of specific components or component types.

Section 6.11 describes the procedure control process that ensures procedure development, review, revision, approval, control and distribution.

6.4.6 Types of Maintenance

SSCs are maintained by performing PM, CM, and TSR Surveillances as applicable.

PM are those tasks performed on a periodic basis to prevent failures, facilitate performance, and maintain or extend life of the equipment. Predictive maintenance is a type of PM that uses various techniques to track and trend equipment performance in order to predict failures. PMs are identified, scheduled, and performed in accordance with maintenance procedures, engineering procedures or work instructions, as appropriate. Reports are available showing the status of scheduled PMs. PMs are adjusted as described in Section 6.4.7.

CM are those actions to check, troubleshoot, and repair equipment that has degraded or failed. CM identification, prioritization, planning and scheduling, performance and documentation are discussed in Section 6.4.7.

TSR Surveillances are performance checks, calibrations, tests, and/or inspections which are performed to verify the proper operability of equipment and/or systems in accordance with the plant's Technical Safety Requirements. The Technical Safety Requirements identify the surveillance requirements and frequencies.

6.4.7 Maintenance Programs

The Maintenance Program is comprised of CM, PM, TSR Surveillances, and trend analysis. Work control is the process used to implement CM and PM activities. Key elements that are used to help the plant achieve the desired level of program performance are listed below.

CM consists of the following elements:

- **Work Request** — A work request is the mechanism by which the need for maintenance is identified and prioritized. After review, work requests are changed to work orders to plan, schedule, and perform work.

- **Planning and Scheduling** — Planning and scheduling activities result in: (1) a work package which identifies the scope, work instructions, and required materials; (2) identification of required support services; and (3) identification of the need for coordination with other jobs. Maintenance activities are prioritized by the facility operational manager or designee based on safety significance and available resources. Necessary permits are identified prior to work execution as defined by applicable plant procedures.

- **Work Execution** — Work packages are reviewed, a pre-job briefing is conducted in accordance with procedures, work is conducted as planned, and the maintenance that was performed is documented.

- **Post-Maintenance Testing (PMT)** — Provides for testing to ensure that equipment and/or components will fulfill their required function when returned to service after maintenance.

- **Work Order Completion** — Provides a post maintenance package review to validate job package completion.

PM consists of the following elements:

- **Basis for PM** — The bases for PM tasks are developed through a review and applicability evaluation of manufacturer recommendations, available industry standards, and historical operating information. PMs are coordinated by Engineering and Scheduling, and involve input from design engineering, system engineering, and operating/maintenance personnel as appropriate. The formal documented bases for the tasks are developed, evaluated, and approved by Engineering.

- **Scheduling** — PMs are scheduled according to plant conditions and task frequencies. The work control process identifies SSCs that require PM work packages. PMs are conducted and closed out in accordance with the work control and PM Program procedures. The TSR surveillances

that are also credited in the PM Program will be conducted as required, or the actions required by the TSR will be followed. For PMs beyond the grace period (not including TSR surveillances), the engineer, with concurrence from the applicable functional area manager, or designee must determine the effect of extention of the PM on system operation. The decision includes a determination of compensatory actions and an acceptable completion date for the PM tasks.

- **Adjustments —** Changes to, adding, or deleting of PM tasks are performed according to the appropriate procedures and may be recommended by operations, maintenance, or engineering. Changes to tasks may be warranted by a system's performance compared to the performance indicators established for that system. Changes may also be initiated if the level of CM dictates that additional preventive measures are necessary to prevent premature failure of a system or its components, or as-found conditions indicate that PM is occuring more often than necessary.

  TSR Surveillances are performance checks, calibrations, tests, and/or inspections which are performed to verify the proper operability of equipment and/or systems according to the plant's TSRs. The TSRs identify the surveillance requirements and frequencies.

  Trend analysis is the evaluation of previously documented equipment/system failures and maintenance information to assess reliability. Engineering selects the equipment/systems for which equipment information is collected and further analyzed. Various sources of information, such as predictive maintenance data, problem reports (ATRs/PRs), work packages, operator and FLM logs, etc. may be used in the evaluation of PM tasks and frequencies, for tracking and trending recurring problems, as a basis for determining material condition, and evaluating equipment performance and reliability.

6.4.8 Work Control Process

The Work Control process plans and schedules maintenance work activities, providing overall integrated scheduling of capital projects, and maintaining a record of work accomplished. The work control process includes provisions for:

- Identifying work needed by requester.
- Prioritizing corrective and preventive maintenance.
- Planning tasks to ready-to-work status.
- Scheduling work to be performed.
- Executing, including coordinating work force and support groups and ensuring communications flow between work groups and management. Ensure that safety, safeguards, quality, and configuration management are properly and effectively implemented in performance of maintenance.
- Closing out, including final validation of work performed and review of the acceptance tests performed.

CM starts with the initiation of a Work Request, including priority, identifying the need for maintenance. The Work Request is reviewed by Maintenance for determination if a work package is required. The Work Control process identifies SSCs that require work packages before work can be started. The work control procedure also contains allowances for non-safety SSCs requiring work packages.

The composition of a work package is dependent on the maintenance to be performed and is defined in the work control procedure. The minimum requirements of a work package for safety system maintenance includes: task description; work instructions or procedures; and post-maintenance test requirements. Depending on the scope of the work, the package may also include equipment specific procedures or checklists and quality control inspection, nuclear criticality safety, radiation protection, OSHA, or operational requirements.

The Planner completes the work package using the approved work control procedure that lists the criteria for support group reviews by Engineering, Security, Fire Services, Health Physics, Health and Safety, Nuclear Criticality Safety, Quality Control, and Waste Management prior to starting work. Any modification (permanent or temporary) to SSCs requires Engineering review and approval according to Engineering procedures. The Planner also coordinates support group involvement in accordance with procedures.

The applicable Maintenance manager reviews work packages for technical content, accuracy and completeness, and provides documented approval to use the package prior to starting work. Conflicts in priorities between operating organizations are resolved through the work control process.

Modifications (permanent or temporary) and replacements are performed in accordance with the requirements described in Section 6.3. These procedures describe the mechanisms for the initiation and control of replacements, additions, or modifications (temporary or permanent) to plant systems or equipment. They delineate the individual and group responsibilities, and prescribe the records and reports that shall be produced and/or maintained at the plant for documenting these changes.

Authorization for release of equipment or systems for maintenance is granted by designated operations managers. Such authorization is documented in the work package and is based upon verification that the equipment or system may be taken out of service. The work package identifies other needed permits. The affected equipment or system is isolated to provide protection for plant personnel and equipment. Radiation Work Permits, lockout/tagout, and various safety and health permits establish conditions to ensure personnel and equipment protection.

When entry into a closed system is necessary, the foreign material exclusion (FME) control process is utilized in accordance with procedures to prevent entry of extraneous material and to ensure that foreign material is removed before the system is closed.

SSCs that are replaced during maintenance are compared to the installed part and verified to be approved for installation. Temporary system alterations, such as temporary bypass lines, electrical jumpers, lifted electrical leads, and temporary trip settings, are governed by approved administrative procedures.

When equipment is returned to service, Operations will verify and document the satisfactory completion of post-maintenance testing and place the equipment in operation.

6.4.9 Post-Maintenance Testing

PMT requirements are approved by and may be developed by Engineering. As needed, special PMT requirements are requested on a case-by-case basis. Performance of PMT is documented in the work package.

6.4.10 Procurement, Receipt Inspection, Control, and Issuance of Repair Parts, Materials and Services

The QAP describes the requirements for procurement control and the control of purchased material, equipment, and services. Procurement of items is performed in accordance with corporation and/or plant procedures.

Repair parts, components and material requirements for SSCs are listed on the Engineering approved specifications. The Engineering approved specifications and associated inspection plans provide the design criteria and inspection requirements needed when procuring SSCs.

The buyer obtains the latest Engineering approved specifications and inspection requirements and reviews them for changes. Commercial grade items are procured according to catalog specifications from the manufacturer or factory authorized dealer or distributor. A computer-based procurement system identifies materials which require a technical receipt inspection upon arrival at the plant. Upon receipt, the item is placed in a segregated area for inspection and acceptance. Quality Control is provided an inspection package by the buyer to determine acceptability of the item. A unique identification number is placed on the item for traceability. If the item is rejected by Quality Control, it is placed in a segregated area until the nonconformance is dispositioned by the appropriate Responsible Dispositioning Authority.

Traceability of SSCs is maintained when they are received and placed in stores for use. Configuration management provides for parts traceability after they are installed in the plant.

6.4.11 Control of Measuring and Test Equipment

To maintain accuracy within specified limits, the maintenance program requires that M&TE be properly controlled, calibrated, and adjusted at specified periods in accordance with program procedures.

The following items are included in PGDP procedures:

- A unique identifier.
- Calibration intervals defined and entered into a recall system.
- A label to indicate calibration status.
- An inventory listing of controlled M&TE.
- Evaluation of calibrations using M&TE that is subsequently found out of tolerance.
- Preparation and maintenance of calibration records.
- Measures for the storage and control of M&TE.

M&TE is calibrated in accordance with procedures or written work instructions. Standards used to calibrate devices have the required accuracy, stability and range for the intended use and are certified and traceable to the NIST. If no national standards exist, the basis for calibration is documented. The M&TE program will apply to all M&TE at PGDP.

6.4.12 Maintenance History

CMMS and completed work packages are used to capture maintenance history for SSCs. The maintenance history includes the following items discussed below.

6.4.12.1 Component Identification and Description

Components are identified by name and number. Where available, the description includes the manufacturer's name, model, serial number, and quality classification. Additional reference may be made to purchase order number, vendor manuals, drawing, system logic and/or flow diagrams, and applicable maintenance procedures. Engineering procedures specify control of modification documents.

6.4.12.2 Maintenance Record

The task history form is a record of significant work performed on the component and is included as part of the work package as appropriate.

6.4.12.3 *Text Deleted*

6.4.13 Items Addressed by Compliance Plan

Section deleted.

6.4.13.1 Maintenance Program Upgrades

Section deleted.

6.4.13.2 Configuration Management Program Upgrades

Section deleted.

6.4.13.3 Procedures Upgrades

Section deleted.

6.4.13.4 Training Upgrades

Section deleted.

6.4.13.5 Document Control Upgrades

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6.5 OPERATIONS

This section describes personnel, practices, and key facilities associated with the continued operation of PGDP.

The site is large enough to provide a considerable buffer between the enrichment process and our rural neighbors. Plant operations are continuous with coordination of operations performed by the Plant Shift Superintendent (PSS) from a central control facility. The plant is protected on a continuous basis by fire services and security forces. Each significant building is equipped with fire alarms and water sprinklers as discussed in SAR Section 5.4.1.1. Emergency mutual assistance exercises are conducted biennially with the emergency forces of the state and of the surrounding communities.

There is a public warning system to alert neighbors in the event of any plant problem that might affect them. Spill control measures are in effect for all continuous liquid effluent discharge points. More information on waterborne effluent control is contained in SAR Section 5.1. There are also internal impoundment structures, spill control equipment, and monitoring stations with alarms. The principal toxic gases on the site are the uranium hexafluoride process gas, fluorine, chlorine trifluoride, chlorine, and hydrogen fluoride. Liquid hazardous chemicals include oil, nitric acid, sulfuric acid, and a variety of other chemicals in smaller amounts.

The plant is normally in one of three modes of operation, from a safety perspective.

Normal Operations

Most of the time is spent in normal operations; in this mode the following conditions apply:

- Operations are proceeding within expected parameters with no safety impacts from deviations,
- Technical Safety Requirements (TSRs) are in effect,
- Routine effluents or emissions are within permits and certificate conditions with no significant impact to the public or environment, and
- Personnel exposures are below 10 CFR 20 limits and OSHA requirements.

Off-normal (but not emergency) Operations

Occasionally, process upsets and/or equipment failures occur which result in “off-normal” conditions within localized areas of the plant; these “off-normal” modes are as follows:

- Small releases of UF_6 or other toxic gases (such as F_2, HF, ClF_3, Cl_2) that result in evacuation of the immediate area and monitoring for reentry, but do not affect other areas of operations of the plant and have no impact off site;
- Occupational safety injuries and/or illnesses with a response required to render aid or transport to the plant or off site medical facility;

- Small fires that are quickly extinguished;

- Unexpected radiological contamination that requires reporting of plant areas or additional employee protective measures.

These "off normal" conditions are managed by the PSS from the C-300 Plant Control Facility with involvement by plant shift emergency response and/or health physics personnel. It may involve call-in of Health and Safety personnel.

Emergency Operations

The third mode is an emergency, as described in the Emergency Plan, which involves an "Alert" or "Site Area Emergency" declaration and activation of the Emergency Operations Center.

The remainder of this section provides an overview of the major operating areas of PGDP with a brief discussion of the safety and safeguards risks and the controls and operational surveillances in place to manage these risks. A description of the plant and plant operations is provided in detail in Chapter 3; a detailed accident analysis and discussion of risks associated with plant operations is provided in Chapter 4.

6.5.1 Shift Operations

The gaseous diffusion process operates continuously. To support this continuous operation, a work force is required 24-hours per day.

The PGDP work force is divided into two primary groups, a day shift (management, support staff, service groups) working primarily Monday through Friday, and shifts that provide continuous coverage of plant operations. The day shift provides the administrative support, activities such as design and fabrication where continuation is not time constrained, procedure development, classroom training, planning, and preventive maintenance. Most of the plant staff is assigned to the day shift.

The shift organization has the prime responsibility for continued plant operation and the evolutions, exchange of information, and response to abnormal and unusual conditions necessary to ensure safe and efficient plant operation. Typical activities of the shift include provide oversight and direction for all plant operations, monitor systems and equipment for proper performance, conduct routine back shift maintenance and emergency equipment repair, prepare equipment for day shift repair/preventative maintenance functions, and respond to emergency situations.

Operational activities of the plant are controlled by the Plant Shift Superintendent (PSS) whose normal watch station is in the C-300 Central Control Facility (CCF). The PSS reports directly to the Shift Operations Manager. Upon recognition of an emergency, the PSS or other qualified individual responds to the scene as Incident Commander. The PSS serves as Crisis Manager during a classified emergency (Alert or Site Area Emergency) until relieved by a manager designated in the emergency line of executive succession when the Emergency Operations Center becomes operational. Emergency command and control is described in the Emergency Plan.

The CCF is the hub of the plant operational activity. The overall UF_6 enrichment process is monitored at this location. Key plant operations can be performed remotely from the CCF, key alarm systems are monitored, and plant communications systems as well as off-site communications capabilities

are located in the CCF. The plant power system is monitored and controlled through a communication network with the power suppliers. Typical operational activities that are monitored and controlled from the CCF include determining and establishing optimal plant power level, executing or altering the maintenance work plan if necessary, and maintaining necessary manpower level to support plant operations.

Staffing levels for the shifts are not fixed but are based on the expected or planned activity for the shift period. Staffing levels take into account the routine monitoring of plant equipment including operator rounds, expected operational activity level, facility size, and Technical Safety Requirement (TSR) specified staffing requirements. When special activities are included in the work plans, the staffing will be increased as required to perform the planned activity. The required minimum staffing level for Paducah is approximately 40 as detailed in Section 3 of the TSRs. This is a fraction of the normal average shift staffing of approximately 80 persons.

Each shift organization is composed of a PSS; a cascade coordinator (CC) who directs overall cascade activities; shift engineer; first-line managers for the cascade buildings, UF_6 handling facilities, security, fire services, maintenance and power operations and utility operations; health physics technicians; Security Shift Commander; Fire Services Shift Commander; and operators, instrument mechanics, Security Police officers, and firefighters. Less than this normal shift staffing is permitted for short periods with the concurrence of the PSS to allow for call-ins or other compensatory actions.

The PSS provides a direct chain of command from the Operations Manager, Shift Operations Manager, Plant Manager and General Manager to the shift operating staff and serves as the senior shift manager in directing activities and personnel. The operations line organization is accountable to the PSS for reporting plant status.

The CC provides managerial oversight, operations coordination, and assures adequate staffing for all cascade operations on a 24-hour basis. This person approves, directs, and integrates all significant cascade operational activities under the oversight of the PSS.

The remaining members of the shift organization provide the needed functions for round-the-clock operations. First-line managers provide management for, coordination of, and assurance for proper execution of assigned tasks. The shift engineer provides engineering support for technical issues involving operations. Health physics technicians provide support for 24-hour shift operations. The first-line manager for Security supervises the activities necessary to ensure the protection of plant facilities, government property, and classified information. The first-line manger for fire services supervises shift fire services work activities and responds to plant emergency events.

There are diverse systems for operational communications. Commercial telephones, an internal plant telephone system, radio network, a plant public address (PA) system, emergency signals, and a pager system are available to provide necessary communications in operating the plant. The CCF is the focal point for all emergency reporting and initiating of all emergency responses. A special emergency telephone network is available in the CCF. Fire alarm and sprinkler indicator systems, criticality alarm panel, seismic alarms as well as numerous operational alarms are monitored in the CCF. As described in the Emergency Plan, the PSS will initiate off-site notifications and plant personnel call-ins when required.

In accordance with the corrective action program, plant personnel are required to report abnormal events or conditions that may have the potential to harm the safety, health, or security of on-site personnel, the general public, or the environment. Plant personnel are also required to immediately report conditions which may require emergency response. The PSS reviews potentially reportable or inoperable safety system equipment reports and determines proper disposition.

6.5.2 Cascade Operations Organization and Administration

The cascade is the UF_6 enrichment portion of the plant. The cascade is composed of six major process buildings which houses two parallel enrichment cascades that share common product and tails withdrawal facilities. There are auxiliary facilities such as the recirculating water pump houses which are also under the direct control of cascade operations.

The Operations Manager is responsible for overall operations. This includes operation of cascade equipment, planning for power usage, control of feeds, product and tails material including sampling, operating plant utilities, radiological decontamination, equipment cleaning, uranium precipitation, and operation of plant laundry. The Operations Manager is supported by managers in the following groups: Shift Operations, Cascade, Chemical, Utilities, Power, and UF_6 Handling. These group managers have subordinate managers assigned to functional areas to provide oversight of the day shift operations.

The optimum cascade arrangement for specific power levels, cascade configuration, product and tails assay levels, and feed availabilities is determined by the technical staff. Recommendations for these operating conditions are made by the technical staff to appropriate Operations Management and implemented by the operations staff in conjunction with the shift organization. The shift organization follow daily instructions and work plans developed and communicated by Operations Management.

The Utilities Manager, in conjunction with key building managers, provides the plant with sanitary water, chilled water, steam, air, nitrogen, and sewer services. These must be supplied on a continuous basis to meet the cascade requirements. Any outage is coordinated with customers to assure proper planning to provide temporary services as necessary.

The Power Operations Manager is responsible for managing the power supply system as well as being involved in the activities associated with power contract and power scheduling. Power systems rely on scheduled preventive maintenance activities to ensure a dependable supply. The power facilities are operated and monitored 24-hours per day and, therefore, have a shift organization which interfaces directly with the PSS.

The Chemical Operations Manager is responsible for operation of the plant laundry, nonradiological and radiological decontamination, cleaning of respiratory protection equipment, uranium precipitation, UF_6 cylinder handling within the plant, and operating the plant fluorine facility.

Other organizations within the plant provide support such as supply of spare parts and equipment, handling of scrap and waste, provisions for employee safety, necessary analysis to control operation and protect the environment, provide status of equipment design, systems engineering support and design change, and administrative support. Chapter 3 provides additional detail on specific cascade equipment and support systems.

6.5.3 Deleted

6.5.4 Operator Responsibility, Authority and Shift Routines

Plant operations, shift routines, and operator responsibilities at PGDP are governed by a series of "Conduct of Operations" procedures. These are summarized as follows:

- Alarm Response Guidelines and Status Control — This procedure provides the administrative requirements for taking an alarm out of service including, if necessary, providing for increased monitoring of the alarmed parameter.

- Shift Routines — This procedure provides guidance to on-shift operators in performing inspection tours, shift turnover, dealing with abnormal operating parameters, etc.

- Operating Area Logs and Records — This procedure provides guidance in filling out required logs, reading sheets, and other required records.

- Required Reading — The required reading program provides a documented record of whether or not an individual has read a particular piece of information required for the performance of their job.

- Daily Instructions and Long Term Orders — Daily Instructions contain specific information and instructions needed to direct or coordinate operator activities. They are approved by the group managers or designees and have short-term applicability. Daily Instructions cover such things as information regarding required operational activities or schedule changes, information on equipment status, reminders on conducting preparatory work for scheduled maintenance, and schedules for power load changes or outages. Also included as Daily Instructions are reminders on conducting required reading and other administrative matters. Long Term Orders address matters that will remain in effect for periods of time that might be a month or more. Conditions such as operational

limitations that must be observed such as limitations more restrictive than required in procedures are communicated in Long Term Orders. Long Term Orders are reviewed quarterly. Other Long Term Orders cover conditions similar to those in the Daily Instructions but which might remain in effect for a month or more. Daily Instructions and Long Term Orders are not permitted to override any requirements or actions directed in operating procedures or in TSRs.

- Temporary System Control — This procedure provides administrative control over temporary alterations such as jumpers and lifted wires or piping spoolpieces.

- Control of Operator Aids — This procedure provides administrative controls to ensure that operator aids are kept up to date and removed when no longer needed or correct.

- Deficient Material Condition Tags — This procedure provides a means of notifying other operations personnel when a maintenance work request has been issued to correct a plant deficiency, such as a leak or a broken component.

- Control Room Activities — This procedure controls the activities performed by the Control Room Operators and personnel entering the "at-the-controls" areas.

- Organization and Administration — This procedure defines the organization of the Operations organization unit and defines the duties and responsibilities of each position.

6.5.4.1 Operator Responsibilities

Authority to operate equipment under the responsibility of the Operations organization requires qualification. Plant qualifications for operational positions that could affect nuclear safety require training and successfully passing required testing as described in the appropriate administrative guide for the required position. The training program is described in Section 6.6. This proficiency is routinely enhanced by retraining and testing coupled with on-the-job training. Training provided to operators is based on operating procedures and their use. Some areas require special qualifications before job performance is allowed. Examples of positions in Cascade Operations with special qualifications include control room operators and operators in UF_6 handling facilities such as C-310, C-315, C-333A, C-337A, and C-360.

In Chemical Operations, qualification is required for small parts disassembly/decontamination, cylinder shipment and movement, decontamination and recovery, metal cleaning and treatment facilities, field decontamination and cleanup, hand tables and honers, wastewater treatment, and cylinder washing operations.

Operator rounds are a key part of overall operator duties. These activities have been proceduralized to identify requirements. A listing of items to be checked on the rounds is included in the applicable procedures.

Training and procedures define the appropriate response by operators to alarms. A set of designated alarm response procedures for alarms has been developed which identifies the alarm signal and the proper response.

6.5.4.2 Shift Routine

Access to the at-the-controls areas in the area control rooms (ACR) is limited to avoid confusion, prevent blocking visual access to operating panel indications, and enhance control room operator functionality. The at-the-controls area applies to ACRs in C-310, C-315, C-331, C-333, C-335, C-337, and the control area of the CCF.

The training program for an operator consists of initial operator classroom training and on-shift training. On-shift training is predominantly on-the-job training (OJT) but does include some classroom training. For OJT, first-line managers and qualified employees who observe and assist the trainee must have completed the associated technical training program and must have completed training on how to conduct and evaluate OJT. If the first-line manager is also the subject matter expert who provided the instruction (by observation and assistance), this person is not permitted to be the evaluator of the trainee's performance for the purposes of watchstation or task qualification. On-shift training is conducted in accordance with applicable plant training procedures. The scope of the on-shift portion of operator training is contained in a Training Development Administrative Guide. OJT is described in Section 6.6.3.3

Only qualified personnel may perform operational evolutions unsupervised. Whenever trainees operate equipment, a first-line manager or qualified employee observes and assists the trainee to ensure errors are not made that could adversely affect safety.

An essential part of the shift routine is operator rounds. In facilities subject to continuous operation, rounds are made a minimum of once per shift. Typical rounds consist of verifying proper system operating parameters, component alignment, and surveying the facility and equipment for abnormal conditions. For many key systems, acceptable operating parameters are listed on the round sheet to aid the operator in ensuring system operation remains within the design basis. “Batch work” such as removing/restoring a cell to service in the cascade require additional rounds to be conducted prior to the operation and in accordance with applicable procedures.

Changes to operations and procedures are disseminated to personnel through the required reading and/or by specific training. Operators are required to review revised procedures and instructions that affect their duties prior to resuming watch standing duties. Management provides day-to-day guidance on plant operations and temporary changes to operational systems via operational memos, daily instructions, and Long Term orders.

Daily Instructions contain specific information and instructions needed to direct or coordinate operator activities. They are approved by the group managers or designees and have short-term applicability. Daily Instructions cover such things as information regarding required operational activities or schedule changes, information on equipment status, reminders on conducting preparatory work for scheduled maintenance, and schedules for power load changes or outages. Also included as Daily Instructions, are reminders on conducting required reading and other administrative matters.

Long Term Orders address matters that will remain in effect for periods of time that might be a month or more. Conditions and operational limitations that must be observed such as limitations more restrictive than prescribed in procedures are communicated in Long Term Orders. Long Term Orders are reviewed quarterly. Other Long Term Orders cover conditions similar to those in the Daily Instructions but which might remain in effect for a month or more.

Daily Instructions and Long Term Orders are not permitted to override any requirements or actions directed in operating procedures or in TSRs.

Formal communication of operating information is defined in plant procedures. Preparation for turnover, the actual turnover, and turnover follow-up are involved in these procedures. A signoff is required to signify understanding by all parties involved.

6.5.4.3 Logkeeping

Operator logs provide a means of documenting the information on activities occurring during shift. Logs are maintained in the ACR, operational monitoring rooms (OMR), shift first-line managers' offices, CC desk, in the PSS office, or in other designated areas.

Logs maintained in ACRs record chronological operations of the shift and equipment realignments and problems encountered. Management logs such as the shift first-line manager's log are required to contain information on key activities conducted, this includes the sequence of key events and some information on times. The shift first-line manager's log will provide details of emergency events in order of occurrence. This supports the Area Control Room log as a source of operating information. Entries in all hand written logs are in black ink with corrections lined out, initialed, and dated. Logs are essential in completing shift turnover, and turnover is documented by signatures in logs by the outgoing and incoming personnel. In areas where electronic logs are used, signature/initials and corrections are performed electronically. This formal turnover is done to assure the information necessary for smooth activity transition is exchanged. Logs are also routinely reviewed by individual building managers.

6.5.5 Operations Procedures and Operator Aids and System Labeling

Operating procedures are prepared, reviewed, and approved as outlined in Section 6.11. Shift operations personnel follow and use procedures as described in Section 6.11. Actions required by emergency and alarm response procedures may be completed before referring to the procedure if conditions warrant.

Another valuable tool for support of operator duties are the operator aids. These aids consist of posted sketches, notes, graphs, instructions, and drawings. A formal program is in place to control and account for these aids and ensure they are correct in all respects. Operating information is also disseminated using division memos, daily instructions, and long-term orders. These communications provide information not included in procedures which is required for a special short-term period by the operations personnel.

Major equipment and piping systems are labeled. These labels aid personnel in identifying specific equipment and systems in the field. In the large cascade buildings, the grouping of equipment into units and cells is clearly marked so that the possibility for operator error is minimized. In addition, equipment location can be identified by a column grid system (alpha-numeric) which can be used to direct operators or emergency responders to the proper location.

6.5.6 Permits and Tagging

A lockout/tagout permit system is in place which provides controls for ensuring safe isolation of systems for maintenance or testing. Lockout/tagout activities are performed by authorized personnel, and boundary isolation points are independently verified. A "Caution Tagging" system has been implemented as a warning to operators to stop and seek assurance of proper action before proceeding.

6.5.7 Management Monitoring of Operations

A management assessment program is used by management to provide oversight of plant operations. The program includes managers at all levels and is described in procedures. The results of the program are disseminated to appropriate management for evaluation.

6.5.8 Control of Equipment

The Cascade Coordinator provides overall coordination of operational activities including removing/returning of cascade equipment to service, increasing/decreasing power levels, radiological protection, maintenance, and instrumentation to accomplish the operating objectives for the shift and to maintain safe and efficient operations. Communications between the coordinator and the first-line managers who authorize the removal and return of equipment and systems from service for maintenance, testing, or operational activities is conducted using the communications methods described above.

Qualified operators are capable of diagnosing facility and equipment conditions and are authorized to perform tasks during normal, off-normal, and emergency conditions which may include the shutdown of equipment. Restart of equipment from routine shutdowns is authorized by the first-line manager. The PSS is authorized to stop operations when system operability or the overall safety of operations is in question.
The PSS is also authorized to initiate restart after shutdown for non-routine reasons. For shutdowns that are directed by the Vice President, Operations; Nuclear Safety and Quality Manager, the General Manager or the Plant Manager; the PSS may authorize restart only after obtaining the approval of the Plant Manager and the General Manager (who will in turn obtain the concurrence of the Vice President, Operations, as described in Section 6.1.1.8).

For the purposes of ensuring the ongoing operability of TSR- required equipment, Operations utilizes procedural requirements which include the following activities:

- Day-to-day operation of the facility
- Plant walkdowns or tours

- Operator observations
- Inspections, assessments, and audits
- Engineering evaluations and design reviews
- TSR-required surveillance tests

The above activities combine to provide continuing assurance that TSR-required equipment will perform as required, when needed.

To regain operability of equipment which has failed, been taken out of service, or had maintenance performed on it, each of the following elements must be satisfied:

- Applicable surveillance test(s) must be successfully performed
- Any involved technical support organizations, such as engineering or criticality safety, must approve restart or return to service
- PSS gives authorization

When all of the above elements have been satisfied, the first-line manager can return the equipment to service.

6.5.9 Items Addressed by Compliance Plan

Section deleted.

6.5.9.1 Procedure Upgrades

Section deleted.

6.5.9.2 Training Program Upgrades

Section deleted.

6.5.9.3 Section Deleted

6.6 TRAINING

In accordance with 10 CFR 76.35(a), USEC is required to submit as part of its application for a certificate of compliance a training program that meets the requirements of 10 CFR 76.95. Section 76.95 requires USEC to establish, implement, and maintain a training program "for individuals relied upon to operate, maintain or modify the GDPs in a safe manner." Section 76.95 also states that the training program for such individuals "shall be based on a systems approach to training that includes the following:

1. Systematic analysis of the jobs to be performed,
2. Learning objectives derived from the analysis that describe desired performance after training,
3. Training design and implementation based on the learning objectives,
4. Evaluation of trainee mastery of the objectives during training,
5. Evaluation and revision of the training based on the performance of trained personnel in the job setting."

This section provides an overview of the training program in place at PGDP including the training applicable to personnel who are "relied upon to operate, maintain, or modify the GDPs in a safe manner." Personnel are trained to recognize and cope with safety hazards they may encounter in their jobs. They are also trained on practices important to public safety, safeguard of licensed material, or protection of the environment.

The overall training program at PGDP is comprised of a number of training elements. These elements include:

- **General Employee Training** for persons who require unescorted access, including visitors (Section 6.6.5);

- **Operations and Maintenance Technical Training** for those persons relied upon to operate, maintain, or modify the GDPs in a safe manner (Section 6.6.6);

- **Radiation Worker Training** for those persons who require unescorted access to or perform work in restricted areas - this program is not SAT-based (Section 6.6.7);

- **Health Physics Technician Training** for those persons identified in the Radiation Protection portion of this application - this program is SAT-based (Section 6.6.8);

- **Fire Protection and Emergency Management Training** for those persons who are identified in the Fire Protection and Emergency Plan portions of this application - this program is not SAT-based (Section 6.6.9);

- **Environmental, Safety and Health (ES&H) Training** for those persons required to have the training described in Section 6.6.10 - this program is not SAT-based;

- **Subcontractor Training** for those temporary personnel performing maintenace or modifications to the GDPs - this program is not SAT-based (Section 6.6.11);

- **Nuclear Criticality Safety Engineer/Specialist Training** for those persons identified in the Nuclear Criticality portion of this application - this program is SAT-based (Section 6.6.12);

- **Auditor and Inspector Training** for those persons identified in the Quality Assurance Plan portion of this application - this program is not SAT-based (Section 6.6.13);

- **Manager/Supervisor Training** for those persons who manage and supervise personnel relied upon to operate, maintain, or modify the GDPs in a safe manner - this program is not SAT-based (Section 6.6.14);

- **Cascade Coordinator Training** for those personnel who direct the overall operations of the gaseous diffusion cascade - this program is SAT-based (Section 6.6.15);

- **Plant Shift Superintendent Training** for those persons who provide managerial oversight for the operation of the Plant Uranium Facility and other support activities - this program is SAT-based (Section 6.6.16);

- **System Engineer Training** for those persons who review modifications to Q or AQ-NCS items - this program is SAT-based (Section 6.6.17);

- **Laboratory Technician Training** for persons who work in the Laboratory Technician classification - this program is SAT-based (Section 6.6.18);

- **Waste Management Operator Training** for persons who collect, store, and package hazardous waste for shipment to off-site facilities - this program is SAT-based (Section 6.6.19);

- **Safeguards/Security Training** for those persons identified in the "Security Plan for the Protection of Classified Matter" portion of this application - this program is not SAT-based (6.6.20).

6.6.1 Training Program Organization and Administration

The plant training organization consists of a centralized staff which reports directly to the Regulatory Affairs Manager. The training staff consists of technical trainers, administrative personnel and mid-level managers who are directly responsible for assisting the plant in the design, development, implementation, and auditing of training programs in the following functional areas:

- General employee training,
- Operations and maintenance technical training,
- Radiological protection training,
- Environmental, safety and health training,
- Subcontractor training, and
- Training instructor/developer qualification.

Central Training Staff personnel are assigned by the Regulatory Affairs Manager to interface with functional line managers to coordinate training development and implementation for functional areas.

Additional personnel who work directly for their respective organizations are selected by their respective Organization Managers and are matrixed to the Regulatory Affairs Manager. This group receives guidance from Training and their programs are audited by Training staff to verify these training programs are established consistently with plant training policies and procedures.

The Regulatory Affairs Manager is responsible for establishing procedures that direct the development and implementation of training programs at the PGDP using a systems approach to training (SAT) for development of training for personnel relied upon to operate, maintain, or modify Q or AQ-NCS items.

Organization managers are responsible for defining job specific qualification requirements for personnel within their organizations and approving the required training programs as defined in Training Development and Administrative Guides (TDAGs), which are approved by both the organization and the applicable group training manager. Workers relied upon to operate, maintain, or modify Q or AQ-NCS items are trained and evaluated for qualification based on these programs prior to assignment of duties.

Line managers (group managers or section managers) are responsible for identifying tasks required for qualification. Line management is responsible for identifying new tasks or revisions to existing tasks as a result of equipment/procedure changes and/or modifications. Such changes are communicated and documented using the training change request form defined in the plant training procedures.

Task or duty area qualification is granted by line management based on successful evaluation of the worker's mastery of learning objectives presented during training. Line management is responsible for placing work restrictions or removing employees from duty areas where training is deficient. Maintenance of qualification is contingent upon successful completion of continuing training and/or through on-the-job training (OJT) evaluations.

Attendance is scheduled and pass/fail status is tracked for each attendee by the training organization and line management based on TDAG requirements.

The central training staff personnel as well as personnel matrixed to the Regulatory Affairs Manager notify line management of personnel who have not received initial training (such as employee reassignment or new hire) or who are past due for continuing training (such as an extended absence).

All training programs have two aspects, Initial Training and Continuing Training.

6.6.1.1 Initial Training

Initial training contains the classroom and on-the-job training necessary to provide an understanding of the fundamentals, basic principles, systems, procedures, and emergency responses involved in work to which an employee is assigned. Initial task or duty area qualification is granted by line management based on successful evaluation of the employee's mastery of the learning objectives presented during the training. New employees or employees transferred from other duty areas within the facility may be partially qualified by reason of previous applicable training or experience. The extent of further training for these employees is determined by regulations, performance evaluations, or comprehensive

examinations. Employees may be exempted from portions of a training program through prior education, performance, or testing.

Applicable process safety training (e.g., technical safety requirements training and nuclear criticality safety training) is included in the initial training.

TSR training is provided to facility operators and supervisors specific to their area of responsibility. It is designed to provide a sufficient understanding of the safety limits and limiting safety system settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls necessary for the safe operation of the GDPs. This training is reviewed and approved by the safety analysis technical staff.

Initial NCS training based on ANSI/ANS-8.20-1991, "American National Standard for Nuclear Criticality Safety Training" is provided for personnel who handle or manage the handling of fissile material and work within Fissile Control Areas. This training is reviewed and approved by the Nuclear Criticality Safety Group and includes a discussion of the following:

- The fission process,
- Controllable factors and examples of their application at this facility,
- NCS postings, and
- Consequences of some of the historical criticality accidents.

Managers of personnel described above receive additional training on managerial responsibilities relating to Nuclear Criticality Safety.

Personnel who work under procedures containing NCSA requirements receive additional training on these procedures with emphasis on NCS limits and controls.

6.6.1.2 Continuing Training

Continuing training is provided for employees in the interest of promoting safety, safeguards, security, and environmental protection awareness. Continuing training is also provided as a means to maintain and improve job-related knowledge and skills.

Training Development and Administrative Guides (TDAGs) contain training requirements which delineate continuing training for employees. The number of hours dedicated to this training annually is based on the following factors:

- Periodicity required by regulatory agencies and national standards;
- "Overtrain" tasks related to Q structures, systems, or components that are identified in SAT-Based programs (see SAR Section 6.6.3.1);
- Training needs as determined by line management. This includes, but is not limited to, nuclear criticality safety assessments, facility system changes, component changes, procedure changes, lessons-learned (to include industry and in-house operating experience and event reports), emergency response procedures, and Technical Safety Requirements (TSRs).

- Training that may be required as the result of facility or equipment modifications is completed prior to declaring the system/equipment operable. Training (as determined by line management with the concurrence of training management) is conducted on new or revised procedures prior to the effective date of the procedure.

The Operational Drill Program is used to augment continuing training as requested by line management. Drills are conducted to reinforce training and to assess the operational readiness of workers in the job environment.

6.6.2 Trainee Selection

Selection of personnel will be made in conformance with the established general employment policies and procedures. Individual group requirements, past experience, education, and skill may also be used to measure qualifications for training program eligibility. Additionally, employment will be contingent upon satisfactory completion of a physical examination, drug screening test, and the ability to obtain the required security clearance.

New hires or position incumbents may be considered for exemption from fundamental, systems/component knowledge, and skills training when at least one of the following are applicable:

1. Management may review an individual's prior training records and/or job performance history for information stating that the individual has achieved the necessary required skills.

2. A test may be provided to experienced newly hired employees to exempt them from receiving certain training requirements. Individuals considered for exemption must pass the written examinations on fundamental subjects and demonstrate competency in the skills areas.

3. Job incumbents may be evaluated to ascertain their knowledge and performance to be exempted from part or all of identified training.

Documentation will be required for all exemptions.

Minimum qualification standards for key positions are documented and maintained by Human Resources. Minimum standards for education, experience, and security for initial hiring or job placement from within the plant, are determined in conjunction with input from line management for each specific job position. For those job positions which are SAT-based, the minimum education and experience requirements for selection into the training programs are defined in each Training Development and Administrative Guide (TDAG).

6.6.3 Systems Approach to Training

Formal training programs for those personnel who operate, maintain, or modify Q or AQ-NCS items are based on a SAT methodology. If a task is identified to operate, maintain, or modify a specific component in a system or process relied upon for safety, then the training will be developed using SAT methodology. This includes the following elements:

- Conduct of needs/job analysis and identification of tasks for training,
- Development of learning objectives,
- Development of lesson plans and training guides,
- Evaluation of trainee mastery of learning objectives, and
- Evaluation of the effectiveness of training.

6.6.3.1 Conduct of Needs/Job Analysis and Identification of Tasks for Training

A needs/job analysis is used to identify the tasks affecting worker or public safety, safeguards of regulated material, or protection of the environment as identified in the application including the Technical Safety Requirements (TSRs). The analysis is conducted using either job incumbent/manager written surveys or the table-top method with subject matter experts. The training programs for the following job positions/worker classifications are based on a needs/job analysis:

- Cascade operators,
- Chemical operators,

- Electricians,
- Instrument and electronic mechanics,
- Maintenance mechanics,
- System engineers,
- Cascade coordinators,
- Plant shift superintendents,
- Health physics technicians,
- Laboratory technicians,
- Waste Management operators, and
- Nuclear criticality safety engineer/specialist.

On-site transportation of UF_6 is covered by SAT-based training for tasks assigned to selected personnel within the programs listed in Section 6.6.3.1.

A facility-specific task list is developed for each of the above positions/classifications. Task lists are analyzed based on input from line management and subject matter experts, rating each task on degree of difficultly, importance of the task, and frequency of task performance. Ratings are applied to a decision tree that contains numerical values for each trait. From this analysis, tasks are selected for training and frequency of training is determined based on these ratings. The ratings are:

- **Overtrain** — requiring initial and continuing training,
- **Train** — requiring initial training,
- **Pre-train** or **just-in-time** — requiring training but will not be taught until that specific knowledge or skill is needed, or
- **No train** — formal training not required.

The tasks selected for training are matrixed to the associated procedures and training materials. The associated training materials are updated as necessitated by changes in procedures, facility system/equipment, or job scope prior to conducting training.

Procedure changes, equipment changes, facility modifications and other changes affecting task performance, are monitored and evaluated for their impact on the development or modification of initial and continuing training programs. The affected training materials are modified or new materials developed, based on the significance of the change, and modifications are documented in the program files.

Training, as determined by Needs Analysis, is required prior to implementation of new or modified procedures except where line management, with the concurrence of training management, has determined that there are no changes to the SAR and the associated programs and plans, TSRs, or NCSAs; the task is very easy to perform; the task is performed very often; and changes to the procedure do not affect the original intent of the procedure.

Reportable events are analyzed by the appropriate plant personnel as described in SAR Section 6.9 to determine the root cause and contributing factors. Corrective actions which necessitate a training intervention are then assigned, scheduled, and tracked to completion. Lessons learned come from many different sources and are shared with others quickly through plant bulletins, memorandums, and required reading files. Lessons learned which have an impact on training are factored into training materials prior to the delivery of the next training session.

6.6.3.2 Development of Learning Objectives

Learning objectives for a specific task are established and listed within the specific training module developed to teach/evaluate the specific task. Both terminal and enabling objectives are developed to identify the training content required and to define satisfactory trainee performance for the task being taught. Learning objectives state the knowledge, skills, and abilities the trainee must demonstrate. The conditions under which the required actions will take place and the standards of performance required of the trainee are also determined in development of the learning objectives. Learning objectives are sequenced within training materials based on their relationship to one another. Learning objectives are revised as necessary based on changes to task statements listed in the task-to-train-to-procedure matrixes.

6.6.3.3 Development of Lesson Plans and Training Guides

Learning objectives derived from the rated task lists are analyzed to determine the appropriate training setting. Classroom lesson plans, OJT training guides or other instructional materials are developed based on this instructional analysis and design. Lesson plans and other training guides provide the guidance and structure necessary to ensure consistent delivery of training material from trainer to trainer and class to class.

Classroom lessons are used primarily to provide cognitive learning on fundamentals, theory, basic operating and maintenance principles, individual systems, system inter-relations, safety requirements, and overviews of processes used at the GDP.

Other forms of instructional materials such as video, computer-based training, and self-study may be used as alternatives or to supplement classroom instruction.

OJT is a systematic method of providing in-field training and evaluation on job-related skills and knowledge for qualification on a job/position. This training is conducted in the actual work environment and demonstrates actual task performance whenever practical and may be implemented on-shift if management determines that manpower and operational conditions will not be impacted by the training activities. Applicable tasks and related procedures for each technical area provide the input for OJT development.

Classroom lesson plans, OJT and other instructional materials receive technical reviews by designated subject matter experts, instructional reviews by training personnel, and final approval for use by line management. Training materials are approved by the responsible organization or group manager and the training staff before issuance.

TDAGs describe programs developed for a specific job/position. This description includes:

- Organization and Administration Responsibilities,
- Trainee Selection Criteria,
- Course Loading and Scheduling Requirements,
- Initial and Continuing Training Program Requirements,
- Training Resource and Facility Guidelines,
- Test/Evaluation Guidelines,
- Training and Evaluation Documentation Guidelines, and
- Courses/Modules for Specific Qualification Areas (listed by title and numbers).

6.6.3.4 Evaluation of Trainee Mastery of Learning Objectives

Within the job position/worker classification training programs are training courses. Each training course contains logical instructional blocks or “modules” and is presented in such a manner that specific learning objectives are accomplished. Trainee progress is evaluated by technical trainers and line management through a variety of performance and knowledge demonstrations such as written examinations, oral examinations, and practical tests to ensure mastery of the job performance requirements or learning objectives contained in these modules. Remediation is provided as appropriate.

6.6.3.5 Evaluation of the Effectiveness of Training

Systematic evaluations of training effectiveness as it is related to on-the-job performance are used to ensure training programs convey required skills and knowledge and to revise training materials content and instructional methodology based on the performance of trained personnel in the post training job setting. Student feedback on the training received and first-line manager's evaluations of the student's performance on the job after training is used to determine effectiveness of training programs and identify areas for refinement or revision. Student feed back occurs at several points in the training program. At the completion of training, students are asked to evaluate the instructor and the course. An evaluation of the effectiveness of training is requested from students and supervisors through post-training evaluations 3 to 6 months after the completion of training. These evaluations are specified in plant training procedures.

Self-assessments and evaluations of the individual training programs are conducted by line and training management as described in Section 6.8.2. Nuclear Safety and Quality auditors provide additional assessments through the audit program. These assessments and evaluations are used to determine training program strengths and weaknesses.

6.6.4 Training Instructor/Developer Qualification

Training Instructor/Developer Qualification is the responsibility of plant training staff. The Basic Instructor/Developer Qualification program is administered by the Training organization. Training is provided to designated subject matter experts (SMEs) and/or knowledgeable technical trainers who develop and/or conduct qualification training for site personnel. The program consists of several modules designed to train instructor/developers in the use of SAT in conducting analysis, design, development, implementation, and evaluation of plant training programs. The program includes initial training and qualification and periodic re-evaluation of skills and knowledge in both material development and/or instructional competency. Personnel are identified by line management to be qualified as training material developers, OJT instructor/evaluators and/or classroom instructor. On-the-job training is conducted by qualified OJT instructors. This may be personnel from the training organization, line managers, or hourly workers who are Subject Matter Experts (SMEs) and who have completed the required qualification training.

Instructor/developers are required to spend a minimum amount of time on a quarterly basis, working in the area they instruct. Instructors are expected to stay up-to-date on procedures/policy changes, modifications to TSRs and lessons-learned. Instructors have ready access to designated subject matter experts who assist them when developing training materials. All SAT-based training program materials must be approved by subject matter experts and line management prior to implementation.

6.6.5 General Employee Training

General Employee Training (GET) is required biennially for all site employees, subcontractors, and visitors who require unescorted plant access. Visitor site access training is required for all escorted site visitors. GET includes the following subject areas:

- General Employee Radiological Safety,
- Nuclear Criticality Safety,
- General Topics,
- Hazard Communication, and
- Emergency Preparedness.

6.6.5.1 General Employee Radiological Training

General Employee Radiological Training (GERT) covers the employee's responsibilities for maintaining exposures to radiation and radioactive materials as low as reasonably achievable (ALARA). The training reviews natural background and manmade sources of radiation, the whole body radiation dose limit for nonradiological workers, the potential biological effects from chronic radiation doses, embryo and fetus protection, ALARA concepts and practices, and methods used to control radiological

materials and contamination. If a person requires unescorted access to a radiological restricted area, radiological safety training is provided as discussed in Section 6.6.7.

6.6.5.2 Nuclear Criticality Safety

An overview of the Nuclear Criticality Safety (NCS) program is provided. The training emphasizes the prevention of accidental nuclear criticality, describes the hazards and risks of a nuclear criticality accident, explains nuclear criticality safety responsibilities, and teaches recognition of and the proper response to nuclear criticality alarms.

Additional NCS training based on ANSI/ANS-8.20-1991, "American National Standard for Nuclear Criticality Safety Training" is provided for personnel who handle or supervise/manage the handling of fissile material and work within fissile control areas. This training is described in Section 6.6.1.1.

6.6.5.3 General Topics

General Topics include a general overview of (1) health and safety awareness programs, (2) the employee's rights and responsibilities and the employer's duties as defined by laws and regulations, and (3) use of procedures and conduct of operations.

6.6.5.4 Hazard Communication

The purpose of this awareness level training is to inform personnel that hazardous chemicals are present in the work place and to help them understand the function of warning labels and signs, Material Safety Data Sheets (MSDSs), and the written Hazard Communication Program.

Additional job-specific chemical safety training is provided to those personnel who handle or supervise the handling of hazardous chemicals.

6.6.5.5 Emergency Preparedness

This training introduces personnel to basic Emergency Plan elements including (1) emergency plan safety objectives and priorities, (2) ways to report emergencies, (3) recognition and correct responses to plant alarm signals, (4) evacuation guidelines for radiological and nonradiological emergencies, (5) personnel accountability procedures, and (6) personnel responsibilities during emergencies.

6.6.5.6 Visitor Site Access Training

Site access training for plant visitors who will be escorted consists of self study of an orientation handbook that covers the following general information:

- Speed limits for plant street,
- Seat belt usage,
- Compliance with all posting and signs,
- Use of eye, head, hearing, and respiratory protection,
- Emergency phone numbers,

- Radiological protection concerns,
- Emergency preparedness,
- Site assembly points,
- Plant horns and signal (both written description and listening to audio tape), and
- Security requirements and limitation of access and items prohibited.

6.6.6 Operations and Maintenance Technical Training

Training and qualification programs for operations and maintenance personnel are established, implemented, and maintained utilizing the graded approach methodology to the systems approach to training. Initial and continuing training is provided for the following operations and maintenance job categories relied on to operate, maintain, modify, or test Q or AQ-NCS items:

- **Cascade Operators** — This program is designed to provide operators the necessary knowledge and skills to monitor/operate/troubleshoot systems and components, and respond to alarms, in the uranium enrichment cascade and/or associated process facilities. Training includes theory, design and operations of the GDP, process systems and components; operational safety requirements, and procedures; physical locations of systems and components; potential consequences of failure to comply with system design criteria and/or operational or regulatory limitations; safety and health concerns and procedures; and, training on job/task specific skills required to perform normal and emergency operator functions. Operators may be trained on any or all of the following process work areas based on job specific assignments:

  - Process building area control rooms,
  - Process cell and operating floor level areas,
  - UF6 liquid withdrawal areas,
  - UF6 feed vaporization area,
  - UF6 cylinder liquid sampling, transfer and shipping/receiving facilities,
  - Process cooling water system,
  - Dry air and nitrogen systems,
  - Recirculating cooling water system, and
  - Steam system.

  Specific program description is documented in the TDAG for Cascade Operators. Program courses include:

  - Cascade Operations Basic Course,
  - C-360 Operator Training Course,
  - C-310 Operator Training Course,
  - C-315 Operator Training Course,
  - RCW Operator Training Course,
  - Vaporizer Facility Training Course, and
  - Area Control Room Operator Training Course.

- **Chemical Operators —** This program is designed to provide operators the necessary knowledge and skills to monitor/operate/troubleshoot systems and components and respond to alarms in the chemical operations facilities/equipment. Training includes how to perform cleanup/decontamination of equipment and materials, packaging, transportation, and storage of uranium contaminated materials/equipment, and other process chemicals used in plant process areas. Program training also includes operational safety requirements and procedures, physical locations of systems and components, potential consequences of failure to comply with system design criteria and/or operational/regulatory limitations, safety and health concerns and procedures, and training on job/task specific skills required to perform normal and emergency operator functions. Chemical operators work both in the plant process areas and in the site's chemical operations facility which provides chemical cleaning services, operation of fluorine distribution system, and chemical solution treatment for the site. Based on job specific assignment, personnel may be trained in any or all of the areas listed below:

  - Chemical Operations Initial Training,
  - Chemical Operations Manager Training,
  - Small Parts Disassembly/Decontamination Training,
  - Cylinder Shipments and Movement Training,
  - Decontamination and Uranium Precipitation Training,
  - Metal Cleaning and Treatment Facilities Training,
  - Field Decontamination/Clean-up Training,
  - Fluorine Plant Clean-up Training,
  - Laundry Operation and Safety Equipment Training,
  - Hand Tables and Honers Training,
  - Waste Water Treatment, and
  - Cylinder Washing Operations.

  Specific program description is documented in the TDAG for chemical operators.

- **Electricians —** This program is designed to provide the necessary knowledge and skills to repair, install, calibrate, and troubleshoot process facility electrical equipment, and distribution systems, in a safe and efficient manner. Training includes installation, repair and calibration of equipment in process buildings, high voltage switchyard areas, and electrical power distribution systems. Specific program description is documented in the TDAG for electricians. Based on job specific assignment, personnel may be trained in any or all of the above listed areas.

- **Instrument and Electronic Mechanics —** This program is designed to provide the necessary knowledge and skills to repair, install, calibrate, and troubleshoot pneumatic, hydraulic, and electronic instrumentation and control equipment in the process facilities, in a safe and efficient manner. Training includes site specific instruction on theory of operation on plant instruments and controls systems/components; computer installation and repair; and calibration and testing of plant instrument and alarm systems. Specific program description is documented in the TDAG for instrument mechanics. Based on job specific assignment, personnel may be trained in any or all of the above listed areas.

- **Maintenance Mechanics —** This program is designed to provide the necessary knowledge and skills to repair, install, calibrate, and troubleshoot the process facilities mechanical equipment in a safe and efficient manner. Training includes site specific training on installation and repair of process equipment; both field and shop repair/calibration of equipment and components; welding, cutting and brazing, equipment alignment, and mobile equipment operation. Specific program description is documented in the TDAG for mechanical maintenance mechanics. Based on job specific assignment, personnel may be trained in any or all of the above listed areas.

Skill of the craft is established as a prerequisite for job selection. If an employee is classified as a journeyman, then that person has demonstrated competency of "skill of the craft." If deficiencies in a journeyman's qualifications are revealed during job specific training and performance evaluations designed to measure the employee's mastery of learning objectives, then remedial training is provided on the appropriate craft fundamentals to maintain "skill of the craft."

6.6.7 Radiation Worker Training

Radiation worker training is a biennial training requirement for personnel whose job requires them to have unescorted access to radiological restricted areas. The training includes a comprehensive curriculum consisting of the following, as appropriate:

- Fundamentals on atomic structure, radiological definitions, types of ionizing radiation, units of measurement, dose, and dose rate calculations;
- Biological effects of ionizing radiation including cell sensitivity, chronic, and acute exposure,
- Radiation work permit applications and use;
- Radiation limits for occupational and nonoccupational workers as well as the general public;
- ALARA practices for protection from exposure to radiation or radioactive materials;
- Personnel Monitoring Programs in place to monitor the worker's exposure to radiation;
- Radioactive Contamination Control to minimize and control the spread of contamination;
- Radiological Postings and Control for familiarization with the signs and postings in the work area;
- Emergencies involving radiological material and the correct response; and
- Chemical toxicity of soluble uranium compounds.

This training also includes practical applications of the personal protective equipment, personnel monitoring, and radiation measurements, if needed. Radiation worker training is reviewed and approved by Radiation Protection management and administered by the central training organization. The extent of the course material shall be commensurate with the potential for exposure.

6.6.8 Health Physics Technician Training

Health Physics Technician training and qualification is administered by Radiation Protection in accordance with guidelines in the TDAGs for Health Physics Technicians. It utilizes the systems approach to training (Section 6.6.3) and applies to those individuals, both plant and subcontractor employees who will be engaged in the evaluation of radiological conditions in the plant facilities and implementation of necessary radiological control measures as they apply to nuclear facility workers and members of the general public.

6.6.9 Fire Protection and Emergency Management Training

6.6.9.1 Emergency Management Training

Emergency Management Training is administered by emergency management personnel under the direction of the Environmental, Safety and Health Manager. It is detailed in the PGDP Emergency Plan Section 7.2.

Emergency Management drills and exercises are conducted to develop, maintain, and test the response capabilities of personnel, facilities, equipment, and training (Section 6.6.9).

6.6.9.2 Fire Protection Training

Fire Protection Training is administered by the central training organization and is covered in Section 5.4.5.

Fire Services personnel are trained and equipped to handle anticipated types of emergencies. Emergency medical response personnel meet requirements for state certification as emergency medical technicians (these are usually also firefighters). Qualified instructors provide a range of classroom and hands-on training to maintain standards of performance for all response personnel. Training needs are reviewed annually and the training program is modified to meet identified needs. State certification requirements provide the basis for firefighter training programs. Drills are conducted quarterly as part of the plant emergency plan.

6.6.9.3 Fire Protection Engineer Training

Fire protection engineering support is available to evaluate the fire hazards of changes to maintenance and process systems, provide in-house consultation, perform building surveys, and investigate fires. Fire Protection Engineer (FPE) qualifications require a four (4) year related technical degree or ten (10) years of related experience, five (5) years of which are directly related to FPE support.

Fire Protection Engineers participate in system engineering training described in Section 6.6.17.

6.6.10 Environmental, Safety and Health Training

This training covers those environmental, worker safety and health subject areas required by applicable local, state, and federal regulations and is provided to personnel commensurate with their job assignments. Specific programs identified as required compliance training for PGDP employees is contained in each organization's compliance training requirement matrix which provides a list of both the subject areas to be trained and the target audience to receive the training. Some of the areas include:

- Radiological Worker Safety,
- Nuclear Criticality Safety,
- Respirator Training,
- Confined Space Entry,

- Asbestos Worker Safety,
- Hearing Conservation,
- Heat/Cold Stress,
- OSHA Hazard Communication,
- Hoisting and Rigging,
- Mobile Equipment (Cranes, forklifts, etc.),
- Lockout/Tagout Work Permits,
- Safety & Health Work Permits, and
- RCRA Storage and Handling.

6.6.11 Contractor Training

Contractor training requirements are determined by the applicable site technical representative/ training review group project manager. This determination will be based upon the site access requirements and job functions of each specific contract.

6.6.12 Nuclear Criticality Safety Engineer/Specialist Training

Nuclear Criticality Safety Engineer/Specialist training and qualification is administered by the Nuclear Criticality Safety Group. Nuclear Criticality Safety Group procedures and TDAG define education and experience prerequisite for incumbents, required training courses, and continuing training requirements.

6.6.13 Audit and Inspection Personnel Training

The qualification and re-qualification of inspection personnel, auditors, lead auditors and nondestructive examination personnel is performed in accordance with QAP Section 2.2.4.

The Nuclear Safety and Quality Manager is responsible for identifying all qualification and requalification requirements for quality assurance auditors and quality control inspectors.

6.6.14 Manager Training

Manager training is provided for those persons who manage the operations and maintenance personnel relied upon to operate, maintain, or modify Q or AQ-NCS items. The training is not SAT-based but is designed, developed, and implemented to assist facility managers in gaining an understanding of the applicable procedures and

practices specific to the gaseous diffusion process and facility. Also, it is used to develop the managerial and leadership skills necessary to effectively manage personnel. This training includes:

- Management Skills Training,
- Initial and Continuing Process Safety Training for Managers, and
- Applicable elements of the Operations and Maintenance Initial and Continuing training.

6.6.15 Cascade Coordinator Training

Cascade coordinator training is administered by the Operations Organization and provided to those persons who direct the overall operations of the gaseous diffusion cascade. Training provides cascade coordinators an understanding of the overall integration of the process and support systems necessary to operate the GDP. Cascade coordinators also receive manager training.

6.6.16 Plant Shift Superintendent Training

Plant Shift Superintendent Training is administered by the Shift Operations Manager and provided to those persons who provide managerial oversight for the daily operations of the Plant Uranium Enrichment Facility and other support activities. This training is based on the systems approach to training and is designed, developed, and implemented to provide the plant shift superintendent an understanding of the overall integration of the processes, support systems, administrative and emergency procedures, and regulatory reporting requirements necessary to operate the GDP. Superintendent qualification is granted by the Operations Manager upon successful completion of training.

6.6.17 System Engineer Training

System Engineer Training is administered by Engineering and is provided to those persons who provide engineering support and review of the modifications to Q or AQ-NCS items. System Engineers are responsible for reviewing design proposals and modifications, ensuring that the appropriate documents and procedures are updated to be consistent with modifications; and assisting in work control package preparation and identification of post-maintenance test requirements for Q systems. The training is based on a detailed review of job analysis data, training requirements for specific systems, and existing training materials.

6.6.18 Laboratory Technician Training

Laboratory Technician Training is administered by Production Support and Product Scheduling in accordance with the guidelines set down in the Training Development and Administrative Guide for Laboratory Technicians Training. The training is based on a SAT process. The analysis results were used to establish the learning objectives, test items, instructional methods, and instructional settings.

6.6.19 Waste Management Operator Training

Waste management operator training is administered by the Environmental, Safety and Health organization and is provided to those persons who handle, store, and move waste for on-site treatment or package for shipment to off-site TSD facilities. The program includes training on the following:

- Basic knowledge of chemical safety

- Use/care of protective equipment
- Emergency response activities
- Spill prevention control and cleanup activities
- Landfill operation
- Conduct of operation
- Applicable ES&H training
- Regulatory requirements

Specific program description is documented in the TDAG for Waste Management Operator B Training program. Based on job specific assignment, personnel may be trained in any or all of the areas listed above.

6.6.20 Safeguards/Security Training

Security education briefings are administered by Security as described in the Security Plan for the Protection of Classified Matter.

6.6.21 Maintenance of Training Records

Training attendance records, examinations, employee qualification records, and program records are maintained in an accurate, auditable manner to document each employee's training. The individual employee training records are maintained by Training in both hard copy and electronic files. The electronic file system consists of a database relating the required training identified by the cognizant line manager to the actual training date of the employee. This electronic file is used for readily determining the status of an employee's qualification status. The training program records contain the job analysis data and history of the module to include records of review and revisions.

6.6.22 Items Addressed By Compliance Plan

Section deleted.

6.6.22.1 Development and Implementation of Systems Approach to Training (SAT)

Section deleted.

6.6.22.2 Development and Implementation of Training Programs on AQ Activities

Section deleted.

6.7 HUMAN FACTORS

6.7.1 Description

Human factors are considered in the conduct of operations at the PGDP. Those processes affecting the ability of personnel to carry out their assigned responsibilities incorporate guidance that provides assurance that human performance is considered, commensurate with the complexity and safety impact of the activity being performed.

Human factors considerations are incorporated in several PGDP practices, including:

- Engineering design work associated with new equipment and facility modifications.
- Preparation, validation, and use of procedures.
- Development of training and qualification of personnel who operate, maintain, or modify structures, systems, and components (Q-SSCs) relied upon for safety.

In addition, reports that identify human factors problems associated with existing facility design or procedures and training provide an information base to identify needs and improve human factors considerations.

Safety functions that require human actions in order to accomplish are considered as follows:

- Safety functions that require human actions are conducted in accordance with procedures, as described in Section 6.11. These procedures take into account the environmental, cognitive, and physical considerations that can affect the performance of the activity under consideration. Procedure writers' guides are used to ensure that the procedures clearly identify the required actions, and that necessary prerequisites, cautions, and warnings are incorporated in a manner that will give the performer adequate notice before proceeding with a procedural step that requires special consideration. The procedure writers' guide incorporates human factors guidance for writing procedures; these are considered during the procedure development/preparation "basic element" of the procedure process described in Section 6.11. The procedure development program that results from application of this guidance will ensure that these procedures will have had the appropriate human factors applied.
- The procedure development process incorporates a walk-through and/or demonstration step, which ensures that the procedure will result in the desired actions. In addition to the accuracy of the procedure, the ability of the performer to implement the steps of the procedure is assessed. Human factor considerations such as accessibility, visibility, ergonomic capability, suitability of environment for the required activity, and interferences are observed and if required, action is taken to mitigate any adverse elements.
- Systematic approach to training addresses consideration of human factors requirements through the job task analysis process. This process considers each element of the task to be accomplished, and identifies those aspects for which development of training requirements is needed. The task analysis breakdown will reveal sequences of steps or requirements for supporting information or observation

that are potentially problems from a human factors perspective. This will provide the information necessary to allow the correction of such deficiencies. Application of the job task analysis process is described further in Section 6.6.

- Verification that human factors deficiencies have not been incorporated in the procedure development or training is accomplished through conduct of drills and exercises, which provides a basis for evaluating operator performance required to accomplish safety functions. Observation, coupled with operator feedback during post-exercise critiques, provides indicators that identify any human factor deficiencies that may have been encountered.

- Event reporting and problem analysis also leads to identification of potential human factor deficiencies, or provides a degree of assurance that substantive deficiencies do not exist. Root cause analysis of events and performance problems occurring during operation applies a systematic process that includes consideration of human factors deficiencies as drivers. Any such deficiencies will be incorporated in the problem reporting and corrective action systems, ensuring they receive management attention on a systematic basis.

- The processes described above may identify physical factors that can impede an expected quality of performance. Any changes in plant or component design recommended to improve human performance will be considered by the engineering organization, and will be evaluated to determine their disposition. Engineering provides guidance in application of human factors elements to the design and specification process. Additionally, design requirements are established with input from the operators and the responsible system engineer. Elements that can impact performance, such as accessibility, reach, visibility, and layout are considered in the design wherever appropriate. Maintenance requirements, such as pull space or front panel location of test points, are considered, as well as operational needs.

- "Operator Aids" are used to provide assistance to operators in performing their duties (e.g., pin charts in the Area Control Rooms to identify the position of valves).

Human factor considerations and improvements can be adequately handled through existing management controls, specifically engineering design, procedures, training and problem analysis. Any changes in human actions required by the TSRs to prevent or mitigate accidents (specified in Chapter 2 of the TSRs) that may involve introduction of complex cognitive challenges will be specifically evaluated for human factor considerations as they are identified.

Additionally, human actions required by the TSRs to prevent or mitigate accidents (specified in Chapter 2 of the TSRs) are systematically evaluated for human factor considerations, including accessibility, visibility, ergonomic capability, suitability of the environment for the required activity, and interferences, on a 3-year cycle. Any improvements identified by the TSR evaluation process will be handled through the problem reporting system for tracking to resolution. The evaluation of human actions required by the TSRs to prevent or mitigate accidents is documented and used in the routine procedure reviews and in evaluation of plant physical and programmatic changes. The evaluation does not include an evaluation of the existing plant and process controls design. There is no formal "Human Factors Review" program. The simplicity of the safety design of the gaseous diffusion plant does not require a formal "Human Factors Review" program.

6.7.2 Items Addressed by Compliance Plan

None.

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6.8 AUDITS AND ASSESSMENTS

A system of audits and assessments is implemented at the Paducah Gaseous Diffusion Plant (PGDP) to ensure that the health, safety, and environmental programs, as described in this application, are adequate and effectively implemented. The system is designed to ensure comprehensive program oversight at least once every 3 years. The system is comprised of two distinct levels of activities. These are audits and assessments.

6.8.1 Audits

Audits are conducted by the USEC plant independent Nuclear Safety and Quality organization in accordance with procedures and checklists by qualified auditors. Audits verify the effectiveness of health, safety and environmental programs and their implementation and determine the effectiveness of the assessment process.

These audits and their associated frequencies are conducted in accordance with Section 2.18 and Appendix A of the Quality Assurance Program and use written plans and checklists. Audits are performed under the direction of a Lead Auditor, qualified in accordance with the American Society of Mechanical Engineers (ASME) NQA-1 Supplement 2S-3. Lead auditors and staff auditors are functionally and organizationally independent of the programs and activities examined. Where appropriate, audit teams are supplemented with on site and/or off site technical specialists.

Audit results are documented and reported as specified in plant procedures. Provisions are made for immediate reporting and corrective action where warranted, as described in Section 6.9. A plant corrective action program is administered to ensure proper control of corrective actions as defined in Section 2.16 of the Quality Assurance Program (QAP).

6.8.2 Assessments

Assessments are performed by management responsible for implementing portions of the QAP to assess the adequacy of the part of the QAP for which they are responsible and to assure its effective implementation, as required by NQA-1 Basic Requirement 2. Personnel from the area being assessed may perform the assessment, provided that they do not have direct responsibility for the specific area being assessed (does not apply to Section 6.8.2.3). Results of assessments shall be documented. Any observations from the program assessments are resolved by the responsible organization manager.

Assessments performed include:

6.8.2.1 Program Assessments

The managers responsible for several major programs assure assessments are performed of their particular programs:

- Nuclear Criticality Safety activities related to assessments are addressed in Section 5.2.2.9, "Operation Surveillance and Assessments."

- Assessments are conducted of the fire protection program in Organizational Self Assessments (Section 6.8.2.2) and Management Self Assessments Activities (Section 6.8.2.3).

- Assessments of environmental programs are performed to assess compliance with environmental laws and regulations and to verify completion of corrective actions for environmental noncompliances.

- Assessments of health and safety programs are performed on a regular basis (typically one to two program areas per month, with all major program areas, as determined by the organization manager, assessed every 3 years) by Safety and Health professionals to verify that programs are effectively achieving their designed purposes. Industrial Safety, Radiation Safety and Chemical Safety are the major programs assessed.

- Assessments of the accuracy of nuclear materials accounting records are performed by Nuclear Material Control and Accountability (NMC&A) Group personnel. These assessments are required as part of the item monitoring activities associated with the item control program, as described in Section 8 of the Fundamental Nuclear Material Control Plan (FNMCP).

- Consistent with Section 2.2 of the QAP, an assessment of the status, adequacy, and effectiveness of the QAP at each GDP is provided to the USEC Vice President, Operations, at least once every 24 months by the NS&Q manager at each GDP.

6.8.2.2 Organizational Self Assessments

Procedures require that each plant organization prepare and submit a surveillance (self assessment) schedule annually that establishes the functional areas to be surveyed to ensure compliance with procedural requirements. Reports are submitted on each surveillance and problem reports are issued on items of noncompliance. The surveillance (self-assessment) process is periodically reviewed by the Nuclear Safety and Quality organization through independent audits.

6.8.2.3 Management Self Assessment Activities

Managers evaluate findings from audits, assessments and problem reports to determine their significance to plant safety and to ensure proper resolution. In addition, a program titled Management by Walking Around (MBWA) describes how senior managers evaluate plant facilities in the areas of Occupational Safety and Health, Nuclear Criticality Safety, Radiological Protection, Environmental Compliance, Safety Requirements, Conduct of Operations, and Conduct of Maintenance. Issues relating to Training, Quality Assurance, Maintenance, Configuration Management, Etc., are also assessed during these assessments. Problem Reports (as described in Section 6.8.2.4) are generated for nonconforming conditions.

6.8.2.4 Problem Reporting

All plant employees have the responsibility to write problem reports on safety, operating and noncompliance items. Problem reports are screened routinely to assign an owner for each problem reported, as well as to determine if identified problems represent significant conditions adverse to quality (SCAQ) based on established criteria. A plant corrective action program is administered to ensure proper control of corrective actions as defined in Section 2.16 of the Quality Assurance Program (QAP). Corrective actions are tracked through completion.

6.8.3 Items Addressed by Compliance Plan

None.

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6.9 EVENT INVESTIGATIONS AND REPORTING

USEC is required by 10 CFR 76.35(a)(7) to describe its management controls and oversight program governing activities directly relevant to nuclear safety and safeguards and security. This section describes the event investigations and reporting elements of the management controls and oversight program. USEC management ensures that activities directly relevant to nuclear safety and safeguards and security are conducted in a controlled manner to protect employees and public health and safety, the environment, and national security interests. As part of this program, abnormal events are identified, reported, and investigated. This includes identification and categorization of the event as well as an analysis to determine the root cause and its effect upon nuclear safety and safeguards and security. The corrective actions developed as a result of the investigation are entered into a commitment management database, which is a dedicated database used to track and trend corrective actions and plant commitments.
This database also facilitates management's review of the corrective actions and plant commitments.

USEC is required by 10 CFR 76.120 and other applicable sections of the regulations referenced in 10 CFR 76.60 to notify the NRC of certain plant events and conditions and to determine the cause, corrective actions, and lessons learned. USEC shall satisfy these requirements by following administrative procedures relating to problem reporting (Problem Reporting Procedure) and nuclear regulatory event reporting (Nuclear Regulatory Event Reporting Procedure). Key aspects of the problem reporting and event reporting procedures are described in Section 6.8 and this section. These procedures work together to ensure that abnormal events and conditions occurring at the plant are promptly reported to appropriate plant personnel, assessed, and when required, reported to the NRC Operations Center or designated NRC office. Table 6.9-1 indicates those events for which a notification is required and those events for which a written report will be provided to the NRC.

6.9.1 Event Identification

In accordance with the Problem Reporting Procedure (PRP), plant personnel are required to report to their line manager or directly to the Plant Shift Superintendent (PSS) abnormal events or conditions that may have the potential to harm the safety, health, or security of on-site personnel, the general public, or the environment. The initial reporting to the PSS is as described in the PRP. Plant personnel are also required to immediately report conditions which may require emergency response.

6.9.2 Event Categorization

In accordance with the Nuclear Regulatory Event Reporting Procedure (NERP), the PSS assesses and categorizes abnormal events or conditions using the notification and reporting criteria set forth in 10 CFR 76 and the other applicable regulations referenced in 10 CFR 76.60. Table 6.9-1 provides a list of the initial event notification and reporting criteria. In making the assessment, the PSS may consult with plant management or other personnel possessing expertise or knowledge concerning the type of event or condition being assessed.

6.9.3 NRC Notification

If an event or condition within the USEC-leased area, or from a USEC directed activity outside the government reservation, is categorized as a reportable event, the PSS shall provide initial notification (verbal or written, as required) to the NRC Operations Center or designated NRC office and provide, to the extent known at the time of notification, the information specified in 10 CFR 76.120(d)(1) and other applicable sections of the regulations referenced in 10 CFR 76.60. Notification shall be made as soon as possible but not later than the time period(s) stated in the regulations. Reporting time periods are shown with the reporting criteria listed in Table 6.9-1. Verbal and/or written communication involving classified information shall be conducted in accordance with the Security Plan for the Protection of Classified Matter that is part of this application.

Site events that occur within the DOE managed property (USEC non-leased area) shall be categorized by the PSS. Events classified as an occurrence shall be reported to DOE by the PSS. These events shall be assessed by the PSS and other plant management, as needed, to determine whether further action is required to be taken by USEC/LMUS personnel, including reports to the NRC.

6.9.4 Event Investigation

All reportable events, where a follow-up written report is required, are investigated to determine the root cause and corrective actions necessary to prevent recurrence. This investigation is conducted and documented, as required, by the plant corrective action process. Other events not requiring a follow-up written report are evaluated using the corrective action process to determine actions to be taken. The magnitude of this investigation is dependent upon the significance and complexity of the reportable event. This may range from assignment of an event investigation team or may be as simple as a one-person investigation. Documentation related to the event investigation may be separate from the event report and will be retained in accordance with Records Management and Document Control requirements described in Section 6.10.

6.9.5 Written Report

When required by Table 6.9-1, a report summarizing the results of the event investigation is prepared in accordance with the NERP. The report shall contain, at a minimum, the information specified in 10 CFR 76.120(d)(2) or other applicable sections of the regulations referenced in 10 CFR 76.60. The written report shall be forwarded to the NRC within the time specified in Table 6.9-1 or applicable NRC regulations. The PORC is required to review each written event report prior to submission to the NRC.

6.9.6 Corrective Actions

For each reportable event, corrective actions to prevent recurrence shall be developed by responsible management. These actions shall be validated and tracked to ensure proper implementation and closure, in accordance with the plant corrective action process. Prior to closure, the actions taken to prevent recurrence shall be reviewed by management. Evidence files used to support action closure shall be maintained in accordance with approved records management procedures.

6.9.7 Lessons Learned

Lessons learned from observations, experiences, events, and problem reports are reviewed and effectively communicated across both plants. The Operating Experience Review Program (OERP) Administrator reviews gaseous diffusion operations and related industry operating experience information to determine whether it warrants informational review or action by the organization with responsibility within the area of concern. Lessons learned from NRC-regulated facilities, as they apply to gaseous diffusion operations, shall be included.

6.9.8 Items Addressed by Compliance Plan

Section deleted.

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Table 6.9-1. Event notification and reporting criteria applicable to USEC.

*Unless otherwise noted, notifications are verbal.
(W) =written (follow-up) report

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
A. Criticality Event		
1. After the discovery of a criticality event.	1 Hour	76.120(a)(1)
	60 Day (W)	76.120(d)(2)**
2. For operations that comply with the double contingency principle: a. moderation is used as the primary criticality control, **or** b. more than a safe mass of fissionable material is involved (regardless of the type of controls used to satisfy the double contingency principle), **and** c. that meet one or more of the following: (1) Any event that results in the violation of the double contingency principle, as defined in ANSI 8.1, and where double contingency cannot be re-established within 4 hours after the initial observation of the event. (2) The occurrence of any unanticipated or unanalyzed event for which the safety significance of the event or corrective actions to re-establish double contingency are not readily identifiable. (3) Any case where it is determined that a criticality safety analysis was deficient and where the necessary controlled parameters were not established or maintained.	4 Hours From Initial Observation	NRC BL 91-01 Supp. 1

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
A. Criticality Event (continued)		
(4) Any event involving a controlled parameter previously identified by the NRC or the certificate holder as requiring immediate reporting to the NRC and where double contingency cannot be re-established within 4 hours after the initial observation of the event.		
3. For operations that do not comply with the double contingency principle, for which:	4 Hours From Initial Observation	NRC BL 91-01, Supp. 1
a. moderation is used as the primary criticality control, or		
b. more than a safe mass of fissionable material is involved, and		
c. that meet one or more of the following:		
(1) The occurrence of any unanticipated or unanalyzed event for which the safety significance of the event or corrective actions to re-establish the approved controls are not readily identifiable.		
(2) Any case where it is determined that a criticality safety analysis was deficient and where the necessary controlled parameter is not established or maintained.		
(3) Any event involving the controlled parameter and the approved control on the parameter cannot be re-established within 4 hours after initial observation of the event.		

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

	Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
	A. Criticality Event (continued)		
4.	All other criticality safety events:	24 Hours	NRC BL 91-01, Supp. 1
	a. For violations involving operations that comply with the double contingency principle and do not meet the aforementioned criteria (listed above), but still result in a violation of the double contingency principle, such as events where the double contingency principle is violated but control is immediately re-established.		
	b. For violations involving operations that do not comply with the double contingency principle and do not meet the aforementioned criteria (listed above), but still result in a violation of a control relied on for the criticality safety of the operation.		
	B. Special Nuclear Material Event		
1.	Any loss, other than normal operating loss, of special nuclear material (SNM).	1 Hour	74.11(a) 76.120(a)(2)
		60 Day (W)	76.120(d)(2)**
2.	Any theft or unlawful diversion of SNM that USEC is authorized to possess, or any incident in which an attempt has been made or is believed to have been made to commit a theft or unlawful diversion of SNM.	1 Hour	74.11(a) 76.120(a)(3)
		60 Day (W)	76.120(d)(2)**
3.	Discovery of any unauthorized production of enriched uranium.	1 Hour	74.11(a)
4.	Discovery of the loss of any shipment of SNM or spent fuel.	1 Hour	73.67(g)(3)(iii) 73.71(a)(1)
		60 Day (W)	73.71(a)(4)
5.	Recovery of or accounting for each lost shipment.	1 Hour	73.67(g)(3)(iii) 73.71(a)(1)
		60 Day (W)	73.71(a)(4)

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

	Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
	B. Special Nuclear Material Event (continued)		
6.	Significant supplemental information (about the loss or recovery or accounting of any lost shipment) that becomes available after initial telephonic notification or after submission of the written report.	Report As Discovered (within 1 hour) 60 Day (W)	73.71(a)(5)
	C. Theft or Loss of Licensed Material (Refer to Appendix C of 10 CFR 20 for Quantities)		
1.	Any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix C, 10 CFR 20 under such circumstances that it appears to USEC that an exposure to persons in unrestricted areas could result.	Immediately After Known (within 1 hour) 30 Day (W)	20.2201(a)(1)(i) 20.2201(b)(1)
2.	Within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to USEC, all licensed material in a quantity greater than 10 times the quantity specified in Appendix C to 10 CFR 20 that is still missing at this time.	30 Day 30 Day (W) after making verbal notification	20.2201(a)(1)(ii) 20.2201(b)(1)
3.	Any additional substantive information on the loss or theft of licensed material.	30 Day (W) After Learning of Such Information	20.2201(d)
	D. Emergency Conditions (Refer to Plant Specific Emergency Action Levels)		
1.	An emergency condition that has been declared an Alert.	1 Hour 60 Day (W)	76.120(a)(4) 76.120(d)(2)**
2.	An emergency condition that has been declared a Site Area emergency.	1 Hour 60 Day (W)	76.120(a)(4) 76.120(d)(2)**

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
E. Protective Action Prevented		
An event (events may include fires, explosions, radiological releases, etc.) that prevents immediate protective actions necessary to avoid releases, or exposures to radiation or radioactive materials that could exceed regulatory limits.	4 Hours	76.120(b)
	60 Day (W)	76.120(d)(2)**
F. Fire Explosion Damaging Radioactive Material (Refer to Appendix B of 10 CFR 20)		
A fire or explosion damaging any radioactive material or any device, container, or equipment containing radioactive material when:	24 Hours	76.120(c)(4)
	60 Day (W)	76.120(d)(2)**
1. the quantity of material involved is greater than five times the lowest annual limit on intake specified in Appendix B to Sections 20.1001-20.2402 of 10 CFR 20 for the material; and		
2. the damage affects the integrity of the radioactive material or its container.		
G. Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Limits		
1. Any event involving byproduct, source, or SNM possessed by USEC that may have caused or threatens to cause any of the following conditions:		
a. An individual to receive:	Immediate (within 1 hour)	20.2202(a)(1)
(i) A total effective dose equivalent (TEDE) of 25 rems (0.25 Sv) or more; or		
(ii) A lens dose equivalent of 75 rems (0.75 Sv) or more; or	30 Day (W)	20.2203(a)(1)
(iii) A shallow-dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or		

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
G. Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Limits (continued)		
b. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot cells or process enclosures).	Immediate (within 1 hour) 30 Day (W)	20.2202(a)(2) 20.2203(a)(1)
2. Any event involving loss of control of licensed material possessed by USEC that may have caused, or threatens to cause, any of the following conditions:		
a. An individual to receive, in a period of 24 hours-	24 Hours 30 Day (W)	20.2202(b)(1) 20.2203(a)(1)
(i) A TEDE exceeding 5 rems (0.05 Sv); or		
(ii) A lens dose equivalent exceeding 15 rems (0.15 Sv); or		
(iii) A shallow-dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or		
b. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).	24 Hours 30 Day (W)	20.2202(b)(2) 20.2203(a)(1)

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
G. Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Limits (continued)		
3. Doses in excess of any of the following:	30 Days Written Notification Report	20.2203(a)(2)
a. The occupational dose limits for adults in Section 20.1201; or		
b. The occupational dose limits for a minor in Section 20.1207; or		
c. The limits for an embryo/fetus of a declared pregnant woman in Section 20.1208; or		
d. The limits for an individual member of the public in Section 20.1301; or		
e. Any applicable limit in the license; or		
f. Air emissions of radioactive material to the environment excluding Radon-222 and its daughters such that the total effective dose equivalent that an individual member of the public likely to receive the highest dose would be in excess of 10 mrem per year as determined by the Annual Air Emission Calculation completed to demonstrate compliance with 10 CFR 20.1302.		20.1101(d)
4. Levels of radiation or concentrations of radioactive material in	30 Days Written Notification Report	20.2203(a)(3)
a. A restricted area in excess of any applicable limit in the certificate; or		
b. An unrestricted area in excess of 10 times any applicable limit set forth in this part or in the certificate (whether or not involving exposure of any individual in excess of the limits in Section 20.1301); or		

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

	Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
	G. Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Limits (continued)		
5.	USEC, being subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 (Subpart B-Environmental Standards for the Uranium Fuel Cycle-Standards for Normal Operations), shall report to NRC levels of radiation or releases of radioactive material in excess of those standards, or of certificate conditions related to those standards.	30 Days Written Notification Report	20.2203(a)(4)
6.	USEC shall submit a written report of any planned special exposure (PSE) conducted in accordance with Section 20.1206.	Within 30 Days of Conducting PSE	20.2204 20.1206(f) 19.13(d)
	H. Unplanned Contamination (Refer to Appendix B of 10 CFR 20 for Annual Limits on Intake)		
	An unplanned contamination event that:		
1.	Requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the area;	24 Hours 60 Day (W)	76.120(c)(1)(i) 76.120(d)(2)**
2.	Involves a quantity of material greater than **five times** the lowest annual limit on intake specified in Appendix B to Sections 20.1001-20.2402 of 10 CFR 20 for the material; **and**		76.120(c)(1)(ii) 76.120(d)(2)**
3.	Causes access to the contaminated area to be restricted for any reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination.		76.120(c)(1)(iii) 76.120(d)(2)**

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
I. Unplanned Medical Treatment of Individual with Radioactive Contamination		
An event that requires unplanned medical treatment at a medical facility of an individual with radioactive contamination on the individual's clothing or body.	24 Hours 60 Day (W)	76.120(c)(3) 76.120(d)(2)**
J. Safety Equipment Failure/Actuations		
1. An event in which equipment is disabled or fails to function as designed when:		
a. The equipment is required by a TSR to prevent releases, prevent exposures to radiation and radioactive materials exceeding specified limits, mitigate the consequences of an accident, or restore this facility to a pre-established safe condition after an accident;	24 Hours 60 Day (W)	76.120(c)(2)(i) 76.120(d)(2)**
b. The equipment is required by a TSR to be available and operable and either should have been operating or should have operated on demand; **and**		76.120(c)(2)(ii) 76.120(d)(2)**
c. No redundant equipment is available and operable to perform the required safety function.		76.120(c)(2)(iii) 76.120(d)(2)**

**Reference: NRC letter, "Paducah Gaseous Diffusion Plant – Exemption from Requirement for Submitting Written Event Reports in 30 Days (TAC NOS. L32179 and L32181)", dated November 15, 2002.

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
J. Safety Equipment Failure/Actuations (continued)		
2. USEC shall notify the NRC within 24 hours of any automatic or manual actuation of a Q safety system that results from an event or condition that has the potential for significant impact on the health or safety of personnel. Events having the potential for significant impact are those events where actual plant conditions existed that the system was designed to protect against. The intent of this reporting requirement is to ensure that the NRC is notified of those events where a Q safety system was actuated, either manually or automatically, in response to a valid signal. Per discussions with NRC staff, this reporting requirement specifically excludes the reporting of: A. Actuations which result from and are part of a pre-planned sequence during testing or operation; B. The actuation is invalid and: (1) Occurs while the system is properly removed from service; (2) Occurs after the safety function has already been completed; C. Actuations caused by invalid signals (e.g., non-safety system signal, instrument drift, spurious signals, human error, or other invalid signals). Invalid Q safety system actuations are documented and evaluated through the Problem Reporting System.	24 Hours 60 Day (W)	
K. Safeguards Events		
1. USEC, being subject to the provisions of Section 73.67 shall notify the NRC Operations Center within **1 hour** of discovery of the safeguards events described in paragraph I(a)(1) of Appendix G to this part [10 CFR 73].	1 Hour 60 Day (W)	73.71(b)(1) 73.71(b)(2)

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Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

	Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
	K. Safeguards Events (continued)		
2.	Significant supplemental information that becomes available after initial telephonic notification to the NRC Operations Center or after the submission of the written report must be telephonically reported to the NRC Operations Center and also submitted in a revised written report.	As Soon As Discovered (within 1 hour) 60 Day (W)	73.71(a)(5) [criterion] 73.71(b)(2) [reporting requirement] 73.71(a)(5)
	L. Violations Regarding National Security Information/Restricted Data		
1.	When a request for security facility clearance is to be withdrawn or canceled, the NRC Division of Nuclear Security will be notified by the requestor immediately by telephone so that processing for this approval may be terminated.	Immediately (Within 1 hour; normal working hours only) Promptly Written Confirmation	95.21 95.21

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

	Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
	L. Violations Regarding National Security Information/Restricted Data (continued)		
2.	Any alleged or suspected violation of the Atomic Energy Act, Espionage Act, or other Federal statutes related to classified information. (e.g., deliberate disclosure of classified information to persons not authorized to receive it, theft of classified information.)	Immediately (Within 1 hour)* With written confirmation within 30 days	95.57(a)
3.	Any infractions, losses, compromises, or possible compromise of classified information or classified documents not falling within 10 CFR 95.57(a).	Log incident within 24 hours of discovery	95.57(b)
	A copy of the security incident log shall be submitted to NRC Region II and the NRC Division of Nuclear Security.	Monthly	95.57 (b)
	M. Material Handling		
1.	Removable radioactive surface contamination exceeds the limits of 10 CFR 71.87(i); or	Immediately (within 1 hour)	20.1906(d)(1)

* Notifications shall be made to NRC Regional Administrator and NRC Division of Nuclear Security (during normal NRC working hours) or NRC Operations Center (after normal NRC working hours).

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
M. Material Handling (continued)		
2. External radiation levels exceed the limits of 10 CFR 71.47.	Immediately (within 1 hour)	20.1906(d)(2)
N. Transportation Incidents		
1. Each certificate holder who transports licensed material outside of the confines of its plant or other place of use, or who delivers licensed material to a carrier for transport, shall comply with the applicable requirements of the regulations appropriate to the mode of transport of Department of Transportation (DOT) in 49 CFR 170 through 189.	Earliest Practicable Moment (within 1 hour) 30 Day (W)	71.5(a)(1)(iv) 71.5(b) [requirement to notify NRC]
a. USEC shall particularly note DOT regulations in the following areas:		
...(iv) Accident reporting-49 CFR 171.15 and 171.16		
49 CFR 171.15 Immediate Notice of Certain Hazardous Materials Incidents		
49 CFR 171.16 Detailed Hazardous Materials Incident Reports		

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
N. Transportation Incidents (continued)		
2. USEC shall notify the NRC of information identified by USEC as having for the regulated activity a significant implication for public health and safety or common defense and security. USEC violates this paragraph only if USEC fails to notify the NRC of information that USEC has identified as having a significant implication for public health and safety or common defense and security. Notification shall be provided to the Administrator of the appropriate Regional Office within **2 working days** of identifying the information. This requirement is not applicable to information already required to be provided to the NRC by other reporting or updating requirements.	2 Working Days	71.7
3. USEC shall report: a. any instance in which there is significant reduction in the effectiveness of any NRC – approved Type B or Type AF packaging during use; or b. details of any defects with safety significance in any NRC-approved Type B or fissile material packaging after first use; with the means employed to repair the defects and prevent their recurrence; or c. Instances in which the conditions of approval in the Certificate of Compliance were not observed in making a shipment, or were not followed during a shipment.	60 days	71.95 (a), (b) [criteria] 71.95 (c) [reporting]

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
O. Failure to Comply or Existence of a Defect		
1. USEC has adopted appropriate procedures to:	Written Notification 30 Days after Receipt of Information	21.21(a)(3) [criteria] 21.21(d)(3)(ii) [reporting requirement]
- Ensure that a director or responsible officer subject to 10 CFR 21 is informed as soon as practicable, and in all cases, within the 5 working days after completion of the evaluation described in 10 CFR Sections 21.21(a)(1) or 21.21(a)(2) if the construction or operation of a facility or activity:		
a. Fails to comply with the Atomic Energy Act of 1954 as amended, or any applicable rule, regulation, order, or license of the NRC relating to a substantial safety hazard, or		
b. Contains a defect.		
2. A director or responsible officer subject to 10 CFR 21 or a person designated under 10 CFR Section 21.21(d)(5) must notify the NRC when he or she obtains information reasonably indicating a failure to comply or a defect affecting:	2 Days via Facsimile	21.21(d)(1) (criteria) 21.21(d)(3)(i) (reporting requirement)
a. The construction or operation of a facility or an activity within the United States that is subject to the licensing requirements under 10 CFR 30, 40, 50, 60, 61, 70, 71 or 72 and that is within his or her organization's responsibility; or		
b. A basic component that is within his or her organization's responsibility and is supplied for a facility or an activity within the United States that is subject to the licensing requirements under 10 CFR 30, 40, 50, 60, 61, 70, 71, or 72.		

Table 6.9-1. Event notification and reporting criteria applicable to USEC. (continued)

Criteria	Notification/ Reporting Time	Reporting Requirement Reference (10 CFR Section)
P. Miscellaneous		
USEC shall notify the NRC of any event or situation, related to the health and safety of the public or onsite personnel, or protection of the environment, for which a news release is planned or notification to other government agencies has been or will be made. Such an event may include an onsite fatality or inadvertent release of radioactively contaminated materials.	4 Hours	

6.10 RECORDS MANAGEMENT AND DOCUMENT CONTROL

Introduction

Records Management and Document Control programs are established to ensure records and documents required by the QAP are appropriately managed and controlled. These programs are designed to meet the specific recordkeeping and document control requirements set forth in 10 CFR 76 and the applicable provisions of other parts of 10 CFR. These programs provide administrative controls that establish standard methods and requirements for collecting, maintaining, and disposing of records. These programs also ensure that documents are controlled and distributed in accordance with identified written requirements and authorizations. The administrative controls for the generation and revision of records and documents are contained in plant implementing procedures. The principal elements of each of the Records Management and Document Control programs and a brief description of the manner in which the functions associated with each element are performed are provided below, along with a list of the types of records that are retained for the duration of the NRC Certification of Compliance for the plant.

6.10.1 Records Management Program

The Records Management program provides direction for the handling, transmittal, storage, and retrievability of records. Records media may include microfilm, electronic (magnetic or optical), or hard copy. Records are categorized and handled in accordance with their relative importance to safety and storage needs. Special provisions are made for handling contaminated records and ensuring their inclusion in the program. Responsibility for the administration of the Records Management program rests with the Regulatory Affairs Manager. Responsibility for Records Management program compliance rests with the managers generating records. This program is implemented through procedures that provide guidance for the following program elements.

6.10.1.1 Legibility, Accuracy, and Completeness

Documents designated to become records shall be legible, accurate, complete, and contain an appropriate level of detail commensurate with the work being performed and the information required for that type of record.

6.10.1.2 Identification of Items and Activities

Records clearly and specifically identify the items or activities to which they apply.

6.10.1.3 Authentication

Records are authenticated or validated by the Organization Manager of the organization which originates the record, or his designee, as specified in the procedure which controls the generation and revision of these records. This is in the form of a signature and date applied to the record.

6.10.1.4 Indexing and Filing

Methods are specified for indexing, filing, and locating records within the record system to ensure the records can be retrieved in a timely manner.

6.10.1.5 Retention and Disposition

Records retention times are specified in a retention schedule. The process for disposition of records that have reached the end of their retention lifetime is specified by procedures and conforms to applicable requirements.

6.10.1.6 Corrections

Corrections to records are approved by the organization which created the record unless other organizations are specifically designated. Changes are made by clearly indicating the correction, the date of the correction, and the identification of the individual making the correction.

6.10.1.7 Protection of Records

Controls are established for protection of records from deterioration, loss, damage, theft, tampering, and/or unauthorized access for the life of the record. Requirements include instructions on protection of records by the record originator until they are transferred to Documents and Records. Instructions for the protection of special record media such as radiographs, photographs, negatives, microform, and magnetic media are provided to prevent damage from excessive light, stacking, electromagnetic fields, temperature, humidity, or any other condition adverse to the preservation of those records. Records that cannot be duplicated are stored in a fashion that minimizes deterioration.

6.10.1.8 Storage Requirements

Records are stored in authorized facilities or containers providing protection from fire hazards, natural disasters, environmental conditions, infestations of insects, mold, or rodents. Storage facilities are maintained to ensure continuous protection of the records. Requirements are specified for both permanent and temporary storage of records.

Permanent Storage

Records are permanently stored in facilities satisfying the following requirements:

1. Storage in 2-hour-rated Class B file containers meeting National Fire Protection Association (NFPA) 232-1986 or NFPA 232 AM-1986 or both, or

2. Storage of duplicate copies in separate facilities that are sufficiently remote from each other to eliminate the possibility of exposure to simultaneous hazards, or

3. A single storage facility meeting the following criteria:

   a. Reinforced concrete, concrete block, masonry, or equal construction;

   b. Floor and roof with drainage control. If a floor drain is provided, a check valve (or equal) shall be included. An exception to this requirement has been taken in that floor drains are not provided. A technical justification has been performed and determined this exception is acceptable.

   c. Doors, structure and frames, and hardware shall be designed to comply with the requirements of a minimum 2-hour fire rating;

   d. Sealant applied over walls as a moisture or condensation barrier;

   e. Surface sealant on floor providing a hard wear surface to minimize concrete dusting;

   f. Foundation sealant and provisions for drainage;

   g. Forced air circulation with filter system;

   h. Fire protection system;

   i. Only those penetrations used exclusively for fire protection, communication, lighting, or temperature/humidity control are allowed; all such penetrations shall be sealed or dampered to comply with the minimum 2-hour fire protection rating. An exception to this requirement has been taken in that two 6-inch roof drains are present in the vault. A technical justification has been performed and determined that this exception is acceptable.

Temporary Storage

The Records Management and Document Control process requires that those completed records documenting nuclear safety or safeguards and security matters that are being held temporarily by originating organizations be properly protected by maintaining them in 1-hour, fire-rated containers. If 1-hour, fire-rated containers are used, they either bear an Underwriters Laboratory (UL) label (or equivalent) certifying 1-hour fire protection, or the containers are certified for 1-hour fire protection by an authorized individual competent in the field of fire protection. Procedural requirements are used to limit the length of time during which records may be maintained in temporary storage, based on the significance of the record.

6.10.1.9 Receipt of Records

A record transmittal process is used to formally transmit records to Documents and Records. The process includes a receipt acknowledgment that notifies the sending organization that the records have been received and accepted.

6.10.1.10 Access to Records and Accountability for Removed Records

Requirements for controlling access to records and maintaining accountability for records are provided to ensure that only authorized personnel have access to records and to prevent loss, damage, or inadvertent destruction of records.

6.10.1.11 Records Requirements for Procured Goods or Services

Records management requirements for goods or services procured from outside suppliers are specified in the applicable procurement documents. These requirements cover:

1. Supplier methods for collection, storage, and maintenance of records;
2. Identification of required records and applicable retention periods;
3. Records submittal plans or indexes;
4. Availability, accessibility, and if applicable, disposition criteria for records retained by the supplier; and
5. Accessibility of the supplier's records prior to the final transfer to the purchaser.

6.10.1.12 Control of Sensitive Records

Control, accountability, protection, and dispositioning of classified, unclassified controlled nuclear information (UCNI), and sensitive records are in accordance with the Security Plan for the Protection of Classified Matter and any other security and privacy requirements.

6.10.1.13 Types of Records

Records series which will be included in the Records Management program include, but are not limited to:

1. Transportation and shipping records for nuclear materials.
2. Radiation Protection records, including ALARA findings and occupational radiation exposure records.
3. Training, qualification, and requalification records.
4. Procurement documents/records.
5. Design documents and changes thereto involving design modifications made to safety systems and equipment.
6. Manuals, instructions, and procedures.
7. Certification documents.
8. Reportable event records.
9. Gaseous and liquid radioactive and hazardous waste records.
10. Safety evaluations and NCS analysis records.
11. Plant radiation surveys and environmental survey records (including radioactive releases).
12. PORC records.
13. QA activity records required by the QA program.
14. Regulatory agency reports and responses.
15. Safeguards and security records.

Specific records will be retained for a period of time specified by applicable NRC, Federal, or State regulations.

6.10.1.14 Usage and Control of Computer Codes and Data

Computer programs used in the Records Management program are controlled and maintained in accordance with the "Computing and Telecommunications Security Manual" and Information Systems procedures. These requirements and practices provide for virus protection as well as access control to the Records Management program database and ensure continuing usability of the codes as hardware and software technology change. Routine backups of the Records Management database are performed by Documents and Records or Information Systems application administrators. Precautions are taken to ensure that computer data that constitute a record are stored in a format that is readily retrievable even as hardware and software technology evolve. The storage format of computer data is reviewed to determine threats to future retrievability, and if necessary, the data are translated to an updated format and verified acceptable.

6.10.1.15 Assessment

The overall effectiveness of the Records Management program is evaluated through the audit program described in Section 2.18 of the Quality Assurance Program (QAP). Deficiencies identified are corrected in a timely manner in accordance with the PRP.

6.10.2 Document Control Program

The Document Control program provides direction for the handling, distribution, and transmittal of documents important to nuclear safety and safeguards and security that specify quality requirements or prescribe activities affecting quality, such as procedures, drawings, and calculations. This program shall be implemented through procedures that provide guidance on the following program elements.

6.10.2.1 Unique Identifier

A unique identification number is assigned or obtained by the generator for each document requiring controlled distribution. Document Control concurs with the numbering scheme for each document type.

6.10.2.2 Approval and Release of Documents

For documents and changes to documents required by the QAP, requirements are established for approval and release of those documents for distribution. Documents requiring review and approval by the Plant Operations Review Committee (PORC) are identified in the TSR for PORC. Requirements for the review and approval of procedures are identified in the TSR for Procedures and SAR Section 6.11. Controlled documents are approved by the organization authorized to approve them as identified in the procedures which control their generation and revision. Changes to controlled documents are approved and released by the organization that performed the document's initial approval unless other organizations are specifically designated. After approval, the documents are forwarded to Document Control for control and distribution to the personnel on the approved distribution list.

6.10.2.3 Master Copy

A master copy of all approved controlled documents is maintained by Document Control to ensure the document is available for controlled copy issuance.

6.10.2.4 Controlled Document Index and Distribution Lists

Creation and maintenance of a controlled document index and controlled distribution list(s) for each document or document type is required. The controlled document index is used to maintain a list of controlled documents and to track the current (latest) approved revision levels of those documents. The index is available to users to verify current document revision levels. The controlled document index and distribution lists are maintained and updated by Document Control.

6.10.2.5 Copies of Controlled Documents

Each controlled copy is stamped, marked, or otherwise identified. A method is established in procedures for duplicating and marking controlled documents so that duplicates are distinguishable from the controlled version. Copies of controlled documents that are not marked or otherwise identified in accordance with procedural requirements are considered information only.

6.10.2.6 Distribution

Controlled documents are distributed in accordance with controlled distribution lists to ensure that controlled documents are available in a timely manner at locations where work is being performed. Specific time requirements are established for controlled document distribution and receipt acknowledgment. Document Control uses a transmittal form to distribute controlled documents to copyholders. Copy holders sign, date, and return the transmittal form to confirm that they have received the documents. Document Control tracks the issuance and receipt of transmittals.

6.10.2.7 Voided, Canceled, or Superseded Documents

When notified by the generator of a controlled document that the document has been voided, canceled, or superseded, Document Control removes the document from distribution and notifies copyholders of the changed status.

The approved revised document is distributed at the time that the original document is superseded. The RMDC database is updated to identify the latest approved revision of the document. Distribution of revised documents is described in the Document Control Program procedure and using a Transmittal Form distributed by either interoffice mail or hand delivery. The holder of the controlled copy is required to acknowledge receipt by returning a signed Transmittal Form to Document Control. Document distribution is completed in accordance with the safety significance of the document being distributed.

6.10.2.8 Marking Sensitive Documents

Proper marking and handling of documents designated as classified, UCNI, or sensitive documents is in accordance with the Security Plan for the Protection of Classified Matter and any other security and privacy requirements.

6.10.2.9 Change Documents

Change documents are documents that are used to modify controlled documents. Controls are also applied to the change documents to provide revision approval and distribution controls equivalent to the original document until completion of installation, at which time the original document is revised. Documents showing the current configuration are not changed until the modifications are completed.

6.10.2.10 Revision Identification

The controlled document revision level is clearly identified on the document.

6.10.2.11 Document User Responsibilities

Responsibilities of the end user and copyholders are defined. Responsibilities include requirements for the use of controlled documents and working copies. Copyholders of controlled documents update their controlled documents each time a revision or change is sent out, and promptly return the transmittal form acknowledging receipt.

6.10.2.12 Usage and Control of Computer Codes and Data

Computer programs used in the Document Control program are controlled and maintained in accordance with the "Computing and Telecommunications Security Manual" and Information Systems procedures. These requirements provide for virus protection as well as access control to the Document Control program database and ensure continuing usability of the codes as hardware and software technology change. Routine backups of the Document Control database are performed by Documents and Records or Information Services application administrators.

6.10.2.13 Assessment

The overall effectiveness of the Document Control program is evaluated through the audit program described in Section 2.18 of the QAP. Deficiencies identified are corrected in a timely manner in accordance with the PRP.

6.10.2.14 Archiving Documents

The record copy of all revisions of controlled documents are transmitted to Records Management in accordance with the requirements of the Records Management program.

6.10.3 Organization and Administration

The Regulatory Affairs Manager is responsible for the implementation of the Records Management and Document Control programs for the life of the certification at PGDP.

6.10.3.1 Responsibilities

The Regulatory Affairs Manager is responsible for:

- Directing all activities and personnel of the Records Management and Document Control programs.
- Directing the development, implementation, and maintenance of methods and procedures encompassing a records management program.
- Directing the development, implementation, and maintenance of methods and procedures encompassing a document control program.
- Assuring that all laws, codes, standards, regulations, and company procedures pertaining to recordkeeping and document control requirements are met.

6.10.3.2 Training and Qualifications

The Records Management and Document Control Manager requires a minimum of five years experience as a supervisor or manager. No specific experience related to the control of documents or management of records is required, although previous technical or records management and document control experience is recommended.

6.10.4 Employee Training

General training in Records Management and Document Control is provided to employees as part of the general topics covered in General Employee Training (GET), as described in Section 6.6.

6.10.5 Items Addressed by Compliance Plan

Section deleted.

6.10.5.1 Statement of Noncompliance

Section deleted.

6.10.5.2 Description of RMDC Nuclear Safety Upgrade Project

Section deleted.

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6.11 PROCEDURES

In accordance with 10 CFR 76.35 (a)(7), USEC is required to describe its management controls and oversight program governing activities directly relevant to nuclear safety, safeguards, and security. This section describes that management controls program for the development, issuance, and control of procedures. Procedures that are not related to nuclear safety, safeguards, and security and do not involve or impact the plant or plant operation as described in the Certification Application or Compliance Plan are not governed by the requirements of this section.

6.11.1 Scope

In accordance with 10 CFR 76.35 (a)(7), USEC is committed to the use of approved and controlled written procedures to conduct nuclear safety, safeguards, and security activities for the protection of the public, plant employees, and the environment. The procedures program will only follow the guidance contained in the specific subsections of ANS 3.2-1994 that are noted in Appendix B along with applicable exceptions/clarifications for each subsection. USEC's commitment to these specific subsections of ANS 3.2-1994 applies only to those provisions which deal with procedures programs and not quality assurance. USEC's quality assurance commitments are described in the Quality Assurance Program description.

A balanced combination of written guidance, craftsman skills, and work site supervision help achieve the quality workmanship essential to realize the goal to conduct nuclear safety, safeguards, and security activities for the protection of the public, plant employees, and the environment. A graded approach in the review and approval of procedures is utilized to provide the necessary rigor for safe plant operation, assure the company's commitments to meeting regulations and standards are maintained, and assure a balance of effective safety with practical efficiency in plant operations.

Procedures are intended to prescribe those essential actions or steps needed to safely and consistently perform operations and maintenance activities. These elements are outlined in a procedures management writers guide, and described in implementing procedures.

6.11.2 Procedure Hierarchy

The procedure hierarchy is established in four levels. The levels are:

- Level 1 - Policy statements issued by executive management that apply to Gaseous Diffusion Plant (GDP) personnel.
- Level 2 - Standard Practice Procedures issued jointly at multiple sites (including headquarters) or an individual site or headquarters' procedure that applies to more than one organization.
- Level 3 - Procedures issued at the organization level that apply to more than one group within a larger group or organization.

- Level 4 - Procedures issued within a group or subfunction.

6.11.3 Procedure Types

The following types of procedures are used by USEC:

- Administrative Procedures: Those procedures that deal with policy or programs/administrative systems, provide programmatic requirements and do not normally involve manipulation of equipment.

- Operating (non-administrative) Procedures: Procedures that direct or cause operation/maintenance of equipment, may directly affect any physical characteristics of equipment, or describe analytical methods.

- Alarm Response Procedures (ARPs): Procedures that provide information that identifies the symptoms of the alarm, possible causes, automatic actions, the immediate operator action to be taken, and the required supplementary actions.

- Off-Normal Procedures: Procedures that describe actions to be taken during unusual or out-of-the-ordinary situations.

- Emergency Operating Procedures: Procedures directing actions necessary to mitigate potential events or events in progress that involve needed protection of on-site personnel, the public health and safety, and the environment.

6.11.4 Procedure Process

Procedures are developed or modified through a formal process incorporating the change controls described in Section 6.3. The procedure process utilizes nine basic elements to accomplish procedure development, review, approval, and control. These elements are Identification, Development, Verification, Review and Comment Resolution, Approval, Validation, Issuance, Change Control, and Periodic Review. These elements are discussed in detail in the following paragraphs.

6.11.4.1 Identification

As a minimum, a procedure is required for any task that is described in the SAR, TSRs, Quality Assurance Program, Emergency Plan, Environmental Compliance Status and Environmental Monitoring Report, Fundamental Nuclear Materials Control Plan, Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance, Security Plan for the Protection of Classified Matter, Radioactive Waste Management Plan, Depleted Uranium Management Plan, Decommissioning Funding Program Description, Supplemental Environmental Information Related to Compliance Plan or the Plan for Achieving Compliance with NRC Regulations at the Paducah Gaseous Diffusion Plant. Maintenance activities can be addressed by written procedures, documented work instructions, or drawings appropriate to the circumstances as discussed in Section 2.5 of the Quality Assurance Program, SAR Section 6.4.8, and Appendix A.6, paragraph (a), of ANS 3.2-1994.

Organization managers have the responsibility for identifying which tasks will be proceduralized within their areas of control, as required by their being identified by the criteria in the preceding paragraph and listed in Appendix A to this section. Procedures are required for operator actions necessary to prevent or mitigate the consequences of accidents described in SAR Chapter 4.

Additionally, new or revised NRC certification requirements are evaluated to determine impact on existing implementing procedures or to identify the need for new implementing procedures. Procedures are reviewed following unusual incidents to determine if changes are appropriate based on the root cause and corrective action determination for the particular incident. Procedure changes that are necessary as a result of a system modification are addressed in Section 6.3 as part of the modification control process.

A procedure is normally not needed if the work is not complex or only involves a few actions (unless failure to properly conduct those actions could result in significant consequences), if the task requires those skills normally possessed by a qualified person (otherwise known as "skill-of-the-craft" as discussed in Section 2.5.3 of the Quality Assurance Program), or if the consequences of error are minimal. This decision can only be made if a procedure does not meet any of the criteria presented in the first two paragraphs of this section.

6.11.4.2 Development

Procedure development/preparation and quality is the user organization's responsibility. Procedure development is accomplished in accordance with procedure guidance. A general description follows:

- A system is in place to track and document the procedure process.
- The approval process for the procedure is as described in Section 6.11.4.5.
- The procedure use category is determined. This determination documents the designation of a procedure as In Hand (Continuous Use), General Intent (Reference Use), or Information Use. The designation is based on the administrative or non-administrative use of the procedure, and the safety or financial consequences of failing to adhere to procedural requirements. Procedure use is discussed in more detail in Section 6.11.5.
- Input and review by affected parties. Other selected reviews will be obtained, such as Quality Assurance to ensure that quality assurance requirements are identified and included in operating procedures.
- Interviews with procedure users and process walkdowns are utilized to ensure procedures are usable, reflect as-built conditions, process operations, and maintain management controls for nuclear safety, safeguards, and security. During development, regulatory commitments, TSR, SAR, QAP, and NCSA requirements are identified and noted as commitments in the procedure.

- As the procedure is drafted, attributes that enhance procedural use are included, such as standard style organization, format, cautions, and warnings.

6.11.4.3 Verification

Verification is a process that ensures the technical accuracy of the procedure and that it can be performed as written. Nonadministrative procedures are verified by the procedure owner/user during the procedure development/change process. There are two basic attributes of the verification process. The first attribute relates to the technical accuracy of the procedure. It ensures that all technical information including formulas, set points, and acceptance criteria are correctly identified in the procedure. The second attribute is administrative, in that it verifies the procedure format and style and that it is consistent with the procedure writing guide. Verification consists of a walk-down of the procedure in the field or a table-top walk through. A standard checklist is used to ensure required attributes are included.

6.11.4.4 Reviews

Draft new procedures and procedure changes are distributed for technical reviews, and cross-discipline reviews, as needed.

Functional area and cross-discipline reviews are performed by individuals not having direct responsibility for processing the new procedure or procedure change. Comments/questions generated during the review process are resolved with the originating organizations. If comments are so extensive that resolution of the comments changes the intent of the original draft, the revised draft procedure is verified a second time, and the validation checked.

10 CFR 76.68 and intent/nonintent screenings are performed for new and changed procedures (except minor administrative changes that are processed according to the procedure process).

Reviews by plant personnel ensure that the operating limits and controls identified in the SAR and TSRs, as well as quality assurance, programmatic, and regulatory requirements, are specified in procedures.

6.11.4.5 Approval

Following the resolution of review comments, procedures are approved. Approval authority rests with the responsible manager. In addition, procedures requiring PORC review are:

1. Each new procedure required by Section 6.11.4.1.

2. Each proposed change to procedures required by Section 6.11.4.1 if:

a. the proposed change requires a written safety analysis in accordance with 10 CFR 76.68, or

b. the proposed change results in a change to the documents listed in the first paragraph of Section 6.11.4.1, or

c. the proposed change constitutes an intent change (i.e., a change in scope, method or acceptance criteria that has safety significance).

New procedures or procedure changes that do not meet these criteria do not require PORC review and can be approved by the responsible manager.

Managers ensure that necessary training is completed prior to procedure implementation (see Section 6.6).

6.11.4.6 Validation

The purpose of procedure validation is to ensure that no technical errors or human factor issues were inadvertently introduced during the procedure review process. Validation is required for all new procedures or procedure changes that require PORC review. Validation is performed by qualified personnel and may be accomplished by detailed scrutiny of the procedure as part of a walk through exercise or as part of a walk through drill (particularly for emergency or off-normal procedures). If the particular system or process is not available for a walk through validation, talk through may be performed in the particular shop or training environment. Performance of procedure validation is documented.

6.11.4.7 Issuance and Distribution

Procedures are issued and controlled in accordance with the Records Management and Document Control program practices as described in Section 6.10.

6.11.4.8 Temporary Changes

Temporary changes to procedures required by Section 6.11.4.1 can be made provided:

1. the temporary change does not require a written safety analysis in accordance with 10 CFR 76.68, and

2. the temporary change does not result in a change to the documents listed in the first paragraph of Section 6.11.4.1, and

3. the temporary change does not constitute an intent change (i.e., a change in scope, method or acceptance criteria that has safety significance), and

4. the change is approved by two members of the plant management staff, at least one of whom is the Plant Shift Superintendent, and

5. the change is documented and reviewed in accordance with SAR Section 6.11.4 within 14 days of implementation.

Temporary changes to procedures may be made permanent once the change is reviewed and approved as required by SAR Section 6.11.4.

6.11.4.9 Periodic Review

Approved procedures are periodically reviewed to ensure their continued accuracy and usefulness. Procedures are periodically reviewed according to established criteria. The periodicity of these reviews is based on procedure content as follows:

Periodic Review Cycle	Procedures to be Reviewed
1 year	Emergency Operating, Alarm Response and procedures dealing with highly hazardous chemicals as defined by the Process Safety Management (PSM) program.
3 years	Procedures not included as part of the 1-year review cycle that (1) are designated as In-Hand; or (2) involve liquid UF_6 handling activities, off-normal procedures, and nuclear material control and accountability procedures.
5 years	Procedures not included as part of the 1-year or 3-year review cycles for (1) any tasks that are described in, or implement a commitment that is described in, the Certification Application (Volumes 1 through 4) or Compliance Plan; (2) operator actions necessary to prevent or mitigate the consequences of accidents described in Chapter 4; or (3) those activities listed in Appendix A.

Procedures not included as part of the 1-year, 3-year, or 5-year review cycles are periodically reviewed as deemed necessary by the responsible manager.

When conducting the periodic review, the procedure owner/SME performs a complete administrative and technical (requirements and references) review ensuring information is complete and accurate and that the procedure is usable as written.

6.11.5 Use and Control of Procedures

In-Hand (Continuous Use) procedures are performed step-by-step without deviation unless deviation is allowed by the procedure. General Intent (Reference Use) procedures are followed as written, unless deviation is allowed by the procedure. Information Use procedures are followed to implement programmatic requirements.

Controlled copies of procedures are marked “Controlled Copy.” Working copies of procedures are marked "Working Copy," verified as the latest version, initialed, and dated prior to use.

Work is stopped, the system is immediately placed in a safe condition, and corrective actions initiated if a step of a procedure cannot be performed as written in accordance with governing site procedures.

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6.11.6 Temporary Procedures

Temporary procedures may be issued only when permanent procedures do not exist (1) to direct operations during testing, maintenance, and modifications; (2) to provide guidance in unusual situations not within the scope of permanent procedures; and (3) to ensure orderly and uniform operations for short periods when the plant, a system, or component of a system is performing in a manner not covered by existing permanent procedures, or has been modified or extended in such a manner that portions of existing procedures do not apply. These temporary procedures may be used for a period of time which should not exceed 60 days, or a period for which the temporary condition must exist, whichever is greater. Temporary procedures that need to exceed the 60 days are assessed to ensure it is appropriate to extend the use of the temporary procedure. Completed assessments are reviewed by the PORC and are documented to provide technical justification for extending the use of the procedure for an additional period of time not to exceed 60 days. These temporary procedures are subject to the same level of review and approval as required for permanent procedures.

6.11.7 Records

Records generated during procedure use are identified in the governing procedure and controlled according to the plant Records Management and Document Control program practices as described in Section 6.10.

6.11.8 Items Addressed by Compliance Plan

This section is implemented as described with exception(s) as listed below. The listing of the exception(s) also contains a brief description of what is currently in place at the plant. The Compliance Plan provides a description of the exceptions (noncompliances), a justification for continued operation, a description of the actions to be taken to achieve compliance and the schedule for completion of those actions.

6.11.8.1 Procedure Upgrades

Section deleted.

6.11.8.2 Procedures to Implement TSRs

Section deleted.

6.11.8.3 Procedure Reviews

Section deleted.

6.11.8.4 PORC Review of Procedures

The PORC will review all procedures designated as In-Hand and procedures that involve liquid UF_6 handling activities within a 5-year period after the initial Certificate of Compliance is issued. This commitment only pertains to those procedures which will not otherwise be reviewed by the PORC (as required by Section 6.11.4.1), or by a PORC subcommittee, before the expiration of the 5-year period. Procedures in this scope have been, and will continue to be, reviewed by a PORC subcommittee, thereby satisfying this commitment for those specific procedures.

Appendix A

Activities defined by SAR Section 6.11.4.1 are the minimum activities that shall be covered by written procedures. In addition, any activity described in SAR Section 6.11.4.1 and listed below shall be covered by a written procedure (except for the maintenance activities listed below which may be covered by written procedures, documented work instructions, or drawings appropriate to the circumstances). This list is not intended to be all inclusive, since many other activities carried out during gaseous diffusion plant operations will be covered by procedures not included in this list. Similarly, this listing is not intended to imply that procedures be developed with the same titles as those in the list. This listing shall provide guidance on topics to be covered rather than specific procedures.

ADMINISTRATIVE PROCEDURES:

Training
Internal audits and inspections
Investigations and reporting
Records management and document control
Changes in facilities and equipment
Modification design control (permanent and temporary)
Security and Visitor control
Quality assurance
Equipment control (lockout/tagout)
Shift turnover
Control room activities
Communications
Work control
Management control

Procedures management
Nuclear criticality safety
Fire protection
Radiation protection
Radioactive waste management
Maintenance
Environmental protection
Packaging and transportation of nuclear material
Safety analysis
Chemical safety
Operations
TSR surveillances
Calibration control
Code inspections
Preventive maintenance

Appendix A (continued)

SYSTEM PROCEDURES THAT ADDRESS STARTUP, OPERATION & SHUTDOWN:

Cascade cells

Coolant
Freezer/sublimers
Purge cascade
Electrical power

Ventilation
Datum
UF_6 leak detection

Criticality alarms
Mass spectrometers
Cell leakrates
Cell negatives

Cascade sampling

Cell treatments
Deposit monitoring
Equipment removal with deposits
Cascade shift routines and operating practices
Reduction of cascade power level
Splitting and remaking the cascade
Cylinder burping
Product withdrawal operations
UF_6 cylinder filling
UF_6 cylinder handling

Liquid UF_6 handling crane operation

UF_6 autoclave operations, feeding, heating, sampling & transfer

UF_6 material handling equipment
Decontamination operations
Uranium precipitation

Electrical switching operations
Electrical equipment inspections
Plant air
Plant nitrogen
Recirculating cooling water

Appendix A (continued)

Sanitary water
Plant water
Chemical trapping

ABNORMAL OPERATION/ALARM RESPONSE:

Debladed compressor
Cell inleakage
Loss of cooling
Loss of instrument air
Loss of electrical power
Loss of autoclave containment
Loss of criticality alarm system
Cell load alarm
Cell coolant alarm
Fires

MAINTENANCE ACTIVITIES THAT ADDRESS SYSTEM REPAIR, CALIBRATION, INSPECTION, TESTING:

Repair of UF_6 smoke detectors
Repair of UF_6 valves
Testing of criticality alarm units
Testing of cranes
Compressor seal replacement
Calibration of autoclave control systems
UF_6 cylinder valve replacement
Calibration of process indicating instruments
Chemical trap changeout
Rigging
HEPA filter maintenance
Safety system relief valve replacement
Replacement of compressor motors
Replacement of autoclave gaskets
UF_6 cylinder inspection & testing
Liquid UF_6 handling crane inspection & testing

EMERGENCY PROCEDURES:

Response to a criticality
Toxic chemical releases (including UF_6)

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Appendix B

ANS 3.2-1994 Section/Paragraph Number	USEC Exception/Clarification
5.1	USEC utilizes only the requirements of this subsection which apply to procedures, and does not commit to those quality assurance aspects described in this subsection or any other subsection of ANS 3.2-1994.
5.2	USEC utilizes the requirements of this section as described in SAR Section 6.11.
5.2.2	USEC utilizes the requirements of this section with the exception that changes shall be made in accordance with the requirements contained in Section 6.11 and TSR 3.9, as appropriate, and not Technical Specifications, the exception that the requirements contained in 10 CFR 50.54(x)[2] do not apply to the gaseous diffusion plants (GDPs), the exception that "reactor operators" are "operators" at the GDPs, and the exception that the examples in ANS 3.2-1994 Subsections 5.3.7.1 and 5.3.7.2 do not apply to the GDPs.
5.2.3	USEC utilizes the requirements of this section, with the clarification that each GDP is not considered a multi-unit site.
5.2.4	No exceptions/clarifications.
5.2.5	USEC utilizes the requirements of this section with the exception of "refueling" (which does not apply to the GDPs), and the requirement to prescribe the review and approval process in the Technical Specifications. USEC prescribes the review and approval process in Section 6.11 and TSR 3.9, as appropriate.
5.2.18/1	USEC commits only to the administrative controls, and not quality assurance program aspects described in the paragraph or the rest of ANS 3.2-1994. The administrative controls only apply to activities affecting items described in the Quality Assurance Program (QAP).
5.2.18/2	The USEC commitments relative to human factors are fully contained in Section 6.7. The reference to a review of procedures six months after the first refueling outage does not apply to the GDPs. Procedures will be reviewed after unusual incident as required by a determination of root cause and corrective action as described in Section 6.9.
5.2.18/3	This paragraph does not apply to the GDPs.

Appendix B

ANS 3.2-1994 Section/Paragraph Number	USEC Exception/Clarification
5.2.18/4	The GDPs do not utilize technical specifications, therefore the second sentence in this paragraph does not apply to the GDPs. The frequency of periodic reviews is specified in Section 6.11.4.9.
5.2.18/5	No exceptions/clarifications.
5.2.18/6	No exceptions/clarifications.
5.2.18/7	USEC commitments relative to document control are fully contained in Section 6.10.
5.2.18/8	No exceptions/clarifications.
5.2.18/9	No exceptions/clarifications.
5.2.18/10	USEC commitments relative to document control are fully contained in Section 6.10.
5.2.18/11	USEC commitments relative to document control are fully contained in Section 6.10.
5.3	USEC utilizes the requirements of this section with the exception that requirements for procedure review and approval are not performed in accordance with Technical Specifications, but in accordance with Section 6.11 and TSR 3.9, as appropriate.
5.3.1	No exceptions/clarifications.
5.3.2	No exceptions/clarifications.
5.3.3	No exceptions/clarifications.
5.3.4	USEC utilizes the requirements of this section, with the clarification that USEC commitments relative to human factors considerations are fully contained in Section 6.7.
5.3.4.1	No exceptions/clarifications.
5.3.4.2	No exceptions/clarifications.
5.3.4.3	No exceptions/clarifications.
5.3.4.4	No exceptions/clarifications.

Appendix B

ANS 3.2-1994 Section/Paragraph Number	USEC Exception/Clarification
5.3.4.5	No exceptions/clarifications.
5.3.4.6	No exceptions/clarifications.
5.3.4.7	No exceptions/clarifications.
5.3.4.8	No exceptions/clarifications.
5.3.4.9	No exceptions/clarifications.
5.3.4.10	No exceptions/clarifications.
5.3.5	No exceptions/clarifications.
5.3.6	No exceptions/clarifications.
5.3.8.1	USEC utilizes only the requirements of this subsection which apply to procedures. Note that maintenance activities are described in Section 6.4.
5.3.8.2	No exceptions/clarifications.
5.3.8.3	No exceptions/clarifications.
Appendix A.6, paragraph (a)	No exceptions/clarifications

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QUALITY ASSURANCE PROGRAM
PADUCAH GASEOUS DIFFUSION PLANT

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1. INTRODUCTION

The United States Enrichment Corporation (USEC) is required by 10 CFR 76.35(d) to submit, as part of its application for a certificate of compliance, a quality assurance program that meets the requirements of 10 CFR 76.93. USEC is required by 10 CFR 76.93 to: "establish, maintain, and execute a quality assurance program satisfying each of the applicable requirements of ASME NQA-1, 1989, "Quality Assurance Program for Nuclear Facilities," or acceptable alternatives to those requirements." Section 76.93 also states that "the Corporation shall execute the criteria in a graded approach to an extent that is commensurate with the importance to safety."

USEC's Quality Assurance Program (QAP) for the Paducah Gaseous Diffusion Plant follows and satisfies the Basic Requirements and Supplementary Requirements of ASME NQA-1, 1989 as described herein.

2. REQUIREMENTS

2.1 ORGANIZATION

The organizational relationships, responsibilities, authorities, delegations, lines of communication, position locations and qualifications, and organizational charts are described in Section 6.1 in the Safety Analysis Report (SAR) and Figure 2-2 of this program, and the following paragraphs:

Nuclear Safety and Quality

The Nuclear Safety and Quality (NS&Q) Organization performs audits, surveillance (assessments) of plant activities affecting safety, quality, and the environment, and follow-up to ensure that corrective actions have been effective. The Nuclear Safety and Quality Organization reviews selected procedures for inclusion of quality requirements, performs independent engineering assessments, and provides operational nuclear safety oversight. NS&Q also provides support functions such as vendor source verification or surveillance, receipt inspection, installation inspection, and review of procurement documents during receipt inspection.

Individual responsibilities are also identified within the various responsibility sections throughout this program.

2.2 QUALITY ASSURANCE PROGRAM

2.2.1 General

This QAP sets forth the minimum requirements for those items, activities, and services within the scope of this QAP. This QAP is established, maintained, and executed as described in this document.

Unless specifically identified within this document, USEC commits to the Basic Requirements and Supplementary Requirements of ASME NQA-1, 1989.

Those requirements of this QAP which are not fully implemented at the present time are identified in Appendix B of this document and the Plan for Achieving Compliance with NRC Regulations at the Paducah Gaseous Diffusion Plant prepared and approved by DOE.

The GDPs were constructed over 40 years ago and were operated by DOE and its predecessors under different quality assurance criteria. USEC assumed responsibility for operations in accordance with the July 1, 1993 Lease Agreement, as amended, between USEC and DOE. This QAP is submitted as part of the USEC application for a certificate of compliance and governs those activities within USEC's control and responsibility for the management, operation, maintenance, and modification of the GDPs.

USEC applies quality assurance in a graded approach commensurate with the category of the structures, systems, and components (SSC), and activities and services associated with the SSCs.

This QAP has been established to achieve the required level of safety and quality in accordance with the requirements referred to in the following sections.

2.2.2 Scope

This QAP establishes a graded, three-category quality assurance program for categorizing items and activities and to establish a level of quality in accordance with the relative importance to safety.

a. Category Q

Category Q applies to the safety systems within the boundaries described in SAR Section 3.15. QAP Sections 2.1 through 2.18 apply fully to Q items and activities.

b. Category AQ

Category AQ applies to SSCs within the boundaries described in SAR Section 3.15. This QAP applies to AQ items and activities to the extent described in Appendix A.

c. Category NS

The remaining SSCs are categorized as non-safety (NS).

d. Discussion

SSCs are categorized Q, AQ, or NS by Engineering using established procedures. Once categorized using the graded approach methodology, SSCs are placed in SAR Section 3.15. The Q and AQ systems and boundaries described in SAR Section 3.15 form the basis and identify the SSCs to which this QAP is applied. Appendix A describes the extent to which QAP Sections 2.1 through 2.18 apply to AQ items and activities. For AQ-NCS and AQ items and services, it is acceptable to apply the more conservative controls normally applied to Q items and services instead of the controls described in Appendix A. This QAP does not apply to items categorized as NS.

The requirements of this QAP apply to activities affecting the ability of Q SSCs to perform their intended Q functions. These activities include designing, purchasing, fabricating, handling, receiving, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, and modifying.

Procedures are established which ensure the requirements of this QAP are applied to Q items and activities in a graded approach. This graded approach is based on an assessment of the relative importance of an SSC to safety, taking into consideration: (1) the requirements of applicable regulations, codes, and standards; (2) the complexity or uniqueness of an item (or activity) and the environment in which it has to function, as determined by specification, design, or fabrication methods; (3) the quality history of the item in service; (4) the degree to which functional compliance may be demonstrated or assessed by testing, by inspection, and by preventive maintenance methods applied; (5) the anticipated life span of the item; (6) the degree of standardization of the item; (7) the importance of data generated; (8) reproducibility of the results; and (9) the consequence of failure.

After determining the relative importance of an SSC to safety and prior to design or procurement activities, USEC identifies and categorizes the Q function(s) to be performed by the SSC. Also, USEC identifies the design considerations and technical and quality requirements for the item, which are necessary to ensure that the Q function(s) can be performed.

The results of the application of the graded approach to quality for the Q and AQ SSCs are incorporated into specifications, procedures, instructions, drawings, and other documents which establish the requirements for item(s) or activities covered by this QAP.

The degree of independent audit given to an item or activity may also be determined on a graded approach as determined by the Nuclear Safety and Quality Manager. Consideration is given to: (1) importance to safety; (2) the previous experience or history of problem areas; (3) those activities conducted by personnel or organizations for which no previous record of past performance is available, such as past assessments or audits; and (4) information from industry problems or lessons learned.

Quality requirements to be applied to an item, process, activity, or service (as determined by the graded approach) are identified in procedures, drawings, specifications, or other appropriate documents.

2.2.3 Program Implementation

This QAP, along with associated policies, procedures, and contractual documents provide the means of communicating and documenting the program goals, objectives, requirements, and elements to all organizational levels. Refer to Figure 2-1 of this section for the hierarchy of technical documents.

This QAP is implemented through policies, procedures, instructions, specifications, drawings, procurement documents, contractual documents, and other documents. Procedures are established to ensure that these documents are consistent with the requirements of this QAP, the SAR, the Technical Safety Requirements, and regulatory requirements. These documents also provide measures which ensure that activities within the scope of this QAP are planned and accomplished under suitably controlled conditions as necessary to accomplish the goals and objectives of this QAP. The provisions contained in this QAP are applicable after the date NRC assumes regulatory oversight of the GDPs.

The terms used in this QAP are as defined in Supplement S-1 to ASME NQA-1, 1989 except the following:

The term "important to safety" is defined as follows: Those Q and AQ items and activities described in SAR Section 3.15.

The term “non-conformance” is used in the QAP as defined in Supplement S-1 to NQA-1, 1989, except that in-service equipment failure resulting from normal use, human error, or equipment end-of-life is not considered to be a hardware non-conformance.

2.2.4 Indoctrination and Training

As an alternative to Supplement 2S-1 to ASME NQA-1, 1989, for personnel performing tests other than inspection personnel (Quality Control), the training programs described in SAR Section 6.6 provide confidence that suitable proficiency is achieved and maintained in the performance of quality affecting activities defined in this QAP. Each organization manager is responsible for assuring their personnel who perform activities affecting quality receive required indoctrination and training in accordance with the requirements of Supplement 2S-4 of ASME NQA-1, 1989. Training sessions are documented as to objective, content of the session, attendees, and date of attendance.

Training records for nondestructive examiners, auditors, and inspection personnel delineate the specific activities those personnel are qualified to perform, and the criteria used to qualify personnel in each activity. Periodic requalification is provided for such personnel who are required to maintain their proficiency.

The qualification and requalification of inspection personnel is performed in accordance with the requirements of Supplement 2S-1 to ASME NQA-1, 1989. Nondestructive examination personnel are qualified and requalified in accordance with the requirements of Supplement 2S-2 of ASME NQA-1, 1989, and SNT-TC-1A, 1980 Edition, and its applicable supplements. USEC commits to the requirements of SNT-TC-1A with the following clarifications:

a. The word "should" in the following paragraphs shall be considered "shall": 4.3(1), 4.3(2), 4.3(3), 6.3, 7.1, 7.2, 8.1, 8.1.1(1), 8.1.1(2), 8.1.1(3), 8.1.1(4), 8.1.2(1), 8.1.2(2), 8.1.3(1), 8.1.3(2), 8.1.4(1), 8.1.4(2), 8.1.4(3), 8.1.5, 8.3, 8.3.1(1), 8.3.1(2), 8.3.2(3), 8.3.4, 8.4.2, 9.7.1, 9.7.3;

b. Paragraph 8.4.4 recommends a composite grade of 80% and a grade of 70% for the general, specific, and practical or the basic method, and specific examination. USEC commits to this recommendation; and

c. Paragraph 9.7.2 provides recommended re-examination criteria. USEC commits to this recommendation.

The qualification and requalification of auditors and lead auditors is performed in accordance with Supplement 2S-3 to ASME NQA-1, 1989.

2.2.5 Review and Assessment

Management of those organizations implementing this QAP, or portions thereof, shall regularly assess the adequacy of that part of the program for which they are responsible and shall assure its effective implementation in accordance with applicable procedures.

The Nuclear Safety and Quality Manager is responsible for the performance of internal and external audits in accordance with the requirements of Section 2.18 and Appendix A of this QAP. Audits determine the performance and effectiveness of activities required by this QAP and identify the need for any revision to this QAP. The results of audits are reported to responsible management as described in Section 2.18.3.6 and plant procedures.

An assessment of the status, adequacy, and effectiveness of this QAP is provided to the USEC Vice President, Operations, at least once every 24 months by the NS&Q manager. This assessment is developed from such sources as audits, self-assessments, trend data, status reports, etc.

2.3 DESIGN CONTROL

2.3.1 General

A design control system is established for Q items and related activities and services within the scope of this QAP as identified in Section 2.2. This system is in accordance with ASME NQA-1, 1989, Basic Requirement 3, and Supplement 3S-1. These requirements and controls ensure that new design and design change activities are carried out in a planned, controlled, and orderly manner, and that design requirements such as design bases, regulatory requirements and appropriate quality standards are correctly translated into design output, procurement, and procedural documents. These controls also establish provisions for verifying or checking the technical adequacy of design documents including computer codes. They also provide for the control of design changes. The design control provisions contained in this QAP are applicable to design activities taking place after the date NRC assumes regulatory oversight for the plant. Reconstitution of the design is not required; however if a deviation to the design is discovered, engineering shall resolve the deviation and as-built the drawings if necessary.

2.3.2 Responsibilities

The Engineering Manager is the plant design authority having responsibility for the implementation and execution of the design control system in accordance with the requirements of this section.

Design changes and new designs are authorized by responsible management and are reviewed (as described in SAR Section 6.2) by the Plant Operations Review Committee (PORC) prior to implementation in accordance with the provisions of 10 CFR 76.68. Management is responsible for ensuring that completed plant changes are tested and for assuring that personnel affected by the change are adequately trained as described in procedures.

2.3.3 Requirements

2.3.3.1 Design Inputs

Procedures for design input activities are established to ensure the following:

1. Design inputs, such as approach to design bases, performance requirements, regulatory requirements, codes, and standards, are identified and documented, and their selection reviewed and approved by the responsible design organization;

2. Design inputs are specified and approved on a timely basis and to the level of detail necessary to permit the design activity to be carried out in a correct manner and to provide a consistent basis for making design decisions, accomplishing design verification measures, and evaluating design changes; and

3. Changes from approved design inputs, including the reason for the changes, are identified, approved, documented, and controlled.

2.3.3.2 Design Process

Procedures are established to ensure the following:

1. Design activities are planned on a timely basis and to the level of detail necessary to permit the design process to be carried out in a correct manner and to permit verification that the design meets requirements. Design inputs are correctly translated into design documents. Design documents shall be adequate to support facility design, construction, and operation;

2. Appropriate quality standards are identified and documented and their selection reviewed, approved, and controlled. Changes from specified quality standards and reasons for the changes shall be identified, approved, documented, and controlled;

3. Design methods, materials, parts, equipment, and processes that are essential to the function of the SSC are selected and reviewed for suitability of application;

4. Applicable information derived from experience, as set forth in reports or other documentation, shall be made available to cognizant design personnel; and

5. Final design output documents including changes thereto:

   a. Are relatable to the design input by documentation in sufficient detail to permit design verification,

   b. Identify assemblies and/or components that are part of the item being designed. When such an assembly or component part is a commercial grade item, the requirements of Section 2.7.3.9 are also applied. Also, when a commercial grade item, prior to its installation, is modified or selected by special inspection and/or testing to requirements that are more restrictive than the supplier's published product description, the component part is represented as different than the commercial grade item in a manner traceable to a documented definition of the difference.

2.3.3.3 Design Analyses

Procedures for design analyses activities are established to ensure the following:

1. Design analyses are performed in a planned, controlled, and documented manner;

2. Design analyses documents are legible and in a form suitable for reproduction, filing, and retrieval;

3. Design analyses documents contain sufficient detail as to the purpose, method, assumptions, design input, references, and units such that a person technically qualified in the subject can review and understand the analyses and verify the adequacy of the results without recourse to the originator;

4. Calculations are identifiable by subject, originator, reviewer, and date or by other data such that the calculations are retrievable;

5. When computer programs are utilized for design analyses, the requirements of Section 3.1(a) of Supplement 3 S-1 of ASME NQA-1, 1989 are applied; and

6. Design analyses documents include the requirements of Section 3.1(b) of ASME NQA-1, 1989 Supplement 3 S-1.

2.3.3.4 Design Verification

Procedures for design verification activities are established to ensure the following:

1. Design verification is performed by competent individual(s) or group(s) other than those who performed the original design. The results of design verification, including the particular methods used, shall be clearly documented with the identification of the verifier clearly indicated;

2. Verifiers are knowledgeable in the areas to be verified. The verifier may be a supervisor, provided the supervisor was not directly responsible for the design (i.e., did not specify a singular design approach or rule out certain design considerations and did not establish the design inputs used in the design) or provided the supervisor is the only individual in the organization competent to perform the verification. Cursory supervisory reviews do not satisfy the intent of this verification;

3. Verification shall be performed in a timely manner. Design verification for the level of design activity accomplished shall be performed prior to release for procurement, manufacture, construction, or release to another organization for use in other design activities except in those cases where this timing cannot be met, such as when insufficient data exist. In those cases, the unverified portion of the design shall be identified and controlled. In all cases, the design verification shall be completed prior to relying upon the component, system, structure, or computer program to perform its function;

4. The extent of the design verification is a function of the importance to safety, the complexity of the design, the degree of standardization, the state of the art, past performance, and similarity with previously proven designs. Where the design has been subjected to a verification process in accordance with this QAP, the verification process need not be duplicated for identical designs. However, the applicability of standardized or previously proven designs, with respect to meeting pertinent design inputs, shall be verified for each application. Known problems affecting the standard or previously proven designs and their effects on other features shall be considered. The original

design and associated verification measures shall be adequately documented and referenced in the files of subsequent application of the design. Where changes to previously verified designs are made, design verification is performed for the changes, including an evaluation of the effects of the changes on the overall design and on any design analysis for which the design is based that are affected by the change to previously verified design; and

5. Acceptable methods of design verification are identified which include, but are not limited to, any one or a combination of the following: design reviews, alternate calculations, and qualification testing in accordance with Supplement 3S-1, Sections 4.2.1, 4.2.2, and 4.2.3 of NQA-1, 1989. Procedures identify the criteria for determining the method of design verification. Verification by testing shall demonstrate adequacy of performance under conditions that simulate the most adverse design conditions. Verification of computer programs includes appropriate testing in accordance with the requirements of Section 2.11.3.2.

2.3.3.5 Design Changes

Procedures for design change control are established to ensure the following:

1. Changes to final designs, field changes, modifications, and nonconforming items dispositioned "use-as-is" or "repair" are justified, documented, and evaluated against criteria established by the Engineering Manager;

2. Design documents, including changes thereto, are controlled in accordance with Section 5 of Supplement 3 S-1 to NQA-1, 1989 and Section 2.6 of this QAP. When a significant design change is found to be necessary because of an incorrect design, the design process and verification procedure are reviewed and modified as necessary; and

3. Changes to the plant are evaluated and processed in accordance with the provisions of 10 CFR 76.68.

2.3.3.6 Design Interfaces

Procedures for design interface control are established to ensure the following:

1. Internal and external design interfaces are identified and controlled and design efforts are coordinated among participating organizations;

2. The responsibilities for the preparation, review, approval, release, distribution, and revision of documents involving design interfaces are defined; and

3. Design information transmitted across interfaces is documented and controlled in accordance with Supplement 3S-1, Section 6 of NQA-1, 1989.

2.3.3.7 Design Documentation and Records

Design documentation and records that provide evidence that the design and design verification processes were performed in accordance with this section are collected, stored, and maintained in accordance with Supplement 3S-1, Section 7 of NQA-1, 1989, and Section 2.17 of this QAP.

2.4 PROCUREMENT DOCUMENT CONTROL

2.4.1 General

A procurement document control system is established for Q items and related activities and services within the scope of this QAP as identified in Section 2.2. The procurement document control system is in accordance with ASME NQA-1, 1989, Basic Requirement 4, and Supplement 4S-1. The procurement document control system ensures that applicable regulatory requirements, technical requirements, and QAP requirements are included or referenced in procurement documents for the procurement of items and services. This system also establishes provisions for the preparation, review, approval, and control of procurement documents, including changes thereto.

2.4.2 Responsibilities

The Engineering Manager is responsible for the preparation and maintenance of design specifications (including specifications for spare and replacement parts) and for identifying the technical and quality requirements necessary to ensure item acceptability. These specifications are subject to the requirements of Section 2.3 of this QAP. The Engineering Manager is also responsible for development of procedures that define these activities, including the criteria for developing the necessary technical and quality requirements for procurement.

The GDP Procurement and Materials Manager is responsible for procurement planning, bid evaluation, and procurement of items and services from suppliers on the approved suppliers list, when required.

2.4.3 Requirements

The requirements of Section 2.4.3.1 apply only to non-commercial grade items and services. Sections 2.4.3.2 and 2.4.3.3 apply to both commercial grade and non-commercial grade items and services.

2.4.3.1 Procurement Document Contents

Procedures governing procurement document content are established to ensure the following:

1. Procurement documents shall contain a statement of work for procurement of services, or an engineering specification for the procurement of items.

2. Procurement documents shall include technical requirements by specific reference to, (or inclusion there in of applicable parts of) drawings, specifications, codes, standards, regulations, procedures, or instructions, including revisions thereto, which describe the items or services to be furnished.

3. Procurement documents shall specify special instructions and requirements for designing, fabricating, cleaning, erecting, packaging, shipping, handling, storing, testing, inspecting, and accepting.

4. Procurement documents shall require the supplier have a documented quality assurance program that implements portions or all of the Basic Requirements of ASME NQA-1, 1989. The extent of the program required is dependent upon the type and use of the item or service being procured and its importance to safety.

5. Procurement documents shall require that the supplier incorporate applicable QA program requirements in the supplier's sub-tier procurement document. The extent of the program required is dependent upon the type and use of the item or service being procured and its importance to safety.

6. Procurement documents shall include a requirement for access to the supplier's facilities and records, for inspection or audit by the purchaser, its designed representative, and/or other authorized parties.

7. Procurement documents shall require suppliers of non-commercial grade items and services to evaluate their lower-tier suppliers that supply Q items or services within the scope of the Statement of Work or Engineering Specification.

8. Procurement documents shall identify the documentation required to be submitted for information, review, or approval as well as the time of submittal, where applicable.

9. When the purchaser requires the supplier to maintain specific quality assurance records, the procurement documents shall identify retention times, and disposition of those records.

10. Procurement documents shall specify the requirements for reporting and obtaining disposition of nonconforming items and services, as appropriate.

11. Procurement documents shall require the identification of appropriate spare and replacement parts or assemblies including associated technical and quality requirements as appropriate. Quality and technical requirements, equal to or better than the original requirements, are provided for ordering replacement parts or assemblies.

2.4.3.2 Procurement Document Review

Procedures for the review of procurement documents are established to ensure the following review are completed:

1. Documents transmitted to the supplier(s) include appropriate provisions to assure that items or services will meet the quality, technical, and administrative requirements discussed in Section 2.4.3.1.

2. Reviews are documented to provide objective evidence of satisfactory accomplishment prior to contract award.

3. Changes made as a result of the bid evaluation or precontract negotiations are incorporated into procurement documents prior to contract award. This review shall ensure the requirements of Section 3 of Supplement 4S-1 to ASME NQA-1, 1989 are satisfied.

4. The reviews and approvals required by this section are performed by personnel who have access to pertinent information and who have an adequate understanding of the requirements and the procurement documents.

2.4.3.3 Procurement Document Changes

Procedures ensure that procurement document changes are subject to the same degree of control as utilized for the preparation of the original procurement document.

2.5 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

2.5.1 General

The requirements for instructions, procedures, and drawings are applied to Q items and related activities and services within the scope of this QAP as described in Section 2.2, are in accordance with ASME NQA-1, 1989, Basic Requirement 5, and this section. Measures are in place to ensure that activities affecting quality are prescribed by documented procedures, drawings, and instructions, appropriate to the circumstances, and are accomplished in accordance with these documents. These documents also include quantitative and qualitative acceptance criteria to ensure that important operations have been satisfactorily accomplished.

2.5.2 Responsibilities

Text deleted.

The Regulatory Affairs Manager is responsible for the system of preparation, review, approval and use of procedures and instructions in accordance with the requirements of this section of this QAP. (PGDP)

The Engineering Manager is responsible for the system of preparation, review, and approval of drawings in accordance with the requirements of this section and Section 2.3 of this QAP.

Organization/Group Managers are responsible for developing and approving procedures which control functions or activities within their area of responsibility, as defined within this QAP.

All personnel are required to use and adhere to the requirements of applicable procedures, instructions, and drawings for activities within the scope of this QAP.

2.5.3 Requirements

Procedures are established to ensure the following:

1. Q activities affecting safety or quality are prescribed and performed in accordance with documented work instructions, procedures, or drawings of a type appropriate to the circumstances as described in governing procedures. These documents include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities are satisfactorily performed.

2. Activities that require skills normally possessed by qualified personnel do not require detailed step-by-step delineation in a procedure but are performed in accordance with work instructions, procedures, or drawings of a type appropriate to the circumstances for the control of maintenance and modification work. The types of activities otherwise known as "skill-of-the-craft" that do not require detailed step-by-step procedures include but are not limited to: gasket replacement; trouble shooting electrical circuits; changing chart or drive speed gears or slide wires on recorders; seal replacement on small pumps; torquing of flanged covers, pipe connections, etc.; lapping and packing of manual-operated valves, erection of nonpermanent structures such as scaffolding; and rigging of chains, hoists, and slings.

3. Written procedures shall be prepared, reviewed, approved, implemented, and maintained in accordance with the Technical Safety Requirements (TSRs) and SAR Section 6.11.

2.6 DOCUMENT CONTROL

2.6.1 General

A document control system is established for Q items and related activities and services within the scope of the QAP as described in Section 2.2. The document control system is in accordance with ASME NQA-1, 1989, Basic Requirement 6, and Supplement 6S-1. This system ensures that documents defining the performance of quality-related activities are controlled so only current and correct information is available at the location where the activity is performed prior to commencing the work.

2.6.2 Responsibilities

The Regulatory Affairs Manager has the overall responsibility for the development and implementation of the document control system.

Organization Managers are responsible for (1) identifying documents to be included in the controlled document system; (2) ensuring instructions, procedures, drawings, and other specified documents are reviewed for adequacy and approved for release; (3) complying with document distribution requirements; and (4) ensuring these documents are maintained and used by personnel performing the prescribed activity.

2.6.3 Requirements

Procedures for the control of document preparation, review, approval, and issuance are established to ensure the following:

1. Identification of documents to be controlled and their specified distribution.

2. Identification of assignments of responsibility for preparing, reviewing, approving, and issuing documents.

3. Review of documents for adequacy, completeness, and correctness prior to approval and issuance.

4. Drawings depicting as-built conditions, including changes thereto, and related documentation are prepared in a timely manner and accurately reflect the actual design.

5. Document controls used to specify the current revision and any changes to instructions, procedures, specifications, drawings, and procurement documents are identified. This document control system has provisions for updating and for distribution to predetermined personnel.

6. Except for minor changes, changes to documents are reviewed and approved by the same organization that performed the initial review and approval or delegated to other qualified organizations. The reviewing organization has access to pertinent background data or information upon which to base their approval.

7. Minor changes to documents, such as inconsequential editorial corrections do not require that the revised documents receive the same review and approval as the original documents. The review and approval for minor changes is specified in procedures.

8. Obsolete or superseded documents are removed and/or replaced in a timely manner.

2.7 CONTROL OF PURCHASED ITEMS AND SERVICES

2.7.1 General

A system for the control of purchased items and services is established for Q items and services within the scope of this QAP as described in Section 2.2. The requirements for the control of purchased items and services are in accordance with Basic Requirement 7 and Supplement 7S-1 of ASME NQA-1, 1989.

2.7.2 Responsibilities

The Nuclear Safety and Quality Manager, as designated by the Vice President, Operations, is responsible for providing the necessary QA functions to support procurement. These QA functions include review of supplier quality documentation, evaluation of supplier's QA capability, supplier audits and annual evaluations, and for the development and maintenance of an approved suppliers list. The Nuclear Safety and Quality Manager provides support functions such as source verification or surveillance, receipt inspections, installation inspections, and review of procurement documents during receipt inspections. The Nuclear Safety and Quality Manager is also responsible for developing and implementing procedures which meet the requirements of this section of the QAP.

The engineering manager is responsible for assisting the Nuclear Safety and Quality Manager by performing evaluations of supplier technical capabilities. The engineering manager is also responsible for determining the methods of acceptance to be applied to purchased items and services. The engineering manager is also responsible for the approval of dispositions and technical evaluations for supplier-generated nonconformances for items and services. The engineering manager is also responsible for providing measures which ensure the proper selection, application, methods of acceptance, and use of items.

The GDP Procurement and Materials Manager is responsible for procurement planning, bid evaluation, and procurement of items and services from suppliers on the approved suppliers list, when required.

2.7.3 Requirements

Sections 2.7.3.1 through 2.7.3.8 apply to noncommercial grade items and noncommercial grade services. The requirements of Section 2.7.3.9 are acceptable alternatives to Sections 2.7.3.1 through 2.7.3.8 for commercial grade items. The requirements of Section 2.7.3.10 are acceptable alternatives to Sections 2.7.3.1 through 2.7.3.8 for commercial grade services.

2.7.3.1 Procurement Planning

Procedures are established to ensure the following:

1. Procurement activities are planned and documented to assure a systematic approach to the procurement process.

2. Procurement planning results in the documented identification of procurement methods and organizational responsibilities.

3. Planning activities meet the requirements of Section 2 of Supplement 7S-1 to ASME NQA-1, 1989.

2.7.3.2 Supplier Selection

Procedures are established for the selection of suppliers. The selection of suppliers is based upon evaluation of the supplier’s capability to provide items or services in accordance with the requirements of the procurement documents prior to award of contract. An assessment of the potential supplier’s technical and quality capability is performed and documented in accordance with one or more of the following:

1. Evaluation of the supplier's history of providing an identical or similar product which performs satisfactorily in actual use. The supplier’s history shall reflect current capability.

2. The supplier's current quality records are supported by documented qualitative and quantitative information which can be objectively evaluated.

3. The supplier's technical and quality capability is determined by a direct evaluation of his facility and personnel and the implementation of the supplier's quality assurance program. As an alternative to supplier quality assurance programs satisfying the applicable criteria of ASME NQA-1, 1989, supplier quality assurance programs that satisfy the applicable criteria of 10 CFR 50, Appendix B, are acceptable.

4. USEC reviews and approves the audit results of recognized industry shared supplier audits, (i.e., third party audits such as the Nuclear Industry Assessment Committee (NIAC), etc.). The review ensures that the requirements of 2.7.3.2.3 above have been met.

5. The supplier has an applicable valid "Certificate of Accreditation" issued by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). When using this method, an implementation audit shall be performed in accordance with 2.18.3.2.5.

6. The supplier implements an NRC accepted quality assurance program. When using this method, an implementation audit shall be performed in accordance with 2.18.3.2.5.

7. The supplier maintains a valid ASME Code certification for the item or service being provided. When using this method, an implementation audit shall be performed in accordance with Section 2.18.3.2.5.

Upon an acceptable evaluation using any of the above methods, the supplier may be placed on the Approved Suppliers List (ASL).

2.7.3.3 Bid Evaluation

Procedures are established which provide measures for the performance of bid evaluations. These procedures ensure the requirements of Section 4 of Supplement 7S-1 to ASME NQA-1, 1989 are met prior to award of the contract.

2.7.3.4 Supplier Evaluation

Procedures governing interface with the supplier are established and conducted as early as practicable which provide measures to verify the supplier's performance. The purchaser's verification activities, however, shall not relieve the supplier of his responsibilities for verification of quality achievement. The measures include:

1. Establishing an adequate understanding between Purchaser and Supplier of the provisions and specifications of the procurement documents.

2. Requirements for the supplier to identify the methods and processes to be used by the supplier in fulfilling the requirements of the procurement.

3. Reviewing the supplier documents generated or processed during activities fulfilling procurement requirements.

4. Identifying and processing necessary change information.

5. Establishing methods for exchange of information with the supplier.

6. Establishing the extent of source surveillance and inspection activities.

The above verification activities are based on the importance to safety, complexity, and quantity of the items or services provided and are performed by personnel assigned to check, inspect, audit, or witness the activities of the supplier. These personnel meet the qualification requirements of Section(s) 2.10 or 2.18 of this program. Activities performed to verify conformance to requirements of procurement documents such as source surveillance and inspections, surveys, audits, receiving inspections, nonconformances, dispositions, and corrective actions are documented and/or recorded in accordance with procedures.

2.7.3.5 Control of Supplier Documents and Changes to Procurement Documents

Procedures are established to determine the acceptability of supplier-generated documents. These measures assure that submittal of these documents is accomplished as required by the procurement documents. These procedures provide measures for the acquisition, processing, and recorded evaluation of technical, inspection, and test data against acceptance criteria. Procedures also are established for the control and documentation of changes to procurement documents. The requirements of Section 2.4.3 are followed when changes to procurement documents are made.

2.7.3.6 Methods of Acceptance for Items

Procedures are established which govern the acceptance of items. Prior to offering the item for acceptance, the supplier shall verify that the item being furnished complies with the procurement requirements. Where required by code, regulation, or contract requirement, documentary evidence that items conform to procurement documents shall be available at the facility site prior to installation or use. Any one or more of the following methods of acceptance are used:

1. **Certificate of Conformance -** When this method is utilized, the following minimum criteria are met:

   a. The certificate identifies the purchased material or equipment.

b. The certificate identifies the specific procurement requirements met. The procurement requirements identified shall include any approved changes, waivers, or deviations applicable to the subject material or equipment.

c. The certificate identifies any procurement requirements that were not met, together with an explanation and means of resolving the nonconformance.

d. The certificate is authenticated by the person responsible for the quality assurance function and whose function and position is described in the purchaser's or supplier's quality assurance program.

e. The procedures used for the preparation, review, and approval of the certificate are described in the purchaser's or supplier's quality assurance program.

f. The validity of the supplier's certificates and effectiveness of certification system is verified and the interval of verification is based on the supplier's past quality performance.

2. **Source Verification -** When this method is utilized, it is performed at intervals consistent with the importance to safety and complexity of the item or service and it shall be implemented to monitor, witness, or observe activities. This method provides plans to perform inspections, examinations, or tests at predetermined points. Upon purchaser acceptance of source verification, documented evidence of acceptance shall be furnished to the receiving destination of the item, to the purchaser, and to the supplier.

3. **Receiving Inspection -** This method is utilized for all purchased items to verify conformance to procurement documents. This method verifies by objective evidence such features as proper configuration; identification; dimensional, physical, or other characteristics; freedom of damage from shipping; cleanness; and review of supplier documentation when procurement documents require the documentation to be furnished. Upon completion of receipt inspection, acceptable items are released for storage or issued for installation or use. Items determined to be nonconforming after completion of the receipt inspection are documented and processed as described in Section 2.15.

4. **Post-Installation Testing -** When this method is utilized for acceptance of non-commercial grade items, post-installation test requirements and acceptance documentation are established by the purchaser and supplier.

2.7.3.7 Acceptance of Services

Prior to offering the service for acceptance, the supplier shall verify that the service being furnished complies with the procurement requirements. Procedures allow for the acceptance of services by one or more of the following methods:

1. Technical verification of data produced.

2. Surveillance and/or audit of the activity.

3. Review of objective evidence for conformance to procurement document requirements.

2.7.3.8 Control of Supplier Nonconformances

Procedures are established to provide methods for disposition of nonconforming items and services that do not meet procurement documentation requirements. These procedures contain provisions for the following:

1. Evaluation of nonconforming items.

2. Submittal of nonconformance notice to the purchaser by the supplier. The submittal includes a recommended disposition and technical justification. The following nonconformances are submitted to the purchaser for approval of the recommended disposition:

    a. Violation of technical or material requirement.

    b. Violation of requirement of purchaser-approved supplier document.

    c. Nonconformances which cannot be corrected by continuation of the manufacturing process or by rework.

    d. Items that do not conform to the original requirements even though the item can be restored to a condition such that the capability of the item to function is unimpaired.

3. Purchaser disposition of the supplier recommendation.

4. Verification of the implementation of the disposition.

5. Maintenance of records of supplier submitted nonconformances.

2.7.3.9 Commercial Grade Items

Procedures are established governing the application and use of commercial grade items:

1. Methods for determining whether an item can be purchased as commercial grade and dedicated for use in a Q application. A commercial grade item is an item satisfying all of the following:

    a. Not subject to design or specification requirements that are unique to nuclear facilities.

b. Used in applications other than nuclear facilities.

c. Is to be ordered from the manufacturer/supplier on the basis of a specification set forth in the manufacturer's published product description (e.g., catalog).

2. The criteria and methods for identifying the critical characteristics that are essential to ensure that the item will perform its intended Q function.

3. The criteria for determining the type and depth of product acceptance and the criteria for determining the point of dedication at which time USEC assumes the responsibility for reportability. Dedication of a commercial grade item occurs after receipt when that item is designated for use in a Q application.

4. As a minimum for acceptance of commercial grade items, receipt inspection, as described in Section 2.7.3.9.9, will be performed to provide reasonable assurance that the item received is the item ordered. If designated by Engineering, based on the complexity of the item or its importance to safety, one or more of the following may also be used.

a. Special test or inspection

b. Commercial grade survey of supplier

c. Source verification

d. Acceptable supplier and item performance record

5. The selection of the method or combination of methods in 4. above is based on the following:

a. Selected critical characteristics

b. Available supplier information

c. Quality history

d. Degree of standardization

e. Importance to safety and complexity of the item

6. Alternate commercial grade items are allowed provided the Engineering Manager provides verification that the alternate commercial grade item will perform its intended Q function.

7. Source evaluation and selection, where determined necessary by Engineering, is based on the complexity and importance to safety and shall be in accordance with the requirements of Section 3.1 of the Supplement 7S-1 of ASME NQA-1, 1989.

8. Commercial grade items are identified in the contract or purchase order by the manufacturer's published product description.

9. Receipt inspections are performed to determine that damage was not sustained during shipment, that the item received is the item ordered, that inspection and testing was performed by the supplier as required by Engineering, to ensure conformance with manufacturer's published requirements and to ensure that required documentation is received and is acceptable.

2.7.3.10 Commercial Grade Services

1. Methods for determining whether a service can be purchased as commercial grade and dedicated for use in a Q application are established and implemented. A commercial grade service is a service satisfying all of the following:

   a. Not subject to design or specification requirements that are unique to nuclear facilities,

   b. Used in applications other than nuclear facilities, and

   c. Is to be ordered from the supplier on the basis of a specification set forth in the service provider’s published service description or other appropriate documents.

2. The criteria and methods for identifying the critical characteristics (critical controls) for acceptance are established. The critical characteristics (critical controls), which once selected to be verified, provide reasonable assurance that the service provided meets specified requirements.

3. In selecting the critical controls, the impact of the activities associated with the service on the safety function of plant equipment is considered.

4. Acceptance reviews will be performed, as a minimum, in accordance with Section 2.7.3.10.10 for acceptance of commercial grade services to provide reasonable assurance that the service performed is the service ordered. If designated by Engineering, based on the complexity of the service or its importance to safety, one or more of the following may also be used for acceptance in addition to the acceptance review:

a. Special tests and inspections

b. Commercial grade survey

c. Source verification

d. Acceptable supplier service performance history for the service.

5. The selection of the method or combination of methods in Section 2.7.3.10.4 above is based on the following:

a. Selected critical controls

b. Available supplier information

c. Quality history

d. Degree of standardization of the service

e. Importance to safety and complexity of the service.

6. Dedication of a commercial grade service occurs when that service is accepted in accordance with 2.7.3.10.4 above.

7. Source evaluation and selection, where deemed necessary by engineering based on complexity and importance to safety, is in accordance with the requirements of Section 2.7.3.2.

8. Procurement documents are issued and controlled in accordance with the requirements of Sections 2.4.3.2 and 2.4.3.3 of this QAP.

9. Commercial grade services are identified in the purchase order by the service provider's published service description (e.g., Supplier's bulletin describing standard calibration services that are provided by the supplier) or other appropriate documents.

10. Acceptance reviews are performed to determine the service performed is the service ordered and that required documentation is received and is acceptable.

2.8 IDENTIFICATION AND CONTROL OF ITEMS

2.8.1 General

A system is established for the identification and control of Q items within the scope of the QAP as described in Section 2.2. The requirements for the identification and control of such items are in accordance with Basic Requirement 8 and Supplement 8S-1 of ASME NQA-1, 1989. This system establishes the requirements for the identification and control of such items and associated materials, consumables, parts, spare parts, components, and sub-assemblies.

2.8.2 Responsibilities

The Engineering Manager is responsible for specifying requirements for identification methods, traceability, shelf life, and operating life of items when required by codes, standards, or specifications. Engineering specifies these requirements during the generation of specifications, drawings, procurement documents, or other documents appropriate to the circumstances.

The Nuclear Safety and Quality Manager is responsible for verifying that items are correctly identified through receipt inspection.

Organization Managers are responsible for maintaining and implementing identification, traceability, and shelf life and operating life requirements for items under their jurisdiction.

The GDP Procurement and Materials Manager is responsible for receipt, delivery, storage, traceability, identification, and control of materials.

2.8.3 Requirements

2.8.3.1 Identification of Items

Procedures are established to ensure that items are identified from initial receipt and fabrication of the items up to and including installation and use to assure that only correct and accepted items are used or installed as required by applicable codes, standards, or specifications. Identification shall relate an item to an applicable design or other pertinent specifying document. Physical identification shall be used to the maximum extent possible. Where physical identification to control the item is either impractical or insufficient, physical separation, procedural controls, or other means are employed. When markings are used, measures are established to ensure that the markings are clear, legible and do not have a detrimental effect on the function or service life of the item. Markings are transferred to each part of an identified item when subdividing and are not to be obliterated or hidden by surface treatments or coatings unless other means of identification are provided.

2.8.3.2 Traceability of Items

Procedures are established for the traceability of items, when specified by codes, standards or specifications.

2.8.3.3 Limited Life Items

Procedures are established to ensure that items which have a limited operating life or shelf-life are identified and controlled to preclude use of items whose operating life or shelf-life has expired. These procedures also establish the requirements for the identification and control of items such as chemicals and reagents.

2.8.3.4 Maintaining Identification of Stored Items

Procedures are established for the control of item identification consistent with the planned duration and conditions of storage such as (1) provisions for maintenance or replacement of markings and identification records due to damage during handling or aging, (2) protection of identifications on items subject to excessive deterioration due to environmental exposure, and (3) provision of updating existing plant records.

2.9 CONTROL OF PROCESSES

2.9.1 General

A system to control processes that affect the quality of items or services is established for Q items and related services within the scope of this QAP as described in Section 2.2. The requirements for the control of special processes are in accordance with Basic Requirement 9, and Supplement 9S-1 of ASME NQA-1, 1989. This system establishes the requirements for the control of special processes used in the course of maintenance, modification, and testing activities.

2.9.2 Responsibilities

The Engineering Manager is responsible for determining special processes, providing technical requirements for identified special processes, and reviewing and concurring with all special process procedures including the utilization and application of nondestructive examination (NDE) procedures. These responsibilities are met in accordance with the requirements of this section of the QAP.

The Nuclear Safety and Quality Manager is responsible for the qualification of NDE personnel, including welder/brazer qualifications, in accordance with the requirements of this section of the QAP.

Organization/Group Managers ensure that identified special processes are performed by qualified personnel, using qualified and approved procedures or documents of a type appropriate to the circumstances.

2.9.3 Requirements

2.9.3.1 Procedures are Established to Ensure the Following:

1. Special processes that control or verify quality, such as those used in welding, heat treating, and nondestructive examination, are performed by qualified personnel using qualified procedures in accordance with specified requirements;

2. Shall assure that process parameters are controlled and that specified environmental conditions are maintained;

3. Training, testing, qualification, and certification requirements for personnel who perform or inspect special process operations (nondestructive examination personnel qualifications are described in Section 2.2.4 of this document); qualification of equipment and procedures used for special processes; documentation of process results, procedures, personnel qualification and certification; and equipment qualifications;

4. Conditions necessary for accomplishment of the process shall be included in procedures or instructions. These conditions shall include proper equipment, controlled parameters of the process, and calibration requirements; and

5. For special processes not covered by existing codes and standards or where quality requirements specified for an item exceed those of existing codes or standards, the necessary requirements for qualifications of personnel, procedures, or equipment shall be specified or referenced in the procedures or instructions.

2.9.3.2 Acceptance Criteria

Procedures are established to ensure that special process procedures include or reference the requirements of applicable codes and standards, including acceptance criteria for the process.

2.9.3.3 Records

Procedures are established to ensure that qualification records of procedures, equipment, and personnel associated with special processes are maintained, filed, and kept current in accordance with the requirements of Section 2.17.

2.10 INSPECTION

2.10.1 General

A system for inspection is established for Q items which are within the scope of this QAP as identified in Section 2.2. The requirements for inspection are in accordance with Basic Requirement 10, and Supplement 10S-1 of ASME NQA-1, 1989. This system provides measures to ensure that maintenance, repair or modification work is completed satisfactorily.

2.10.2 Responsibilities

The Nuclear Safety and Quality Manager is responsible for inspection planning, for ensuring inspections are performed, and for utilizing qualified and certified inspection personnel.

The Engineering Manager is responsible for specifying "hold" and "witness" points for inclusion in applicable work control documents. Such work control documents are developed from approved design documents, which specify the criteria for acceptance of the work.

Management establishes measures to ensure that the requirements of this section of the QAP are met.

2.10.3 Requirements

Procedures are established for governing the inspection of items and activities to ensure the following:

1. Inspections required to verify conformance of an item or activity to specified requirements shall be planned and executed.

2. Characteristics to be inspected and inspection methods to be employed shall be specified.

3. Inspection results shall be documented and shall contain information in 2.10.3.16.

4. Inspection personnel shall not report directly to the immediate supervisors who are responsible for performing the work being inspected.

5. Each person who verifies conformance of work activities for purpose of acceptance is qualified to perform the assigned inspection task in accordance with Section 2.2.4. Inspections by persons during on-the-job training for qualification shall be performed under the direct observation and supervision of a qualified person and verification of conformance shall be by the qualified person until certification is achieved.

6. If mandatory inspection hold points are required beyond which work shall not proceed without the specific consent of the designated representative, the specific hold points shall be indicated in appropriate documents. Consent to waive specified hold points shall be recorded prior to continuation of work beyond the designated hold point.

7. Planning for inspection activities shall be accomplished and documented. The documentation shall identify characteristics, methods, and acceptance criteria and provide for recording objective evidence of inspection results.

8. Where a sample is used to verify acceptability of a group of items, the sampling procedure shall be based on recognized standard practices.

9. Inspection of items in-process or under construction shall be performed for work activities where necessary to verify quality.

10. A combination of inspection and process monitoring methods, when used, shall be performed in a systematic manner to assure that the specified requirements for control of the process and quality of the item are being achieved throughout the duration of the process. Controls, where required, shall be established and documented for the coordination and sequencing of these activities at established inspection points during successive stages of the conducted process or construction.

11. Final inspection shall include the following:

    a. Final inspections shall include a records review of the results and resolution of nonconformances identified by prior inspections. The final inspection shall be planned to arrive at a conclusion regarding conformance of the item to specified requirements.

    b. Completed items shall be inspected for completeness, markings, calibrations, adjustments, protection from damage, or other characteristics as required to verify the quality and conformance of the item to specified requirements. Quality records shall be examined for adequacy and completeness if not previously examined.

    c. The acceptance of the item shall be documented and approved by authorized personnel.

    d. Modifications, repairs, or replacement of items performed subsequent to final inspection shall required reinspection or retest, as appropriate, to verify acceptability.

12. Required in-service inspection or surveillance of structures, systems, or components shall be planned and executed by or for the organization responsibility for operation as specified in the QAP, the SAR or TSRs.

13. Inspection methods for item 12 above shall be established and executed to verify that the characteristics of an item continue to remain within specified limits. Inspection methods shall include evaluation of performance capability of essential emergency and safety systems and equipment, verification of calibration and integrity of instruments and instrument systems, and verification of maintenance, as appropriate.

14. The depth and extent of inspections are determined by the significance of the Q function, and the complexity of the item or activity.

15. The identification of inspection activities and attributes is based on the complexity of the item or activity to be inspected; on mandatory inspections required by codes, standards, regulatory requirements or commitments; and inspection requirements established by the Engineering Manager.

16. Inspection records shall, as a minimum, identify (a) through (f) below:

    a. Item inspected
    b. date of inspection
    c. inspector
    d. type of observation
    e. results or acceptability
    f. reference to information on action taken in connection with nonconformances

2.11 TEST CONTROL

2.11.1 General

A system for test control is established for Q items within the scope of this QAP as described in Section 2.2. The requirements for the test control system are in accordance with Basic Requirement 11 and Supplement 11S-1 of ASME NQA-1, 1989. This system is planned and executed to assure that testing is performed to demonstrate that SSCs will perform satisfactorily in service. The system requires written test procedures identifying prerequisites with provisions for documenting and evaluating test results to assure that requirements are satisfied. This section also contains amplified requirements for testing of computer programs and associated computer systems within the scope of this QAP as described in Section 2.2 The requirements for computer program testing are in accordance with Supplement 11S-2 of ASME NQA-1, 1989.

2.11.2 Responsibilities

The Engineering Manager is responsible for providing technical criteria for plant modification testing. The Engineering Manager is also responsible for the evaluation of test results and resolution of deficiencies identified from these tests.

Management is responsible for the conduct of testing activities under their cognizance which are in accordance with procedures consistent with the requirements of this section of the QAP.

2.11.3 Requirements

2.11.3.1 Test Control

Procedures are established for the control of testing activities that provide measures that ensure the following:

1. Test requirements and acceptance criteria are based upon specified requirements contained in applicable design or other pertinent technical documents.

2. Test procedures contain the following information as appropriate to the test:

    a. Test purpose or objectives and characteristics to be tested and test methods to be employed.

    b. References and related documents.

    c. Provisions for assuring that prerequisites for a given test have been met.

    d. Adequate instrumentation is available and suitable environmental conditions are maintained.

    e. Provisions for establishing prerequisites and precautions, as applicable: calibration instrumentation, appropriate equipment, trained personnel, condition of test equipment, and the item to be tested, and provisions for data acquisition.

    f. Provisions for documenting and evaluating the test results for conformance with acceptance criteria.

    g. In lieu of written test procedures, appropriate sections of related documents, such as ASTM methods, vendor manuals, maintenance instructions, or approved drawings or travelers with acceptance criteria may be used. Such documents must include adequate instructions to assure the required quality of work.

3. Tests required to collect data, such as for siting or designing input are planned, executed, documented, and evaluated.

4. Test records contain the following information as a minimum: item tested, test date, tester or data recorder, type of observation, results and acceptability, actions taken with any deviations noted, and identification of the person evaluating the results.

2.11.3.2 Computer Program Testing

Procedures are established to provide measures to ensure the following:

1. Test requirements and acceptance criteria are provided or approved by the organization responsible for the design or use of the program to be tested unless otherwise designated in procedures.

2. Required tests, including (as appropriate) verification tests, hardware integration tests, and in-use tests, are controlled.

3. Test requirements and acceptance criteria are in accordance with applicable design or other pertinent technical documents.

4. Verification tests encompassing the range of permitted program usage as specified by the program documentation demonstrate the capability of the computer program to produce valid results. Testing of the computer program is dependent upon its complexity and may range from a single test of the completed computer program to a series of tests performed at various stages of the program development to verify correct translation between stages and proper working of the individual modules, followed by an overall computer program test. Regardless of the number of stages of tests, verification testing shall be sufficient to establish that test requirements are satisfied and that the computer program produces a valid result for its intended function. Acceptable test problem verification methods may include one or more of the following features:

   a. Hand calculations.

   b. Calculations using comparable proven programs.

   c. Empirical data and information from technical literature.

5. Operational verification testing includes the following features:

   a. Test problems are developed and documented to permit confirmation of acceptable performance of the computer program in the operating system.

   b. Test problems are run whenever the computer program is installed on a different computer, or when significant hardware or operating system configuration changes are made.

   c. Periodic in-use manual or automatic self-check routines are required and are performed for those applications where computer failures or drift can affect required performance.

6. Test procedures or plans specify the following as applicable: required tests and test sequence, required ranges of input parameters, identification of the stages at which testing is required, criteria for established test cases, requirements for testing logic branches, requirements for hardware integration, anticipated output values, acceptance criteria, reports to be generated during the test, records of test results to be generated, standard formatting and conventions of electronic media generated, and provisions for the documentation and evaluation of test results by a responsible authority to assure that test requirements are met.

7. Verification test records identify the following: computer program tested, computer hardware used, test equipment and calibrations if applicable, date of test, tester or data recorder, simulation models used if applicable, test problems, results and acceptability, actions taken in correction (with any deviations noted), and the person evaluating the test results.

8. In-use test records identify the following: computer program tested, computer hardware used, test equipment and calibrations, where applicable, date of test, tester or data recorder and the acceptability.

2.12 CONTROL OF MEASURING AND TEST EQUIPMENT

2.12.1 General

A system is established for the control of measuring and test equipment (M&TE) used for measurement, test, and calibration of Q items within the scope of this QAP as described in Section 2.2. The requirements for the control of measuring and test equipment are in accordance with Basic Requirement 12 and Supplement 12S-1 of ASME NQA-1, 1989. This system establishes measures that ensure that tools, gauges, instruments, reference and transfer standards, nondestructive test equipment, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified intervals to maintain equipment performance within required limits.

This system also establishes measures to ensure that devices and standards used for measurement, tests, and calibration activities are of the proper type, range, accuracy, and tolerance to accomplish the function of determining conformance to specified requirements.

2.12.2 Responsibilities

The Maintenance Manager has the overall responsibility for the calibration control system for M&TE. The calibration control system meets the requirements of this section of the QAP.

Organization/Group Managers are responsible for implementation of the calibration control system for M&TE under his/her cognizance.

2.12.3 Requirements

Procedures are established for the control of M&TE to ensure the following:

1. A list of devices (and their assigned location) is established to identify those items within the calibration control system. This identification listing includes, as a minimum, the due date of the next calibration and any use limitations (when it is calibrated for limited use). Calibration controls are not necessary for rulers, tape measures, levels, and other such devices if the commercial equipment provides adequate accuracy.

2. M&TE is calibrated at specified intervals or prior to use against certified equipment having known valid relationships to nationally recognized standards. If no nationally recognized standard exists, the bases for calibration are documented.

3. The method and interval for calibration for each item shall be defined, based on the type of equipment, stability characteristics, required accuracy, intended use, and other conditions affecting measurement control.

4. When M&TE is found to be out of calibration, an evaluation is made and documented as to the validity of previous inspection and test results and of the acceptability of items previously inspected or tested. Out-of-calibration devices are tagged or segregated and are not used until recalibrated. When M&TE is consistently found to be out of calibration, it is repaired or replaced. Also, calibrations are performed when the accuracy of the equipment is deemed suspect by personnel performing measurements and tests.

5. M&TE is properly handled and stored to maintain accuracy.

6. Records are maintained and equipment is suitably marked to indicate its calibration status.

2.13 HANDLING, STORAGE, AND SHIPPING

2.13.1 General

A system is established for the handling, shipping, and storage of Q items identified as within the scope of this QAP as described in Section 2.2. This system is in accordance with Basic Requirement 13 and Supplement 13S-1 of ASME NQA-1, 1989. This system provides the requirements for item handling, storage, and shipping, to prevent damage, loss, or deterioration.

2.13.2 Responsibilities

The Engineering Manager is responsible for specifying the requirements for handling, storage, shipping, cleaning, packaging, and on site movement of items in specifications, drawings, instructions, procedures, procurement documents, and/or other appropriate documents, in accordance with requirements of this section of the QAP.

Organization/Group Managers have the responsibility for the proper handling and on-site movement of items under their cognizance from the point of issuance through installation and use. These activities are accomplished in accordance with procedures consistent with the requirements of this section of the QAP.

The GDP Procurement and Materials Manager has the responsibility for the proper handling, storage, and on-site movement of items under his/her cognizance (i.e., upon receipt, during storage, and to the point of issuance). These activities are accomplished according to procedures consistent with the requirements of this section of the QAP.

The Nuclear Safety and Quality Manager is responsible for selectively verifying that items are properly handled, stored, and shipped.

2.13.3 Requirements

1. Procedures identify requirements for the handling, storage, cleaning, packaging, shipping, and preservation of items. These requirements are established during the generation of procurement, design, and shipping documents to prevent damage, loss, or deterioration. Periodic inspections are provided to verify compliance with storage requirements and to prevent deterioration;

2. Procedures document the training and experience requirements for operators of special handling and lifting equipment;

3. Procedures provide measures for the identification, control, use, and qualification of special handling equipment. These procedures also include inspection and testing requirements, with specified time intervals, to assure adequate maintenance of special handling tools and equipment;

4. Procedures designate the methods of controlling stored items;

5. Procedures or procurement documents specify cleaning operations that must be performed prior to preservation, packaging, storing, or installing items; and

6. Procedures and procurement documents specify the requirements for marking, and labeling of items to identify, maintain, and preserve the item, including indication of the presence of special environments or the need for special controls.

2.14 INSPECTION, TEST, AND OPERATING STATUS

2.14.1 General

A system for identifying inspection, test, and operating status of SSCs is established for those Q items within the scope of this QAP as described in Section 2.2. The requirements for identification of the inspection, test, and operating status are in accordance with Basic Requirement 14 of ASME NQA-1, 1989 and this section. This system provides assurance that contractors and on-site organizations identify the inspection, test, and operating status of Q SSCs by suitable methods of identification or in associated records. These controls are required to prevent the inadvertent use of nonconforming, inoperative, or malfunctioning items, and to readily verify that required tests and inspections have been performed.

2.14.2 Responsibilities

The Nuclear Safety and Quality Manager is responsible for providing a status-indicating system for inspections performed in accordance with the requirements of this section of the QAP.

Organization/Group Managers participating in testing and operational activities of the facilities are responsible for the development and implementation of status indicating systems which are consistent with the requirements of this section of this QAP.

2.14.3 Requirements

1. Procedures are established to ensure that the status of inspection and test activities are either marked or labeled on the item or in documents traceable to the item. This activity is required where it is necessary to assure that required inspections and tests are performed, and to assure that items which have not passed the required inspections and tests are not inadvertently installed, used, or operated;

2. Procedures require that status indicators, such as physical location and tags, markings, work controlling documents, stamps, inspection records, or other suitable means are utilized when required. Procedures identify the authority for the application and removal of tags, markings, labels, and stamps; and

3. Procedures also provide measures for indicating the operating status of systems and components, such as by tagging valves and switches, to prevent inadvertent operation.

2.15 CONTROL OF NONCONFORMING ITEMS

2.15.1 General

A system is established for the control of nonconforming Q items and related activities and services within the scope of this QAP as described in Section 2.2. This system is in accordance with Basic Requirement 15 and Supplement 15S-1 of ASME NQA-1, 1989. The system establishes the requirements for identification, segregation, disposition, prevention of inadvertent installation or use, documentation, and notification to affected organizations for items which do not conform to specified requirements.

2.15.2 Responsibilities

Personnel participating in Q quality affecting activities within the scope of this QAP are responsible for reporting and documenting nonconforming items or related activities and services.

The GDP Procurement and Materials Manager is responsible for implementation of the nonconformance control system for materials which meet the requirements of this section of the QAP until the materials are issued for installation or use.

The Engineering Manager is responsible for providing documented technical justification for the acceptability of nonconforming items dispositioned "use-as-is" or "repair." This manager is also responsible for applying the design control measures of Section 2.3 of this QAP to those nonconformances to design requirements that are dispositioned "use-as-is" or "repair," and for ensuring that as-built records reflect the accepted deviation.

The Plant Shift Superintendents (PSS) are responsible for evaluating identified and reported nonconformances for impact on system operability and reportability to the NRC.

2.15.3 Requirements

Procedures are established to provide measures for the control of Q items and related activities and services that do not conform to specified requirements. These measures ensure the following:

1. Nonconforming items are identified in a manner that does not adversely affect the end use of the item, by markings, tagging, and other appropriate methods. The identifications shall be legible and easily recognizable. When identification of the item is not practical, the container, package, or segregated storage area is identified;

2. Nonconforming items are segregated, when practical, by placing them in a clearly identified and designated area until properly dispositioned. When segregation is impractical or impossible due to physical conditions such as size, weight, or access limitations, other measures are employed to preclude inadvertent use of the item;

3. Nonconforming characteristics are reviewed and dispositions are recommended. Further processing, delivery, installation or use of the nonconforming item is controlled pending an evaluation and approved disposition by authorized personnel, and notification to affected organizations is provided;

4. Nonconforming items or services are evaluated to determine whether reporting is required;

5. Nonconforming items or services identified by suppliers are reviewed to determine applicability and to initiate corrective action if required;

6. The responsibility and authority for the evaluation and disposition of nonconforming items is defined. The personnel performing evaluations to determine the disposition have demonstrated competence in the specific area they are evaluating, have an adequate understanding of the requirements, and have access to pertinent background information;

7. The disposition of nonconforming items is identified and documented. Technical justification for the acceptability of nonconforming items dispositioned "repair" or "use-as-is" are also documented;

8. Nonconformances to design requirements dispositioned "use-as-is" or "repair" are subject to design control measures as described in Section 2.3. The as-built records, if such records are required, reflect the accepted deviation. This as-built requirement applies only to those as-built conditions captured after the effective date of this QAP; and

9. Repaired or reworked items are reexamined in accordance with applicable procedures and with the original acceptance criteria unless the nonconforming item disposition has established alternate acceptance criteria.

2.16 CORRECTIVE ACTION

2.16.1 General

A corrective action system is established for those Q items and related activities and services within the scope of the QAP as described in Section 2.2. This system is in accordance with Basic Requirement 16 of ASME NQA-1, 1989 and this section. This system establishes measures which ensure that conditions adverse to quality are identified and corrected as soon as practical. The system also ensures that, in the case of significant conditions adverse to quality, the cause of the condition is determined, and corrective action is

taken to preclude recurrence. These actions are documented and reported to appropriate levels of management. This system also ensures that follow-up actions are taken to verify implementation of the corrective action.

2.16.2 Responsibilities

The Regulatory Affairs Manager is responsible for development, maintenance, and implementation of the corrective action system. This manager is also responsible for verifying that adverse conditions are reviewed and assessed by appropriate levels of management.

Organization/Group Managers are responsible for evaluating and performing assigned corrective actions in a timely manner in accordance with procedures that implement the requirements of this section of the QAP. They are also responsible for assuring the identification and documentation of conditions adverse to quality in accordance with applicable procedures.

2.16.3 Requirements

Procedures for the corrective action process are established to ensure the following:

1. Conditions adverse to quality are promptly identified and corrected as soon as practical;

2. For significant conditions adverse to quality, the cause of the condition is determined and corrective action is taken to preclude recurrence; and

3. The identification, cause, and corrective action for significant conditions adverse to quality are documented and reported to appropriate levels of management; follow-up action is taken to verify implementation of the corrective action.

2.17 QUALITY ASSURANCE RECORDS

2.17.1 General

A records management system is established for Q items and related activities and services within the scope of this QAP as described in Section 2.2. The records management system is in accordance with Basic Requirement 17 and Supplement 17S-1 of ASME NQA-1, 1989. The records management system provides measures to control quality assurance records.

2.17.2 Responsibilities

The Regulatory Affairs Manager is responsible for the development, maintenance, and implementation of the records control system consistent with the requirements set forth in this section of the QAP.

Organization/Group Managers are responsible for (1) identifying quality assurance records initiated by their organization/group including those received from suppliers of items and services; (2) controlling the records within their jurisdiction; and (3) transferring records, for which their group previously had record copy responsibility, to the Regulatory Affairs Manager for retention consistent with governing procedures meeting the requirements established in this section of the QAP.

2.17.3 Requirements

Procedures for the identification and control of quality assurance records are established to ensure the following:

1. Applicable design specifications, procurement documents, test procedures, operational procedures or other documents specify the records to be generated, supplied, or maintained. These documents are designated to become records and are legible, accurate, and complete;

2. Methods of authentication or validation of documents as records are identified;

3. Documents shall be considered valid records only if stamped, initialed, or signed and dated by authorized personnel or otherwise authenticated;

4. Establishment of a records indexing and classification system, including record retention times,
and the location of the record within the record system, which meets the requirements of the Technical Safety Requirements document, the provisions of 10 CFR Part 76, and other regulatory requirements;

5. Methods are established to permit identification between the record and the item(s) or activity(ies) to which it applies;

6. Corrections to records are approved by the originating organization and the corrections include the date and the identification of the individual authorized to issue the correction;

7. Establishment of a record receipt control system which meets the requirements of Supplement 17S-1, Section 3 of ASME NQA-1, 1989;

8. Requirements for records storage, preservation, and safekeeping satisfy the requirements of Supplement 17S-1, Sections 4.1, 4.2, and 4.3 of ASME NQA-1, 1989;

9. Quality Assurance records are stored in facilities which meet the requirements of Supplement 17S-1, Section 4.4 of ASME NQA-1, 1989, except as noted in Appendix C of this QAP;

10. Record requirements for procured non-commercial items or services are identified in applicable procurement documents. These documents contain provisions for the following:

    a. Assuring that supplier methods for the collection, storage, and maintenance of records is commensurate with the above requirements,

    b. Identification of required records and the required retention periods,

    c. A record index which includes sufficient identifying information for record retrieval,

    d. A record submittal plan,

    e. The availability, accessibility, and if applicable, the disposition criteria of records retained by the supplier, and

    f. The accessibility of the supplier's records prior to final transfer to the purchaser and the method of transmittal.

11. The storage system provides for retrieval of information in accordance with planned retrieval times based upon the record type. A list is maintained designating those personnel who have access to the files within the storage system;

12. Single copy records shall only be allowed out of permanent storage if they cannot be copied and then only for a maximum of 90 days.

2.18 AUDITS

2.18.1 General

An audit system is established for Q items and activities and services within the scope of this QAP as described in Section 2.2. The audit system is in accordance with Basic Requirement 18 and Supplement 18S-1 of NQA-1, 1989. This system establishes planned and periodic audits to verify the compliance and the effectiveness of this QAP in meeting quality requirements. Audit personnel have sufficient authority and organizational freedom to make the audit process meaningful and effective. Audits are executed in accordance with established procedures and are performed by personnel having no direct responsibilities in the areas being audited.

Internal audits of selected aspects of operational activities are performed with a frequency commensurate with their importance to safety and in such a manner as to assure that audits of activities within the scope of this QAP, as described in Section 2.2, are completed within specified time periods.

External audits of selected suppliers and service contractors, in keeping with the procurement and service activities, are performed to verify and evaluate their Quality Assurance Programs, procedures and activities to ensure that they are complying with applicable aspects of this QAP and procurement requirements. This includes verification that the suppliers and contractors similarly review and audit the quality assurance programs of their suppliers as required.

2.18.2 Responsibilities

The Nuclear Safety and Quality Manager is responsible for the development, maintenance, scheduling and performance of the internal audit and external supplier audit system consistent with the requirements of this section of the QAP.

Audited organizations are responsible for providing assistance as required during the planning and performance of audits, for providing access to facilities, personnel, documents, and records, as required, and for ensuring that requests for corrective action are promptly answered and that actions taken to correct any discrepancy are adequate and timely.

2.18.3 Requirements

2.18.3.1 Training and Qualification

1. Audit personnel shall be provided with appropriate training such that they are competent to perform the required audits; and

2. Auditors and lead auditors shall meet the training and experience requirements as described in Section 2.2.4. Technical specialists may participate as audit team members provided they receive the required indoctrination and guidance during the audit.

2.18.3.2 Scheduling

1. Internal and external audits are scheduled in a manner to provide coverage and coordination with ongoing QAP activities.

2. Audits are scheduled at a frequency commensurate with the status and importance of the activities.

3. The audit schedules are reviewed periodically and revised as necessary to assure coverage is maintained current.

4. Regularly scheduled audits are supplemented by additional audits or surveillance (assessment) of specific subjects when necessary to provide adequate coverage.

5. An implementation audit for initial evaluation of suppliers, when required by 2.7.3.2, may be scheduled and performed after award of the contract when sufficient time has lapsed for implementing their QA Program, and they are performing the functions as defined in their QA program, codes, standards, and other contract documents.

6. External audits of approved non-commercial grade suppliers are scheduled and performed at least once every three years from the date of the last acceptable supplier evaluation. The following alternatives apply:

   a. Approved non-commercial grade suppliers, if used infrequently, do not require re-audit every three years. However, they shall be audited prior to use if their QAP approval has lapsed.

   b. Suppliers of services do not require external audit if they perform work to the USEC QAP and procedures under USEC supervision. Otherwise, external audit is required for suppliers of services.

   c. Third party audits allowed by 2.7.3.2.4 are acceptable for triennial supplier re-audit.

7. Approved, non-commercial grade suppliers' performance is evaluated annually in the years between audits. External audits of non-commercial grade suppliers, after award of a contract, are not necessary for procurement actions when the items or services are all of the following: (1) relatively simple and standard in design, manufacture, and test; (2) subject to standard or automated inspections or tests of the end product to verify quality characteristics after delivery; and (3) such that receiving inspection does not require operations that could adversely affect the integrity, function or cleanness of the items.

2.18.3.3 Audit Plan

The auditing organization shall develop and document an audit plan for each audit. The plan is required to identify the audit scope, requirements, audit personnel, activities to be audited, organizations to be notified, applicable documents, schedule, and applicable written procedures or approved checklists, of questions covering the items to be audited.

2.18.3.4 Personnel and Selection of Audit Team

1. Measures are established for the selection of the audit team, and audit team familiarization prior to the beginning of each audit. These measures ensure consideration is given to special abilities, specialized technical training, prior experience, personal characteristics, and education when personnel are selected as audit team members;

2. The selected auditors shall be independent of any direct responsibility for performance of the activities which they will audit and, in the case of internal audits, personnel having direct responsibility for performing the activities being audited are not involved in the selection of the audit team;

3. The audit team shall contain one or more auditors and shall have an individual appointed to lead the team who organizes and directs the audit, coordinates the preparation and issuance of the audit report, and evaluates the responses; and

4. Measures are established for audit team preparation prior to initiation of the audit, particularly that pertinent information including policies, procedures, standards, instructions, codes, regulatory requirements, and prior audit reports, is available for review by the auditors for formulation of the checklist and the conduct of the audit.

2.18.3.5 Audit Performance

Audits shall be performed in accordance with the requirements of Supplement 18S-1, Section 4 of ASME NQA-1, 1989.

2.18.3.6 Reporting

1. The audit report is signed by the audit team leader. The report should be issued within 30 days of the post-audit conference. The audit report is distributed to responsible management of both the auditing and the audited organizations.

2. The audit report shall include the following information, as appropriate:

   a. Description of the audit scope;

   b. Identification of the auditors;

   c. Identification of persons contacted during audit activities;

   d. Summary of audit results, including a statement of the implementation effectiveness of the quality assurance program elements which were audited;

   e. Description of each reported adverse audit finding in sufficient detail to enable corrective actions to be taken by the audited organization (Audit findings are processed as required by QAP Section 2.16, “Corrective Action.”)

2.18.3.7 Response and Follow-Up Action

1. Management of the audited organization or activity shall investigate adverse audit findings, identify and schedule corrective action, identify and schedule measures to prevent recurrence, and notify the appropriate organization in writing of the actions taken or planned. The adequacy of the written audit responses is evaluated by or for the auditing organization; and

2. Follow-up action shall be taken to verify that corrective action is completed as scheduled.

2.18.3.8 Records

Audit records include audit plans, audit reports, written replies, and record of completion of corrective action.

Hierarchy of Technical Documents

Federal (CFRs), State, and Local Regulations
↓
Certificate of Compliance Includes:
- Technical Safety Requirements
- Safety Analysis Report
- Fundamental Nuclear Material Control Plan
- Security Plan
- Emergency Plan
- Quality Assurance Program
- Radioactive Waste Management Program
- Depleted Uranium Management Plan
- Nuclear Safety Programs
- Nuclear Criticality Safety Program
- Compliance Plan

↓
USEC Policies
↓
Procedures

Note 1. Listed documents are for information, not all documents are included in the scope of the quality program.
Note 2. Not all layers of documents need to be present to flow down requirements to a lower level document.

Figure 2-1. Hierarchy of technical documents.

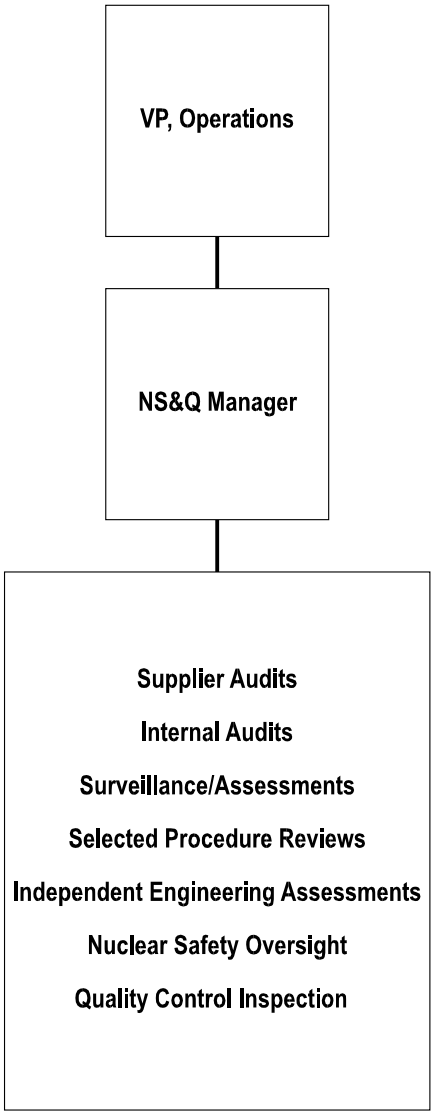

Figure 2-2. Nuclear Safety and Quality Organization

Figure 2-3. Deleted

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Appendix A

AUGMENTED QUALITY PROGRAM

This Appendix describes the extent to which QAP Sections 2.1 through 2.18 apply to AQ items and activities or describes alternatives. Section 3.15 of the Paducah Safety Analysis Report describes the AQ systems and boundaries to which this appendix applies. Appendix A, Section 1 describes the QAP applicability for Nuclear Criticality Safety. Section 2 describes the QAP applicability for the remaining AQ systems. Section 3 describes the quality requirements for AQ structures.

AQ items and activities are important to safety. Sections 1, 2, and 3 describe the extent of applicability of the Q quality assurance program or provide alternatives to Q requirements.

Appendix A (AQ-NCS)

Section 1

AQ - Nuclear Criticality Safety

The following elements as specified below apply to those SSCs identified in NCSAs/NCSEs as being relied upon for the criticality safety of an operation as described in SAR Section 5.2.2.8.

1.1 QAP Organization

Section 2.1 "Organization" of the Q program applies.

1.2 Quality Assurance Program

Section 2.2 "Quality Assurance Program" of the Q program applies.

1.3 Design Control

Section 2.3 "Design Control" of the Q program applies.

1.4 Procurement Document Control

Section 2.4 "Procurement Document Control" of the Q program applies.

1.5 Instructions, Procedures, and Drawings

Section 2.5 "Instructions, Procedures, and Drawings" of the Q program applies.

1.6 Document Control

Section 2.6 "Document Control" of the Q program applies.

1.7 Control of Purchased Items and Services

Section 2.7 "Control of Purchased Items and Services" of the Q program applies.

1.8 Identification and Control of Items

Section 2.8 "Identification and Control of Items" of the Q program applies.

1.9 Control of Processes

Section 2.9 "Control of Processes" of the Q program applies.

1.10 Inspection

Section 2.10 "Inspection" of the Q program applies.

1.11 Test Control

Section 2.11 "Test Control" of the Q program applies.

1.12 Control of Measuring and Test Equipment

Section 2.12 "Control of Measuring and Test Equipment" of the Q program applies.

1.13 Handling, Storage, and Shipping

Section 2.13 "Handling, Storage, and Shipping" of the Q program applies.

1.14 Inspection, Test, and Operating Status

Section 2.14 "Inspection, Test, and Operating Status" of the Q program applies.

1.15 Nonconformance Control

Section 2.15 "Nonconformance Control" of the Q program applies.

1.16 Corrective Action

Section 2.16 "Corrective Action" of the Q program applies.

1.17 Quality Assurance Records

Section 2.17 "Quality Assurance Records" of the Q program applies.

1.18 Audits

Section 2.18 "Audits" of the Q program applies.

Appendix A

Section 2

AQ - Other SSCs

The following elements apply as specified below for AQ SSCs (except NCS) contained within the boundaries discussed in SAR Section 3.15.

2.1 Organization

Section 2.1 "Organization" of the Q program applies.

2.2 Quality Assurance Program

Section 2.2 "Quality Assurance Program" of the Q program applies with the following alternatives:

1. Training for AQ activities differ from training for Q activities in the rigor and formality for individual SAT elements, and includes as a minimum:

    a. Conduct of needs/job analysis and identification of tasks for training - The needs/job analysis is an informal table-top discussion or a subject matter expert interview to identify training needs.

    b. Development of learning objectives - The learning objective is a single overall terminal objective rather than a breakdown of multiple enabling or learning objectives tied back to the overall objective.

    c. Development of lesson plans and training guides - The lesson plan development and approval process is less formal and limited to technical reviews in lieu of additional instructional technologist review and approval.

    d. Evaluation of trainee mastery of learning objectives - The evaluation of trainee mastery of learning objectives is determined by the needs/requests of line management. Written performance evaluations are not required.

    e. Evaluation of the effectiveness of training - The evaluation of the effectiveness of training is determined by the needs/requests of line management. Formal assessments and surveys are not required.

2.3 Design Control

2.3.1 General

A design control system is established for AQ items and related activities and services within the scope of this Appendix as identified in Section 2.2. This system is based on ASME NQA-1, 1989, Basic Requirement 3, and Supplement 3S-1. These requirements and controls ensure that new design and design change activities are carried out in a planned, controlled, and orderly manner, and that design requirements such as design bases, regulatory requirements and appropriate quality standards are correctly translated into design output, procurement, and procedural documents. These controls also establish provisions for verifying or checking the technical adequacy of design documents including computer codes. They also provide for the control of design changes. The design control provisions contained in this Appendix are applicable to design activities taking place after the date NRC assumes regulatory oversight for the plant. Reconstitution of the design is not required; however if a deviation to the design is discovered, engineering shall resolve the deviation and as-built the drawings if necessary.

2.3.2 Responsibilities

The Engineering Manager is the plant design authority having responsibility for the implementation and execution of the design control system in accordance with the requirements of this section.

Design changes and new designs are authorized by responsible management and are reviewed (as described in SAR Section 6.2) by the Plant Operations Review Committee (PORC) prior to implementation in accordance with the provisions of 10 CFR 76.68. Management is responsible for ensuring that completed plant changes are tested and for assuring that personnel affected by the change are adequately trained as described in procedures.

2.3.3 Requirements

2.3.3.1 Design Inputs

Procedures for design input activities are established to ensure the following:

1. Design inputs, such as approach to design bases, performance requirements, regulatory requirements, codes, and standards, are identified and documented, and their selection reviewed and approved by the responsible design organization;

2. Design inputs are approved on a timely basis and to the level of detail necessary to permit the design activity to be carried out in a correct manner and to provide a consistent basis for making design decisions, accomplishing design verification measures, and evaluating design changes; and

3. Changes from approved design inputs, including the reason for the changes, are identified, approved, documented, and controlled.

2.3.3.2 Design Process

Procedures are established to ensure the following:

1. Design activities are planned on a timely basis and to the level of detail necessary to permit the design process to be carried out in a correct manner and to permit verification that the design meets requirements. Design inputs are correctly translated into design documents;

2. Appropriate quality standards are identified and documented and their selection reviewed, approved, and controlled including changes thereto;

3. Design methods, materials, parts, equipment, and processes that are essential to the function of the SSC are selected and reviewed for suitability of application; and

4. Final design output documents including changes thereto are:

   a. Relatable to the design input by documentation in sufficient detail to permit design verification,

   b. Identify assemblies and/or components that are part of the item being designed.

2.3.3.3 Design Analyses

Procedures for design analyses activities are established to ensure the following:

1. Design analyses are performed in a planned, controlled, and documented manner;

2. Design analyses documents are legible and in a form suitable for reproduction, filing, and retrieval;

3. Design analyses documents contain sufficient detail as to the purpose, method, assumptions, design input, references, and units such that a person technically qualified in the subject can review and understand the analyses and verify the adequacy of the results without recourse to the originator;

4. Calculations are identifiable by subject, originator, reviewer, and date or by other data such that the calculations are retrievable;

5. When computer programs are utilized for design analyses, the requirements of Section 3.1(a) of Supplement 3 S-1 of ASME NQA-1, 1989 are applied; and

6. Design analyses documents include the requirements of Section 3.1(b) of ASME NQA-1, 1989 Supplement 3 S-1.

2.3.3.4 Design Verification

Procedures for design verification activities are established to ensure the following:

1. Design verification is performed by competent individual(s) or group(s) other than those who performed the original design;

2. Verifiers are knowledgeable in the areas to be verified. The verifier may be a supervisor, provided the supervisor was not directly responsible for the design (i.e., did not specify a singular design approach or rule out certain design considerations and did not establish the design inputs used in the design);

3. Design verification is completed prior to relying upon the component, system, structure, or computer program to perform its function;

4. The extent of the design verification is a function of the importance to safety, the complexity of the design, the degree of standardization, the state of the art, past performance, and similarity with previously proven designs. Where changes to previously verified designs are made, design verification is performed for the changes, including an evaluation of the effects of the changes on the overall design and on any design analysis for which the design is based; and

5. Acceptable methods of design verification are identified which include, but are not limited to, any one or a combination of the following: design reviews, alternate calculations, and qualification testing. Procedures identify the criteria for determining the method of design verification. Verification by testing shall demonstrate adequacy of performance under conditions that simulate the most adverse design requirements. Verification of computer programs includes appropriate testing in accordance with the requirements of Section 2.11.

2.3.3.5 Design Changes

Procedures for design change control are established to ensure the following:

1. Changes to final designs, field changes, modifications, and nonconforming items dispositioned "use-as-is" or "repair" are justified, documented, and evaluated against criteria established by the Engineering Manager;

2. Design documents, including changes thereto, are controlled in accordance with Section 5 of Supplement 3 S-1 to NQA-1, 1989 and Section 2.6 of this Appendix. When a significant design change is found to be necessary because of an incorrect design, the design process and verification procedure are reviewed and modified as necessary; and

3. Changes to the plant are evaluated and processed in accordance with the provisions of 10 CFR 76.68.

2.3.3.6 Design Interfaces

Procedures for design interface control are established to ensure the following:

1. Internal and external design interfaces are identified and controlled and design efforts are coordinated among participating organizations;

2. The responsibilities for the preparation, review, approval, release, distribution, and revision of documents involving design interfaces are defined; and

3. Design information transmitted across interfaces is documented and controlled.

2.3.3.7 Design Documentation and Records

Design documentation and records that provide evidence that the design and design verification processes were performed in accordance with this section are collected, stored, and maintained in accordance with Section 2.17.

2.4 Procurement Document Control

2.4.1 General

A procurement document control system is established for AQ items and related activities and services within the scope of this Appendix as identified in Section 2.2. This system is based on ASME NQA-1, 1989, Basic Requirement 4, and Supplement 4S-1. The procurement document control system ensures that applicable regulatory requirements, technical requirements, and QAP requirements are included or referenced in procurement documents for the procurement of items and services. This system also establishes provisions for the preparation, review, approval, and control of procurement documents, including changes thereto.

2.4.2 Responsibilities

The Engineering Manager is responsible for the preparation and maintenance of design specifications (including specifications for spare and replacement parts) and for identifying the technical and quality.

requirements necessary to ensure item acceptability. These specifications are subject to the requirements of Section 2.3 of this Appendix. The Engineering Manager is also responsible for development of procedures that define these activities, including the criteria for developing the necessary technical and quality requirements for procurement taking into consideration the importance to safety.

The GDP Procurement and Materials Manager is responsible for purchasing activities and for ensuring that items are procured in accordance with the technical and quality requirements specified by engineering.

2.4.3 Requirements

AQ items and services are procured as commercially available in accordance with the criteria in this section and Section 2.7 of this Appendix.

2.4.3.1 Procurement Document Contents

Procedures governing procurement document content are established to ensure the following:

1. Items are purchased by reference to the manufacturer's part number and nomenclature unless other technical requirements are specified by Engineering, taking into consideration the importance to safety. When specified by Engineering, technical requirements are included in procurement documents by specific reference to drawings, specifications, codes, standards, regulations, procedures, or instructions, including revisions thereto, that describe the items or services to be furnished. Procurement documents identify any special instructions and requirements for designing, fabricating, cleaning, erecting, packaging, shipping, handling, storing, testing, inspecting, and accepting.

2. Services are purchased by reference to the service provider's published service description unless other technical requirements are specified by engineering in a statement of work. When specified by engineering, the statement of work is included in procurement documents.

3. Procurement documents specify appropriate quality requirements needed to ensure acceptability and useability of the items or services being procured.

4. Procurement documents identify the documentation required to be submitted for information, review, or approval. The identification of technical and quality requirements equal to or better than the original requirements are provided for ordering replacement parts or assemblies.

2.4.3.2 Procurement Document Review

Procedures for the review of procurement documents are established to ensure the following:

1. A review of procurement documents and changes thereto shall be made to assure that documents transmitted to the prospective supplier(s) include appropriate provisions to assure that items or services will meet the specified requirements;

2. Changes made as a result of the bid evaluation or precontract negotiations are incorporated in procurement documents. The review of these changes are completed prior to contract award. This review shall ensure the requirements of Section 3 of Supplement 4S-1 to ASME NQA-1, 1989 are satisfied; and

3. The reviews and approvals required by this section are performed by personnel who have access to pertinent information and who have an adequate understanding of the requirements and the procurement documents.

2.4.3.3 Procurement Document Changes

Procedures ensure that procurement document changes are subject to the same degree of control as utilized for the preparation of the original procurement document.

2.5 Instructions, Procedures, and Drawings

Section 2.5 "Instructions, Procedures, and Drawings" of the Q program applies.

2.6 Document Control

Section 2.6 "Document Control" of the Q program applies.

2.7 Control of Purchased Items and Services

2.7.1 General

A system for the control of purchased items and services is established for AQ items and services within the scope of this Appendix as described in Section 2.2. This system is based on Basic Requirement 7 and Supplement 7S-1 of ASME NQA-1, 1989.

2.7.2 Responsibilities

The Nuclear Safety and Quality Manager, as designated by the Vice-President, Operations, is responsible for providing the necessary QA functions to support procurement as described in this section. The Nuclear Safety and Quality Manager provides support functions such as source verification or surveillance, receipt inspections, installation inspections, and review of procurement documents during receipt inspections. The Nuclear Safety and Quality Manager is also responsible for developing and implementing procedures which meet the requirements of this section.

The engineering manager is responsible for assisting the Nuclear Safety and Quality Manager by performing evaluations of supplier technical capabilities. The engineering manager is also responsible for the approval of dispositions and technical evaluations for supplier-generated nonconformances for items when required by purchasing documents. The engineering manager is also responsible for providing measures which ensure the proper selection, application, methods of acceptance, and use of items.

The GDP Procurement and Materials Manager is responsible for purchasing items in accordance with the technical requirements specified by engineering and for providing a support function for the performance of standard receiving inspection of AQ items when specified by the engineering manager in accordance with 2.7.3.2.1i of the Appendix of the QAP. The GDP Procurement and Materials Manager is also responsible for ensuring that personnel assigned to perform these standard receiving inspections have received appropriate indoctrination and training according to Section 2.2.4 of the QAP and that procedures are in place according to Section 2.5 of the QAP. The standard receiving inspection (non-technical) may be performed by GDP Procurement and Materials or Nuclear Safety and Quality as determined by management and as described in appropriate corporation and/or site procedures.

2.7.3 Requirements

AQ items and services are procured in accordance with the requirements of this section.

2.7.3.1 Changes to Procurement Documents

The requirements of Section 2.4.3.3 are followed when changes to procurement documents are made.

2.7.3.2 Application, Use and Methods of Acceptance for Items and Services

Procedures are established which govern the application, use and acceptance of items and services. Engineering specifies the use, acceptance criteria and method of acceptance for procured items and services in accordance with the following:

1. Engineering specifies methods used to accept items and services. Methods include one or more of the following:

    a. Receipt Inspection (Technical) - Note: done for all AQ items except when 1.i. below is the only method specified. Receipt inspections include the attributes as described below in paragraph 6 of this section,
    b. Acceptance review, (done for all services)
    c. Post-installation test, (items or services)
    d. Supplier survey, (items or services)
    e. Source verification, (items or services)
    f. Acceptable supplier and item performance record, (items or services)
    g. Certificate of Compliance, (items or services)
    h. Special test, and (items or services)
    i. Standard Receipt Inspection (Non-Technical) - Note: This method is used when application of the graded approach (based on the complexity and safety significance) indicates that the attributes described in paragraph 7 below provide reasonable assurance of the item's quality. This method can be used for acceptance of consumables, commodity items, and other standardized items. (items only)

2. The selection of the method or combination of methods in Section 2.7.3.2.1 above is based on the following:

    a. Importance to safety and complexity of the item or service,
    b. Selected critical characteristics or controls,
    c. Available supplier information,
    d. Quality history,
    e. Degree of standardization

3. Alternate items are allowed provided the Engineering Manager provides verification that the alternate item will perform its intended AQ function.

4. Procurement documents are issued and controlled in accordance with the requirements of Section 2.4 of this Appendix.

5. Acceptance reviews determine that the service performed is the service ordered and that required documentation is received and is acceptable.

6. Receipt inspections (Technical) determine that inspection and testing are performed as required, ensure conformance with manufacturer's published requirements, and ensure that required documentation is received and is acceptable.

7. Standard Receipt Inspections (Non-Technical) determine the following:

   a. the item is clean and damage was not sustained during shipping,
   b. the item received was the item ordered as identified on the contract or purchase order in the description and amount,
   c. the material received is packaged as required on the contract or purchase order including marking and tagging of shipping containers and individual items,
   d. commercial documentation (bill of lading, invoice, shipping invoice, etc.) as applicable to the item received is complete,
   e. special commercial shipping requirements as required on the contract or purchase order have been met (e.g., plastic enclosures to maintain cleanliness, anti-static enclosures, etc.), and
   f. simple dimensional checks, which do not require use of M&TE, may also be required.

2.8 Identification and Control of Items

2.8.1 General

A system is established for the identification and control of AQ items within the scope of the Appendix as described in Section 2.2 of this Appendix. This system is based on Basic Requirement 8 and Supplement 8S-1 of ASME NQA-1, 1989. This system establishes the requirements for the identification and control of such items and associated materials, consumables, parts, spare parts, components, and sub-assemblies.

2.8.2 Responsibilities

The Engineering Manager is responsible for specifying requirements for identification methods, traceability, shelf life, and operating life of items when required by codes, standards, or specifications. Engineering specifies these requirements during the generation of specifications, drawings, procurement documents, or other documents appropriate to the circumstances.

Organization Managers are responsible for maintaining and implementing identification, traceability, shelf life and operating life requirements for items under their jurisdiction.

The GDP Procurement and Materials Manager is responsible for receipt, delivery, storage, identification, traceability, and control of materials.

2.8.3 Requirements

2.8.3.1 Identification of Items

Procedures are established to ensure that items are identified from initial receipt and fabrication of the items up to and including installation and use to assure that only correct and accepted items are used or installed. Where physical identification to control the item is either impractical or insufficient, physical separation, procedural controls, or other means are employed. When markings are used, measures are established to ensure that the markings are clear, legible and do not have a detrimental effect on the function or service life of the item. Markings are transferred to each part of an identified item when subdividing and are not to be obliterated or hidden by surface treatments or coatings unless other means of identification are provided.

2.8.3.2 Traceability of Items

Procedures are established for the traceability of items, when specified by codes, standards or specifications.

2.8.3.3 Limited Life Items

Procedures are established to ensure that items which have a limited operating life or shelf-life are identified and controlled to preclude use of items whose operating life or shelf-life has expired. These procedures also establish the requirements for the identification and control of items such as chemicals and reagents.

2.8.3.4 Maintaining Identification of Stored Items

Procedures are established for the control of item identification consistent with the planned duration and conditions of storage such as (1) provisions for maintenance or replacement of markings and identification records due to damage during handling or aging, (2) protection of identifications on items subject to excessive deterioration due to environmental exposure, and (3) provision of updating existing plant records.

2.9 Control of Processes

Section 2.9 "Control of Processes" of the Q program applies.

2.10 Inspection

2.10.1 General

A system for inspection is established for AQ items which is within the scope of this Appendix as identified in Section 2.2. This system is based on ASME NQA-1, 1989, Basic Requirement 10, and Supplement 10S-1. This system provides measures to ensure that maintenance, repair or modification work is completed satisfactorily.

2.10.2 Responsibilities

The Nuclear Safety and Quality Manager is responsible for inspection planning, for ensuring inspections are performed when required by documents or procedures, and for utilizing qualified and certified inspection personnel.

The Engineering Manager is responsible for specifying "hold" and "witness" points for inclusion in applicable work control documents. Such work control documents are developed from approved design documents, which specify the criteria for acceptance for the work.

2.10.3 Requirements

Procedures for the inspection of AQ items and activities ensure the following:

1. Inspection for acceptance shall be performed by persons other than those who performed or directly supervised the work or activity being inspected.

2. Inspection for acceptance following maintenance or repair is accomplished by Post Maintenance Testing and/or Functional Testing as a minimum. Engineering specifies additional inspection requirements taking into consideration the importance to safety, and applicable codes, standards, and other commitments.

3. Personnel performing Post Maintenance Testing and/or Functional Testing are qualified to perform the specific operation or maintenance tasks, based on knowledge of the specific operation or maintenance requirements. Quality control personnel performing inspection are trained and qualified in accordance with Section 2.2.

4. Inspection hold points are established to ensure that work does not bypass required inspections. These hold points are established in work control documents. Work shall not proceed beyond an inspection hold point without specific consent of the designated inspection representative. Consent to waive hold points is recorded prior to continuation of work beyond the designated hold point.

5. Inspection activities are performed to verify the quality and conformance of the item to specified requirements.

6. The identification of inspection activities, including inservice inspection, and attributes are based on the importance to safety and the complexity of the item or activity to be inspected; on mandatory inspections required by codes, standards, regulatory requirements, and commitments; and on inspection requirements established by the Engineering Manager. The depth and extent of inspections are determined by the importance to safety and complexity of the item or activity.

7. Final inspection consist of Post Maintenance Testing and/or Functional Testing for the specific item involved. Where necessary, engineering identifies additional final inspection requirements.

8. Repairs, replacements, and modifications performed subsequent to final inspection require reinspection or retest, as appropriate, to verify acceptability.

9. Inspection and test requirements are identified in either maintenance procedures or work control documents and include acceptance criteria specified by engineering. Inspections are documented. The documentation identifies the acceptance criteria, and provides for the recording of the objective evidence of the inspection results.

10. Where a sample is used to verify acceptability of a group of items, the sampling procedure is documented and clearly identifies the sampling basis (typically based on recognized standard/practices).

11. Work control documents specify the minimum documentation requirements for inspection as follows:

    a. item inspected
    b. date of inspection
    c. inspector
    d. type of observation
    e. results or acceptability
    f. reference to information on action taken in connection with nonconformances

2.11 Test Control

Section 2.11 "Test Control" of the Q program applies.

2.12 Control of Measuring and Test Equipment

Section 2.12 "Control of Measuring and Test Equipment" of the Q program applies.

2.13 Handling, Storage, and Shipping

2.13.1 General

A system is established for the handling, shipping, and storage of AQ items identified as within the scope of this Appendix as described in Section 2.2. This system is in accordance with Basic Requirement 13 and Supplement 13S-1 of ASME NQA-1, 1989. This system provides the requirements for item handling, storage, and shipping, to prevent damage, loss, or deterioration.

2.13.2 Responsibilities

The Engineering Manager is responsible for specifying the requirements for handling, storage, shipping, cleaning, packaging, and on-site movement of items in specifications, drawings, instructions, procedures, procurement documents, and/or other appropriate documents, in accordance with requirements of this section of the Appendix.

Organization/Group Managers have the responsibility for the proper handling and on-site movement of items under their cognizance from the point of issuance through installation and use. These activities are accomplished in accordance with procedures consistent with the requirements of this section of the Appendix.

The GDP Procurement and Materials Manager has the responsibility for the proper handling, storage, and on-site movement of items under his/her cognizance (i.e., upon receipt, during storage, and to the point of issuance). These activities are accomplished according to procedures consistent with the requirements of this section of the Appendix.

2.13.3 Requirements

1. Procedures identify requirements for the handling, storage, cleaning, packaging, shipping, and preservation of items. These requirements are established during the generation of procurement, design, and shipping documents to prevent damage, loss, or deterioration. Periodic inspections are provided to verify compliance with storage requirements and to prevent deterioration.

2. Procedures document the training and experience requirements for operators of special handling and lifting equipment.

3. Procedures provide measures for the identification, control, use, and qualification of special handling equipment. These procedures also include inspection and testing requirements, with specified time intervals, to assure adequate maintenance of special handling tools and equipment.

4. Procedures designate the methods of controlling stored items.

5. Procedures or procurement documents specify cleaning operations that must be performed prior to preservation, packaging, storing, or installing items.

6. Procedures and procurement documents specify the requirements for marking, and labeling of items to identify, maintain, and preserve the item, including indication of the presence of special environments or the need for special controls.

2.14 Inspection, Test, and Operating Status

Section 2.14 "Inspection, Test, and Operating Status" of the Q program applies.

2.15 Nonconformance Control

2.15.1 General

A system is established for the control of nonconforming AQ items and related activities and services within the scope of this Appendix as described in Section 2.2. This system is in accordance with Basic Requirement 15 and Supplement 15S-1 of ASME NQA-1, 1989. The system establishes the requirements for identification, segregation, disposition, prevention of inadvertent installation or use, documentation, and notification to affected organizations for items which do not conform to specified requirements.

2.15.2 Responsibilities

Personnel participating in AQ quality affecting activities within the scope of this Appendix are responsible for reporting and documenting nonconforming items or related activities and services.

The GDP Procurement and Materials Manager is responsible for implementation of the nonconformance control system for materials which meet the requirements of this section of the QAP until the materials are issued for installation or use.

The Engineering Manager is responsible for providing documented technical justification for the acceptability of nonconforming items dispositioned use-as-is or repair. This manager is also responsible for applying the design control measures of Section 2.3 to those nonconformances to design requirements that are dispositioned "use-as-is" or "repair," and for ensuring that as-built records reflect the accepted deviation.

The Plant Shift Superintendents (PSS) are responsible for evaluating identified and reported nonconformances for impact on system operability and reportability to the NRC.

2.15.3 Requirements

Procedures are established to provide measures for the control of AQ items and related activities and services that do not conform to specified requirements. These measures ensure the following:

1. Nonconforming items are identified in a manner that does not adversely affect the end use of the item, by markings, tagging, and other appropriate methods. When identification of the item is not practical, the container, package, or segregated storage area is identified.

2. Nonconforming items are segregated, when practical, by placing them in a clearly identified and designated area until properly dispositioned. When segregation is impractical or impossible due to physical conditions such as size, weight, or access limitations, other measures are employed to preclude inadvertent use of the item.

3. Nonconforming characteristics are reviewed and dispositions are recommended. Further processing, delivery, installation or use of the nonconforming item is controlled pending an evaluation and approved disposition by authorized personnel, and notification to affected organizations is provided.

4. Nonconforming items or services identified by suppliers are reviewed to determine applicability and to initiate corrective action if required.

5. The responsibility and authority for the evaluation and disposition of nonconforming items is defined. The personnel performing evaluations to determine the disposition have demonstrated competence in the specific area they are evaluating, have an adequate understanding of the requirements, and have access to pertinent background information.

6. The disposition of nonconforming items is identified and documented. Technical justification for the acceptability of nonconforming items dispositioned "repair" or "use-as-is" are also documented.

7. Nonconformances to design requirements dispositioned "use-as-is" or "repair" are subject to design control measures as described in Section 2.3. The as-built records, if such records are required, reflect the accepted deviation. This as-built requirement applies only to those as-built conditions captured after the effective date of this Appendix.

8. Repaired or reworked items are reexamined in accordance with applicable procedures and with the original acceptance criteria unless the nonconforming item disposition has established alternate acceptance criteria.

2.16 Corrective Action

Section 2.16 "Corrective Actions" of the Q program applies.

2.17 Quality Assurance Records

Section 2.17 "Quality Assurance Records" of the Q program applies.

2.18 Audits

2.18.1 General

An audit system is established for AQ items and activities and services within the scope of this Appendix as described in Section 2.2. The audit system is in accordance with Basic Requirement 18 and Supplement 18S-1 of NQA-1,1989. This system establishes planned and periodic audits to verify the compliance and the effectiveness of this Appendix in meeting quality requirements. Audits are executed in accordance with established procedures and are performed by personnel having no direct responsibilities in the areas being audited.

Internal audits of selected aspects of operational activities are performed with a frequency commensurate with their safety significance and in such a manner as to assure that audits of activities within the scope of this Appendix, as described in Section 2.2, are completed within specified time periods.

Required external audits of suppliers of services are performed to verify compliance with applicable quality assurance requirements and procurement document requirements. External audits of suppliers of items is not required.

2.18.2 Responsibilities

The Nuclear Safety and Quality Manager is responsible for the development, maintenance, scheduling and performance of internal and external audits consistent with the requirements of this section.

Audited organizations are responsible for providing assistance as required during the planning and performance of audits, for providing access to facilities, personnel, documents, and records, as required, and for ensuring that requests for corrective action are promptly answered and that actions taken to correct any discrepancy are adequate and timely.

2.18.3 Requirements

2.18.3.1 Training and Qualification

1. Audit personnel shall be provided with appropriate training such that they are competent to perform the required audits; and

2. Auditors and lead auditors shall meet the training and experience requirements as described in Section 2.2.4. Technical specialists may participate as audit team members provided they receive the required indoctrination and guidance during the audit.

2.18.3.2 Scheduling

1. Internal and external audits are scheduled in a manner to provide coverage and coordination with ongoing QAP activities.

2. Audits are scheduled at a frequency commensurate with the status and importance of the activity.

3. The audit schedules are reviewed periodically and revised as necessary to assure coverage is maintained current.

4. Regularly scheduled audits are supplemented by additional audits or surveillance (assessment) of specific subjects when necessary to provide adequate coverage.

5. An implementation audit for initial evaluation of suppliers, when required by 2.7.3.2, may be scheduled and performed after award of the contract when sufficient time has lapsed for implementing their QA Program, and they are performing the functions as defined in their QA program, codes, standards, and other contract documents.

6. External audits of approved non-commercial grade suppliers are scheduled and performed at least once every three years from the date of the last acceptable supplier evaluation. The following alternatives apply:

    a. Approved non-commercial grade suppliers, if used infrequently, do not require re-audit every three years. However, they shall be audited prior to use if their QAP approval has lapsed.

b. Suppliers of services do not require external audit if they perform work to the USEC QAP and procedures under USEC supervision. Otherwise, external audit is required for suppliers of service.

c. Third party audits allowed by 2.7.3.2.4 are acceptable for triennial supplier re-audit.

7. Approved, non-commercial grade suppliers' performance is evaluated annually in the years between audits. External audits of non-commercial grade suppliers, after award of a contract, are not necessary for procurement actions when the items or services are all of the following: (1) relatively simple and standard in design, manufacture, and test; (2) subject to standard or automated inspections or tests of the end product to verify quality characteristics after delivery; and (3) such that receiving inspection does not require operations that could adversely affect the integrity, function or cleanness of the items.

2.18.3.3 Audit Plan

The auditing organization shall develop and document an audit plan for each audit. The plan is required to identify the audit scope, requirements, audit personnel, activities to be audited, organizations to be notified, applicable documents, schedule, and applicable written procedures or approved checklists, of questions covering the items to be audited.

2.18.3.4 Personnel and Selection of Audit Team

1. Measures are established for the selection of the audit team, and audit team familiarization prior to the beginning of each audit. These measures ensure consideration is given to special abilities, specialized technical training, prior experience, personal characteristics, and education when personnel are selected as audit team members;

2. The selected auditors shall be independent of any direct responsibility for performance of the activities which they will audit and, in the case of internal audits, personnel having direct responsibility for performing the activities being audited are not involved in the selection of the audit team;

3. The audit team shall contain one or more auditors and shall have an individual appointed to lead the team who organizes and directs the audit, coordinates the preparation and issuance of the audit report, and evaluates the responses; and

4. Measures are established for audit team preparation prior to initiation of the audit, particularly that pertinent information including policies, procedures, standards, instructions, codes, regulatory requirements, and prior audit reports, is available for review by the auditors for formulation of the checklist and the conduct of the audit.

2.18.3.5 Audit Performance

Audits shall be performed in accordance with the requirements of Supplement 18S-1, Section 4 of ASME NQA-1, 1989.

2.18.3.6 Reporting

1. The audit report is signed by the audit team leader. The report should be issued within 30 days of the post-audit conference. The audit report is distributed to responsible management of both the auditing and the audited organizations.

2. The audit report shall include the following information, as appropriate:

    1. Description of the audit scope;

    2. Identification of the auditors;

    3. Identification of persons contacted during audit activities;

    4. Summary of audit results, including a statement of the implementation effectiveness of the quality assurance program elements which were audited;

    5. Description of each reported adverse audit finding in sufficient detail to enable corrective actions to be taken by the audited organization (Audit findings are processed as required by QAP Section 2.16, "Corrective Action.")

2.18.3.7 Response and Follow-Up Action

1. Management of the audited organization or activity shall investigate adverse audit findings, identify and schedule corrective action, identify and schedule measures to prevent recurrence, and notify the appropriate organization in writing of the actions taken or planned. The adequacy of the written audit responses is evaluated by or for the auditing organization; and

2. Follow-up action shall be taken to verify that corrective action is completed as scheduled.

2.18.3.8 Records

Audit records include audit plans, audit reports, written replies, and record of completion of corrective action.

Appendix A

Section 3

AQ Structures Important to Safety

The following requirements apply for AQ structures important to safety identified in SAR Section 3.15.

3.1 Responsibilities

The Engineering Manager is responsible for inspection and evaluation of structures important to safety.

3.2 Requirements

3.2.1 Modifications or changes to structures require evaluation in accordance with SAR Section 6.3.

3.2.2 Engineering will inspect and evaluate the physical condition of structures on a five year cycle. The structural inspection will determine if structural degradation has occurred that will affect the building's structural capacity as described and analyzed in the SAR.

3.2.3 The building inspection will include the following items:

1. Foundations - Visible portions of the foundations for signs of settlement, anchorage integrity, cracking, spalling or other detrimental effects.

2. Building frames - Beam and column components for deformation and deflection.

3. Bracing - Bracing for trueness and deformation.

4. Connections - Connections for bolting and weld integrity.

5. Corrosion - Corrosion, such as paint degradation, rust, water damage, etc., found on the structural components for significance and potential repair.

3.2.4 As found conditions identified will be evaluated in accordance with SAR Section 6.3.

3.2.5 Modifications to structures will be conducted in accordance with Appendix A, Section 2.3.

3.2.6 Repairs to structures will be conducted by using the maintenance control system (maintenance service requests). Engineering will review work package instructions to ensure that no change to the building structural capacity has occurred. Repairs will be "like-for-like" or be evaluated as modifications.

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Appendix B

1.0 ITEMS ADDRESSED BY COMPLIANCE PLAN

This program is implemented as described with exception(s) as listed below. The listing of the exception(s) also contains a brief description of what is currently in place at the plant. The Compliance Plan provides a description of the exceptions (noncompliance), a justification for continued operation, a description of the actions to be taken to achieve compliance and the schedule for completion of those actions.

1. Except as described below, non-compliances associated with procedures, equipment, and training needed for implementation of Q requirements (described in Sections 2.2 through 2.17 of the QAP), and AQ requirements (described in Sections 2.2 through 2.17 of Appendix A of the QAP), are addressed in the respective sections of the SAR related to the implementation of those requirements (e.g., Records Management non-compliances are addressed in SAR Section 6.10 and PGDP Compliance Plan Issue 26). Refer to the SAR and associated Compliance Plan Issues for a description of these non-compliances, JCOs, and corrective action plans.

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Appendix C

TECHNICAL JUSTIFICATIONS FOR EXCEPTIONS TO THE QAP

Exception for the Paducah Records Storage Vault

The following is the technical justification for an exception to the requirements of NQA-1, 1989 for the records storage vault. An exposed fire protection sprinkler pipe passes through the records storage vault as well as two roof drain lines and there are no floor drains. The following explanation and technical justification provides reasonable assurance of the integrity of the stored records in the unlikely event of a pipe failure.

Detailed Problem Statement

The C-100 Records Storage Vault does not conform to NQA-1, Supplement 17S-1, Section 4.4.1 Part (b) which requires the record storage area to have a floor with drainage control. There are no floor drains in the vault. Additionally, NQA-1, Supplement 17S-1, Section 4.4.1 Part (i) requires only those penetrations used exclusively for fire protection, communication, lighting, or temperature/humidity control to be allowed. There are two roof drain lines which penetrate the records storage vault. This justification addresses the unlikely event of a pipe failure or inadvertent sprinkler activation and determines the integrity of the stored records in exception to these NQA-1 requirements.

Impact on Nuclear Safety

Sections 2.17.3 (8) and (9) of the Quality Assurance Program (QAP) require that quality assurance records are protected and stored in facilities which meet the requirements of Supplement 17S-1, Sections 4.1 through 4.4 of ASME NQA-1, 1989. This applies to the C-100 Records Storage Vault such that the integrity of the records be protected from damage. This is not a nuclear safety issue.

Summary of Evaluation Results

The maximum anticipated pool of accumulated water from the failures addressed in this evaluation would be 3.0". The existing storage in the vault is arranged to be above the anticipated pool level of 3.0" caused by either a roof drain failure or an inadvertent sprinkler activation. Records stored on top of shelving are protected from sprinkler activation by use of metal shelf covers. Where shelving with covers is not used, the records are stored in boxes with tops. If the fire protection system in the C-100 Records Storage Vault becomes impaired, a 4-hour fire patrol is acceptable.

Evaluation

The records storage in the first floor vault of the C-100 Building were reviewed. Two failures were considered independently: 1) one of the two roof drains experiences a guillotine failure, releasing its entire capacity into the vault for a 100 year flood; and 2) inadvertent activation of one sprinkler head releasing water for approximately 30 minutes.

Roof Drain Failure

The SAR was reviewed and the precipitation in inches of a 100 year storm was determined to be 5.02 inches for 6 hour storm duration (Table 2.4-2 of SAR-PGDP). There are two roof drains for the vault roof but it was assumed that only one of the roof drains would fail. The roof has the same surface area as the first floor vault. Approximately 20% of the vault floor was assumed to be occupied due to the mobile shelving foundation, columns, and on-floor items, therefore the total depth of the water would be increased by 20%. Assuming only one roof drain failing, half of the 5.02 inches would flood the first vault floor to a depth of approximately 3.0".

Although for purposes of this evaluation the vault door was considered water tight; the door will in fact leak. This is conservative.

Inadvertent Sprinkler Activation/Failure

Each of the sprinklers in the C-100 first floor vault are independent and only one (1) sprinkler head inadvertently operating is assumed at any given time. The sprinkler piping is (typically schedule 40) steel. Due to the lack of moving equipment in the area, pipe failure was not anticipated.

The discharge from a single sprinkler head would cause water to pool approximately 3 inches in the vault within approximately 72 minutes. The vault sprinkler system alarm is continuously monitored by plant staff. The fire department response to an alarm is on the order of a few minutes. Valves are readily available outside the vault to shut the sprinkler system off, if needed. Fire department personnel could access the vault and decide to shut off the sprinkler system within a 30 minute time frame.

Upon activation of the sprinkler system, water could spray onto records located on the tops of storage shelves in the vault. In order to meet NQA-1, Supplement 17S-1, Section 4.2 requirements, RMDC utilizes shelving with metal covers to protect these records. Where such shelving with covers is not used, the records are stored in boxes with tops. These methods provide reasonable assurance that records located on the tops of shelves in the vault will not be damaged in case of sprinkler activation.

Fire suppression systems are required by NQA-1 to protect records from loss due to fire. As described in SAR 5.4, “Fire Protection,” and plant procedures, an impairment control program is implemented, requiring a 4-hour fire patrol which is typical in the fire industry. If the fire protection system in the C-100 Records Storage Vault becomes impaired, the typical 4-hour fire patrol is acceptable. For records to become water damaged it would require two concurrent conditions. The detection system would need to be impaired (while the suppression system is still valved-in) and a sprinkler head would need to inadvertently open (for a duration greater than 72 minutes). These are very unlikely to occur simultaneously. A 4-hour fire patrol would provide reasonable protection of records from water damage, including flooding, based upon the risk and duration of such circumstances. The expectation is that the impaired equipment be repaired expeditiously.

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PADUCAH GASEOUS DIFFUSION PLANT

EMERGENCY PLAN

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PLAN SUMMARY

In accordance with 10 CFR 76.91, the United States Enrichment Corporation (USEC) has established and shall maintain and be prepared to follow the Paducah Gaseous Diffusion Plant (PGDP) Emergency Plan (the Plan) to ensure that plant personnel are adequately prepared for accidents and other emergencies involving the potential release of radioactive materials and that prompt, orderly, and effective response actions are taken to mitigate the consequences of such accidents and emergencies and protect the health and safety of the public and workers at the plant.

This Plan is implemented by the Emergency Plan Implementing Procedures (EPIPs). The EPIPs address generic requirements for responses to incidents involving hazardous chemicals, radioactive materials, natural phenomena, and other adverse conditions. The Plan and the accompanying EPIPs meet 10 CFR 76.91.

The Nuclear Regulatory Commission (NRC) Notice promulgating Title 10 Code of Federal Regulations (CFR) Part 76 confirmed that the emergency planning requirements set forth in 10 CFR 70 for other nuclear fuel cycle facilities are appropriate for the gaseous diffusion plants (GDPs) and that the requirements in 10 CFR 76.91 are based upon the emergency planning provisions in 10 CFR 70. Accordingly, the format of the Plan is generally based upon NRC Regulatory Guide 3.67, "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities" (January 1992). Additionally, PGDP emergency action levels have been developed using examples provided in this Regulatory Guide. The details of the EPIPs implementing each section of the Plan are not included in the Plan itself, but the Plan includes a general description of the procedures that are followed in connection with each activity to demonstrate that appropriate actions can and will be taken to mitigate accident consequences and to protect the health and safety of the public and plant personnel in the event of an emergency.

The Plan provides an overall description of the comprehensive site-wide emergency preparedness program and is based in large measure on the emergency preparedness policies, procedures, and practices that have been successfully used at PGDP for over 40 years. This program has been established to manage and respond in a consistent and integrated way to accidents or other emergency situations that may occur at the site. The structure of this program is intended to ensure that the consequences of emergencies are promptly mitigated and that the health and safety of the public, personnel on the surrounding Department of Energy (DOE) reservation, and plant personnel are protected, regardless of the cause or nature of the emergency. Therefore, the Plan addresses both radiological and nonradiological emergencies as well as potential emergencies arising out of activities at the site which are not regulated by the NRC.

The scenarios addressed in the Plan include accidents involving radioactive materials, nonradioactive materials, and chemicals; fires; natural disasters such as earthquakes and tornadoes; and security-related emergencies. The scenarios include a large uranium hexafluoride (UF_6) release.

The Plan includes a general description of the leased plant property, the surrounding DOE reservation, and the surrounding area. It identifies the types of accidents and the emergencies for which protective actions may be needed and describes the manner in which accidents are detected and classified.
The Plan also contains a description of the policies and procedures that are followed for the notification of and communication with plant personnel, DOE reservation personnel, local governments, and regulatory agencies in the event of an emergency, and for the coordination of the emergency response activities of both on-site and off-site response organizations. The Plan provides a description of the

responsibilities of the key individuals and organizations involved in emergency response activities and the manner in which the consequences of an emergency are mitigated and assessed. The Plan also includes separate sections and subsections addressing the establishment and maintenance of emergency response equipment, facilities, and capabilities, the training and exercises that are conducted to maintain and enhance emergency preparedness, the manner in which plant equipment and systems are restored to a safe condition after an accident and all other topics required under 10 CFR 76.91. The Plan also confirms that USEC has met its responsibilities under the Emergency Planning and Community Right-to-Know Act of 1986. The Plan is maintained and updated by USEC. In accordance with 10 CFR 76.91(o), USEC may change the Plan without receiving prior NRC approval, providing the change does not decrease the effectiveness of the Plan and the NRC and affected off-site response organizations are provided with copies of any changes to the Plan.

In summary, the Plan is the master document addressing the emergency preparedness program and the policies, procedures, and actions that will be implemented in any emergency arising from activities at the GDP or from outside sources affecting personnel working at the GDP to mitigate the consequences of the emergency and protect the health and safety of the public, personnel on the DOE reservation, and plant workers.

1. FACILITY DESCRIPTION

USEC leases portions of Paducah DOE reservation from the Department of Energy (DOE) and conducts uranium enrichment activities at the plant. These uranium enrichment activities are regulated by the NRC. DOE and DOE contractors also conduct activities and operate other facilities at the site, which are not regulated by the NRC.

1.1 DESCRIPTION OF NRC-REGULATED ACTIVITIES

The primary mission of the plant is the enrichment of uranium with the isotope necessary to produce fuel for nuclear reactors (^{235}U) using the gaseous diffusion process. A basic summary of this process follows.

Uranium hexafluoride is received from the conversion plant operated by Honeywell Corporation in Metropolis, Illinois, and other conversion facilities. The material is shipped to PGDP by truck and rail in cylinders containing 10 or 14 tons of UF_6 in accordance with Department of Transportation (DOT) regulations.

When UF_6 is received, it is assayed and weighed in the toll cylinder facility and stored. When needed, the assayed cylinder is moved to a feed facility, heated, and evacuated to the gaseous diffusion enrichment process.

Uranium hexafluoride is a white crystalline solid at ambient pressures and temperature and a gas at process conditions. The enrichment method increases the concentration of ^{235}U by the physical process of diffusion. The UF_6 gas is not physically altered nor are its chemical properties changed.

The gaseous diffusion enrichment process employs a series of compressors and converters to enrich UF_6 in ^{235}U. The fundamental building block of the process consists of a compressor, a converter, and a motor that form a stage. Stages are grouped together to form cells. The cells are then interconnected to provide what is known as a cascade. The compressors, which are driven by electric motors, are used to circulate the process gas and maintain flow through the cascade. The converters contain porous tubes and barriers through which the process gas is diffused. In each converter, a portion of the process gas diffuses through the barrier and is fed to the next higher stage with the undiffused gas being recycled to the next lower stage. The diffused stream is slightly enriched in the 235 isotope while the undiffused portion is slightly depleted in the 235 isotope to the same degree. Each stage also contains a gas cooler to remove the heat of compression from the process gas and a control valve for process control. The process is repeated through numerous cells until the desired enrichment level is reached.

Upon completion of the enrichment process, the enriched portion of the process stream is extracted in the product withdrawal facility and placed in 10-ton or 14-ton (< 1.0 wt % ^{235}U) cylinders. The 10-ton cylinders $\leq$ 4.5 wt % ^{235}U may be shipped by rail or truck, in accordance with DOT and state requirements, to the Portsmouth Gaseous Diffusion Plant (PORTS) for shipping to a customer or to a licensed or DOE-operated facility for conversion to uranium metal. The 10-ton cylinders > 4.5 wt % ^{235}U are transferred to 2.5-ton cylinders prior to shipping. Any of these 10- or 14-ton cylinders may be refed to the cascade.

The depleted portion of the process stream is extracted in the tails withdrawal facility in 10- or 14-ton cylinders. The depleted uranium cylinders are moved to the cylinder storage yards located within the fence of PGDP, where they are currently being stored.

PGDP is designed to operate at a capacity of 11.3 million separative work unit (SWU) annually at its rated power level of 3,040 MW.

Source material, special nuclear material (SNM), and byproduct material are primarily handled in the buildings and storage yards listed in Table 1-1 and 1-2, respectively. The possession limits for source material, byproduct material, and SNM are shown in Table 1-3 of the Safety Analysis Report.

Uranium hexafluoride (UF_6) is a radioactive, poisonous material, which is found at PGDP as a gas liquid and solid. Additionally, UF_6 reacts with water to form hydrogen fluoride (HF) and uranyl fluoride (UO_2F_2). UF_6 and UO_2F_2 are chemical toxological hazards due to the heavy metal properties of uranium.
The organs primarily affected are the kidneys. HF is an acid and may cause effects from irritation of skin, eyes, mucous membranes, and lungs to chemical burns causing deep tissue destruction. The radiotoxological effects of uranium at the assays encountered at PGDP are not significant when compared to the chemical toxological effects.

Numerous substances associated with the enrichment process could pose hazards if they were released to the environment. Only a few of these substances are highly toxic and present in large quantities at the plant. Based upon the hazards and consequence analyses that have been conducted, USEC has concluded that any nonradiological hazardous release would most likely involve one or more of the following:

- Chlorine trifluoride (ClF_3) is a poisonous gas, oxidizer, and corrosive. Additionally, ClF_3 reacts with water to form hydrogen fluoride and chlorine. ClF_3 is used as a drying agent in the cascade and is purchased and delivered in 160-lb cylinders. Cylinders are stored in the C-745-B cylinder yard and are transferred as needed to the C-350 drying agent storage building. The ClF_3 is vaporized into the C-350 ClF_3 storage drum, which is used for the controlled flow of ClF_3 to the distribution piping. This permits the controlled flow of ClF_3 to the C-310 building and to the C-331 and C-335 buildings' metering station for cell treatment on an as-needed basis. The inventories are controlled so that less than 1,000 lbs of ClF_3 are available for release from a single credible accident.

- Nitric acid (HNO_3) is a volatile, corrosive liquid. HNO_3 up to 70% concentration is delivered by truck and is stored in a 11,000 gal tank located outside the southwest corner of building C-400. Prior to use, the acid is transferred to and stored in a 500-gal day tank inside the building. HNO_3 is used primarily in a solution with water to decontaminate uranium-contaminated metal surfaces. It is also used for other miscellaneous chemical operations. The maximum inventory of HNO_3 at PGDP is limited by the capacity of the storage tanks.

- Hydrochloric acid (HCl) is a volatile, corrosive liquid. HCl is delivered by truck and is stored in a 17,000 gallon, two-section tank each containing 8,500 gallons, inside building C-400. Prior to use,

the acid is diluted to less than 30% to form a "pickling" solution to be used as part of the cleaning process after degreasing.

- Fluorine (F_2) is a poisonous gas and oxidizer that is used to passivate metal surfaces prior to exposure to UF_6 and for cell treatment on an as-needed basis. F_2 is purchased and stored in multi-tube trailers that contain a high pressure gas mixture that is composed of 20 percent F_2 and 80 percent nitrogen (N_2) by moles. A multi-tube trailer nominally contains 1800 lbs of F_2 contained in 8 separately isolated tubes (i.e., nominally 225 lbs of F_2/tube) at a nominal pressure of 2000 psig. One nominally full and one nominally empty (i.e., heeled) multi-tube trailer may be stored in both the C-745-A and C-745-B storage yards. A multi-tube trailer at C-410-K and the three nominally 1000 ft^3 storage tanks in C-410-D are used to feed the F_2 distribution header in C-410-D.

- Chlorine (Cl_2) is a poisonous gas used for water and sewage treatment. An important function of the water treatment process is prechlorination for removal of disease-carrying organisms. Cl_2 is purchased and stored in 1-ton containers and 150 lb cylinders. One-ton chlorine containers are used in building C-611 water treatment plant (6 total containers) and in buildings C-631, C-633, C-635, and C-637 water treatment pump houses and appurtenant structures (12 cylinders total). Eight one-ton containers are normally stored in the C-745-A cylinder storage yard. The quantity of chlorine kept at C-615 is administratively controlled below the 29 CFR 1910.119, Appendix A, process threshold quantity. A maximum of six 150-lb cylinders are stored and used at the building C-615 sewage treatment plant.

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1.1.1 DESCRIPTION OF DOE-REGULATED DUF_6 CONVERSION ACTIVITIES

USEC provides emergency response for activities in the PGDP site and within the DOE reservation. The DOE regulates a depleted uranium hexafluoride (DUF_6) conversion facility that is located on the DOE reservation south of the PGDP site. The DOE conversion facility removes DUF_6 from cylinders by vaporization, converts DUF_6 to uranium oxide (U_3O_8) and hydrogen fluoride (HF) vapor. The HF vapor is condensed into an aqueous solution (HF acid). The uranium oxide solid and HF acid are loaded into appropriate containers and shipped off-site by trucks or railcars. The main operations conducted in the conversion facility include:

- Storage, handling and movement of cylinders of UF_6, primarily depleted enrichment uranium,
- Receipt and preparation of the cylinders for heating in the processing building,
- Heating, feed and conversion of the DUF_6 to uranium oxide and storage of uranium oxide in disposal containers,
- Collection, purification and packaging of HF for offsite shipment,
- Production of hydrogen from natural gas for use in the conversion process,
- Treatment and/or disposition of process wastes,
- Handling and shipping of uranium oxides and other waste materials.

DOE approved a documented safety analysis (DSA) with associated technical safety requirements (TSRs) for the operation of the DUF_6 Conversion Facility. The DSA identifies that the conversion facility uses a standards-based, defense-in-depth design that meets or exceeds the DOE requirements established for new facilities. The DSA qualitatively concludes that the safety-significant administrative and engineering controls identified in the DSA and implemented through associated TSRs provide

reasonable assurance that the conversion facility operations do not pose an undue risk to the offsite public, onsite worker, or facility worker.

A number of substances associated with the DUF_6 conversion process could pose hazards if they were released to the environment. A smaller number of substances used in the DUF_6 conversion plant are highly toxic and present in relatively large quantities. The following is a brief description of each of these more highly toxic substances, the manner in which they are used in the DUF_6 conversion processes, and the locations where they are stored or used at the conversion facility.

1. Depleted Uranium hexafluoride (DUF_6 or depleted UF_6). In gaseous and liquid forms, UF_6 can present a significant hazard if released. Material in these forms is used with the conversion process and is primarily located in the Conversion Building. DUF_6 (primarily in solid form) is located in the cylinder storage/staging areas.

2. Hydrogen Fluoride (HF). Hydrogen fluoride is a product of the conversion process. It is produced as a gas and condensed into a liquid solution (e.g., 55 weight% in water). Material in these forms is present in the Conversion Building, the HF recovery system, and the HF storage tank system.

3. Uranium Oxide. Uranium oxide is a product of the conversion process. First DUF_6 is converted into uranyl fluoride (UO_2F_2) and HF. The resulting UO_2F_2 is then converted into uranium oxide (primarily U_3O_8). Material in these forms is present in the Conversion Building and oxide cylinder staging area.

1.2 DESCRIPTION OF FACILITY AND SITE

The Paducah Gaseous Diffusion Plant is located at latitude 37°06′49″ N. and longitude 88°47′39″ W. measured at the center of the plant, on a 3,423-acre tract in McCracken County, Kentucky. The site is generally in a rural area and was previously part of the Kentucky Ordnance Works. Approximately 2079 acres of the site are leased to the Kentucky Department of Fish and Wildlife Resources. The largest cities within a 50-mile radius are Paducah, Kentucky, located approximately 12 miles to the east, and Cape Girardeau, Missouri, located approximately 40 miles to the west. Portions of 28 counties are located within a 50-mile radius of the plant. Of the 28, 11 are in Kentucky, 4 are in Missouri, 10 are in Illinois, and 3 are in Tennessee. Figure 1-1 shows the regional area surrounding PGDP. The general location is an area of low relief with elevations predominantly below 500 ft. The region contains many rivers and streams. The largest rivers in the area are the Mississippi to the west, the Ohio to the north, and the Tennessee and the Cumberland to the east. The plant site and surrounding area elevations vary from 290 ft above sea level at the Ohio River to 380 ft above sea level at the plant site 3.6 miles away. The average slope of 23.7 ft/mile is typical of both the immediate vicinity and the region south of the Ohio River.

There are no institutional or residential structures within the plant property, nor are any military installations located near the site. DOE is engaged in numerous activities related to cylinder management, operation of a depleted UF_6 conversion facility, and decommissioning and decontamination both within the fenced plant protected area and on the surrounding DOE reservation.

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Roadways within the fenced, limited access or protected area of the plant consist of approximately 23 miles of paved surface. Several paved roads branch to the periphery of the plant area. Water Works Road extends from the southwestern corner of the secured area west to the water treatment plant. The plant access road extends from the main plant entrance to Kentucky Highway 1154 (Woodville Road), which in turn connects with U.S. 60. One intersection exists on the plant entrance road. At this location, South Acid Road leads to the west, and Dykes Road wraps around the eastern side of the plant. Dykes Road and McCaw Road, which enters the area from the east, are access routes for shipments to and from the toll enrichment facility, C-360.

Rail is a means used for cylinder movements and coal shipments. The existing rail system is approximately 17 miles in length. The rail spur enters the site west of C-720 and branches to several areas inside the fence. With the exception of the metals plant (C-340) and the water treatment plant (C-611), all the process buildings and most of the support facilities have direct rail service.

No rivers or major streams traverse the plant area. However, two small tributaries of the Ohio River, Little Bayou Creek on the east and Big Bayou Creek on the west, provide surface drainage from the PGDP site. These creeks have little flow other than treated effluents from the plant except during the wetter months of the year. The two streams join north of the site and discharge to the Ohio River. An extensive system of dikes and inverted pipe dams are in place to contain on-site spills of hazardous substances that might otherwise enter these waterways. Cooling water for plant processes is taken from the Ohio River and discharged through Big Bayou Creek.

PGDP is situated on a fenced approximately 650-acre (controlled access area) site, which is part of the 3422.95-acre DOE reservation as shown in Figure 1-6 and on the Paducah Gaseous Diffusion Plant Facility Lease Status map. More than 115 buildings and structures are located at PGDP accounting for a cumulative gross floor area of 8,183,718 ft^2. Process buildings C-333 and C-337 contain the most space, each having a gross area of 2,130,120 ft^2. The Paducah Gaseous Diffusion Plant Facility Lease Status map shows the plant layout at PGDP. The plant includes six major process buildings, a series of electrical switchyards, storage areas, cooling towers, a steam plant, a water treatment plant, a sewage disposal plant, a pollution abatement facility, service and maintenance buildings, and facilities for administration, medical, fire, and security.

The plant contains four large process buildings, which are referred to as the cascade buildings. These are designated C-331, C-333, C-335, and C-337. Two small buildings, C-310 and C-315, are referred to as the purge and product withdrawal building and the surge and waste building, respectively. Some of the instruments and controls in these buildings are duplicated in the C-300 Central Control Facility (CCF). This facility also contains the Emergency Operations Center (EOC) and the headquarters of the Plant Shift Superintendent (PSS). A description of the cascade/process buildings and key support buildings is as follows:

The four main process buildings are grouped in two pairs, C-331 and C-333 and C-335 and C-337, which are located in the eastern portion of the plant site. Such a grouping permits easy connection of the multitude of overhead and underground piping and service lines required between the process buildings. The purpose of the process buildings is to house the equipment and much of the support systems necessary for the isotopic separation of uranium. Buildings C-331 and C-335 are essentially identical, as are C-333 and C-337.

The vaporization facilities (C-333-A and C-337-A) are located adjacent to their respective process buildings. These are the entry points of the feed material into the cascade. Autoclaves are used to vaporize the feed from the cylinders.

The purge and product withdrawal building (C-310) is used to withdraw the product after enrichment. The product material UF_6 is transformed from the gaseous to the liquid state, loaded into cylinders, and solidified.

The surge and waste building (C-315), which contains the tails withdrawal system, is where depleted UF_6 is withdrawn as a liquid, and then stored as a solid in cylinders before it is moved to a storage area.

There are 2 monitored release points, the C-310 Purge Vent Stack and Alternate Purge Vent Stack; neither of these could be a major release pathway. Major hazardous material release pathways to the environment would be directly to the atmosphere or through process building ventilation exhaust systems.
Both of these pathways would be modeled as ground level releases. A summary of air emission point data can be found in SAR Table 5.1-3.

The toll transfer and sampling building (C-360) is the central receiving and shipping point for all toll UF_6 entering and leaving the plant. The building houses equipment necessary to sample, transfer, and weigh the cylinders for accountability purposes.

For the purposes of emergency management, the entire DOE reservation is assumed to be controlled by USEC in that lease and contractual agreements exist between USEC and DOE or between their respective contractors that govern site responsibilities and services to be provided. In this capacity, USEC prescribes protective actions for all persons on the DOE reservation. Persons at the DOE reservation boundary are considered members of the public. State and county functions recognize the DOE reservation boundary as the defining boundary between the public and PGDP.

1.3 DESCRIPTION OF AREA NEAR THE SITE

The areas adjacent to the site are largely agricultural, with a relatively low population density. Agricultural and forested land predominate land use patterns in the surrounding area. Agricultural and open-space land account for approximately 75% of the area surrounding the plant. Urban/built-up areas total approximately 10% of the nearby area.

With the exception of the host county of McCracken, counties adjacent to the plant include Ballard, Carlisle, Graves, and Marshall in Kentucky and Massac in Illinois. Nearby cities, and their approximate distances from the site, include Metropolis, Illinois, 6 miles northwest; Mayfield, Kentucky, 28 miles south-southeast; and Benton, Kentucky, 31 miles southeast. Other cities in the area are small, with populations averaging 1,000 people. Communities closest to the site include the unincorporated towns of Grahamville, Heath, Kevil, Woodville, and Rossington, all of which are within approximately 3 miles of the site. Paducah, located about 12 miles east of the plant and the largest city in the region, has an estimated population of 26,307 (2000). As Figure 1-4 indicates, PGDP is in a rural, low-population area. The plant is well separated from high-density, high-growth-rate areas that might complicate emergency preparedness efforts.

There are no facilities such as schools, nursing homes, or prisons located within an 1-mile radius of the plant nor does the area contain any industrial facilities as shown in Figure 1-5. The plant has established an Immediate Notification Area, shown in Figure 1-6, which extends approximately two miles from the center of the plant. The plant would use the Public Warning System to notify members of the public within this area in the event of a radiological or chemical release.

The plant maintains Letters of Agreement with off-site emergency support organizations such as fire departments, law enforcement agencies, hospitals, and other emergency support groups. The descriptions of services and locations of support organizations are included in Section 4.3.

Table 1-1. Buildings where quantities greater than 10 mCi of NRC-regulated materials are handled.

Building Number	Primary Regulated Material Handled (See SAR Table 1-3)	Principal Activity Conducted
C-310	A,B,C	Purge and Product Withdrawal
C-310-A	A,B,C	Product Withdrawal
C-315	A,B,C	Surge and Waste
C-331	A,B,C	Cascade Process
C-333	A,B,C	Cascade Process
C-333-A	A,B,C	Feed Vaporization
C-335	A,B,C	Cascade Process
C-337	A,B,C	Cascade Process
C-337-A	A,B,C	Feed Vaporization
C-360	A,B,C	Toll Transfer and Sampling
C-360-A	A,B,C	Toll Transfer and Sampling Annex
C-400	A,B,C,D	Decontamination and Related Activities
C-409	A,B,C,D	Decontamination, Related Activities, and Packaging Sample Cylinders
C-709	A,B,C,D,E	Laboratory
C-710	A,B,C,D,E	Laboratory
C-720	A,B,C,D,E	Maintenance and Stores
C-721[a]	D,E	Storage of Sources
C-727	A,B,C,D	Low-Level Waste Storage
C-745-R1	A,B,C	Cylinder Changeout Building
C-746-Q1	A,B,C,D	Higher Assay Waste Storage
C-754	A,B,C,D	Low-Level Waste Storage
C-754-A	A,B,C,D	Low-Level Waste Storage
C-754-B	A,B,C,D	Low-Level Waste Storage

a. Density meters are stored in this facility but are used site-wide for measurements.

Table 1-2. Storage yards where quantities greater than 10 mCi of NRC-regulated materials are handled.

Yard Number	Primary Regulated Material Handled (See SAR Table 1-3)	Principle Activity Conducted
C-745-A	A,B,C	UF_6 Cylinder Storage
C-745-B	A,B,C	UF_6 Cylinder Storage
C-745-E	A,B,C,D,E	Kellogg Storage[a]
C-745-H	A,B,C	UF_6 Cylinder Storage
C-745-Q	A	UF_6 Cylinder Storage
C-745-R	A	UF_6 Cylinder Storage
C-745-U	A	UF_6 Cylinder Storage
C-745-V	A	UF_6 Cylinder Storage
C745-X	A, B. C, D	Storage of Failed Cascade Equipment[a]
C-745-Y	A, B. C, D	Storage of Failed Cascade Equipment[a]

a. Storage of contaminated equipment with inaccessible surfaces that are possibly contaminated with regulated material.

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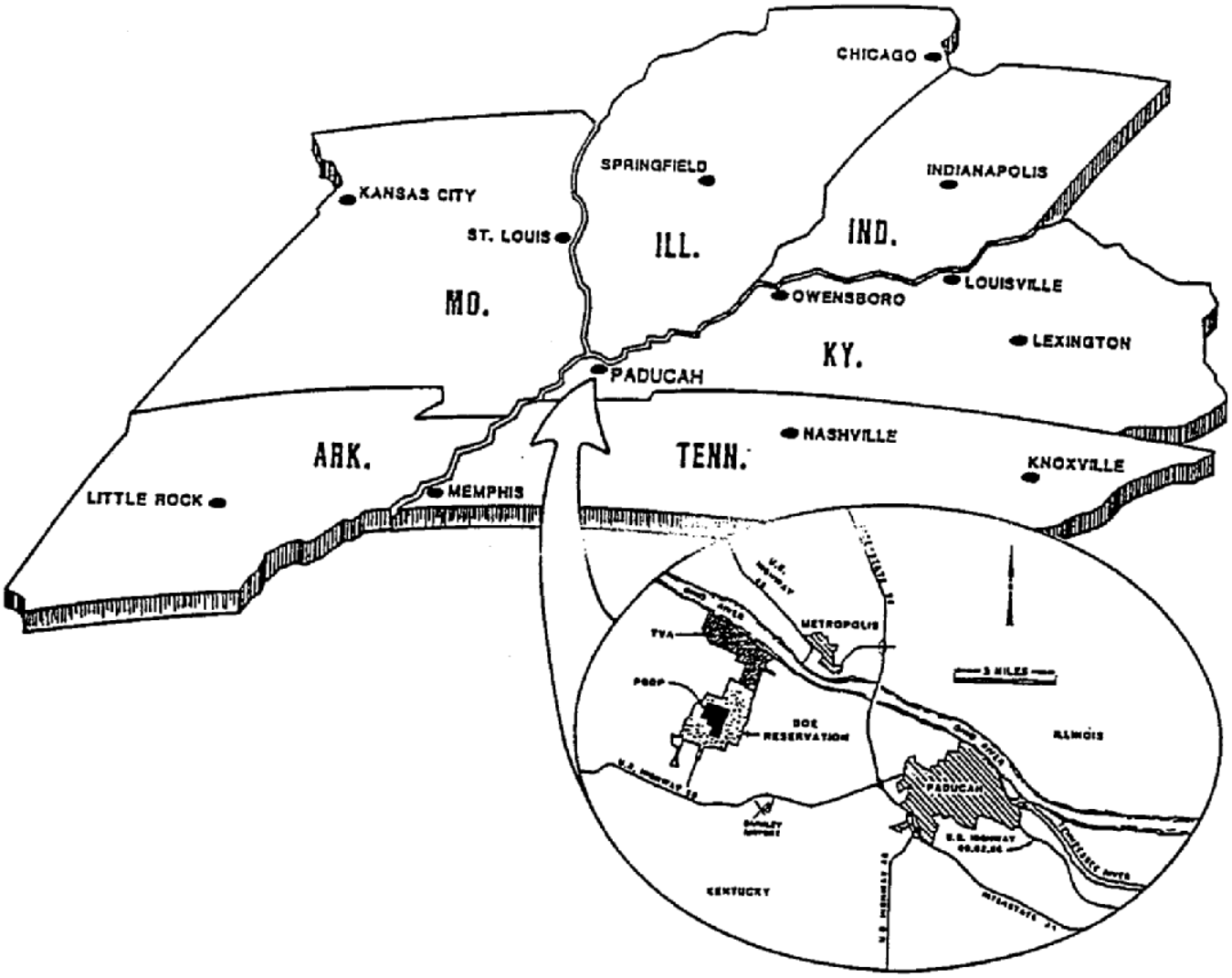

Figure 1-1. Regional area surrounding PGDP.

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by USEC letter GDP 95-0010 dated September 15, 1995.
A copy this oversized figure (USGS Topographical Map
is available for reference at Emergency Management.

Figure 1-5. USGS topographical map.

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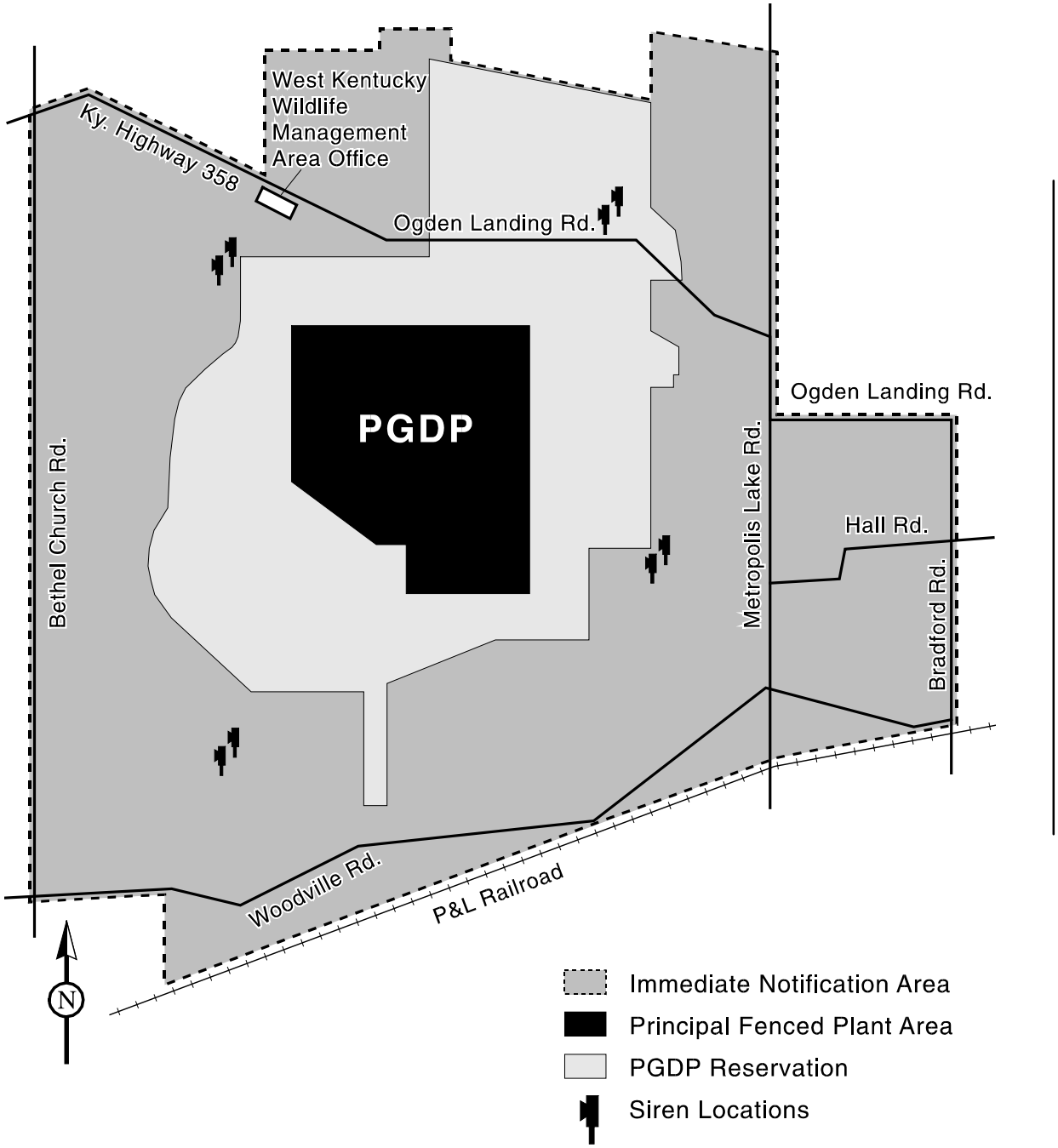

Figure 1-6. Immediate notification area.

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2. TYPES OF ACCIDENTS AND OTHER EMERGENCIES

A hazards and consequence analysis (hazards analysis) forms the basis for this emergency preparedness plan. The NRC Notice promulgating 10 CFR 76 indicated that the regulatory analysis for the emergency preparedness requirements for other nuclear fuel cycle facilities regulated by the NRC "concluded that off-site emergency preparedness should be based on chemical toxicity from a large UF_6 release."[a]

This Plan is based upon an evaluation of the risks associated with various accident scenarios identified in the site-specific hazards analysis for PGDP and other potential emergency situations at PGDP. This analysis concluded that the most extreme credible scenario would be an accident involving a large UF_6 release. The analysis included consideration of the risks associated with the potential release of other hazardous radioactive and nonradioactive materials stored or used on-site. These other hazardous materials are identified in Material Safety Data Sheets (MSDS), the chemical inventory, information from the Safeguards and Security Plan, the Spill Prevention, Control and Countermeasure Plan, and Hazardous Waste Contingency Plans.

Each type of credible accident or event that could result in an emergency associated with these hazards has been identified and analyzed to assess the potential consequences to plant workers, the public, the environment, and on-site and off-site property.

This Plan is applicable to radiological and nonradiological accidents or other emergencies that could occur, including the following:

1. Hazardous materials (HAZMAT) releases involving toxic or radioactive materials,
2. Fires,
3. Industrial accidents,
4. Equipment failures or misoperations,
5. Natural phenomena such as tornadoes and earthquakes, and
6. Security-related events, such as bomb threats, civil disturbances, extortions, and hostage takings.

2.1 DESCRIPTION OF POSTULATED ACCIDENTS AND OTHER EMERGENCIES

Various hazardous materials are used or stored at the site. Accidents involving the release of these materials could require an emergency response. Fires, a nuclear criticality event, or severe natural phenomena could also require an emergency declaration and/or response.

a. 59 Federal Register 48946 (September 23, 1994).

It should be noted that other events that do not meet the criteria for classification as an emergency under this Plan may also require reporting to federal, state, and local agencies, require time-urgent mitigation efforts, or possibly impact plant operations. Examples of these types of events include certain equipment failures or industrial accidents and loss of power, steam, process water, or compressed air to certain areas of the site.

The following sections contain brief descriptions of each of the types of accidents and other events that could be classified as potential emergencies under the Plan, based upon the hazards analyses.

2.1.1 Nuclear Criticality Event

Based on the safe operating history of the plant, a nuclear criticality is very unlikely. Detectors and alarm systems are in place as described in Section 5.2 of the Safety Analysis Report (SAR). The consequences of an inadvertent criticality event are likely to be limited to a localized region. Because criticality produces primarily local radiation effects, the expected consequences are limited to the on-site workers with no effects to persons at the DOE reservation boundary. No significant fission product release and transport are anticipated from an inadvertent criticality event.

2.1.2 UF_6 Release

UF_6 reacts with moisture in the air. The resulting hydrolysis produces uranyl fluoride particles and hydrogen fluoride (HF) gas. The radiotoxicity of uranium is insignificant when compared with its chemical toxicity. Radiation doses received by persons at the DOE reservation boundary due to a UF_6 release would also be insignificant.

2.1.2.1 Liquid Cylinder Rupture

The dropping and rupturing of a UF_6 liquid cylinder at the Building C-310, C-315, or C-360 outdoor cylinder areas could result in a significant on-site and off-site hazard. Historical evidence indicates an incident involving the rupture of a liquid 14-ton UF_6 cylinder could release UF_6 into the atmosphere. In the worst-case scenario, serious injuries or fatalities could occur on-site, at the DOE reservation boundary, and beyond. Sheltering citizens in the path of the plume would greatly mitigate the consequences.

2.1.2.2 Other Postulated UF_6 Releases

Other postulated UF_6 releases would present lower potential on-site and DOE reservation boundary consequences.

2.1.3 ClF_3 Release

ClF_3 cylinders are stored in the C-745-B cylinder yard and in Building C-350 and could be released if a valve broke and ignited nearby cylinders. ClF_3 reacts with water to form hydrogen fluoride and chlorine. In the worst-case scenario, serious injuries or fatalities could occur on-site. However, due to the limited quantity of material available for release and the low probability of coincident extreme atmospheric conditions, no hazards should exist at the DOE reservation boundary.

2.1.4 HNO_3 Release

Nitric acid is stored in the C-400 area and is used for miscellaneous chemical operations and maintenance activities. Nitric acid is volatile and corrosive. In the worst-case scenario, serious injuries or fatalities could occur on-site, sheltering citizens in the path of the plume would greatly mitigate the consequences at the DOE reservation boundary, and beyond.

2.1.5 F_2 Release

Fluorine is delivered to C-745-A, C-745-B or C-410-K and fed to storage tanks in the C-410-D and C-350 buildings. Fluorine is used to pacify metal surfaces prior to exposure to UF_6 and for cell treatment on an as-needed basis. Fluorine is a poisonous gas and readily combines with water vapor to form HF. In the worst-case scenario, serious injuries or fatalities could occur on-site, at the DOE reservation boundary, and beyond. Sheltering citizens in the path of the plume would greatly mitigate the consequences.

2.1.6 Cl_2 Release

Chlorine is used in water and sewage treatment. One-ton chlorine containers are used in building C-611 water treatment plant and in buildings C-631, C-633, C-635, and C-637 water treatment pump houses and appurtenant structures. One-ton containers are stored in the C-745-A storage yard. Cylinders (150 lb) are stored and used at the building C-615 sewage treatment plant. A cylinder or container rupture could release Cl_2 gas, and the resulting plume could be carried off-site. In the worst-case scenario, serious injuries or fatalities could occur on-site, at the DOE reservation boundary, and beyond. Sheltering citizens in the path of the plume would greatly mitigate the consequences.

2.1.7 *Section Deleted*

2.1.8 HCl

HCl is delivered to building C-400 and stored in a 17,000 gallon tank consisting of two 8,500 gallon sections. A diluted solution of HCl (less than 30 percent) is used in the cleaning process after degreasing. Due to the volatility and corrosive nature of the material, releases could result in personal injuries or fatalities on-site, but would pose no hazard to off-site populations.

2.1.9 Other Nonradioactive Hazardous Material Releases

Other nonradioactive hazardous materials releases from off-site sources, such as highway or rail accidents, may pose a threat to the safety of personnel and impact plant operations and activities.

2.1.10 Natural Phenomena and Fire

Natural phenomena, such as earthquakes, tornadoes, severe storms, and fires, may cause varying degrees of damage to the plant. These also may result in a nuclear criticality or hazardous material release or potential for release as described earlier in this section.

2.1.11 Security-Related Events

Security-related events, such as bomb threats, civil disturbances, extortion, and hostage taking, could also result in personal injuries or fatalities to on- and off-site personnel.

2.1.12 DUF_6 Conversion Facility Events

USEC provides emergency response for activities in the PGDP site and within the DOE reservation. A DOE-regulated depleted uranium hexafluoride (DUF_6) conversion facility operates adjacent to the PGDP site. This conversion facility uses various processes to convert DUF_6 into a stable uranium oxide (primarily U_3O_8) and HF acid. The types of accidents or other events associated with the conversion facility that could require emergency declaration and/or response include: hazardous chemical releases, radiological material releases, fire, explosion, natural phenomena, security, and other adverse events. Section 1.1.1 provides additional information addressing the DUF_6 conversion process and associated hazardous materials.

2.2 DETECTION OF ACCIDENTS AND OTHER EMERGENCIES

The CCF is located in Building C-300, which also houses the PSS, cascade coordinator, and operators. Its function is to monitor, coordinate, or control critical plant processes, power distribution, utilities, communications, plant alarm systems, and emergency operations.

Area Control Rooms (ACRs) in the major process buildings, C-331, C-333, C-335, and C-337, permit operators to monitor process equipment, make changes in operations, and take corrective action to mitigate abnormal operating conditions. In addition to the ACR, most areas in the process buildings have process monitoring panels that provide audible and visual alarms.

Systems are designed to ensure that the consequences of a major malfunction are mitigated prior to any adverse effect on the plant population and the general public. These include UF_6 detection equipment and associated alarms, a criticality accident alarm system (CAAS), automatic sprinkler systems, various chemical detectors, and other alarm systems. Operations personnel stationed locally, in the ACRs, and in the CCF continuously observe alarm systems. Descriptions follow of the various alarms and detection methods for the hazards that have been analyzed.

Personnel within the protected area fence report emergencies and emergency requests for assistance to the CCF in Building C-300 by plant radio or telephone as described in EPIPs. This reporting mechanism is also available to DOE contractor personnel located anywhere on the DOE reservation, as provided for in a separate site agreement.

2.2.1 Nuclear Criticality

Previous plant analyses show the risk associated with inadvertent criticality is extremely low. Although considered to be very unlikely, analyses of possible criticality incidents reveal that both a fast-burst type reaction and a low-power incident have little effect on personnel except those in the immediate vicinity of the incident.

Criticality alarms are installed in facilities containing fissile material as described in Section 5.2 of the SAR. The criticality detection system consists of locator clusters and an alarm system. When a criticality accident alarm activates, a radiation alarm is generated, which actuates building local horns and

lights as well as audible and visual alarms in the CCF. Alarm activation requires evacuation of personnel from the affected area to a designated assembly point that is located a safe distance from the accident. On the basis of the alarmed location, actions can be directed that are necessary to mitigate the accident.

2.2.2 UF_6

UF_6 detection systems are used to monitor selected equipment and areas that possess potential for a UF_6 release in the process facilities. Various UF_6 release detectors provide system isolation capability and/or alarm. A system may be isolated by automatic shutdown, automatic valve closing, or automatic valve opening. Upon a UF_6 detection system actuation, audible and visual alarms located locally and in the ACR and CCF alert operators to investigate and take appropriate response measures delineated in operating procedures.

Another means of detecting UF_6 releases is by physical operator observation and normal visual or sensory awareness.

Emergency response measures for a UF_6 release incident classified as an emergency are provided in Section 5, Emergency Response Measures.

2.2.3 Other Toxic Chemical Releases

Detection equipment and/or chemical release alarms for the various toxic chemicals in the plant have been installed at strategic locations where the appropriate chemicals are present. As in a UF_6 release, if an operator is in the immediate vicinity of a chemical release, the operator should see or smell the release. Upon recognition or detection of a release, the release is reported immediately to the PSS in the C-300 building, who in turn dispatches the Emergency Squad to the incident area. Section 5 describes emergency response measures in detail, including on-site and off-site protective actions.

2.2.4 Natural Phenomena and Fire

2.2.4.1 Fire

An extensive fire protection system is installed throughout the plant site, primarily consisting of automatic sprinkler systems and fire alarms as described in Section 5.4 of the SAR. Water flow and other fire alarms are received and acknowledged in C-300, or in an alternate location in C-200 or C-303, as described in SAR 5.4.2. The actuation of a fire alarm is reported to the PSS. Confirmed alarms require the activation and response of the Emergency Squad.

2.2.4.2 Earthquake

A seismic switch system monitors seismic activity. The seismic switch system consists of two seismic switches in C-331 and two in C-335. Activation of this system at 0.1 g produces audible and visual alarms in the CCF to alert C-300 plant personnel that a significant earthquake has occurred. This seismic detection system is sufficient for rapid identification of significant seismic events. Seismic events are responded to as emergencies. Section 5 describes emergency response measures in detail, including on-site and off-site protective actions.

2.2.4.3 Tornadoes/Strong Winds

Like earthquakes, tornadoes can produce multiple emergency categories and emergency action levels due to the great amount of energy that is released. Personnel injury, building and facility damage, hazardous material releases, and electrical hazards can be expected, depending upon the location of touchdown and width/path of the tornado. If a tornado watch is issued, the CCF is notified by the National Weather Service (NWS) tone alert radio. Upon receiving notification of a tornado watch, a public address (PA) announcement is made. Monitoring of communications and warning systems is increased during a tornado watch.

When the NWS issues a tornado warning or a tornado is sighted, an announcement is made to plant personnel through the plant PA system that directs the plant personnel to take appropriate protective response actions in accordance with plant implementing procedures.

Strong downbursts of wind are more likely to occur than tornadoes. An intense downburst can produce straight-line damaging winds of up to 100 mph over a very limited area. Downbursts can occur in association with any severe thunderstorm. Tornadoes or strong winds may produce effects that would be classified as emergencies. Section 5 describes emergency response measures in detail, including on-site and off-site protective actions.

2.2.5 Security-Related Events

Security-related events will generally be detected by observation of the event by plant personnel, communication from perpetrators of the event, such as hostage takers, people making bomb threats, etc. or law enforcement agencies.

2.2.6 Detection of Events in the DUF_6 Conversion Facility

A DUF_6 conversion facility is located on the DOE reservation just south of the PGDP site. The DOE-approved documented safety analysis identifies the conversion facility is equipped with safety-significant administrative and engineering controls that provide reasonable assurance that the conversion facility operations do not pose an undue risk to the offsite public, onsite worker, or facility worker. USEC provides emergency response for activities in the PGDP site and within the DOE reservation. Appropriate PGDP personnel (i.e., the PSS) are notified of events that occur in the DUF_6 conversion facility that require emergency response.

3. CLASSIFICATION AND NOTIFICATION OF ACCIDENTS AND OTHER EMERGENCIES

Significant plant emergencies are classified as either Alerts or Site Area Emergencies (SAEs). This classification system facilitates the notification process and the implementation of immediate response actions applicable to a specific emergency. This system also provides for upgrading the response, accordingly in the event of a change in the severity of the condition.

Emergency action levels (EALs) are used to determine whether any given accident or event arises to the level of an emergency, and if so, whether it should be classified as an Alert or SAE. These levels are used to give a relatively quick indication to the plant staff of the severity of an accident or event. The purpose of the EALs is to provide the earliest possible indication of actual or potential emergency conditions. EALs associated with off-site radiological or nonradioactive hazardous materials releases are based upon the U.S. Environmental Protection Agency's (EPA) Protective Action Guides (PAGs), as summarized in EPA 400-R-92-001, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, and the Emergency Response Planning Guides (ERPGs) established by the American Industrial Hygiene Association for extremely hazardous chemicals. Additionally, examples from NRC Regulatory Guide 3.67, Appendix A, have been used to develop EALs. The plant emergency response organization (ERO) determines the potential for reaching or exceeding the PAGs or ERPGs in the event of a radiological or nonradioactive hazardous materials release to the environment.

EALs associated with on-site radiological releases are based upon the U.S. EPA PAGs. EALs associated with on-site nonradioactive releases are based upon the initial isolation and protective action distances as defined in the current edition of the U.S. Department of Transportation (DOT) Emergency Response Guidebook, and upon the exposure limits as specified by the U.S. National Institute for Occupational Safety and Health (NIOSH) and the U.S. Occupational Safety and Health Administration (OSHA) in the current edition of the NIOSH Pocket Guide to Chemical Hazards. The plant ERO determines when an on-site radiological or nonradioactive hazardous materials release to the environment reaches or exceeds the PAGs or the DOT initial isolation and protective action distances.

EALs may be symptom based or event based. However, the nature of plant operations and instrumentation generally precludes symptom-based EALs. Developed EALs are provided in an EPIP.

3.1 CLASSIFICATION SYSTEM

The classification system is based on the requirements of 10 CFR 76.91.

3.1.1 Alert

An Alert is defined as an incident that has led or could lead to a release to the environment of radioactive or other hazardous material. Such a release is not expected to require a response by an off-site response organization to protect the general public off-site.

An Alert involves emergency situations that could have a direct effect on the health and safety of plant personnel. Upon classification of an emergency as an Alert, the ERO is activated and key off-site authorities are notified. An Alert also addresses limited releases of radioactive and/or hazardous material and therefore might require some on-site monitoring and assessment actions by the plant ERO.

An Alert ensures that emergency personnel are readily available to respond to a change in plant conditions and to provide assessment support as required. An incident classified as an Alert may require

off-site emergency support organizations to respond to on-site emergencies, such as fires or security related events. Classification of an emergency as an Alert will ensure that appropriate on-site, off-site, and USEC personnel are properly advised and available for activation with appropriate resources if the situation becomes more serious.

3.1.2 Site Area Emergency

The most severe classification used in emergency planning at the gaseous diffusion plants is the Site Area Emergency (SAE). An SAE is defined as an incident that has led or could lead to a significant release to the environment of radioactive or other hazardous material. Such an incident could require response by an off-site organization to protect persons off-site.

An SAE could result in off-site releases that exceed the Environmental Protection Agency PAGs for radiological releases or ERPGs for toxic materials releases.

Classification of an emergency as an SAE requires the full activation of the ERO, including the Emergency Operations Center (EOC) cadre, and other appropriate personnel and resources as necessary to mitigate the consequences of emergency conditions, monitor the situation, and ensure protection of on-site and off-site personnel. The nature of SAEs requires prompt protective actions for on-site personnel in the vicinity of the incident area and may require protective response measures for the entire site population and members of the public. Actions include activating the on-site ERO, alerting or mobilizing field monitoring teams, notifying appropriate off-site authorities, and activating the Public Warning System.

The SAE classification includes accidents or other emergency conditions that have a significant potential for the release of radioactive or hazardous materials. The Crisis Manager (CM) classifies an emergency as an SAE whenever conditions exist that indicate protective actions are or may be required for the general public off-site. An SAE may also result in the request for assistance from off-site emergency support organizations.

3.2 NOTIFICATION AND COORDINATION

This section describes the methods used for notification of emergency response personnel and appropriate local, state, and federal agencies and response organizations. Also described are response actions for Alerts and SAEs. Actual methods and sequencing of notifications are covered in specific EPIPs. Section 3.3 describes requirements, content, and format of the information to be provided to off-site authorities during a classified plant emergency. The EOC is operational within 60 minutes of the announcement to activate the facility, which takes into account the transit time of the responding EOC cadre.

3.2.1 Alert

The purposes of classifying an emergency as an Alert are to ensure that appropriate emergency response personnel are activated and stationed at their emergency duty stations to mitigate the consequences of the

accident, that the emergency is properly assessed, that off-site officials are notified, and that steps can be taken to quickly escalate the response if necessary.

The PSS is responsible for initially classifying the event and directing activation of applicable portions of the plant ERO as necessary. This activation is accomplished by using the plant radio system, pagers, PA system, or the plant telephone system. The means for notification of plant personnel is the Plant Emergency Alarm System, which consists of several distinct alarms, the PA system, pagers, and telephones. Upon classifying an event as an Alert, the PSS becomes the CM.

The CM promptly notifies or directs notification of the appropriate county and state authorities normally within 15 minutes after an event is classified as an Alert as provided for in the EPIP. USEC Headquarters is also notified as soon as is practical. However, this notification will not interfere with the county and state notifications. The emergency notifications to state and local authorities are conducted via telephone or radio if the telephone system is not operational. The specifics of this notification process are described in Section 3.3 and in more detail in the appropriate EPIPs. Additional information on emergency communications equipment is provided in Section 6.2.

The CM notifies or directs notification of the NRC Operations Center as provided for in the EPIP immediately after notification of appropriate state and local authorities but no later than one hour after the emergency is classified as an Alert. When the EOC is operational, a manager designated on the emergency line of executive succession assumes responsibility as CM including NRC notification.

Based on the nature of the event, the CM issues protective response measures to the applicable plant population at his/her discretion. Typically, during an Alert, protective actions for plant personnel, if any at all, are limited to the particular incident area. Specific plant protective actions are described in detail in Section 5.4, Protective Actions, and more thoroughly in designated EPIPs.

Although very unlikely during Alerts, the CM determines the need and subsequent request for off-site assistance. The various off-site emergency support organizations and agencies that may be requested to provide assistance to the plant are listed in Section 4.3.

The CM monitors emergency conditions during an Alert for potential changes in the emergency classification. This entails the decision to escalate the emergency class to an SAE as plant conditions degrade and the decision to terminate the emergency and begin plant recovery operations when specific event termination criteria have been reached.

3.2.2 Site Area Emergency

The purpose of declaring an SAE is to ensure that off-site officials are informed of potential or actual off-site consequences, that off-site officials are provided with recommended actions to protect persons off-site as necessary, and that the plant's ERO is augmented by additional personnel and equipment as necessary.

It is possible that an emergency may be classified as an SAE without the initial classification of the emergency as an Alert. The PSS is responsible for the initial classification of the event. When the EOC is operational, a manager designated in the emergency line of executive succession assumes the responsibility as

CM including declaring the appropriate class of emergency and making any changes to the emergency classification, including event termination. The classification of an emergency as SAE requires the full activation of the ERO. Plant emergency response personnel receive notification of activation through the plant telephone system, radios, pagers, and the PA system. Upon classifying an event as a SAE, the PSS becomes the CM.

The CM promptly notifies or directs notification of the appropriate county and state authorities, normally within 15 minutes after an emergency is classified as an SAE as provided for in the EPIP. USEC Headquarters is also notified as soon as is practical. However, this notification will not interfere with the county and state notifications. The state and local notifications include appropriate recommended protective actions for the general public near the plant property. The NRC Operations Center is notified as soon as possible after the state and local notifications have been made but no later than one hour after the declaration of an SAE. The emergency notifications to state and local authorities are conducted via telephone. The specifics of this notification process are described in Section 3.3. Additional information on emergency communications equipment is provided in Section 6.2.

The CM directs plant personnel to take appropriate protective response actions based on the assessment of the emergency. During an SAE, protective actions for plant personnel may range from evacuating a particular building or area based on emergency conditions. Specific plant protective actions are described in detail in Section 5.4 and more thoroughly in designated EPIPs.

During an SAE, additional emergency support may be necessary to augment the plant ERO. The CM normally makes the determination of need for and subsequently requests assistance from off-site emergency support organizations. The various off-site emergency support organizations and agencies that may be requested to provide assistance to the plant are listed in Section 4.3.

The CM monitors emergency conditions during an SAE for potential changes in the emergency classification. The CM terminates the emergency and begins recovery operations when specific termination criteria have been met.

3.2.3 Other Emergency Events

For those emergency events that are not classified as Alerts or SAEs, the plant maintains the responsibility and capability for assessment of the event, implementing appropriate protective actions, and ensuring that off-site officials are informed of potential or actual consequences.

3.3 INFORMATION TO BE COMMUNICATED

Upon classification of an emergency as an Alert or an SAE, the CM notifies or directs initial emergency notifications to off-site authorities as soon as possible, normally within 15 minutes of classification as provided for in the EPIP. Additional emergency information is provided to off-site authorities periodically as new information becomes available. Notifications to off-site authorities will be provided when a change in emergency classification occurs and when protective action recommendations off-site are required. An example of the form used for off-site notifications is included in the appropriate EPIP for emergency notifications.

Information provided in emergency notifications to off-site authorities includes plant status conditions, radiological/hazardous materials release data, recommendations for protective actions to be implemented by off-site response organizations, and other applicable emergency information as necessary.
Protective response actions off-site are the responsibility of governmental authorities. Off-site protective action recommendations for the different types of postulated emergencies requiring protective measures are discussed in detail in Section 5.4.2.

The CM ensures that the following state and local agencies at a minimum are notified promptly, normally within 15 minutes of the initial emergency classification:

1. Paducah-McCracken County Office of Emergency Management,
2. Kentucky Division of Emergency Management, and
3. DOE-Oak Ridge Operations

Upon the issuance of protective action recommendations, the plant may request verification callbacks from state and local agencies responsible for implementing off-site protective actions to ensure that the recommendations are understood. Callbacks also enable plant officials to receive information regarding off-site protective actions implemented.

Based on the nature and status of the incident, in addition to the primary agencies listed above, other off-site organizations may be notified of emergency conditions. These organizations include the following:

1. U.S. National Response Center,
2. U.S. Occupational Safety and Health Administration (OSHA), and
3. Other affected organizations.

The U.S. Nuclear Regulatory Commission (NRC) Operations Center is notified immediately after notification of the appropriate state and local agencies but no later than one hour after the declaration of an Alert or an SAE. Once the PGDP EOC is operational, a dedicated open communications telephone line will be maintained with the NRC Operations Center. The communications line is used during a declared emergency (alert or site area emergency) to keep the NRC Operations Center current as the event is occurring.

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4. RESPONSIBILITIES

USEC is responsible for overall direction and control of NRC-regulated activities at PGDP. USEC is also required to provide site-wide emergency response services to DOE pursuant to Appendix F of the Lease Agreement.

4.1 NORMAL FACILITY ORGANIZATION

While the Vice President, Operations is ultimately responsible for the safe operation of the plant, the General Manager is responsible for the day-to-day management and operation of the plant, including the program of emergency response services. An organizational chart showing the functional levels and reporting responsibilities is provided in the Safety Analysis Report, Section 6.1. The administrative and technical support personnel staffing the plant organization are normally on-site daily, Monday through Friday, holidays excluded. Plant operational personnel are on duty 24 hours per day. Descriptions of the key managers at the plant and their responsibilities are provided below.

4.1.1 General Manager

The General Manager has direct responsibility for operation of the plant in a safe, reliable, and efficient manner. The General Manager is responsible for emergency management and is authorized to declare an emergency and to initiate the appropriate response.

4.1.2 Plant Manager

The Plant Manager provides assistance and support to the General Manager in providing for safe operation of the plant and is assigned specific areas of oversight for day-to-day production operations, and maintenance.

4.1.3 Operations Manager

The Operations Manager is responsible for the operations of the enrichment cascade. This includes such activities as ensuring the correct and safe operations of the plant utility and chemical services, UF_6 processes, proper handling of UF_6, and the periodic testing of equipment to ensure safe and efficient operation.

4.1.4 Section Deleted

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4.1.5 Maintenance Manager

The Maintenance Manager is responsible for providing planning and safe and reliable performance of preventive, predictive, and corrective maintenance and support services on plant facilities and equipment.

4.1.6 Security Manager

The Security Manager is responsible plant police services and security. During emergencies, the Incident Commander directs the Security Organization as appropriate. The General Manager and delegated positions have stop work authority on security operations.

4.1.7 Section Deleted

4.1.8 Engineering Manager

The Engineering Manager is responsible for engineering activities in support of operations including design, fabrication, and construction of plant modifications or additions; the configuration management program. Responsibilities also include project management, construction, and coordination of large project plant modifications or additions.

4.1.9 Environmental, Safety and Health Manager

The Environmental, Safety and Health (ES&H) Manager is responsible for the environmental, industrial safety and hygiene programs, emergency management, waste management, and medical services at the facility. This includes activities to protect workers from chemical and physical hazards, and to maintain compliance with OSHA regulations.

The Environmental, Safety and Health Manager is also responsible for developing, maintaining, and updating the emergency plan, ensuring that the emergency management program is designed to comply with federal, state, and local regulations and for the establishment and oversight of the site environmental protection and monitoring programs.

The ES&H Manager is also responsible for establishing and implementing the radiation protection program.

4.1.10 Regulatory Affairs Manager

The Regulatory Affairs manager is responsible for the day-to-day interface with NRC representatives on matters of regulatory compliance. As delegated by the Director, Regulatory Affairs, the Regulatory Affairs Manager has responsibility for coordinating certification related and certificate renewal-related activities. The Regulatory Affairs Manager is also responsible for nuclear criticality safety, nuclear safety, and developing, maintaining, and updating the plant's corrective action and commitment management program, including administration of the problem reporting system. The Regulatory Affairs Manager is also responsible for the training, procedures, and records management and document control (RMDC) programs.

4.1.11 Shift Operations Manager

The Shift Operations Manager oversees the activities of the PSSs and fire services, and has the responsibility and authority to make decisions to assure safe operation of the plant.

4.1.12 Nuclear Safety and Quality Manager

The Nuclear Safety and Quality Manager is responsible for implementing and directing independent assessments, quality control, nuclear material control and accountability, and nuclear safety assurance.

4.1.13 Section Deleted

4.1.14 On-Duty PSS

As the senior manager on shift, the on-duty PSS represents the General Manager and managers and has the authority and responsibility to make decisions as necessary to ensure safe operation, including stopping work and placing the plant in a safe condition.

The on-duty PSS is responsible for making proper notification in regard to abnormal plant conditions, determining the severity of the event, declaring an emergency, and initiating appropriate response. The on-duty PSS may respond to an incident scene as the on-scene incident commander or dispatch other qualified individual in this capacity. The on-duty PSS is the crisis manager until relieved by a member of management designated in the emergency line of executive succession.

4.1.15 Section deleted.

4.1.16 GDP Procurement and Materials Manager

The GDP Procurement and Materials Manager is responsible for managing the projects, programs, and the activities related to packaging and transportation, material control, stores, shipping and receiving, and property disposition.

4.1.17 Nuclear Criticality Safety Manager

The Nuclear Criticality Safety Manager is responsible for implementing the nuclear criticality safety program. This position reports to the Regulatory Affairs Manager.

4.1.18 Production Support & Product Scheduling Manager

The Production Support & Product Scheduling Manager is responsible for production maintenance work scheduling and for establishing and implementing the laboratory operations program.

4.2 ON-SITE EMERGENCY RESPONSE ORGANIZATION

The Emergency Response Organization (ERO) is responsible for taking immediate mitigative and corrective actions to minimize the consequences of an incident to workers, public health and safety, and the environment. The ERO is staffed with trained personnel who respond to events and are required to participate in formal training, drills, and exercises. The incident type and severity dictate the level of ERO activation.

The ERO has the following specific functions and responsibilities, depending on the incident and level of response needed to mitigate the problem: event categorization, determination of emergency class, notification, protective action recommendations, management and decision making, control of on-site emergency activities, consequence assessment, protective actions, medical support, public information, activation and coordination of on-site response resources, security, communications, administrative support, and coordination and liaison with off-site support and response organizations.

The ERO is divided into functional groups as follows:

1. Plant Emergency Squad,
2. EOC cadre, and
3. Joint Public Information Center (JPIC).

Members of these groups are assigned to on-scene response locations and emergency response centers, such as the EOC. Emergency assignments correspond as closely as possible to daily duties. Primary and alternate personnel are assigned to the ERO positions. Assignments are updated periodically. Management ERO positions in each group provide oversight and final authority in the group's decision-making process.

4.2.1 Direction and Coordination

The initial ERO consists of the plant emergency squad with the PSS, or other qualified individual as incident commander (IC) at the scene. Upon classification of the emergency as an Alert or SAE, the PSS becomes the CM and maintains overall control of the plant during the emergency until relieved. When the EOC is operational, a manager designated in the emergency line of executive succession relieves the PSS as CM and the overall control of the emergency shifts from the PSS to the CM.

The PSS conducts transition and turnover of command and control authority and responsibility of the CM function in a formal manner by use of specially developed procedural checklists and, if possible, face-to-face briefings. A primary and alternates are identified for the CM.

The order of succession for the CM position is identified in an EPIP and includes the following:

1. PSS
2. General Manager
3. Plant Manager
4. Others as designated by the General Manager and trained and qualified as CM

Because of the importance of some emergency responsibilities, these responsibilities may be performed only by the ERO position assigned to address them. The following responsibilities are transferred when the overall responsibility of the emergency response is transferred.

1. Emergency Classification. Initially this is a PSS responsibility as CM. After the EOC is operational, this responsibility is transferred from the PSS to the CM in the EOC.

2. Protective Action Recommendations. Initially this is a PSS responsibility as CM. When the EOC is operational, approval of off-site protective action recommendations is transferred to the CM in the EOC.

3. Facility Activation. The PSS is responsible for directing activation of the EOC. The EOC is automatically activated for Alerts and SAEs and may be selectively activated for other emergencies related to non-NRC regulated activities.

4.2.2 On-Site Staff Emergency Assignments

4.2.2.1 Plant Emergency Squad

Capability for on-scene emergency response is provided by the plant emergency squad consisting of the following:

1. PSS personnel,
2. Police personnel,
3. Fire Services personnel, and
4. Operating shift, nonsupervisory, supervisory, and specialist personnel.

Within the plant emergency squad are personnel who have experience and are trained in fire fighting, HAZMAT response, health physics, and environmental response. Fire Services personnel are also trained in emergency medical treatment. Figure 4-2 illustrates a typical plant initial on-scene ERO. In addition, shift personnel can provide support for various technical areas, such as operations, maintenance, and engineering activities.

4.2.2.2 Emergency Operations Center Cadre

The Emergency Operations Center (EOC) cadre provides the external support required by the IC and provides information to federal, state, and local government agencies. Specifically, the EOC cadre provides additional technical expertise in engineering, radiological/hazardous materials monitoring and assessment, logistics support such as transportation, food, communications, materials, and supplies, and other needed services.

The EOC is the primary facility for coordinating on-site response and mitigation and off-site interface activities. Senior managers confer, provide personnel and materials, coordinate activities, and communicate with on-site and off-site personnel. Appropriate support staff are in the EOC to provide technical support to the EOC cadre and to the IC at the scene.

4.2.2.3 Joint Public Information Center

The Joint Public Information Center (JPIC) is normally activated at the declaration of an SAE or for other events that may generate significant interest from the media. This organization provides for timely information dissemination to the media and to the public regarding a plant emergency.

4.2.2.4 Recovery Manager

When the nature and extent of an emergency indicate that recovery operations are required, the CM designates a recovery manager (RM) to direct these operations prior to terminating the emergency. The RM, in turn, designates a staff to assist in these operations. The duties and responsibilities of the RM and the Recovery Organization are addressed in Section 9.

4.3 LOCAL OFF-SITE ASSISTANCE TO FACILITY

The severity of some emergencies may warrant the use of off-site individuals, organizations, and agencies. As a result, Letters of Agreement (as identified in Appendix B) have been entered into with off-site groups to provide assistance in the event of an emergency. These support services encompass areas such as medical assistance, fire control, evacuation, ambulance services, and law enforcement. When the CM determines that off-site assistance is needed, the appropriate organization is notified and assistance is requested. Plant police personnel provide site access control and ensure escort support is provided for the responding off-site organizations. TLD's will be provided to off-site responders as required when entering the CAA. Except for suspension of the formal visitor access system to accommodate requested off-site support personnel, normal safeguard and security measures, including material controls and accountability, are maintained. Necessary emergency information is provided to the responding organizations, including potential hazards associated with the incident.

The off-site emergency support organizations are described in the following subsections.

4.3.1 Medical Support

In certain instances, medical emergencies may require the transport of an injured person from the plant to an off-site medical facility. Transportation of injured persons to the medical facility is normally provided by the plant's on-site ambulance. In the event that the on-site ambulance is not available, commercial ambulance service provides the transportation of injured persons to the off-site medical facility. This includes contaminated injured on-site workers. Ambulances are equipped with radios to maintain communications with local hospitals. The primary medical facilities for injured personnel, with or without contamination, are the Western Baptist Hospital and Lourdes Hospital, both

located in Paducah approximately 14 and 12 miles respectively from the plant site. These hospitals have agreed to accept injured personnel or victims of radiation/hazardous materials-related accidents for emergency medical and surgical treatment and observation. Notification of these hospitals of the need for off-site assistance is performed by telephone or radio.

4.3.2 Fire Support

When a determination that off-site fire support is needed, the applicable off-site fire departments are alerted. Notification of off-site fire fighting assistance is made by means of a telephone call to the Paducah-McCracken County 911 center or by plant radio.

The off-site fire departments include the Paducah Fire Department, located approximately 12 miles from the plant, Lone Oak Fire District, McCracken County, located 15 miles from the plant, and the West McCracken County Fire District, West Paducah, located 1.75 miles from the plant. These fire fighting groups have agreed to furnish the plant with fire-fighting personnel and necessary resources upon request. As assistance is being rendered on-site by the off-site organizations, each off-site fire department is under the immediate control of its respective officers. The fire departments are under the general direction and control of the IC, who retains responsibility for the overall on-scene emergency response effort. In instances where off-site fire-fighting assistance is needed to fight a fire involving radioactive/hazardous materials, knowledgeable members of the plant ERO provide radioactive/hazardous materials, radiological/toxicological information and assistance.

4.3.3 Law Enforcement Assistance

The nature of an emergency may require that the local law enforcement agencies be activated to assist in the emergency response effort. The Paducah Police Department, McCracken County Sheriff's Department, and the Kentucky State Police have agreed to provide local law enforcement assistance. The emergency support may include the following:

1. Ensuring that reasonable and appropriate steps are being taken to protect the public health and safety and to mitigate the accident,

2. Controlling access to areas affected by the emergency,

3. Directing area evacuation, and

4. Responding to bomb threats.

4.4 COORDINATION WITH PARTICIPATING GOVERNMENT AGENCIES

Coordination between the local, state, and plant emergency plans serves to better ensure the safety and health of the general public. It also enables emergency organizations to participate in the emergency effort with a minimum of confusion and hesitation. During an emergency effort, participating agencies must have a clear picture of their responsibilities, which is provided for in their respective emergency plans and procedures. Appendix C provides a list of supporting emergency plans.

Emergency Management coordinates required emergency planning activities directly with these organizations and agencies. Emergency management personnel offers to meet at least annually with each off-site response organization to review emergency plans and procedures and any changes relevant to the plant's emergency management program. Plant emergency action levels, notifications, and the overall response coordination process are discussed at these meetings. Response roles of the key agencies are summarized in this section.

4.4.1 Commonwealth of Kentucky Government Interfaces

The Commonwealth of Kentucky Emergency Operations Plan provides guidance on dealing with all types of disasters or emergency incidents. Annex X of the state plan outlines the state and county response to incidents at the plant. The Kentucky Division of Emergency Management is responsible for coordinating overall state response and overseeing the local implementation of recommended protective actions. The Kentucky Division of Emergency Management assists the Governor in formulating policy, establishing priorities, gathering and analyzing information, monitoring the execution of planned actions, and directing modifications as necessary. The Kentucky State Police assist in coordinating security emergencies and provide support to site security and off-site law enforcement actions as requested. The Kentucky Environmental and Public Protection Cabinet coordinates environmental hazard assessment and is the principal contact for technical information and recommendation of protective actions. The Kentucky Division of Waste Management oversees removal and disposal of hazardous waste generated as a result of a PGDP emergency. The Kentucky State Fire Marshal provides technical advice on hazardous materials incidents and large structural fires. The Kentucky Health and Family Services Cabinet is the cognizant state agency for incidents involving the release of radiological materials off-site.

The Commonwealth of Kentucky has a permanent EOC in Frankfort, 275 miles distant from the plant, that has been designed and equipped to be the direction and control center for all major emergencies in the state. The EOC is manned 24 hours a day by trained operations duty officers and has the capability to provide almost instantaneous communications with the Governor and key state officials.

4.4.2 Local Government Interfaces

Depending upon the jurisdictions involved, the McCracken County judge-executive or the mayor of Paducah has overall responsibility and authority for administering off-site emergency responses as well as drills and exercises. They serve as the chief executive officers for their local governments during an emergency. The judge-executive and mayor are supported by the city-county EOC staff.

The Paducah-McCracken County Office of Emergency Management (OEM) director serves as the chief of staff for the county judge-executive and mayor's EOC staff. The director is responsible for ensuring that the Paducah-McCracken County EOC is fully functional. In addition, the director is responsible for coordinating local government emergency management planning and response activities. The PGDP Public Affairs manager or the Public Information advisor in the EOC interfaces with the Public Information officer on the Paducah-McCracken EOC staff to control rumors and disseminate information.

The county judge-executive, mayor, or OEM director can authorize the opening and staffing of the Paducah-McCracken County EOC. The EOC may be opened and staffed because of a threat of an emergency or for an actual emergency. Minor emergencies may be directed by agency officials from their normal workstations.

Local law enforcement and fire services assistance will be coordinated with the director and staff in the Paducah-McCracken County EOC or with the appropriate mutual aid or assistance agency.

Notification and warning points have been established for each local government (Paducah and McCracken County). Local governments coordinate response efforts from the Paducah-McCracken County EOC.

4.4.3 Federal Government Interfaces

4.4.3.1 United States Nuclear Regulatory Commission

The NRC has established certification requirements applicable to the GDPs to protect the public health and safety from radiological hazards, to provide for the common defense and security, and to ensure adequate safeguards. The NRC also provides regulatory oversight over USEC's uranium enrichment activities to ensure compliance with these requirements, including the emergency planning requirements set forth in 10 CFR 76.91. The NRC Operations Center is notified of any emergency immediately after notification of the appropriate off-site organizations within one hour after the declaration of an Alert or SAE. The NRC evaluates the protective actions taking place and coordinates with USEC and DOE to ensure that all reasonable and appropriate actions are being taken to protect the public health and safety.

4.4.3.2 United States Department of Energy

DOE provides nuclear safety oversight for those activities on-site involving DOE environmental management facilities and operations. Events involving DOE operations or property are reported to DOE's Oak Ridge Operations Office (ORO/DOE). DOE maintains various emergency response assets capable of providing radiological monitoring and support assistance during an emergency.

4.4.3.3 Federal Bureau of Investigation

The Federal Bureau of Investigation (FBI) has jurisdictional authority for safeguards and security emergencies involving violations of federal criminal law. A representative of the FBI may assume command and control of these types of emergencies. The FBI Hostage Rescue Team or regional SWAT team may also be provided if requested. The FBI will coordinate all responding federal law enforcement agencies.

4.4.3.4 Other Federal Agencies

The following federal agencies may be involved in plant emergencies:

1. *Federal Aviation Administration (FAA).* FAA restricts airspace over the plant at the request of the CM or the PSS as appropriate.

2. *U.S. Coast Guard (USCG).* USCG functions as the federal authority on all navigable waterways and their tributaries. The USCG commander of the Ohio River Group will control all waterway traffic and coordinate response to emergencies on behalf of the U.S. EPA.

3. *Federal Emergency Management Agency (FEMA).* FEMA is the primary federal government agency for the administration of planning, preparedness, operational coordination, and recovery programs.

4. *U. S. Environmental Protection Agency (USEPA).* USEPA is the major federal government agency for the regulation and control of pollution and waste management programs. USEPA provides a federal on-scene coordinator for significant hazardous materials incidents.

5. *U. S. Occupational Safety and Health Administration (OSHA).* OSHA is the primary federal government agency for the regulation of nonradiological worker safety.

Figure 4-1. ***Figure deleted.***

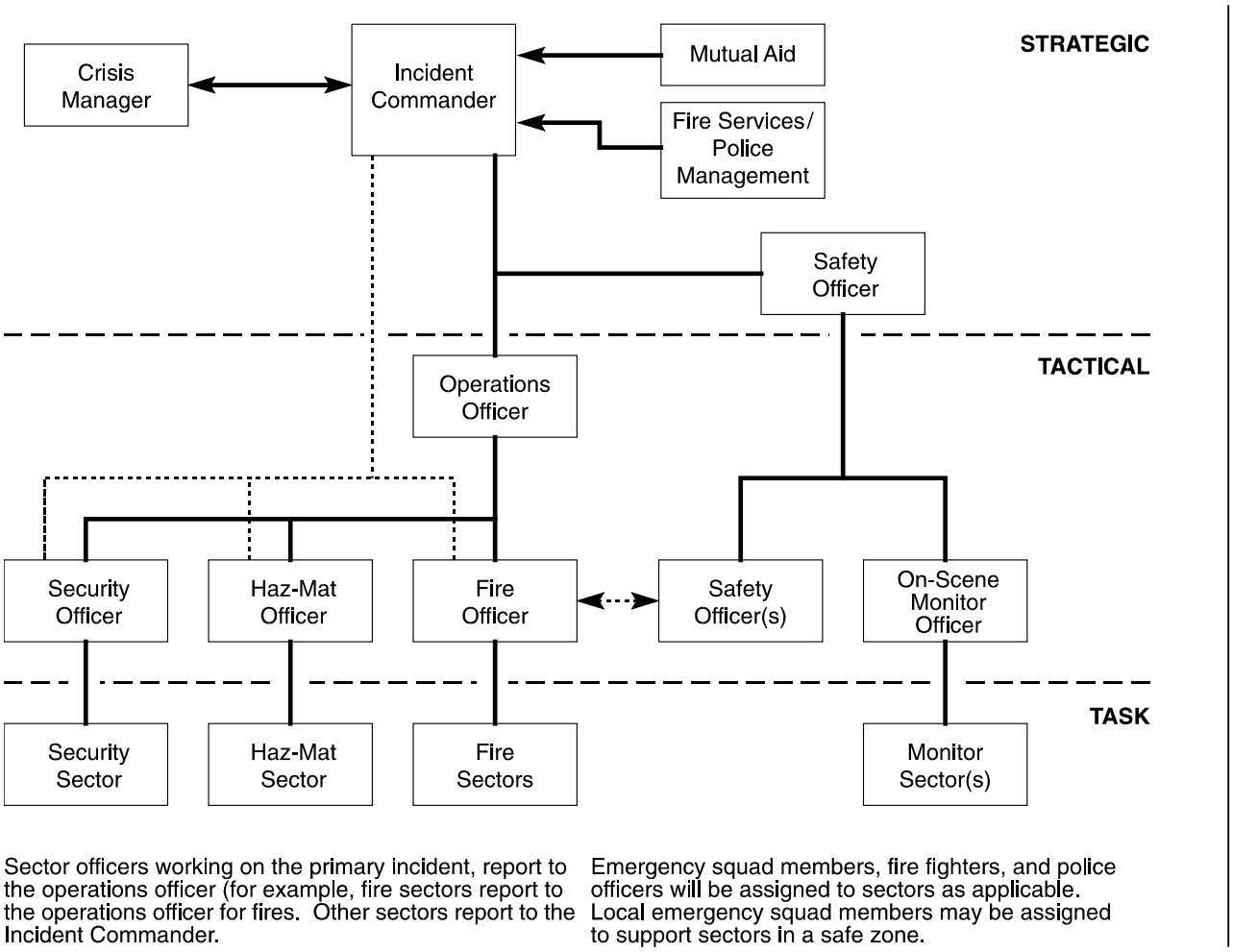

Figure 4-2. Typical plant on-scene ERO.

5. EMERGENCY RESPONSE MEASURES

Emergency measures must be taken in response to an emergency. Upon recognizing that an emergency exists, necessary portions of the emergency organization are activated. Once activation has taken place, assessments of the condition are made, corrective and protective actions are taken, and aid to affected persons is administered as required.

After becoming aware that an emergency exists, the PSS does the following:

1. Takes actions to ensure the safety of plant personnel and the general public,

2. Takes actions to ensure safe operation/activities of the plant,

3. Classifies the emergency and makes required notifications,

4. Performs assessment actions, and

5. Performs any other emergency actions as appropriate.

5.1 ACTIVATION OF EMERGENCY RESPONSE ORGANIZATION

Upon recognition of an emergency, the PSS, or other qualified individual responds to the incident scene as the IC. The IC determines appropriate immediate protective actions at the incident scene. The PSS classifies the event if applicable. If the emergency is classified as either an Alert or SAE, the PSS as CM activates the EOC. Minimum staffing requirements for activation and operation of the EOC are identified in an EPIP, and must be met prior to assumption of command and control by the crisis management team. CM responsibilities are assumed by a manager designated in the emergency line of executive succession when the EOC is operational. Methods for ERO notification/activation are the same regardless of the time of the emergency and include plant radios, emergency pager system, and telephones. When notified, EOC cadre members are required to respond immediately. ERO activation is accomplished through the appropriate EPIPs.

The CM delegates public information duties to the public information advisor, who, in concert with USEC headquarters, is responsible for activating the JPIC.

The IC maintains command and control over the specific area response and protective actions. The IC coordinates mitigation and protective action strategy and direction and keeps EOC informed of the incident status when the EOC is operational.

In the event that two or more emergencies occur simultaneously so that they cannot be managed effectively as a single incident scene, provisions in the appropriate EPIPs allow for the establishment of additional incident scenes, designation of multiple incident commanders, and division of response resources as necessary.

5.1.1 Section deleted

5.1.2 *Section deleted*

5.2 ASSESSMENT ACTIONS

This section describes the processes used for assessing the actual or potential on-site and off-site consequences of an emergency. Initial and continuing assessment actions are the responsibility of the CM. Post-accident assessments are a shared responsibility between the IC, the CM, and the recovery manager, if assigned.

Continuous assessment throughout the course of an emergency is necessary to effectively coordinate and direct the elements of the ERO. The initial assessment actions are dictated in part by the nature and severity of the emergency. Emergency assessment provides an indication of the vulnerability to life, the environment, and property injury or damage if an emergency occurs. The different assessment actions for Alert and SAEs are described in Sections 5.2.1 and 5.2.2. Equipment used to assess releases is described in Section 6.4.

5.2.1 Assessment Actions During an Alert

An Alert requires basic emergency assessments. Attention must be paid to parameters that may indicate a possible worsening of conditions (e.g., radioactive/hazardous materials releases). The existence of an Alert requires the following initial and ongoing assessment actions as applicable:

1. Increased surveillance of applicable plant instrumentation and visual observation of the incident conditions,

2. Determination of the resources necessary to mitigate the event from evaluation of reports of damage and injury or by on-scene inspection,

3. Monitoring event conditions for potential changes in emergency classification level.

5.2.2 Assessment Actions During an SAE

In the event of an SAE, assessment activities are more extensive than for an Alert. During a release of radiological/hazardous materials, assessment of on-site and off-site exposures are performed regularly to determine if and when on-site sheltering or evacuations or off-site sheltering may be required.
The results, including methods and assumptions, are communicated to appropriate off-site officials as off-site protective action recommendations. In addition to the activities that would be carried out during an Alert, the following activities are performed at the direction of the PSS or the CM when the EOC is operational, as appropriate:

1. Performing continuing emergency assessments for mitigating events and protective actions on-site, based on on-scene and field monitoring results, release information, and meteorological conditions for radiological/hazardous material releases, and

2. For off-site hazardous material releases, providing specific material information, release information, plume direction, projected plume location, appropriate meteorological information, and field monitoring results to responsible off-site authorities.

5.2.3 Post-Accident Assessment

Post-accident emergency assessments are provided by the IC, the CM, and the RM, if assigned.

EPIPs contain criteria that must be met before recovery can be initiated. These criteria may be radiation readings for criticality events, airborne concentration values for hazardous material releases, or other appropriate identifiable conditions. Concurrence from off-site officials must be obtained before terminating an SAE.

In the event of a UF_6 release, individuals exposed or suspected of being exposed are evaluated for uranium uptake by urinalysis. If appropriate, surface water samples may be taken and evaluated during the release if access is available to the monitors and post-accident as part of the overall recovery plan. Post accident soil samples are taken and evaluated as required by the recovery plan.

During post-accident assessments, specific recovery goals are identified such as the removal of contaminated soil or the return of a damaged facility to productivity. These actions may be based on survey or inspection data obtained prior to entry into the recovery phase or based on new data obtained specifically for the proposed recovery goal. See Section 9, Recovery and Plant Restoration for information regarding plant restoration and recovery activities.

5.3 MITIGATING ACTIONS

Plant personnel who are technically trained and capable of implementing the plant's emergency plan and procedures perform mitigating actions. Emergency procedures have been established to provide effective response to the various emergency events described in this plan. During emergency conditions, the primary concern is to minimize the impact on plant personnel and the general public.

Actions to mitigate releases to protect plant personnel and members of the public may require operation personnel to take corresponding emergency operating or off-normal procedure actions. Actions taken by operating personnel may be indicated by plant operating parameters required by Technical Safety Requirements or directed by plant management personnel.

5.3.1 Personnel Actions

By initiating prompt protective actions, such as evacuating personnel in the immediate incident area and controlling access to the surrounding accident vicinity, consequences to plant workers as well as the general public are minimized. Additional information on protective actions is provided in Section 5.4.

5.3.2 Limiting Releases

Emergency operating, implementing procedures, and facility design provide for radioactive and toxic material release prevention and for the proper mitigating actions to reduce or stop any releases. Mobile firefighting equipment is provided and maintained on-site to support fire-fighting, back up the fixed fire suppression systems, and provide a hazmat response capability. This equipment includes a minimum of one 1,000 gpm pumper, one truck with Hazmat, radiological and rescue equipment, and one ambulance. Each major process building is provided with an automatic sprinkler system. Detailed descriptions of the plant water supplies and automatic sprinkler systems are provided in the SAR. Isolable system releases are mitigated by qualified operators using emergency operating procedures. Non-isolable system or cylinder releases are mitigated to the degree possible by 29 CFR 1910.120(q) certified hazardous materials technicians using industrial hazmat response methods. Release mitigation or prevention actions or features include the following:

- Process gas and other chemical leak detection systems
- Seismic alarms
- Sprinkler system and other fire-suppression systems
- Fire detection systems
- Firefighting capabilities
- Hazmat response capabilities, including plugging and patching
- Use of water sprays on airborne releases of material
- Storage in fire-resistant containers
- Use of fire-resistant building materials
- Criticality controls

5.3.3 Safe Shutdown

An emergency condition that may have an actual or potential impact on operations may require the safe shutdown of process equipment or systems. The SAR describes the plant systems and instrumentation available for detecting abnormal operating conditions that could result in an emergency and the methods and criteria used to ensure a safe shutdown of plant equipment and systems. The PSS or CM determines which, if any, equipment or systems require shutdown in connection with a specific accident or emergency and takes appropriate action to ensure that the designated equipment or systems are shut down safely and promptly. Individual equipment and processes generally require 5 to 30 minutes to shut down safely. After an accident or other emergency, the plant is restored to a safe condition before the IC issues an all clear. The means for ensuring that the plant is in a safe condition include monitoring, visual inspections, and equipment testing.

5.4 PROTECTIVE ACTIONS

During emergencies, the IC or CM must determine the best possible means to limit exposure of on-site and off-site personnel to potential or actual threats, such as radioactive or toxic materials that may be accidentally released to the environment. As discussed in this section, emergencies include natural events. Guidelines are provided to limit the exposure of personnel in the case of accidental releases to the environment. These guidelines, which are prescribed corresponding to potential health effects, are called PAGs for radioactive materials and ERPGs for hazardous materials. Specific EPIPs have been developed for the protection of emergency workers and other on-site and off-site personnel.

This section describes the protective actions developed to limit exposure of plant personnel and the public following an emergency. The protective actions to be implemented on-site are the responsibility of the plant, while the appropriate off-site authorities are responsible for providing off-site protective actions.

5.4.1 On-Site Protective Actions

On-site protective actions will be prescribed by the IC for the incident scene or CM for all persons within the boundaries of the DOE reservation, which includes the protected area of the plant. Protective actions for persons on-site (including employees, visitors, contractor personnel, and transient populations) include alerting, evacuation and assembly, accountability, sheltering, search and rescue, and monitoring and decontaminating, as appropriate.

5.4.1.1 Alerting

Whenever it is determined that a threat or potential threat to the safety of personnel on the DOE reservation exists, the CM directs that potentially affected persons on the DOE reservation or within a specified area be alerted. Alerting is accomplished by use of the PA system, plant radios, telephones, or if required, by runner.

5.4.1.2 Evacuation and Assembly

One action available to protect personnel on the DOE reservation is evacuation and subsequent assembly. When required, the IC or CM orders an evacuation of all persons from affected areas. The evacuation alarm and announcement, including any special instructions, is sounded over the PA system, plant radios, or other plant communications systems as appropriate. Evacuations are directed in the event of actual or imminent structural failure, release of hazardous material that would expose personnel to unacceptable concentrations, a criticality, or a severe weather warning. The procedures to be followed in these evacuations are included in an EPIP. Provisions are made for consideration of impediments to evacuation caused by weather conditions, traffic, or radiological/hazardous materials release. Because of the large area within the protected area fence and the nature of the potential hazards, no scenario has been identified that would require the evacuation of the entire protected area.

Within the protected area fence, all persons in the affected area will proceed to an assembly point or evacuation area. Assembly points for criticalities are designated in an EPIP. For other events, directions on the specific evacuation routes will be provided. The appropriate selection of an evacuation area and evacuation route for a HAZMAT release is determined according to plant conditions, wind direction, and weather.

For other areas of the DOE reservation, the following procedures will be followed:

- USEC contractors/subcontractors and their visitors will be directed to an assembly point specified as for persons within the protected area.
- DOE contractors/subcontractors and their visitors will be directed to an assembly area identified in an EPIP and in DOE contractor emergency plans.
- Transients on the DOE reservation (i.e., hunters, fisherman, hikers, etc.) will be directed to exit the reservation.

5.4.1.3 Accountability

In an emergency, one of the more probable protective actions for persons on the DOE reservation is evacuation of a building or area to a designated assembly area. When required, the IC or CM orders an accountability of all persons from affected areas. The accountability announcement, including any special instructions, is sounded over the PA system, plant radios, or other plant communications systems as appropriate. Provisions for determining and maintaining the accountability of personnel at these assembly areas or for accountability of personnel at their work stations or locations are detailed in an EPIP or in the case of DOE or DOE contractor personnel, in DOE contractor emergency plans. Search and rescue operations may be initiated if a person is determined to be missing.

Persons within the protected area fence, areas flexed outside the protected fence area, and Building C-611 are provided training on their assembly/accountability roles and responsibilities or are provided with an escort. Employees and contractor personnel are trained on actions to be taken in an emergency prior to their work

assignments. Escorts are trained in emergency response procedures, which includes instructions on methods of notification and the required actions in the event of an emergency. Escorts are responsible for accounting for visitors by name through their line organizations.

To ensure proficiency, periodic evacuation and accountability drills are conducted. When an accountability is required, personnel report through their line organizations to Building C-300, which maintains the overall accountability status of the plant. The PGDP accountability is considered complete when all USEC, USEC contractor, and USEC visitor personnel are accounted for or missing persons are identified.

Accountability for other persons on the DOE reservation outside of the protected area fence is conducted as required by DOE orders and DOE contractor implementing procedures.

5.4.1.4 Sheltering

Sheltering of personnel could be prescribed as a protective action if an analysis of the shelter is available indicating that it would provide effective protection from the existing or potential hazard or if other means of protection is not available.

5.4.1.5 Search and Rescue

If an accountability reveals that a person is missing and there is a high probability that the person might be located within the incident area, the IC may assemble a search and rescue team made up of members of the Emergency Squad subject to entry requirements identified in EPIPs. The search and rescue team obtains information on the latest known location, and likely areas are searched until missing persons are located. The IC provides on-scene direction of the search and rescue teams. Teams are briefed prior to entry on their specific mission, route of ingress/egress, area of danger, personal protective clothing/equipment required, and stay times for control of exposure to radioactive or hazardous materials.

5.4.1.6 Monitoring and Decontamination

If decontamination is necessary, the decontamination sectors are established using appropriate decontamination equipment. Decontamination and waste disposal are conducted in accordance with specific implementing procedures. Monitoring capability is provided to assembly areas when necessary depending upon the nature of the emergency, using mobile resources available within the emergency response equipment inventory, monitoring equipment provided by field monitors dispatched from Building C-300, or equipment provided by Health Physics technicians directed to support these areas.

5.4.1.7 Use of Protective Equipment and Supplies

Individuals entering an area during an emergency where airborne concentrations of contaminants are considered immediately or potentially hazardous to life or health are required to wear appropriate protective clothing and self-contained breathing apparatus. Plant personnel assigned emergency response

tasks requiring the donning of protective equipment maintain communications via the plant radio system, either by hand-held radio or radios within the self-contained breathing apparatus. Protective clothing and other required personal protective equipment are available throughout the plant at predesignated areas. Emergency personnel receive training on donning and using specific protective clothing and related equipment. Section 7.2 describes the plant's comprehensive emergency management training program.

Emergency kits and other supplies are used to provide monitoring equipment, protective clothing, and respiratory equipment for individuals arriving or remaining at the plant during certain emergency situations. These supplies are on emergency vehicles. Specific procedures dictate the requirements for use of this equipment. The facilities, equipment inventory, and emergency equipment maintenance are described in Section 7.6.

5.4.1.8 Contamination Control Measures

Personnel evacuating areas potentially contaminated by an incident proceed to monitoring and decontamination stations as directed by the IC or CM. Monitoring and decontamination is performed in accordance with plant procedures. Access to the potentially contaminated area is controlled to provide for plant contamination control. Contamination control measures for both radiological and toxic materials are implemented in plant procedures.

5.4.2 Off-Site Protective Actions

The plant is equipped with a detection and warning system to recognize hazardous and radioactive material releases. In the event of a release, the CM is responsible for providing protective action recommendations to local officials as part of initial notifications and ongoing communications. These recommendations are based on assessment actions and a thorough understanding of the actual and potential plant conditions.

By prior agreement with off-site authorities, the CM has full authority to activate the Public Warning System sirens in the event of a radiological/hazardous material release that has spread beyond or that threatens to travel beyond the DOE reservation boundary. This activation notification applies to residents and transient members of the public within approximately a two-mile radius from the plant center, including the Kentucky Wildlife Management area.

In conjunction with activating the Public Warning System sirens, the CM, also by prior agreement with off-site authorities, contacts the Emergency Alert System (EAS) affiliate to initiate the appropriate EAS announcement. The EAS messages associated with siren activation for nearby residents are to shelter in-place or advisories that no action is needed. Additionally, the CM may recommend that roads that traverse the DOE reservation be closed.

The plant will provide continuing assessments during releases off-site, but protective actions beyond those mentioned will be directed by off-site authorities who are responsible for members of the public living within their jurisdiction.

The most severe, credible accident at the plant would involve the dropping and rupturing of a liquid UF_6 cylinder. During a liquid UF_6 cylinder release incident, the UF_6 reacts with moisture in the air. The resulting hydrolysis products are uranyl fluoride particles and HF gas. An off-site hazard could result from the chemical toxicity of HF and uranium. The radiotoxicity of uranium is insignificant when compared with its chemical toxicity. Analysis indicates that there is an off-site hazard from a release of other plant hazardous materials. (Section 2 describes the various types of hazards and their consequences.) In either event, sheltering citizens in the path of the plume can greatly mitigate the consequences.

5.5 EXPOSURE CONTROL IN RADIOLOGICAL EMERGENCIES

In the event of a radiological/hazardous material release, potentially affected personnel are evacuated or sheltered in accordance with an EPIP. A monitoring and decontamination station is established at designated plant locations when directed by the IC or CM. Plant emergency response personnel perform personnel monitoring and decontamination in accordance with plant procedures.

When releases occur on-site before the evacuation of nonessential personnel can be completed, personnel are routed to the evacuation/decontamination assembly areas.

On-site contamination control measures are described in plant procedures.

5.5.1 Emergency Radiation Exposure Control Program

5.5.1.1 Radiation Protection Program

This section of the Plan describes measures that are used to provide necessary assistance if individuals are injured or radiologically exposed or contaminated.

In certain emergency situations, the acceptance of above-normal radiation exposure may be warranted. It may not be possible to perform corrective/protective actions while maintaining exposures below limits specified in 10 CFR 20.

Although an emergency situation transcends the normal requirements for limiting exposure, there are EPA recommended levels of exposure acceptable in emergencies (set forth in Section 5.5.1.2).

Three categories of risk versus benefit are considered:

1. Saving of human life and reduction of injury,
2. Protection of health and safety of the public, and
3. Protection of property.

The CM authorizes emergency workers to receive emergency doses above the established plant administrative exposure limits. Exposure guidelines for emergency situations are described in the following section.

5.5.1.2 Exposure Guidelines

Exposure guidelines for radiological emergencies are consistent with the U.S. Environmental Protection Agency's PAGs summarized in EPA 400-R-92-001, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*. Exposure guides for toxic/hazardous chemicals have been incorporated in EPIPs and are consistent with the ERPGs established by the American Industrial Hygiene Association for extremely hazardous chemicals.

The following are radiation exposure guidelines:

- Doses to all workers during emergencies to the extent practical, are limited to 5 rem. Justifications for exposing workers beyond the 5 rem limit include the presence of conditions that prevent the rotation of workers or other commonly used dose-reduction methods.

- Emergency exposures are limited to 10 rem for protecting valuable property.

- Emergency exposures are limited to 25 rem for life saving activities and the protection of large populations.

- Emergency exposures in excess of 25 rem are authorized only for rare situations when such exposure is unavoidable in order to carry out a lifesaving operation or to avoid extensive exposure to large populations. Persons undertaking any emergency operation in which the dose will exceed 25 rem to the whole body do so only on a volunteer basis and with full awareness of the risks involved, including the numerical levels of dose at which acute effects of radiation will be incurred and the numerical estimates of the risks of delayed effects. Details for providing this information and for documenting an individual's willingness to volunteer are in an EPIP.

For hazardous material/toxic gas release incidents, the IC and emergency response personnel assess the incident scene and take appropriate protective and mitigative response actions based on available information, such as MSDSs, emergency response guidebooks, professional industrial hygiene guidance, and meteorological conditions.

During a UF_6 release on-site, the resulting hydrolysis products are uranyl fluoride particles and HF gas. The radiotoxicity of uranium is insignificant when compared with the chemical toxicity of HF and uranium. Therefore, exposure control during an emergency involving UF_6 will be based on chemical toxicity.

5.5.1.3 Monitoring

Provisions have been made for 24-hour-per-day capability to determine uranium uptakes received by emergency personnel. Personnel who may be required to respond to the scene of an emergency are required to wear thermoluminescence dosimeters (TLDs). Issuance of self-reading dosimeters and maintenance of interim emergency whole body dose records are addressed in an EPIP. Emergency worker dose records are maintained in accordance with radiological protection procedures.

5.5.2 Decontamination of Personnel

On-site personnel decontamination facilities for emergency conditions are equipped with decontamination material and necessary supplies. The primary means of decontamination is through the use of equipment and supplies carried on emergency response vehicles. Other decontamination facilities are located in other areas of the plant. The decontamination facilities have provisions for disrobing, collecting contaminated clothing, showering of contaminated personnel, and donning clean clothing. Contaminated wastes are contained and processed by on-site personnel.

All personnel exiting from a contamination control zone, contamination area, high contamination area, or an airborne contamination area are monitored for contamination. The instruments used for this monitoring procedure are portable contamination survey instruments. If personnel contamination above established limits is detected, preventive measures must be initiated to mitigate the spread of contamination.

Emergency decontamination activities are supervised by qualified plant response personnel.

5.6 MEDICAL TRANSPORTATION

Injured employees are normally transported to the plant medical treatment facility using a plant ambulance. Transportation of injured persons to an off-site hospital is normally provided by an on-site ambulance. In the event that an on-site ambulance is unavailable, the local off-site ambulance service provides the transportation of injured persons to an off-site hospital.

Contaminated injured persons are decontaminated prior to transport if medical conditions permit. In the event that contaminated injured persons must be transported, contamination control materials and measures are taken to protect response personnel and to prevent contaminating the ambulance.

5.7 MEDICAL TREATMENT

In the event of a serious accident requiring medical treatment, local hospitals have agreed to provide the required assistance. Lourdes Hospital and Western Baptist Hospital, both located in the city of Paducah, are equipped to handle contaminated injured individuals as well as injuries not related to contamination or overexposure. Upon request from the hospitals, plant health physics personnel are dispatched to assist in contamination control and decontamination of the patient, hospital staff, and hospital facilities/equipment. Both hospitals have Nuclear Medicine and Radiography departments and therefore have staff or expertise to make limited medical diagnoses of an injury from radiation or exposure to radioactive materials. Letters of Agreement (listed in Appendix B) have been obtained to document these arrangements.

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6. EMERGENCY RESPONSE EQUIPMENT AND FACILITIES

Emergency planning requires facilities and equipment that allow the emergency organization to perform the following actions:

1. Assess the extent of the emergency,
2. Perform the proper corrective actions to mitigate the effects of the emergency,
3. Perform actions to protect on-site and off-site personnel,
4. Provide information to off-site support agencies, and
5. Perform the proper recovery actions.

Emergency facilities, equipment, and materials are established and maintained to adequately support emergency response operations. Response activities will be coordinated at the emergency facilities required to be activated for each particular classification. These facilities and associated equipment will be used to coordinate and manage response as well as to assess and monitor functions. Additional facilities provide for specific response activities, such as security, decontamination, medical support, laboratory analyses, and media interface.

6.1 EMERGENCY RESPONSE FACILITIES

Emergency facilities are activated as needed to provide direction and control, off-site resource coordination, and public information for emergencies. Facilities are declared operational when minimum staffing is present and vital equipment is operational as outlined in procedures. The following are descriptions of facility locations, composition, activation criteria, and functions.

6.1.1 Section Deleted

6.1.2 Central Control Facility

The CCF, located in Building C-300, is used to maintain surveillance and control of operational processes, conduct incident assessment and mitigation, and initially direct protective actions. Response actions of the CCF staff are directed by the PSS. The PSS provides overall command and control of plant emergencies. CCF personnel are responsible for initially performing the following duties until the EOC is operational:

1. Assessing abnormal conditions,
2. Notifying EOC personnel,
3. Making off-site notifications,
4. Activating the Public Warning System,
5. Performing corrective actions,
6. Directing plant operations, and
7. Implementing on-site protective actions.

6.1.3 Command Post

The Command Post is a distinctly marked vehicle or specific area equipped with communications capabilities and other resources required to manage the incident. The Command Post provides the IC and emergency response personnel with a location as close as possible to the actual scene from which they can operate and assess the situation.

Uncontrolled events, such as meteorological changes or escalation of the emergency, may cause the relocation of the Command Post.

6.1.4 Emergency Operations Center

The EOC is the on-site facility for the overall management of the emergency response. The EOC is a dedicated facility located in Building C-300. The EOC is the facility for coordinating on-site response and mitigation and off-site interface activities.

The PSS activates the EOC for Alerts, SAEs, and for other emergencies at his/her discretion. When operational, the EOC provides coordination and management for the overall site emergency response. The EOC communicates with USEC and federal, state, and local organizations.

The CM directs activities at the EOC with support from the EOC director. The EOC director is responsible for coordination of EOC functions and communications.

EOC personnel are responsible for performing the following functions:

1. Dispatch of field monitoring teams,
2. Technical interactions with off-site federal, state, and local officials,
3. Generation of emergency information for public information activities,
4. Ensuring required support to the incident scene, and
5. Coordination of support for on-site response and mitigation.

6.1.5 C-200 Headquarters

The C-200 Headquarters serves as a focal point for security activities during an emergency. Protective force management personnel not at the scene

are responsible for coordinating protective force activities and communications. During an emergency, Protective Force Management reports to the Incident Commander and provides updates to the EOC staff. C-200 Headquarters performs the following functions:

1. Dispatches protective force personnel,
2. Maintains communications with the protective force officer at the emergency scene,
3. Advises protective force personnel management, and
4. Advises the EOC staff

6.1.6 Decontamination Facilities

Specific facilities, resources, and provisions for the decontamination of personnel, vehicles, and equipment are provided. These facilities are located, designed, and equipped to handle potential emergencies identified in the Emergency Plan.

Adequate decontamination equipment and supplies are available on emergency response vehicles for required decontamination activities in the field.

Building C-400 has provisions for decontaminating vehicles and equipment. Chemical Operations has the equipment and personnel capability to provide equipment decontamination services in the field.

6.1.7 Joint Public Information Center

The JPIC is the designated location for the dissemination of official information about the emergency to the media and to the public. The JPIC accommodates the following:

1. The coordination of information with interfacing federal, state, and local organizations and spokespersons,

2. Press releases and media briefings, and

3. Work space for site personnel, interfacing organization personnel, and representatives of the news media.

The primary JPIC is located at the Barkley Regional Airport.

JPIC operations are described in EPIPs.

6.2 COMMUNICATIONS EQUIPMENT

This section describes the communications systems in place to support emergency response. The communications systems are designed to ensure the reliable, timely flow of information and action directives between all parties having a role to play in the mitigation of emergencies. Reliability is provided via redundancy, dedicated communication equipment to preclude delays due to system overload, and routine use and testing of many of the systems, which lowers the probability of undetected system failures. Timeliness of information flow is achieved by prompt notification, predefined lines of communications, predefined emergency action levels, and predefined levels of authority and responsibility. The communications network is formulated around this basic concept and is designed to channel information directly to the key parties having closely related functions, thus eliminating errors often associated with second-hand information. The essential communications links are manned continuously and are periodically tested to ensure availability. The communications systems in place include the following:

1. Commercial telephone system,
2. Private automatic exchange (PAX) telephone system,
3. Red handle emergency telephone system (ETS),
4. Pull box system,
5. Alert signal system, general plant and building (howlers, sirens, etc.),
6. Facsimile machines,
7. STE secure phone,
8. Radio repeater network for plant groups,
9. Mobile communications system,
10. National Warning System (phone line),
11. Local emergency response agency radio network,
12. PA system,
13. Cellular telephones,
14. Pagers,
15. Public Warning System,
16. Mutual Aid radio system.

6.2.1 On-Site Communications

The Environmental, Safety and Health Manager or designee is responsible for planning and scheduling the inventory and inspection of designated emergency equipment and supplies and ensures that identified deficiencies are corrected in a reasonable period of time. Section 7.6, “Maintenance and Inventory of Emergency Equipment, Instruction, and Supplies,” describes inventory and inspection of designated equipment.

6.2.1.1 Telephone Systems

The administrative telephone system provides business and emergency communications. The telephone system consists of single line, multi-line, and programmable digital units.

STEs provide secure voice communications to on-site and off-site users of other STE telephones. It can operate as a normal telephone in the "clear" mode.

Cellular telephone service is available from the plant site. The PSS response vehicles are equipped with cellular telephones. This system also provides backup for the plant telephone system.

6.2.1.2 PA System

A PA system is in place with the capability to cover most occupied site buildings. During emergencies, the system is not used for routine traffic. The system is tested daily. Two-way radios and runners are used to communicate with individuals that are not covered by the PA system.

6.2.1.3 Radio Systems

The plant radio network supports normal plant operations and, therefore, is effectively utilized daily. The PSS response vehicles are equipped with two-way radios. The PSS, and fire service response vehicles, including the plant ambulances, each have the capability of communicating with responding units on the county emergency response frequency.

6.2.1.4 Pager System

Key EOC personnel have pagers which provide access from any tone-type telephone and can relay return telephone numbers or coded responses to the holder of the unit. EOC cadre pager drills are conducted at least quarterly. Pagers are used frequently for nonemergency uses, which enhances the regular testing program.

6.2.1.5 Facsimile Machines

The facsimile machines located in the EOC are used to communicate with USEC and federal, state, and local agencies.

6.2.2 Off-Site Communications

The plant uses the commercial telephone system for off-site emergency communications. Cellular telephones can be used as a backup to the commercial telephone system. The PSS, and fire service response vehicles, including the plant ambulances, each have the capability of communicating on the county emergency response frequency.

The Public Warning System, consisting of outdoor warning sirens and emergency alert system announcements, is used to provide emergency notification. Operations testing of the Public Warning System sirens is conducted monthly.

6.3 ON-SITE MEDICAL FACILITIES

The plant maintains medical coverage consistent with the activities being conducted on-site. In an emergency, off-duty medical personnel are notified and directed to required locations as needed. The PSS notifications include alerting appropriate occupational health services and medical personnel in the event of emergencies ranging from industrial accidents to toxic or radiological releases. Letters of Agreement are maintained with area hospitals. These off-site hospitals also have facilities, equipment, and supplies for the treatment of contaminated individuals. A summary of the medical resources follows.

A plant medical facility is maintained on-site during the day shift excluding weekends and holidays. This facility has the supplies, equipment, and personnel to treat most injuries. This includes capabilities for the treatment of contaminated individuals including a shower for contaminated ambulatory patients, radiation survey instruments, and decontamination supplies. Medical personnel assess patient condition, provide necessary emergency care, and determine appropriate supplemental treatment.

Health Services personnel are available during the day shift hours with plant fire fighters providing emergency medical coverage the remainder of the time. Health Services personnel may be called on-site during off shifts, as deemed necessary.

Emergency medical technicians provide and staff ambulance service. Additional ambulance support is available from off-site.

6.4 EMERGENCY MONITORING EQUIPMENT

The plant maintains various radiation detection equipment on-site for normal and emergency response use. Criticality accident alarms have been placed in those areas and in facilities containing fissile material as described in Section 5.2 of the SAR. The criticality accident alarm system provides for radiation detection and an alarm system to alert plant personnel.

Persons requiring radiation exposure monitoring wear beta-gamma-sensitive dosimeters (TLDs), which are processed and evaluated by a processor holding current accreditation from the National Voluntary Laboratory Accreditation Program of the National Institute of Standards and Technology. These personnel exposure monitoring dosimeters are exchanged and analyzed in accordance with Section 5.3 of the SAR. As appropriate, other types of dosimeters, (e.g., finger rings, direct-reading dosimeters, and neutron dosimeters) are used.

Radiation dose rate and contamination survey instruments used are appropriate to measure the types and energies of radiation encountered at GDPs. Instruments capable of supporting radiography operations are also maintained in inventory. Instrumentation includes alpha/beta count rate and scaler instrumentation as well as ion chambers used to evaluate personnel exposure.

Designated plant emergency vehicles responding to the scene will contain necessary emergency equipment and supplies and ensure that radiological monitoring equipment is readily available to emergency personnel. Radiological monitoring equipment is also stored in Building C-300 for designated field monitoring personnel. Emergency equipment and its storage locations are identified in appropriate EPIPs.

In addition to radiological monitoring equipment, the plant maintains emergency monitoring instrumentation for chemically toxic material releases. These instruments are maintained in dedicated emergency response kits and will also be supplied from the plant's inventory of routinely used monitoring equipment. Equipment to monitor toxic chemical materials is also located on designated emergency vehicles. The dedicated emergency instruments are listed in applicable EPIPs.

Meteorological data is used to ensure safe emergency scene response (from the upwind direction), facilitate plume dispersal modeling, and to develop appropriate protective action recommendations in the event of an airborne release.

The primary source of meteorological information for wind speed, wind direction, and temperature can be obtained from the C-300 meteorological station located east of the C-300 Central Control Facility at PGDP. This data is displayed at the C-300 Cascade Operations Console. In the event of an accident that results in a chemical release, the data obtained from the C-300 Cascade Operations Console can be manually entered into the ALOHA air dispersion modeling program for plotting chemical release plumes. In addition to C-300 meteorological station data, other sources of input data can also be obtained and used from the National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service at Barkley Regional Airport, about 4 miles southeast of PGDP (wind speed, wind direction, and temperature are measured at one level above ground). Internet data information sites can also be used as a source of meteorological data as well as estimations of meteorological parameters, as appropriate, at the emergency scene.

PGDP has no weather forecasting capability. Weather forecasting information is obtained from the Paducah office of the National Weather Service located at Barkley Regional Airport. Weather forecasts are used to inform plant personnel of impending related hazards, principally driving hazards, and may affect the scheduling of proposed plant evolutions such as cylinder movement.

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7. MAINTAINING EMERGENCY PREPAREDNESS CAPABILITY

This section describes the responsibilities for developing, maintaining, and updating the Plan and EPIPs and for maintaining emergency preparedness capability.

7.1 WRITTEN EMERGENCY PLAN AND PROCEDURES

Emergency Management is responsible for maintaining and updating the plan, as appropriate, in support of the application for renewal of the certificate of compliance. USEC may make changes to the plan without prior Commission approval if the changes do not decrease the effectiveness of the plan. USEC will furnish these changes to the NRC in accordance with 10 CFR 76.5 and to affected off-site response organizations within six months after the change is made. Emergency Management controls the distribution of the emergency plan ensuring that groups having responsibilities for response functions are included in the distribution.

EPIPs are Level 2 plant procedures and are revised, reviewed, approved, controlled, and distributed in accordance with plant administrative procedure requirements. These requirements, in part, ensure that new or revised EPIPs state duties, responsibilities, and actions to be taken by individual groups or individuals in response to an emergency condition. Level 2 procedures are approved by the General Manager and are distributed to each controlled procedure set holder. The revisions of the procedures incorporate required changes to correct deficiencies identified in emergencies, training, drills, or exercises.

7.2 TRAINING

The Environmental, Safety and Health Manager is responsible for emergency management training program oversight. A series of course modules has been developed for on-site and off-site training programs.

Personnel assigned to the ERO are required to satisfactorily complete an initial training program prior to assignment. Required continuing or refresher training is conducted biennially except for firefighting and hazardous material emergency response, which is conducted annually, and emergency medical technician recertification, which is conducted in accordance with Kentucky statute. A physical examination and respiratory protection training are prerequisites to both firefighting and hazardous material emergency response initial and refresher training.

The initial training program is composed of a collection of functional modules which emergency personnel receive based on their emergency assignment. Specific training requirements are defined by applicable EPIPs.

A formal training record retention program has been established and is maintained for ERO members, support personnel, and off-site agency response organizations. Evaluation records for each course are maintained for incorporation into upgrades of the program.

Emergency Management staff participates in professional emergency management development training activities and other related training.

7.2.1 General Emergency Plan Training

Emergency Plan Training for USEC employees, contractors, and subcontractors requiring unescorted access to the CAA is provided biennially through General Employee Training (GET) as described in SAR 6.6.5. Proper response to emergencies is ensured by covering the following basic Emergency Plan elements in GET:

1. Emergency Plan safety objectives and priorities;
2. Ways to report emergencies;
3. Recognition and correct response to plant alarm signals;
4. Evacuation guidelines for radiological and non-radiological emergencies;
5. Methods of personnel accountability; and
6. Personnel responsibility during emergencies.

DOE employees, contractors, and subcontractors requiring unescorted access to the CAA also receive biennial training on the six Emergency Plan elements listed above. This training requirement may be satisfied by attending GET delivered by the USEC Training organization, or training prepared by a DOE contractor/ subcontractor that has been reviewed by the USEC Training organization to ensure it is equivalent with respect to the six Emergency Plan elements listed above. Any deviations will be referred to the Shared Site process.

All personnel requiring unescorted access to the CAA (DOE and USEC) are subject to direct control of their training through denial of access if the training described above is not up-to-date. Visitors to the CAA are provided with escorts who are up-to-date on this training. Access control includes checking training expiration dates.

Proper emergency response for DOE reservation personnel (i.e. personnel who work outside of the CAA), is limited to protective actions, horn and siren recognition, and site assembly areas.

7.2.2 Specialized Emergency Plan Training for the Emergency Response Organization

A formal training program which includes classroom-type training (lectures, seminars), practical applications (tabletop drills, functional drills, and exercises), and self-study programs has been developed for the ERO and support personnel.

The ERO receives training commensurate with assigned positions. This training program ensures the continued emergency management training of all persons who may respond/participate during a plant emergency. Specialized emergency management training is provided and includes but is not limited to the following categories of topics:

- On-Scene Response Activities. Topics covered include incident command, firefighting, HAZMAT response, including monitoring and emergency medical technician training.

- Emergency Management Orientation. Topics covered include concept of operations, emergency organizations, responsibilities and authorities, requirements, facilities and equipment overview, and off-site interface summary including public information.

- Incident Classification and Notification. Topics covered include classification systems, notification requirements, procedures, and EALs.

- Hazard/Consequence Assessments and Protective Actions. Topics covered include the spectrum of hazards and possible emergencies (man-made, natural, and security) as well as reference material, site profile information, and site dispersion models. On-site and off-site protective actions and protective action decision-making philosophy are covered as well as recovery decision making.

- Ongoing Incident Assessment. Topics covered include on-site incident monitoring, off-site field monitoring, personnel protection, and reporting.

Specific emergency training requirements for each position are described in an EPIP, which includes lesson plans for the emergency management training, frequency of retraining, and the number of hours of initial and retraining that are provided to the ERO.

7.2.3 Section Deleted

7.2.4 Off-Site Emergency Management Training

Training is offered biennially by letter of invitation to emergency support organizations that may be called upon to respond to emergencies at the plant. These agencies include local fire, law enforcement, and ambulance services. Assistance is provided as needed by personnel from other plant functions, such as Training, Procedures, Health Physics, Operations, Security, or Medical. This training includes site-specific information on radiological and chemical hazards, including exposure guidelines, personnel monitoring devices, and basic contamination control principles and orientation tours.

Initial training for precautions associated with the care and treatment of contaminated injured persons has been provided to the emergency room staffs of Lourdes and Western Baptist Hospitals. Additional training will be provided on an as-requested basis.

7.3 DRILLS AND EXERCISES

Emergency drills and exercises are conducted to develop, maintain, and test the response capabilities of emergency personnel, facilities, equipment, procedures, and training.

A drill is a supervised instruction session that develops, tests, or maintains a specific emergency response capability using a limited scope scenario. Drills involve decision making and actions by participating personnel to simulate emergency conditions but do not involve off-site response personnel.

An exercise is an event that tests the integrated capability of all or most of the basic elements existing within the emergency plan and EPIPs. Exercises use scenarios that are wider in scope than drills and may involve off-site response personnel and agencies.

Persons trained in the control and evaluation of drills conducts drills and exercises. Controllers and evaluators are provided to each location if a drill or exercise involves simultaneous activities at more than one location. Evaluators are provided with criteria for acceptable performance to evaluate the performance of participants.

The Environmental, Safety and Health Manager has overall responsibility for implementing a coordinated program of emergency drills and exercises. This program is identified in an EPIP. The EPIP requires Emergency Management to promulgate annually a drill and exercise schedule that identifies drill/exercise category, shift/group, and tentative date. Line supervisory personnel are responsible for ensuring that employees under their supervision are available to participate in drills and exercises. Site personnel are required to participate in drills and exercises in a safe and realistic manner.

The Emergency Management Drill and Exercise Committee is responsible for proper exercise scenario development, establishing a planning schedule, developing the scenario, and identifying participants and evaluators. The committee is chaired by a representative of Emergency Management and consists of members representing the areas of police operations, fire services, PSS staff, and others as appointed.

Members of the ERO participate in drills and exercises. This requirement is met if the activated personnel of the ERO respond to an emergency and response objectives are met, records are kept, and a critique is performed.

7.3.1 Biennial Exercises

Plant personnel plan and conduct biennial exercises. Off-site response organizations and the NRC are invited to observe or participate in these scheduled exercises.

An exercise scenario manual containing relevant documentation is developed for each exercise. The exercise scenario contains a preplanned description of the accident to be used. It is prepared according to the scope and objectives of the exercise. Each scenario describes a hypothetical situation which serves as the basis for emergency response actions. Scenarios are varied from year to year and are designed to minimize simulation. No scenario information is given to participants prior to an exercise.

The exercise scenario manual is provided to the NRC at least 60 days before the exercise.

Exercise controllers and evaluators are trained on proper conduct of emergency exercises. This training includes information on safety precautions, scenario messages, simulated actions, participant interactions and controller input, evaluation methodology, and critique format.

7.3.2 Quarterly Communications Checks

Communications checks with off-site response organizations are conducted on a quarterly basis and include the check and update of necessary telephone numbers.

7.4 CRITIQUES

Formal critiques are conducted for key participants, controllers, and evaluators following each exercise. These critiques are conducted by personnel who were not participants, normally emergency management or contractor personnel.

Emergency Management screens all critique comments. Critique items that have safety significance indicate a regulatory violation or reflect serious deficiencies in plan content or implementation are identified to the PSS and an Assessment and Tracking Report is initiated. Resulting corrective actions are tracked in the plant management tracking system in accordance with plant procedures. The remaining critique items are submitted to the Emergency Management Drill and Exercise Committee, which determines their validity and determines the appropriate method for corrective actions as required by an EPIP.

Emergency Management tracks corrective actions identified by the Emergency Management Drill and Exercise Committee through completion or implementation. Organization Managers are responsible for implementing exercise corrective actions in their respective functional areas.

7.5 PROGRAM AUDIT

The Emergency Management Program is audited in accordance with Section 2.18 of the Quality Assurance Program to ensure adequate and effective program function. This ensures that changes in plant layout are included in revisions to the Plan. The scope of the audit includes the Plan and the EPIPs, training activities, exercise deficiencies, emergency facilities, equipment, and supplies, and those records associated with off-site support agency interface.

Selection of audit team members and audit team familiarization is as required by Quality Assurance procedures. Audit personnel do not have direct responsibilities for implementing the Emergency Management Program and are qualified according to Quality Assurance procedures. Lead auditor qualification and requalification is performed in accordance with Supplement 2S-3 to ASME NQA-1-1989.

Procedures require that Emergency Management investigate adverse audit findings and schedule corrective actions that prescribe measures to prevent recurrence. The auditing organization evaluates the adequacy of the written responses.

Procedures require that follow-up actions be taken to verify that corrective actions are completed as scheduled.

7.6 MAINTENANCE AND INVENTORY OF EMERGENCY EQUIPMENT, INSTRUMENTATION, AND SUPPLIES

The Environmental, Safety and Health Manager or designee is responsible for planning and scheduling the inventory and inspection of designated emergency equipment and supplies and ensures that identified deficiencies are corrected in a reasonable period of time. Scope, responsibilities, and frequencies for inventories and inspections of designated emergency equipment and supplies are specifically described in plant procedures.

A two-way radio network and two telephones systems, including the telephones in the EOC, are in daily use at the plant and, therefore, are effectively tested on a continual basis.

Adequate equipment and supplies are kept available and maintained in operable status for emergency response personnel to perform their respective duties and responsibilities. This includes equipment and materials for radiological and toxicological monitoring, protective clothing, fire-fighting equipment, sampling equipment, respiratory protection equipment and emergency air supplies, vehicles, and administrative supplies.

Emergency response vehicles (i.e., fire, HAZMAT, E-Squad, and plant ambulances) are maintained as required by Fire Services and Maintenance procedures. Emergency equipment and supplies provided on emergency response vehicles are inspected and inventoried as required by plant procedures.

Emergency equipment and supplies provided on emergency response vehicles include instruments, demand respirators, self-contained breathing apparatus, firefighting equipment and gear, medical equipment, rescue equipment, HAZMAT response materials, and supplemental lighting. Emergency equipment stored in building C-300 is inspected and inventoried quarterly. Materials and supplies with rated shelf-lives are tracked and replaced as required in Emergency Management, Fire Services, Health Physics, or Industrial Hygiene and Safety procedures. Emergency instruments are operationally tested quarterly and after each use. Normal plant use two-way radios are used for emergency response.

Sufficient reserves of emergency equipment and instruments are available to replace emergency equipment that is removed for calibration or repair. A summary report of each inventory and inspection is prepared and submitted as Emergency Management documentation.

7.7 LETTERS OF AGREEMENT

Changes to the Plan are communicated to the appropriate off-site response organizations. Letters of Agreement with off-site support organizations and agencies are reviewed and updated every four years or more frequently if needed. A change in original signatory to a given letter of agreement does not in itself require revision of that letter. A change in applicability of content of a letter of agreement, however, does require a revision to that letter. Letters of Agreement are identified in Appendix B.

8. RECORDS AND REPORTS

8.1 RECORDS OF INCIDENTS

Event documentation includes the cause of the incident, personnel and equipment involved, extent of injury and damage (on-site and off-site) resulting from the incident, locations of contamination with the final decontamination survey results, corrective actions taken to terminate the emergency, measures taken to restore the plant to normal conditions, and action taken or planned to prevent a recurrence of the incident. The documentation includes plant and off-site support assistance requested and received and any program changes resulting from a critique of emergency response activities.

The PSS is responsible for reporting and recording incidents of abnormal operation, equipment failure, and accidents that lead to a plant emergency. Records unique to a radiological emergency and those event-related records important to decommissioning are retained until the certificate is terminated.

8.2 RECORDS OF PREPAREDNESS ASSURANCE

Records are retained and maintained to document readiness assurance. These records include the following:

1. Emergency management training and retraining, including lesson plans and test questions,
2. Drills, exercises, and related critiques,
3. Inventories and locations of emergency equipment and supplies,
4. Maintenance, surveillance, calibration, and testing of emergency equipment and supplies,
5. Letters of Agreement,
6. Reviews and updates of the Plan, and
7. Notification of personnel and off-site agencies affected by an update of the Plan and the EPIPs.

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9. RECOVERY AND PLANT RESTORATION

In any emergency, the immediate action is directed toward limiting the consequences of the incident in a manner that affords the maximum protection to plant personnel and the general public. Once the corrective and protective actions have established an effective control over the situation and emergency conditions no longer exist, the emergency response shifts into the recovery phase.

Emergencies may or may not impact plant operations within the scope of NRC-regulated activities.
Therefore, it is possible to continue operations that are not impacted, either directly or indirectly, by an emergency situation.

It is the responsibility of the CM to determine when the recovery phase of the emergency can be initiated. The following criteria for terminating an emergency and beginning recovery operations are considered when appropriate to the circumstances:

- If classified emergency, conditions no longer meet any emergency classification criteria (EAL).
- The affected facility/area is in a stable condition and can be maintained in that condition, indefinitely.
- Fire or other similar emergency conditions no longer constitute a hazard.
- Releases of hazardous materials to the environment have ceased or are controlled.
- Discussions with the ERO and appropriate off-site agencies identify no valid reason to continue in any emergency classification.

9.1 RECOVERY

The nature and extent of the emergency determines what recovery operations are required and the extent of the recovery organization that must be formed. A recovery plan must be flexible enough to adapt to the existing conditions.

It is not possible to anticipate in advance all of the conditions that may be encountered as a result of the emergency. However, recovery and restoration activities will be conducted to maintain exposures as low as reasonably achievable (ALARA). Depending of the nature of the emergency, recovery activities could include decontamination of facility personnel, sampling to determine the extent of material release, or bioassay strategy for exposed or potentially exposed persons.

Recovery includes those actions necessary to return an incident site and the surrounding environment to pre-emergency conditions to the maximum extent practical. General principles addressed in this section serve as a guide for developing a flexible plan of action.

The PSS manager is responsible for ensuring retention of all records associated with an incident relating to an NRC regulated activity or a USEC leased facility.

Specific recovery plans are developed in accordance with applicable EPIPs. The DOE site manager is responsible for ensuring the adequacy and appropriateness of recovery operations involving nonleased portions of the facility.

9.2 RECOVERY ORGANIZATION

Prior to termination of an emergency and deactivation of the ERO, a recovery organization is established to implement recovery plans. This organization is managed by a recovery manager who has overall responsibility for recovery activities including checking safety equipment involved in the emergency and restoring it to normal conditions. The recovery manager compiles and evaluates records related to the recovery including ALARA records and delivers these records to the PSS office for retention. The recovery manager is aided by key operating and management positions representing broad functional areas. These include some or all of the following, depending on the nature of the event:

1. Operations,
2. Maintenance,
3. Engineering,
4. Environmental, Safety, and Health,
5. Security,
6. Public Affairs,
7. Administration, and
8. Logistics.

10. COMPLIANCE WITH COMMUNITY RIGHT-TO-KNOW ACT

The plant complies with the EPA Superfund Amendments and Reauthorization Act (SARA) Title III regulations, also known as the Emergency Planning and Community Right to Know Act. Specific responsibilities include emergency response planning, emergency release reporting, hazardous chemical inventory reporting, and toxic chemical release reporting.

The Plan and appropriate EPIPs are used during any hazardous chemical release emergencies. Plant administrative procedures have been developed for hazardous materials releases that are not classified as emergencies to ensure that requirements of SARA Title III are met. MSDSs are maintained in several areas throughout the plant.

Hazardous materials spills or releases are reported to the PSS who responds to the incident scene as IC or dispatches other qualified individual in that capacity. The IC directs the emergency containment of spills. Actions to be implemented are described in appropriate EPIPs and include the following:

1. Establish command,
2. Evacuate/isolate the area of release/spill activity, as necessary, and determine areas of concern,
3. Classify the emergency, if appropriate,
4. Determine if activation of additional ERO personnel is necessary,
5. Take measures to minimize safety concerns,
6. Determine a course of action and personal protective equipment requirements,
7. Initiate containment procedures,
8. Terminate the source,
9. Make appropriate notifications to on-site and off-site officials,
10. Determine material disposal, and
11. Terminate the incident and enter recovery.

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Appendix A - Deleted

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Appendix B

LETTERS OF AGREEMENT

1. Office of the McCracken County Judge-Executive , McCracken County, Kentucky
2. Paducah-McCracken County Office of Emergency Management, Paducah, Kentucky
3. Paducah Fire Department, Paducah, Kentucky
4. Lone Oak Fire District, McCracken County, Kentucky
5. West McCracken County Fire District, West Paducah, Kentucky
6. Lourdes Hospital, Paducah, Kentucky
7. Western Baptist Hospital, Paducah, Kentucky
8. Vanderbilt University Hospital, Lifeflight Air Ambulance, Nashville, Tennessee
9. St. Mary’s Medical Center, Lifeflight Air Ambulance, Evansville, Indiana
10. PHI Air Medical, Paducah, Kentucky
11. Mercy Regional Emergency Medical Services, Paducah, Kentucky
12. Purchase Area District Health Department, Paducah, Kentucky
13. Federal Bureau of Investigation (FBI), Louisville, Kentucky
14. Kentucky State Police, Post 1, Mayfield, Kentucky
15. McCracken County Sheriff's Department, Paducah, Kentucky
16. Paducah Police Department, Office of the Mayor, Paducah, Kentucky
17. U. S. Army 717th Explosive Ordnance Disposal, Ft. Campbell, Kentucky

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Appendix C

LIST OF SUPPORTING DOCUMENTS

1. Kentucky Division of Emergency Management, *Commonwealth of Kentucky Emergency Operations Plan*

2. Paducah-McCracken County Office of Emergency Management, *McCracken County Emergency Operations Plan*

3. Western Baptist Hospital, *Support Plan for Paducah Gaseous Diffusion Plant*

4. Lourdes Hospital, *Support Plan for Paducah Gaseous Diffusion Plant*

5. DOE Paducah Environmental Management & Enrichment Facilities Integrating Emergency Plan

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Appendix D

DEFINITIONS/ACRONYMS

Accident — A deviation from normal operations or activities associated with a hazard that has the potential to result in an emergency.

ACR — Area Control Room.

ALARA — As Low as Reasonably Achievable.

Text deleted.

Assessment Actions — Those actions taken during or after an accident to obtain and process information that is necessary to make decisions to implement specific emergency measures.

CAAS — Criticality Accident Alarm System.

CAS — Central Alarm Station.

CCF — Central Control Facility.

CM — Crisis Manager.

Consequence — The result or effect (especially projected doses or dose rates) of a release of radioactive or hazardous materials to the environment.

Corrective Actions — Those emergency measures taken to lessen the severity of or terminate an emergency situation at or near the source of the problem in order to prevent or control a release of radioactive material or to minimize the damage to plant equipment, e.g., shutting down equipment, fire fighting, repair, and damage control.

Decontamination — The removal of surface radioactive/hazardous material from individuals, equipment, surfaces, etc.

DOE — Department of Energy.

Drill — A supervised, hands-on instruction period intended to test, develop, or maintain a specific emergency response capability. A drill is often a component of an exercise.

EAS — Emergency Alert System

EMA — Emergency Management Agency.

Emergency — A sudden, usually unforeseen occurrence or occasion requiring time-urgent and immediate action/response. It may result from accidental causes, natural causes, or malicious man-made actions.

Appendix D (Continued)

Emergency Action Level (EAL) — Specific, predetermined, observable criteria used to detect, recognize, and determine the class of emergencies. An EAL can be an instrument reading, an equipment status indicator, a measurable parameter, on-site or off-site, a discrete, observable event, a result of analyses, or another observed phenomenon that indicates entry into a particular emergency class.

Emergency Operations Center (EOC) — An emergency response facility that accommodates personnel acting in support of the command and control functions but separate from the incident commander and on-scene command post. Under the guidance of the CM, these personnel supply in-depth strategic and corrective engineering and radiological, hazardous materials, and environmental support assistance to the incident scene.

Emergency Response Organization (ERO) — The designated group of personnel responsible for coping with and minimizing or mitigating the effects of any emergency.

Emergency Response Planning Guideline (ERPG) — A hazardous material personnel exposure level or range which, when exceeded by a short-term or acute exposure, will cause irreversible or other serious health effects in humans. The ERPGs are approved by a committee of the American Industrial Hygiene Association.

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EPA — Environmental Protection Agency.

EPIP — Emergency Plan Implementing Procedure.

Event — Any real-time occurrence or significant deviation from planned or expected behavior that could endanger or adversely affect people, property, or the environment.

Exercise — A scheduled and planned large-scale activity that tests the integrated capability and most aspects of the emergency management program.

FAA — Federal Aviation Administration.

FBI — Federal Bureau of Investigation.

GDP — Gaseous Diffusion Plant.

Hazardous Material — Any solid, liquid, or gaseous material that is toxic, flammable, radioactive, corrosive, chemically reactive, or unstable upon prolonged storage in quantities that could pose a threat to life, property, or the environment.

IC — Incident Commander.

Appendix D (Continued)

Immediate Notification Area (INA) — An area that extends approximately two miles from the center of plant in which members of the public would be notified by Public Warning System sirens in the event of a chemical release.

JPIC — Joint Public Information Center.

Letter of Agreement — An agreement drawn up between the plant and off-site local governments or other organizations for assistance in the event of an emergency (also called Memorandum of Understanding, Mutual Aid Agreement, and Letter of Assistance).

MSDS — Material Safety Data Sheet.

NRC — Nuclear Regulatory Commission.

NWS — National Weather Service.

PA — Public Address.

Plan — The plant emergency plan.

PORTS — Portsmouth Gaseous Diffusion Plant.

Protective Action — Physical measures, such as evacuation or sheltering, taken to prevent potential health hazards resulting from a release of hazardous materials to the environment from adversely affecting employees or the off-site population.

Protective Action Guide (PAG) — A radiation personnel exposure level or range beyond which protective action should be considered. PAG values should reflect a balance of risks and costs to on-site personnel, public health and safety, and the environment weighed against the benefits obtained from protective actions.

PSS — Plant Shift Superintendent.

Recovery — Actions taken after the emergency to restore the plant or area as nearly as possible to pre-emergency conditions.

RM — Recovery Manager.

SAE — Site Area Emergency.

Appendix D (Continued)

SAR — Safety Analysis Report.

TLD —Thermoluminescence Dosimeter.

USEC — United States Enrichment Corporation.

Appendix E

ITEMS ADDRESSED BY COMPLIANCE PLAN

Section deleted.

1.3 Description of Area Near the Site

Section deleted.

1.3.1 Item of Noncompliance

Section deleted.

1.3.2 Current Status

Section deleted.

5.4 Protective Actions

Section deleted.

5.4.1 Item of Noncompliance

Section deleted.

5.4.2 Current Status

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2.0 Types of Accidents and Other Emergencies

Section deleted.

2.1 Item of Noncompliance

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2.2 Current Status

Section deleted.

7.2 Training

Section deleted.

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7.2.1 Item of Noncompliance

Section deleted.

7.2.2 Current Status

Section deleted.

ENVIRONMENTAL COMPLIANCE STATUS AND ENVIRONMENTAL MONITORING REPORT

PADUCAH GASEOUS DIFFUSION PLANT

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1. INTRODUCTION

As part of its application for a certificate of compliance, Title 10 Code of Federal Regulations (CFR) Part 76.35(g) requires that United States Enrichment Corporation (USEC) provide an environmental compliance status report describing the status of federal, state, and local environmental permits, licenses, approvals, and other entitlements, as well as the compliance status with applicable environmental quality standards and requirements described in 10 CFR 51.45(d) that are applicable to USEC operations. In addition, 10 CFR 76.35(g) requires that the compliance status report contain current environmental and effluent monitoring data. This report covers the compliance status of the Paducah Gaseous Diffusion Plant (PGDP) with applicable federal, state, and local permits, licenses and other entitlements through the end of calendar year (CY) 2007 except for public dose assessments. Due to the required schedule for submission of this document, the public dose assessments for CY 2007 will not be available in time for inclusion here. Consequently, the dose assessments for CY 2006 are provided instead.

2. DESCRIPTION AND COMPLIANCE STATUS OF PERMITS, REGISTRATIONS, ANDOTHER ENTITLEMENTS, AND OTHER APPLICABLE ENVIRONMENTAL QUALITY STANDARDS AND REQUIREMENTS

USEC is required to operate PGDP in compliance with a number of federal and state environmental permits, registrations, other entitlements, and other applicable environmental quality standards and requirements. The following matrices (Tables 1 and 2) identify each of the environmental permits that govern USEC activities at PGDP. They also identify the principal permit limits, provide a summary of monitoring and emissions/effluent data for each permit, and contain a summary statement on the status of USEC compliance.

2.1 CLEAN AIR ACT

Pursuant to the Federal Clean Air Act (CAA), as amended, and corresponding Commonwealth of Kentucky laws and regulations, USEC currently has the responsibility for several air permits issued by the Kentucky Division for Air Quality (KDAQ):

1. Permit number O-110-85, was issued in September of 1985 to the Department of Energy (DOE). Based on the lease agreement, responsibility for a number of these points has been transferred to USEC. KDAQ will issue a new air permit for these sources during the Title V permitting process. Until the new Title V permit is issued, the permit conditions and limitations, contained in O-110-85, remain in effect unless a modification is needed before the Title V permit is issued.

2. Permit number S-95-036, Revision 1, was issued to USEC on November 26, 1997 for plantwide hydrogen fluoride (HF) emissions.

3. Permit number F-97-004, was issued to USEC on September 26, 1997 for Boiler No.1. The existing boiler had deteriorated necessitating replacement.

On December 11, 1998, USEC submitted a plantwide Title V permit application. After the submission of additional information, KDAQ determined the application was complete on March 3, 1999. Included in the Title V permit application were sources covered under the 40 CFR 61 radiological NESHAP regulations. The submission of a complete Title V application provides a permit shield under which USEC may operate until KDAQ issues a final permit. All previous permits remain effective until superseded by the Title V permit.

Updates to the Title V permit application have been submitted as required. There have been several updates including; high assay operation, emergency generators, and maximum achievable control technology (MACT) standards for industrial boilers. MACT standards pertaining to industrial boilers were proposed on January 13, 2003 and finalized on September 13, 2004. As part of the process, USEC submitted a 40 CFR 63, Part 1, application on May 10, 2002. The rule was remanded and vacated by the D.C. Circuit Court on July 30, 2007 before the compliance deadline. USEC is awating further action on the boiler MACT. In the fall of 2007, KDAQ began actively working the Title V permit. Additional information has been submitted as requested. A permit has not been issued.

As required by KDAQ regulations, USEC submitted annual plantwide compliance certifications starting with CY 2001. Each year, certifications are due by January 30 for the previous calendar year. The annual certifications are based on current permit conditions and information submitted in the Title V permit application. The CY 2007 certification was submitted in January 2007. Air emission sources were certified to be in compliance with no deviations noted. Table 1 contains permit and compliance information.

USEC is in compliance with federal regulations issued pursuant to the CAA that govern management of asbestos.

Finally, the PGDP Fire Services section conducts its own fire training exercises on property leased by USEC from DOE. USEC is in compliance with KDAQ regulations governing open burning.

2.2 CLEAN WATER ACT

Previously, USEC and DOE jointly held a Kentucky Pollutant Discharge Elimination System (KPDES) permit reissued pursuant to state laws and regulations and the Federal Water Pollution Control Act, as amended (commonly referred to as the Clean Water Act [CWA]). The permit was initially issued by the Kentucky Division of Water (KDOW) to DOE in September 1991, with an effective date of November 1, 1992. In June 1993, KDOW added USEC as a joint permittee of the KPDES permit. Subsequently USEC and DOE were issued individual permits. The newly issued USEC KPDES permit became effective on April 1, 1998 and was to expire on March 31, 2003. A new KPDES permit application was submitted on October 3, 2002 and was determined to be complete on December 30, 2002 by KDOW. USEC continues to discharge under the 1998 permit until KDOW issues a new permit in response to the application submitted in 2002.

The KPDES permit encompasses 10 outfalls discharging into two creeks. Permit limits for USEC outfalls are summarized in Table 2. Data on the discharge of radionuclides are provided below in Sections 3 and 4. Information and data on outfalls for which DOE is responsible are not included in this report. During 2007, USEC was in compliance with the permit limits with the following exceptions:

1 phosphorus exceedance	Outfall 002
1 phosphorus exceedance	Outfall 008
1 toxicity exceedance	Outfall 008

2.3 RESOURCE CONSERVATION AND RECOVERY ACT

Until April 1996, USEC and DOE jointly held a permit issued pursuant to the Resource Conservation and Recovery Act (RCRA), as amended, and applicable Commonwealth laws and regulations promulgated thereunder. In April 1996, USEC was removed from the RCRA permit and was issued a separate generator identification number. DOE retained all of the responsibilities set forth in the permit.

USEC generates hazardous and mixed waste, and complies with requirements for generators, including accumulation of waste in satellite accumulation areas and accumulation of waste in 90-day accumulation areas (90-DAAs). DOE operates the permitted treatment and storage facilities under the RCRA permit. USEC did not receive any NOVs for RCRA noncompliance during 2007.

USEC is currently shipping the majority of USEC-generated hazardous and mixed waste directly from 90-DAAs to off-site treatment, storage, and disposal (TSD) facilities.

An Agreed Order (AO) between USEC and the Kentucky Natural Resources and Environmental Protection Cabinet became effective on November 15, 1995. This AO established requirements for the management of mixed waste. USEC completed all obligations under the AO on December 1, 2005. Final approval for closure of the AO and discontinuation of all reporting requirements was received from the Kentucky Division of Waste Management on November 30, 2007.

2.4 STORAGE TANKS

USEC operates two fuel underground storage tanks (USTs). The tanks are registered under and in compliance with Kentucky Department of Environmental Protection regulations governing USTs.

USEC also operates approximately 36 aboveground tanks, including 2 large fuel oil tanks and various smaller tanks holding gasoline, diesel fuel, kerosene, and transformer oil. A Spill Prevention, Countermeasures, and Control Plan has been submitted to the United States Environmental Protection Agency (USEPA) and KDOW for these tanks pursuant to the CWA, and a Facility Response Plan has been submitted pursuant to the Oil Pollution Act of 1990.

2.5 POLYCHLORINATED BIPHENYLS

USEC leases transformers and capacitors from DOE that contain greater than 50 parts per million (ppm) polychlorinated biphenyls (PCBs). Matters regarding the management of equipment, as well as the storage, disposal, and attention to past spills of PCBs are the responsibility of DOE pursuant to the lease agreement between DOE and USEC.

2.6 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT; RELEASE REPORTING UNDER THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT

USEC is in compliance with requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA), including the preparation of an emergency response plan under Section 302, hazardous chemical reporting under Sections 311 and 312, and toxic chemical release reporting under Section 313. In addition, USEC is in compliance with release reporting requirements for reportable quantities of hazardous substances under Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended.

3. NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP)

Under the requirements of 40 CFR 61 (NESHAP) Subpart H, emissions of radionuclides to the ambient air from DOE facilities must not exceed those amounts that would cause any member of the public to receive an effective dose equivalent (EDE) of 10 mrem/year in any year. The dose standard is for the DOE PGDP site and not from individual USEC and DOE operations. In January 1992, DOE and EPA finalized a compliance plan setting forth the process by which PGDP would demonstrate compliance with the NESHAP standards.

In 2006, as result of both USEC and DOE operations at PGDP, the calculated EDE due to airborne radionuclide emissions for the maximally exposed individual located approximately 2,350 meters north of the north side of the plant security fence was 0.12 mrem. Off-site ambient air samples obtained during 2007 did not indicate the presence of any significant contamination above normal levels.

The calculated CEDE from airborne releases was 0.06 person-rem.

4. ENVIRONMENTAL MONITORING DATA

In addition to the data required by environmental permits and regulations, USEC monitored environmental media for the purpose of identifying possible effects of plant emissions on the surrounding area. The activities included ambient air, soil, and sediment sampling, sampling of locally grown food crops, and monitoring of direct radiation from plant sources. The data obtained from this program during 2007 are summarized in Tables 5 through 11.

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Table 1. Air permits - 2007.

Permit/Description	Principal Permit Limits		Compliance Summary[a]
40 CFR 61, Subpart H, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities	Total EDE to the most exposed member of the public ≤ 10 mrem/year		NEI (CY 2006)
O-85-110 KDAQ Permit to Operate C-600 Steam Plant Boiler Nos. 2 and 3	Opacity Particulate matter Sulfur Dioxide Hydrogen Fluoride	20% 0.242 lbs/mmBTU 125 tons/yr 3.1 lbs/mmBTU 1,604 tons/yr 1.50 lbs/hr	NEI
Coal/Oil Handling Operations	Coal Oil	84,520 tons/yr 2,700,000 gal/yr	
F-97-004 KDAQ Permit to Operate C-600 Steam Plant Boiler No. 1	Nitrogen oxides Sulfur dioxide Particulate matter Particulate matter ≤ 10 microns (PM_{10}) Oil consumption <u>Natural gas</u>: Opacity Nitrogen oxides Sulfur dioxide Particulate matter <u>Fuel oil</u>: Opacity Nitrogen oxides Sulfur dioxide Particulate matter	39.9 tons/yr 39.9 tons/yr 24.9 tons/yr 14.9 ton/yr 1,000,000 gal/yr 20% 0.0517 lbs/mmBTU 0.0006 lbs/mmBTU 0.0100 lbs/mmBTU 20% 0.20 lbs/mmBTU 0.5 fuel weight percent 0.10 lbs/mmBTU	NEI
O-85-110 KDAQ Permit to Operate C-611-B Chemical Unloading	Opacity 40% Particulate matter	 22.3 lbs/hr 0.268 tons/yr	NEI
O-85-110 KDAQ Permit to Operate C-616 Chemical Unloading	Opacity 40% Particulate matter	 22.3 lbs/hr 0.268 tons/yr	NEI

Table1. Air permits - 2007. (Continued)

Permit/Description	Principal Permit Limits	Compliance Summary[a]
S-95-036, Revision 1, KDAQ Permit to Operate Gaseous Diffusion Purge Vent (200-foot stack)	Hydrogen Fluoride: Operating scenario 1 – 37.2 lbs/12 hr Operating scenario 2 - 84.0 lbs/12 hr Operating scenario 3 - 0.00 lbs/12 hr	NEI
S-95-036, Revision 1, KDAQ Permit to Operate Gaseous Diffusion Purge Vent (70-foot stack)	Hydrogen Fluoride: Operating scenario 1 - 0.00 lbs/12 hr Operating scenario 2 - 0.00 lbs/12 hr Operating scenario 3 - 7.68 lbs/12 hr	NEI
S-95-036, Revision 1, KDAQ Permit to Operate C-335 Surge Drum Purging Vent	Hydrogen Fluoride: Operating scenario 1 - 17.64 lbs/12 hr Operating scenario 2 - 0.0 lbs/12 hr Operating scenario 3 - 7.68 lbs/12 hr	Not in operation
S-95-036, Revision 1, KDAQ Permit to Operate C-409 High Assay Cylinder Wash	Hydrogen Fluoride: Operating scenario 1 - 0.0008 lbs/12 hr Operating scenario 2 - 0.0008 lbs/12 hr Operating scenario 3 - 0.0008 lbs/12 hr	Not in operation
S-95-036, Revision 1, KDAQ Permit to Operate C-410-K Fluorine Manifold Facility	Hydrogen Fluoride: Operating scenario 1 - 0.09 lbs/12 hr Operating scenario 2 - 0.09 lbs/12 hr Operating scenario 3 - 0.09 lbs/12 hr	NEI

NOTES:
a. NEI - No exceedances identified.

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 002)	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	1 exceedance
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (µg/L)	In compliance
	Trichloroethylene	report daily maximum (µg/L)	In compliance
	PCBs	report monthly average (µg/L)	In compliance
	PCBs	report daily maximum (µg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 004)	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	BOD (5-day)	30 monthly average (mg/L)	NEI
	BOD (5-day)	45 daily maximum (mg/L)	NEI
	Fecal coliform	200/100 mL monthly average (100 mL)	NEI
	Fecal coliform	400/100 mL daily maximum (100 mL)	NEI

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 006)	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Suspended solids	30 monthly average (mg/L)	NEI
	Suspended solids	50 daily maximum (mg/L)	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 008)	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	1 exceedance
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (µg/L)	In compliance
	Trichloroethylene	report daily maximum (µg/L)	In compliance
	PCBs	report monthly average (µg/L)	In compliance
	PCBs	report daily maximum (µg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Chronic toxicity	report monthly average	In compliance
	Chronic toxicity	1.00 daily maximum	1 exceedance
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 009)	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (µg/L)	In compliance
	Trichloroethylene	report daily maximum (µg/L)	In compliance
	PCBs	report monthly average (µg/L)	In compliance
	PCBs	report daily maximum (µg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Chronic toxicity	report monthly average	In compliance
	Chronic toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 010)[c]	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	1 exceedance
	Trichloroethylene	report monthly average (µg/L)	In compliance
	Trichloroethylene	report daily maximum (µg/L)	In compliance
	PCBs	report monthly average (µg/L)	In compliance
	PCBs	report daily maximum (µg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Chronic toxicity	report monthly average	In compliance
	Chronic toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 011)[c]	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (µg/L)	In compliance
	Trichloroethylene	report daily maximum (µg/L)	In compliance
	PCBs	report monthly average (µg/L)	In compliance
	PCBs	report daily maximum (µg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 012)	Temperature	report daily maximum (°F)	In compliance
	Temperature	89 monthly average (°F)	NEI
	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Phosphorus	1.0 monthly average (mg/L)	NEI
	Phosphorus	1.0 daily maximum (mg/L)	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (μg/L)	In compliance
	Trichloroethylene	report daily maximum (μg/L)	In compliance
	PCBs	report monthly average (μg/L)	In compliance
	PCBs	report daily maximum (μg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
	Chlorine residual	report monthly average (mg/L)	In compliance
	Chlorine residual	report daily maximum (mg/L)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 013)	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (μg/L)	In compliance
	Trichloroethylene	report daily maximum (μg/L)	In compliance
	PCBs	report monthly average (μg/L)	In compliance
	PCBs	report daily maximum (μg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals[b]	report daily maximum (mg/L)	In compliance

Table 2. KPDES water discharge permits - 2007. (Continued)

Permit/Description	Principal Permit Limits		Compliance Summary[a]
KPDES KY0102083 (Outfall 016)	pH	6.0 minimum	NEI
	pH	9.0 maximum	NEI
	Hardness	report monthly average (mg/L)	In compliance
	Hardness	report daily maximum (mg/L)	In compliance
	Oil and grease	10 monthly average (mg/L)	NEI
	Oil and grease	15 daily maximum (mg/L)	NEI
	Trichloroethylene	report monthly average (μg/L)	In compliance
	Trichloroethylene	report daily maximum (μg/L)	In compliance
	PCBs	report monthly average (μg/L)	In compliance
	PCBs	report daily maximum (μg/L)	In compliance
	Flow	report monthly average (MGD)	In compliance
	Flow	report daily maximum (MGD)	In compliance
Quarterly parameters	^{99}Tc	report monthly average (pCi/L)	In compliance
	^{99}Tc	report daily average (pCi/L)	In compliance
	Total uranium	report monthly average (mg/L)	In compliance
	Total uranium	report daily maximum (mg/L)	In compliance
	Acute toxicity	report monthly average	In compliance
	Acute toxicity	1.00 daily maximum	NEI
	Total metals[b]	report monthly average (mg/L)	In compliance
	Total metals	report daily maximum (mg/L)	In compliance

NOTES:
a. NEI - No exceedances identified.
b. Total metals include: antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, thallium, and zinc.
c. Assumes C-617 Lagoon is discharging to Outfall 010.

Table 3. Summary of radionuclide emissions from monitored vents - 2007.

Radionuclide	Sampling Frequency	Number of Samples	Emissions (Ci) Maximum[a]	Minimum[a]	Average[a]	Total[a]
C-310 Purge and Vent Stack						
Uranium	Daily	366	7.37E-6	2.72E-8	3.50E-7	1.21E-4
^{99}Tc	Monthly	12	3.81E-5	5.22E-6	1.53E-5	1.84E-4
^{230}Th	Quarterly	4	8.00E-7	< MDA	<7.58E-7	<3.03E-6
^{237}Np	Quarterly	4	<MDA	<MDA	<MDA	<MDA
^{239}Pu	Quarterly	4	<MDA	<MDA	<MDA	<MDA

NOTES:
a. MDA - Minimum Detectable Activity

Table 4. Summary of estimated radionuclide emissions - 2007.

Source	Radionuclide	Basis of Estimate	Total Emissions (Ci)
C-709/C-710 Laboratory Group	Total uranium ^{237}Np ^{99}Tc	Inventory estimates, EPA emission factors[a]	6.21E-4 4.39E-7 0
Seal Exhaust/Wet Air Group	Total uranium ^{237}Np ^{239}Pu ^{99}Tc ^{230}Th	2007 NESHAP sampling data, inventory estimates EPA emission factors.[a]	1.30E-3 1.33E-4 <MDA[b] 1.71E-4 <MDA
C-400 Group	Total uranium ^{237}Np ^{239}Pu ^{99}Tc ^{230}Th	Inventory estimates, EPA emission factors[a]	2.25E-4 1.96E-5 6.13E-8 7.07E-3 6.31E-7
C-400 Cylinder Drying Group	Total uranium ^{237}Np ^{239}Pu ^{99}Tc ^{230}Th	Inventory estimates, EPA emission factors[a]	6.86E-5 1.23E-6 5.89E-9 1.58E-8 1.17E-8
C-409 Group	Total uranium ^{237}Np ^{239}Pu ^{99}Tc ^{230}Th	Inventory estimates, EPA emission factors[a]	1.03E-6 4.07E-9 5.88E-8 1.83E-5 2.18E-7
C-360 Group	Total Uranium ^{237}Np ^{99}Tc	Inventory estimates	5.02E-5 5.54E-6 0

NOTE:

a. Emission factors from 40 CFR 61, Appendix D.

b. MDA – Minimum Detectable Activity

Table 5. Radionuclide concentration in water effluents 2007.

Location	No. of Samples	Uranium Concentration (mg/L) Maximum	Minimum	Average	pCi/L Average	Wt. % ^{235}U (average)	No. Of Samples <MDL[a]
K002	4	0.016	<MDL[a]	0.005	NA[b]	NA[b]	1
K008	4	0.012	0.001	0.006	NA[b]	NA[b]	0
K009	4	0.008	<MDL[a]	0.003	NA[b]	NA[b]	2
K010	4	0.017	0.003	0.011	4.59	0.287	1
K011	13	0.450	0.019	0.099	35.5	0.178	0
K012	4	0.006	0.001	0.004	NA[b]	NA[b]	0
K013	4	0.003	<MDL[a]	0.001	NA[b]	NA[b]	3
K016	4	0.003	<MDL[a]	0.002	NA[b]	NA[b]	1
C-616-F	4	0.004	<MDL[a]	0.002	NA[b]	NA[b]	1

Location	No. of Samples	^{99}Tc Concentration (pCi/L) Maximum	Minimum	Average	No. of Samples <MDA[c]
K002	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K008	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K009	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K010	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K011	13	<MDA[c]	<MDA[c]	<MDA[c]	13
K012	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K013	4	<MDA[c]	<MDA[c]	<MDA[c]	4
K016	4	<MDA[c]	<MDA[c]	<MDA[c]	4
C-616-F	5	<MDA[c]	<MDA[c]	<MDA[c]	5

Radionuclide	Released to Surface Water[d]
Total Uranium	0.077 Ci
^{99}Tc	0 Ci

NOTES:
a. MDL - Minimum Detectable Level.
b. NA - Not applicable, no assay determined.
c. MDA - Minimum Detectable Activity.
d. Big Bayou and Little Bayou Creeks from continuous flow outfalls.

Table 6. Annual radiological data summary - surface water sampling - 2007.

	Station SW1 - Upstream Big Bayou Creek, Background					
Analysis	**Units**	**Maximum**	**Minimum**	**Average**	**No. of Samples**	**No. of Samples <MDA/MDL[a]**
Total uranium	mg/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
% ^{235}U[b]	wt %	NA[c]	NA[c]	NA[c]	12	12
^{99}Tc	pCi/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
Gross alpha	pCi/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
Gross beta	pCi/L	5.51	<MDA[a]	1.30	12	9

	Station SW5 Downstream Big Bayou Creek					
Analysis	**Units**	**Maximum**	**Minimum**	**Average**	**No. of Samples**	**No. of Samples <MDA/MDL[a]**
Total uranium	mg/L	0.005	<MDA[a]	0.002	12	13
% ^{235}U[b]	wt %	NA[c]	NA[c]	NA	12	13
^{99}Tc	pCi/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
Gross alpha	pCi/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
Gross beta	pCi/L	31.2	<MDA[a]	16.33	12	1

	Station SW10					
Analysis	**Units**	**Maximum**	**Minimum**	**Average**	**No. of Samples**	**No. Of Samples <MDA/MDL[a]**
Total uranium	mg/L	0.017	0.001	0.006	12	0
% ^{235}U[b]	wt %	NA[c]	NA[c]	NA[c]	12	12
^{99}Tc	pCi/L	<MDA[a]	<MDA[a]	<MDA[a]	12	12
Gross alpha	pCi/L	6.44	<MDA[a]	1.50	12	9
Gross beta	pCi/L	13.7	<MDA[a]	5.23	12	5

NOTES:
a. MDL - Minimum Detectable Level; MDA - Minimum Detectable Activity.
b. Maximum assay reported. Assay is not obtained for samples <MDL and are identified as NA.
c. NA - Not applicable.

Table 7. Radiological data summary - ambient air sampling - 2007.

		Gross alpha (pCi/cubic meter)			Gross beta (pCi/cubic meter)		
Station	**No. of Samples**	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**
BCP	52	<MDA[a]	0.0017	<MDA[a]	0.012	0.047	0.021
HBP	52	<MDA[a]	0.0022	0.0015	0.012	0.047	0.022
HCC	52	<MDA[a]	0.0019	0.0014	0.015	0.041	0.023
KOW	52	<MDA[a]	0.0019	0.0012	0.015	0.068	0.025
PSL	52	<MDA[a]	0.0013	0.0011	0.013	0.076	0.023
VAW	52	<MDA[a]	0.0013	0.0012	0.012	0.073	0.022

NOTE:
a. MDA - Minimum Detectable Activity

Table 8. Results of annual food crop sampling - 2007.

		Radionuclide	
Location	**Food Crop**	**^{99}Tc (pCi/g)[a]**	**U (µCi/g)[a]**
NW	Tomato	<MDA	<MDA
NW	Squash	<MDA	<MDA
NE	Tomato	<MDA	<MDA
NE	Corn	<MDA	<MDA
NE	Pepper	<MDA	<MDA
SSE	Tomato	<MDA	<MDA
SSE	Squash	<MDA	<MDA
SSE	Cucumber	<MDA	<MDA
SW	Tomato	<MDA	<MDA
SW	Squash	<MDA	<MDA
SW	Cucumber	<MDA	<MDA
SSW	Tomato	<MDA	<MDA
SSW	Corn	<MDA	<MDA
SSW	Cucumber	<MDA	<MDA
ESE	Tomato	<MDA	<MDA
ESE	Cucumber	<MDA	<MDA
ESE	Pepper	<MDA	<MDA
	Background Food Crops		
BKG	Tomato	<MDA	<MDA
BKG	Cucumber	<MDA	<MDA
BKG	Squash	<MDA	<MDA

NOTE:
a. MDA - Minimum Detectable Activity

Table 9. Radionuclide concentrations in sediments - 2007.

Point	Location	^{99}Tc (pCi/kg)	^{237}Np (pCi/kg)	^{239}Pu (pCi/kg)	^{230}Th (pCi/kg)	U-Total (µg/g)	^{235}U (wt %)
SS1	Downstream, Big Bayou Creek	1170	<MDA[a]	<MDA[a]	318	<MDAa	NA[b]
SS2	Downstream, Little Bayou Creek	736	<MDA[a]	<MDA[a]	402	<MDA[a]	NA[b]
SS20	Upstream, Big Bayou Creek	2700	<MDA[a]	<MDA[a]	300	<MDA[a]	NA[b]
SS21	Upstream, Little Bayou Creek	<MDA[a]	<MDA[a]	<MDA[a]	372	<MDA[a]	NA[b]
SS27	Below North/South Diversion Ditch in Little Bayou Creek	1240	<MDA[a]	<MDA[a]	722	<MDA[a]	NA[b]
SS28	Massac Creek at Hwy 62	<MDA[a]	<MDA[a]	<MDA[a]	<MDA[a]	<MDA[a]	NA[b]

NOTES:
a. MDA - Minimum Detectable Activity.
b. NA - Not applicable

Table 10. Uranium in soils - 2007.

Location	U-Total (µg/g)
Property boundary	
S1 North	<MDA[a]
S2 East	<MDA[a]
S3 South	<MDA[a]
S4 West	<MDA[a]
8 km from plant	
S5 North	<MDA[a]
S6 East	<MDA[a]
S7 South	<MDA[a]
S8 West	<MDA[a]
13 to 15 km from plant	
S9 South	<MDA[a]
S10 West	<MDA[a]

NOTE:
a. MDA - Minimum Detectable Activity

Table 11. Summary of external gamma radiation monitoring - 2007.

TLD Location		Direct Radiation (mrem/hr)				
		1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr	Average
EG1	Plant North	0.004	0.003	0.003	0.005	0.004
EG2	Plant East	0.006	0.005	0.005	0.007	0.006
EG3	Plant South	0.113	0.010	0.010	0.011	0.036
EG4	Plant West	0.006	0.005	0.004	0.007	0.006
EG5	Boundary North	0.003	0.002	0.002	0.004	0.003
EG6	Boundary East	0.004	0.004	0.003	0.005	0.004
EG7	1 Mile North	0.003	0.003	0.002	0.004	0.003
EG8	1 Mile East	0.004	0.003	0.003	0.004	0.004
EG9	1 Mile South	0.004	0.004	0.004	0.004	0.004
EG10	1 Mile Southeast	0.004	0.004	0.004	0.007	0.005
EG11	1 Mile West	0.004	0.004	0.004	0.006	0.005
EG12	Grahamville	0.004	0.003	0.004	0.005	0.004
EG13	Magruder Village	0.004	0.004	0.004	0.005	0.004
EG14	Paducah	0.004	0.004	0.005	0.007	0.005
EG15	Oaks Road	0.006	0.005	0.006	0.006	0.006
EG16	Boundary South	0.005	0.005	0.006	0.008	0.006
EG17	Boundary Southeast	0.004	0.004	0.005	0.006	0.005

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1. MANAGEMENT OF MIXED AND RADIOACTIVE WASTE

As part of its application for a certificate of compliance, 10 Code of Federal Regulations (CFR) 76.35(m) requires that United States Enrichment Corporation (USEC) provide:

> "A description of the program, as appropriate, for processing, management, and disposal of mixed and radioactive wastes and depleted uranium generated by operations. This description must be limited to processing, management, and disposal activities conducted during operation of the facilities while under lease to the Corporation . . ."

This section addresses the management of radioactive and mixed wastes. The management of depleted uranium is addressed in a separate section of this application. Information in this section pertains only to USEC-generated wastes and USEC-leased facilities.

2. WASTE MINIMIZATION

The site Waste Minimization/Pollution Prevention Program is coordinated by the Plant Waste Minimization Program coordinator within the Environmental, Safety and Health organization.

It is the policy of the Paducah Gaseous Diffusion Plant (PGDP) to:

- Promote the use of nonhazardous materials in plant operations to minimize the potential risk to human health and the environment.
- Reduce or eliminate pollution to all media (i.e., land, water, air) at the source to the lowest reasonably achievable level through material substitution, process optimization and innovation.
- Use, reuse, reclaim, or recycle to the maximum extent practical those wastestreams that cannot be eliminated or minimized by source reduction.
- Promote the continual evaluation and implementation of waste minimization and pollution prevention opportunities in ongoing plant operations, technical support activities, and project design.
- Develop in employees an awareness of environmental problems through participation in the Waste Minimization and Pollution Prevention Plan activities.
- Conduct and implement waste minimization activities with full regard to requirements for quality, productivity, safety, and environmental compliance.

To this end, waste generating activities will be evaluated for waste minimization opportunities with emphasis on those that generate hazardous wastes, mixed (i.e., both hazardous and radioactive) wastes, and low-level radioactive wastes (LLRW).

This policy applies to site operations, associated support operations, and site subcontractors that generate waste. A copy of the Waste Minimization and Pollution Prevention Plan is available under separate cover. This Plan is updated annually.

3. WASTESTREAM DESCRIPTIONS

The following are the principal radioactive and mixed wastestreams generated as a result of USEC plant operations:

	Wastestream Description	Waste Category ID No. (see Tables 1 and 2)
1.	Aqueous wastes	RD-112, RW-112, RW-113, RW-114, RW-115
2.	Petroleum/organic liquids	RD-111, RW-117, RW-118, RW-120,
3.	Hardware/scrap metal	RD-102, RD-113, RW-103, RW-104, RW-105, RW-107
4.	Dry active waste (DAW)	RD-101, RD-110
5.	Rubble/aggregates	RD-107, RD-108
6.	Treatment residues	RD-109
7.	Laboratory wastes	RD-104, RW-109, RW-111, RW-113, RW-115, RW-118
8.	Sealed source	RD-105
9.	Other process wastes	RD-103, RD-106, RD-114, RW-101, RW-102, RW-106, RW-108, RW-109, RW-110

Many of these categories encompass wastestreams that have both a hazardous waste component and a LLRW component which identifies the waste as a mixed waste. The mixed waste determination is made by applying Resource Conservation and Recovery Act (RCRA) criteria to determine whether a waste is hazardous as a listed waste or a characteristically hazardous waste. Table 1 lists the mixed wastestreams, and Table 2 lists the LLRW wastestreams that are typically generated by USEC at PGDP. The identification numbers for mixed and hazardous wastes are prefixed with the letters “RW,” and the LLRW identification numbers are prefixed with the letters “RD.” The name of the wastestream along with its corresponding identification number, description, physical form, and typical waste generation volume are included in the table. The narrative below describes each wastestream in more detail.

Aqueous wastes include, but are not limited to, UF_6 cylinder wash, decontamination and cleaning solutions, and contaminated water from process buildings. The hazardous components of the mixed wastes in this category are metals that cause the waste to exhibit the toxicity characteristic. Several of these wastestreams are also hazardous due to corrosivity.

Petroleum/organic liquids include, but are not limited to, waste oils and organic cleaning solutions. These wastes are typically generated during process equipment maintenance activities and some equipment repair activities. Mixed wastes in this category are hazardous because they are a listed waste or they exhibit the toxicity and/or ignitability characteristic.

Hardware/scrap metal includes, but is not limited to, enrichment process equipment that is no longer useable (including instruments), scrap from equipment repair activities, tools, and parts from other equipment that have come in contact with UF_6 (laboratory cylinders, valves, etc.). Some of the wastestreams, metal shavings for example, may be hazardous for toxicity due to the presence of metals.

Dry active wastes include, but are not limited to, protective clothing (used for protection from both chemical and radiological hazards), certain decontamination materials, wood, and other solid materials. Wet and/or oily absorbent materials are collected separately due to the potential to contain free liquids.

Rubble/aggregates include, but are not limited to, contaminated concrete, soil, rock, and gravel. These wastes are typically generated during construction and demolition activities, site grounds maintenance, and to a lesser extent, from plant maintenance activities.

Treatment residues include, but are not limited to, uranium precipitate and sludges from aqueous waste processing, spent ion exchange resin, and solids from systems that handle uranium-contaminated solutions such as sludges from tank cleanouts.

Laboratory wastes consist of, but are not limited to, solid and liquid wastes (organic and aqueous) from laboratory activities involving the analysis of UF_6 feed, tails and product materials, environmental and waste samples, health and safety samples, and off-specification chemicals.

Sealed sources include, but are not limited to, radioactive standards from laboratory and Health Physics operations.

The group of other plant wastes is comprised of solids and liquids and is generated in a wide variety of settings on the plant site. These wastes include, but are not limited to, trapping materials, filters, and other wastes generated by plant operations that are not included in one of the other categories. The mixed wastes may be listed hazardous wastes and/or may exhibit one or more of the hazardous characteristics of ignitability, toxicity, corrosivity, or reactivity.

The annual LLRW generated at PGDP has typically averaged approximately 53,000 ft^3 and the annual mixed waste has typically averaged approximately 700 ft^3.

4. RADIONUCLIDES

The principal radiological contaminants in waste generated at PGDP are uranium (^{238}U) and its associated decay-chain products ^{235}U and ^{234}U. Other identified contaminants may include trace quantities of transuranics (^{237}Np, ^{239}Pu) and fission (^{99}Tc) products from the past processing of reactor return material. Also, residues from the off-site treatment (e.g., incineration, smelting, etc.) of USEC wastes at commercial facilities could contain traces of radionuclides other than those normally found at PGDP. These radionuclides may have been introduced into the treatment system with waste from other facilities which were processed prior to wastes from USEC.

5. RADIOLOGICAL CHARACTERIZATION

5.1 RADIOLOGICAL CHARACTERIZATION CRITERIA

USEC-generated wastes are radiologically characterized as suitable or not suitable for release to unrestricted areas by one or more of the following methods: radiological surveys, sampling and analysis, and/or radiological status of area of generation.

The area around certain plant operations is designated as a Fissile Control Area (FCA), for the accumulation of potentially fissile waste. FCA's are identified where possible by unique markings. Currently this is shown by posting and by using orange lines along the edges of a gray background painted on the floor surrounding the operation. Radioactive wastes that have the potential to be fissile as described in the SAR section 5.2, are generated, handled, and stored using safe volume, spacing, or geometry controls, which are implemented through Nuclear Criticality Safety Approvals. When ready for disposal, potentially fissile wastes are characterized according to applicable Nuclear Criticality Safety Approvals. Changes to fissile waste operations are approved by Nuclear Criticality Safety.

5.2 SOLID WASTE CHARACTERIZATION

Wastes meeting certain criteria and/or with survey results below the levels shown in Table 5.3-6 of SAR Section 5.3, and for which there is no reasonable possibility of bulk/volumetric contamination, may be released to unrestricted areas and may be disposed of or recycled on-site or off-site.

Wastes generated in areas controlled for transferable contamination, for which volumetric/bulk contamination is a reasonable possibility (such as loose solids), will be managed as low-level radioactive waste. Unless utilizing a Department of Energy (DOE)-disposal facility, request for disposal of such materials as not being low-level radioactive waste will be submitted to the NRC under the provisions of 10 CFR 20.2002, should USEC desire to dispose of such materials in a manner other than as specified in 10 CFR 20.2001. Disposal of such materials in a DOE-disposal facility will meet the waste acceptance criteria for the DOE facility.

Waste from areas not controlled for transferable radioactive contamination in accordance with SAR Section 5.3 may be released to unrestricted areas without survey and/or sampling and analysis.

5.3 LIQUID WASTE CHARACTERIZATION

5.3.1 Aqueous Wastes

Aqueous wastes meeting applicable release requirements of 10 CFR 20.1301 may be discharged through the plant drainage system or through the sewage treatment plant as described in SAR Section 5.1. Wastes with radioactivity exceeding the limits of 10 CFR 20.1302 are treated to reduce the radioactivity levels to less than those limits or are managed and/or disposed of as radioactive waste in accordance with the requirements of 10 CFR 20.2001.

Aqueous waste from areas not controlled for transferable radioactive contamination in accordance with SAR Section 5.3 may be discharged without sampling and analysis.

5.3.2 Nonaqueous Wastes

Nonaqueous liquid waste generated in areas controlled for transferable radioactive contamination, for which volumetric/bulk contamination is a reasonable possibility, will be managed as low-level radioactive waste. Unless utilizing a DOE-disposal facility, request for disposal of such materials as not being low-level radioactive waste will be submitted to the NRC under the provisions of 10 CFR 20.2002, should USEC desire to dispose of such materials in a manner other than as specified in 10 CFR 20.2001. Disposal of such materials in a DOE-disposal facility will meet the waste acceptance criteria for the DOE facility.

Nonaqueous wastes from areas not controlled for transferable radioactive contamination in accordance with SAR Section 5.3 may be released to unrestricted areas and may be disposed of or recycled at on-site or approved off-site locations.

5.4 RADIOACTIVE WASTE CLASSIFICATION

Wastes not suitable for release to unrestricted areas are classified in accordance with 10 CFR 61.55 prior to disposal.

6. WASTE MANAGEMENT

6.1 WASTE SEGREGATION AND COLLECTION

USEC-generated wastes are collected and packaged, where feasible, by the waste generator. Wastes are accumulated at the source in drums, tanks, or bulk containers appropriate to the type of waste generated prior to treatment or transfer to a waste storage facility. Hazardous and mixed wastes are transferred to a 90-day hazardous and mixed waste accumulation area or directly to a DOE-storage facility. From a 90-day hazardous and mixed waste accumulation area, the hazardous and mixed wastes are transferred to a DOE-storage facility until treatment/disposal options are available, or shipped off-site or treated on-site if options are available. USEC mixed waste may be also temporarily stored in DOE facilities to facilitate shipments to off-site facilities.

Wastes known to be suitable for release to unrestricted areas based on the point and process of generation are segregated at the source, when possible, from wastes not suitable for release to unrestricted areas. Wastes from areas controlled for transferable radioactive contamination are considered to be potentially contaminated until characterized. Wastes requiring characterization to determine whether they may be released to unrestricted areas are segregated upon completion of such characterization.

Wastes known to be potentially fissile are collected, packaged, and characterized per Nuclear Criticality Safety Approvals. Fissile Control Areas are established for short/long term accumulation and characterization. Waste may be characterized as either fissile, NCS Spacing Exempt, or low-level radioactive waste.

6.2 WASTE PACKAGING AND LABELING

Containers, known to contain radioactive waste, including packaging, are labeled in accordance with SAR Section 5.3.1.7 or are managed in accordance with SAR Section 5.3.4.1.

Wastes are packaged for shipment and/or storage in appropriate containers to meet Department of Transportation (DOT) and applicable 10 CFR 71 requirements. Some general types of waste packaging are as follows:

Solid waste	Sealand boxes; 5-, 30-, or 55-gal drums
Liquid wastes	Poly tanks; 5-, 30-, or 55-gal drums
Corrosives, acids	United Nations (UN) approved for corrosives; 5-, 30-, or 55-gal drums
Scrap metal	Sealand, Metal Melt or other similar boxes, various drums

In addition, 85-gal plastic and metal overpacks may be used for appropriate wastes and damaged containers.

6.3 RADIOACTIVE WASTE PROCESSING AND STORAGE

Those USEC wastes that are regulated for radiological content are stored at designated USEC waste storage facilities. The permanent storage facilities are listed in SAR Section 3.10.2 and are identified on the Paducah Gaseous Diffusion Plant Facility Lease Status map. Other areas may be utilized as waste storage facilities as required by facility operations. If outdoor storage is necessary, radioactive wastes with transferable contamination are packaged in containers, or wrapped and covered to prevent the release of radioactivity. Storage areas are posted and controlled in accordance with SAR Section 5.3.

Access to LLRW or mixed waste storage containers is restricted to qualified radiological workers, or personnel are escorted by qualified radiological workers. Containers and tanks in waste storage areas are inspected at least monthly to identify and correct any leaks or other problems. Mixed waste containers in USEC-operated 90-day accumulation areas are inspected weekly.

When near-term treatment/disposal of USEC-generated mixed wastes cannot be completed within 90 days, these wastes are transferred to DOE owned and operated facilities for storage until treatment and/or disposal can be accomplished. Such transfers are documented through the Request for Disposal system.

6.3.1 C-757 Solid and Low-Level Waste Processing Facility/90-Day Accumulation Area

This facility is a 9,000 ft^2, pre-engineered, concrete and metal building, which is divided into two 4,500 ft^2 areas with an internal partition to separate radiological and nonradiological operations. The entrances are capable of allowing a dumpster truck to enter the building and execute the dumping maneuver.

The radiological side of the facility may be used to inspect and sort LLRW and potentially contaminated waste for further processing or storage. Wastes are inspected for hazardous materials and may be monitored for the presence of radioactive contamination using bulk or hand monitors. Radioactive wastes are containerized for shipment to storage or treatment facilities. Wastes suitable for release to unrestricted areas may be transferred to the nonradiological side of the facility for processing for disposal. A 90-day accumulation area within this facility may be used for the storage of mixed and hazardous waste temporarily to facilitate off-site shipment.

6.3.2 C-754 Clamshell Building

The C-754 Clamshell Building is a 10,000 ft^2 facility consisting of a concrete pad with a lightweight fabric cover on a steel frame. The facility is capable of handling truck and forklift traffic. Solid and liquid LLW may be stored in this facility.

6.3.3 C-754-A Waste Storage Area

The area may be used to process, store, and handle only solid NCS-exempt waste in containers including drums, roll-off bins, metal boxes, etc.

6.3.4 C-746-Q1 High-Assay Waste Storage Facility

C-746-Q1 may be used for the storage of liquid and solid LLW. This 9,000 ft^2 facility is a permanent steel-framed, metal-walled structure with a sealed concrete floor. The floor includes sealed integral concrete dikes, which provide secondary containment. The eastern section of this building consisting of approximately 5,000 ft^2 is leased by USEC and is separated from the DOE-operated western side of the facility by a metal partition. The facility is equipped with a criticality accident alarm system. Nuclear criticality safety requirements for the storage of fissile and potentially fissile wastes in this facility are implemented through the Nuclear Criticality Safety program.

6.3.5 C-727 Mixed Waste 90-Day Accumulation Area/Low Level Waste Storage Area

The C-727 facility is a pre-engineered metal building with an area of approximately 3,000 ft^2. The concrete floor is sealed, and secondary containment is provided for liquid mixed wastes. This facility may be used for the storage of radioactive waste and/or materials and is identified as a 90-day storage area for hazardous and mixed solid and liquid waste.

6.3.6 C-745-J Yard

The C-745-J yard may be utilized to process, store, and handle only solid NCS-exempt waste material, and/or equipment. The yard is controlled through fencing and a lockable gate.

6.3.7 Fissile Waste Storage Areas in Process Buildings

Designated area(s) within plant buildings may be used to store fissile/potentially fissile waste. NCS requirements for these area(s) are implemented through the NCS approvals.

6.3.8 C-754-B Arch Style Metal Building

The C-754-B building is a 4000 ft^2 facility consisting of an arch style metal building with a concrete foundation/footers and dense grade aggregate floor. The facility is capable of handling tuck and forklift traffic. The facility may be used to process, store, and handle only NCS-exempt waste in containers including drums, roll-off bins, metal boxes, etc.

6.4 RADIOACTIVE WASTE TREATMENT

USEC operates two facilities in C-400 for the removal of uranium from wastewaters—the Lime Precipitation Unit (Number 5 Dissolver) and the Number 4 Dissolver. Another unit, the C-400 Ion Exchange Unit, is used for the removal of technetium-99 from wastewater. These facilities are limited to the treatment of certain radioactive solutions containing uranium at assays of less than 1 percent. The Lime Precipitation Unit uses lime to remove uranium from the solution. The particulate uranium is then removed from the wastestream using a rotary vacuum filter precoated with diatomaceous earth. Figure 2 is a flow diagram of this system. A drum crusher is also operated in C-400 for volume reduction of empty containers.

The Number 4 Dissolver uses sodium hydroxide to remove uranium from solution. This system also uses a rotary vacuum filter precoated with diatomaceous earth to filter the uranium-bearing solids from the wastewater stream. This system is depicted in Figure 3.

Processed wastewater from these units is contained in tanks for sampling and analysis prior to discharge or reuse. The wastewater is discharged through Kentucky Pollution Discharge Elimination System (KPDES) Outfall 008. Solid treatment residues are managed as waste not suitable for release to unrestricted areas pending characterization.

The C-400 Ion Exchange Unit uses resin to remove Tc-99 from wastewater. The wastewater is passed through 3 resin columns operated in series. After processing the water is returned to storage tanks for sampling and analysis prior to discharge to outfall 008.

Aqueous wastes containing uranium at an assay greater than 1.5 percent are treated in the C-409 High Assay Cleaning/Decontamination facility. Uranium is removed from the solutions using sodium hydroxide as the precipitating agent. The precipitated uranium is filtered from the solution using a rotary vacuum filter. Wastewater is reused in C-409, is sampled and analyzed prior to discharge through outfall

008, or is transferred to C-400 for reuse or discharge through Outfall 008 after sampling and analysis. The system is configured similar to the Number 4 Dissolver in C-400.

USEC-generated LLRW, such as metal, incinerable, and/or classified waste, is shipped to off-site commercial facilities for volume reduction or land burial. Treatment residues from volume reduction processes are either returned to PGDP or are shipped directly to an approved off-site commercial disposal company.

Mixed wastes that cannot be processed in USEC facilities are shipped off-site for treatment/disposal, or transferred to DOE for on-site storage until treatment is available at commercial treatment/disposal facilities that are licensed in accordance with 10 CFR 61, or applicable Nuclear Regulatory Commission (NRC) Agreement state requirements, or a foreign facility licensed in accordance with the rules and regulations of that country or a DOE facility in accordance with the DOE facility waste acceptance criteria.

Dry Active Waste (DAW) is shipped off-site for volume reduction through available technology or directly to a disposal facility. Suitable scrap metal is shipped off-site for recycling by smelting the metal into usable products, shipped directly to a disposal facility, or shipped to a volume reduction facility followed by shipment to a disposal facility.

6.5 OFF-SITE WASTE SHIPMENTS

Off-site shipments of radioactive wastes are manifested in accordance with 10 CFR 20.2006. Waste shipments are packaged, labeled, and manifested in accordance with applicable state, DOT, NRC, and Environmental Protection Agency (EPA) requirements. Copies of shipment manifests are maintained as quality records.

6.6 WASTE DISPOSAL

USEC-generated radioactive wastes are disposed of at commercial disposal facilities that are licensed in accordance with 10 CFR 61 or applicable NRC Agreement State requirements or a foreign facility licensed in accordance with the rules and regulations of that country or a DOE facility in accordance with the DOE facility waste acceptance criteria. Foreign disposal of waste will be in accordance with NRC export requirements.

Packages are inspected prior to shipment, as appropriate, to verify compliance with applicable packaging and transportation requirements. Copies of the disposal site license are retained by Environmental, Safety and Health in accordance with 10 CFR 76.83.

Waste disposals are in compliance with 10 CFR 20, Subpart K. Waste disposal records are retained by USEC in accordance with 10 CFR 20.2108.

6.7 WASTE TRACKING AND DOCUMENTATION

USEC LLRW and mixed waste are tracked through a "Request for Disposal" form. Each waste container is assigned a unique identification number. The identification numbers are entered and maintained in a computer-based network system which is updated to reflect waste movement onsite. Treatment and waste disposal information are also tracked through this system.

7. ITEMS ADDRESSED BY COMPLIANCE PLAN

Section deleted.

Table 1. PGDP mixed waste.

Wastestream and ID No.	Description	Form[a]	Typical Annual Waste Generation (ft^3/year)
Aerosol Cans (RW-101)	Flammable/Nonflammable Aerosol Cans	S	4
Reactives (RW-102)	Lithium Batteries, Compressed Gas Cylinders, Developer Solution, Cyanide-Bearing Solution	L, S, G	3
Ni-Cad Batteries (RW-103)	Ni-Cad Batteries	S	13
Mercury Batteries (RW-104)	Mercury Batteries	S	1
Broken Lead-Acid Batteries (RW-105)	Broken Lead-Acid Batteries	S	0
Circuit Boards and Misc. Electronic Compounds (RW-106)	Circuit Boards, Color Monitors, etc.	S	0
Misc. Metal-Bearing Solids (RW-107)	Incandescent Bulbs, Fuses, Starters, Bullets, Photoreceptors, Brass Shell Casings, Brass Shavings, HEPA Filters, PPE, Dust/Debris, Scrap Metal, Weapons Cleaning Patches/Wipes, Tamper Indicating Device, Cable, Washers, Solder, Latex Paint Rags, Chromic Oxide, Residues, Concrete, Ceramic Media, F_2 Generator Scrap/Debris, F_2 Generator Sludge, Rags, Absorbent Material, Sand Blast Residues, Glass Beads, Silver Electrodes, Silver Recovery Cartridges, Microfiltration Sludge, Machine Grinding Sludge, Lead Seals, Cement Dust, Microfilm, Floor Sweepings, Paint Chips, Grease	S	36
Misc. Mercury-Bearing Solids (RW-108)	Fluorescent Bulbs, Mercury Vapor Bulbs, High Pressure Sodium Bulbs, Mercury Metal, Thermometers, Debris, PPE, Switches, HEPA Filters, Respirator Canisters, Heavy Metal Sludge, Ion Exchange Resin, Filter Table Gunk	S	407
Solvent-Laden Solids (RW-109)	Rags, Gloves, Wipes, Absorbent Material, Paint Spray Booth Sludge	S	52
Metal-Bearing Solvent-Laden Solids (RW-110)	Rags, Gloves, Wipes, Absorbent Material, Decontamination Solids, Bag Filters, Oil and Grease Removal Cake, Machine Turnings, Degreaser Sludge	S	0

Notes:
a. S — Solid
L — Liquid
G — Gas

Table 1. PGDP mixed waste. (Continued)

Wastestream and ID No.	Description	Form[a]	Typical Annual Waste Generation (ft^3/year)
Laboratory and Non-laboratory Off-Specification Chemicals (RW-111)	Standards, Reagents, Chemicals, etc.	L, S, G	2
Misc. Metal-Bearing Aqueous Solutions (RW-112)	Antifreeze, Photographic Fixer Solution, Graphic Arts Solution, Silver Solution, Penetone/Water Solution, Machine Coolant, Motor Cleaning Solution	L	1
Metal-Bearing Corrosive Solutions (RW-113)	Flushing Solution, Uranium Salvage, Sodium Hydroxide Solution, Source Cleaning Solution, Sulfamic Acid Solution, SX-11, Aqueous Laboratory Solution, Arsenic Trioxide Solution	L	127
Mercury-Bearing Corrosive Solution (RW-114)	Mercuric Nitrate, Uranium Precipitation	L	0
Misc. Acids and Bases (RW-115)	X-Ray Solution, Sodium Hydroxide Solution, Mop Water, Gas Analyzer Solution, Nickel Stripping Solution, Sulfamic Acid, Phosphoric Acid, Mixed Acids	L	13
Metal-Bearing Organic Solutions (RW-116)	Decontamination Waste Solutions, Parts Cleaning Solution, Machine Coolant	L	0
Solvent Solutions (RW-117)	TCA, Paint Spray Booth Water	L	6
Misc. Flammables (RW-118)	Tri(2)-Ethylhexyl-Phosphate and Hexane, Pseudo Cumene, Gas Analyzer Solution, Kerosene, Mineral Spirits, Electrostatic Plotter Solution, Gasoline, Excess CPVC/PVC Glue, Acetone, Paint Waste, Thenoyl-Trifluoro-Acetone (TTA)/Xylene, Xylol, Blankrola, Oil Test Solution	L	24
Metal-Bearing Flammables (RW-119)	Gasoline, Waste Solvents, Acetone	L	1
Ignitable Corrosive (RW-120)	Lab Waste, Pseudo Cumene/Nitric Acid	L	0
Waste Oils (RW-121)	Waste Oil	L	2
Metal-Bearing Oils (RW-122)	Non-PCB Capacitors, Waste Oil	L	0
Total Typical Annual Waste Generation			~702

Notes:
a. S — Solid
L — Liquid
G — Gas

Table 2. PGDP LLW.

Wastestream and ID No.	Description	Form[a]	Typical Annual Waste Generation (ft^3/year)
Dry Active Waste (RD-101)	PPE, Plastic, Paper, Rubber, Wood, Filters, Clothing, Floor Sweepings, Oil Absorbents, Insulation, Heavy Metal Filter Paper	S	31,000
Scrap Metal (RD-102)	Copper, Steel, Aluminum, Empty Drums, Filters	S	16,000
Trap Media (RD-103)	Alumina, NaF, MgF_2	S	170
Chemical Compounds (RD-104)	Excess Nonhazardous Chemicals	S	2
Sealed Sources (RD-105)	Instrument Sources	S	0
U Compounds (RD-106)	U Metal, Depleted UF_4	S	1
Rubble (RD-107)	Glass, Sand, Gravel, Concrete, Clay Absorbents	S	3000
Soil (RD-108)	Soil	S	0
Metal Slag (RD-109)	Residue from Metal Melt	S	0
Compactibles (RD-110)	PVC Pipe, Insulation, Respirator Cartridges, Filters	S	0
Waste Oil (RD-111)	Used Oil	L	1,600
Aqueous Solutions (RD-112)	Decontamination Solutions, Machine Coolant, Antifreeze	L	260
Refrigeration Equipment (RD-113)	Water Coolers, AC Units, Refrigerators	S	0
Sludges (RD-114)	Uranium Precipitate, Sewage Sludge	S	1300
Total Typical Annual Waste Generation			~53,333

Notes:
a. S — Solid
L — Liquid

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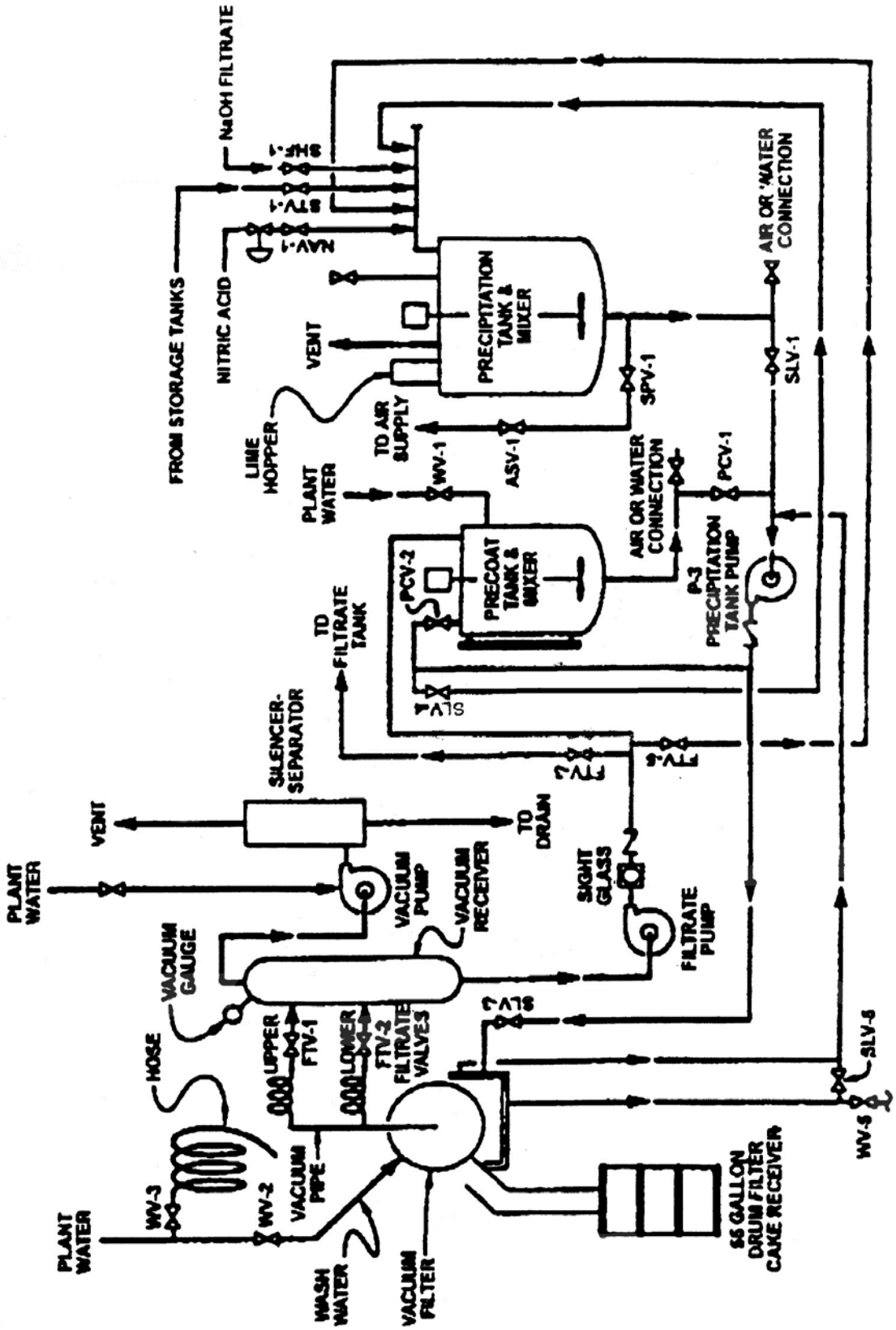

Figure 2. Lime precipitation unit.

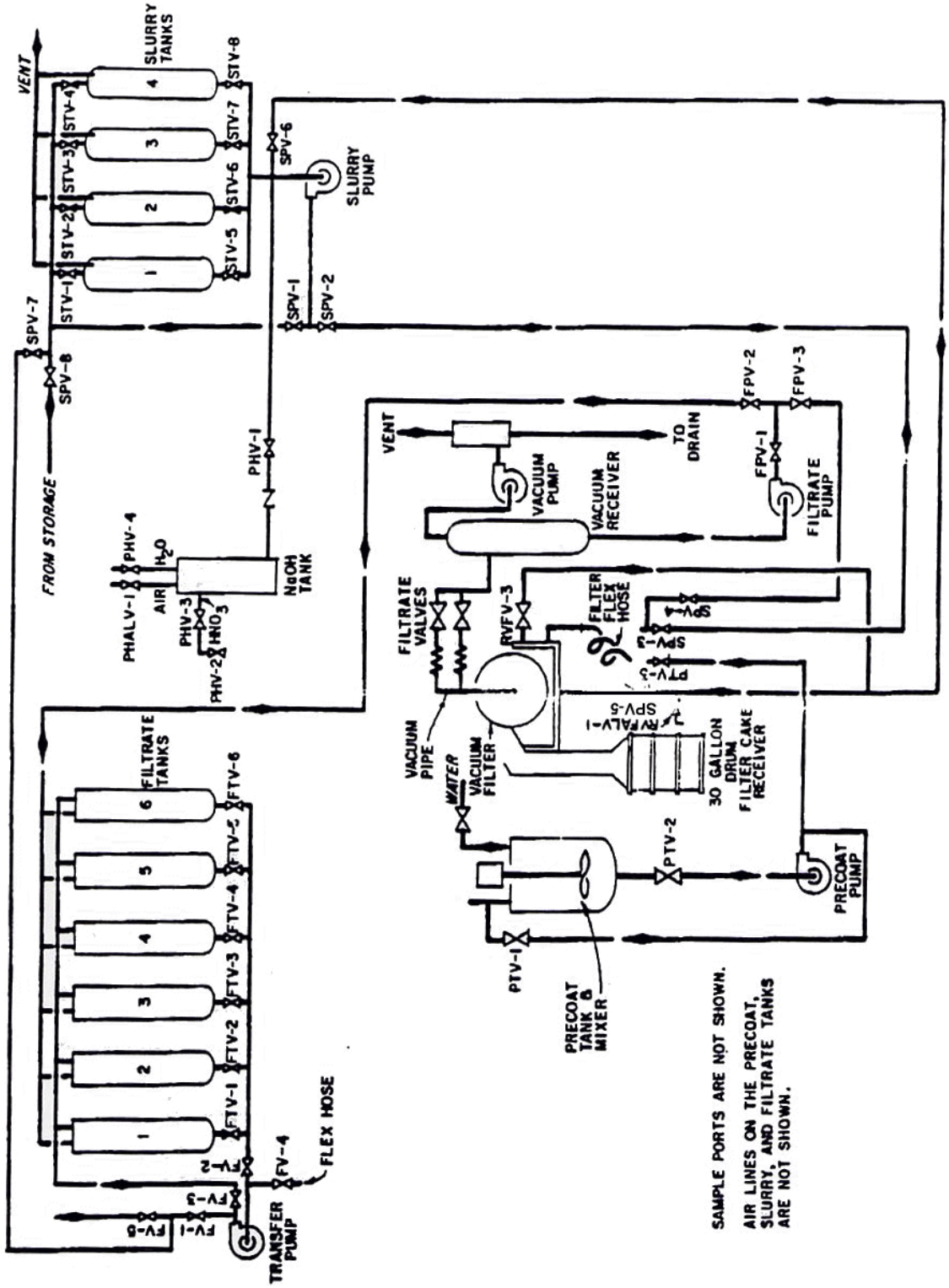

Figure 3. Number 4 dissolver.

DEPLETED URANIUM MANAGEMENT PLAN

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1.0 INTRODUCTION

Under 10 Code of Federal Regulations (CFR) 76.35(m), the United States Enrichment Corporation (USEC) is required, as part of its application for a certificate of compliance, to provide:

> "A description of the program, as appropriate, for processing, management, and disposal of mixed and radioactive wastes and depleted uranium generated by operations. This description must be limited to processing, management, and disposal activities conducted during operation of the facilities while under lease to the Corporation. The application must also include a description of the waste streams generated by enrichment operations, annual volumes of depleted uranium and waste expected, identification of radioisotopes contained in the waste, physical and chemical forms of the depleted uranium and waste, plans for managing the depleted uranium and waste, and plans for ultimate disposition of the waste and depleted uranium before turnover of the facilities to the Department of Energy under the terms of the lease agreement between the United States Enrichment Corporation and the Department."

In accordance with 10 CFR 76.35(m), this plan describes USEC's program for the management and disposition of the depleted uranium (DU) produced as part of the enrichment activities at the Paducah (PGDP) Gaseous Diffusion Plant (GDP) and formerly at the Portsmouth (PORTS) GDP. USEC's program for the processing, management, and disposal of mixed and radioactive wastes is described in the Radioactive Waste Management Plan submitted as part of this application.

2.0 DEPLETED URANIUM PRODUCTION ESTIMATES

The production of depleted uranium will continue throughout the period that enrichment activities are conducted at PGDP. The production rate of depleted uranium is a function of the demand for enriched uranium, the portion of that demand supplied by the Russian enriched uranium, and the operating mode of the plant (determined by power load, power costs, enrichment levels, and other factors). USEC's projected depleted uranium production estimates cover the period of the Nuclear Regulatory Commission (NRC) Certificate of Compliance. The estimates are provided in Table 1, along with the amount of depleted uranium that USEC is responsible for, taking into account the factors discussed in Section 3.0 below.

The funds set aside for the disposition of depleted uranium will be based on the actual production rates of depleted uranium at the plant during the period that the plant is operated under the USEC/DOE Lease Agreement. USEC's funding plan for the disposition of depleted uranium is described in the Decommissioning Funding Program Description submitted as part of this application.

3.0 MANAGEMENT AND DISPOSITION PLAN

The depleted uranium is currently being stored as solid uranium hexafluoride (UF_6) in carbon steel cylinders at PGDP (cylinder storage is described in PGDP SAR Section 3.7.2). The cylinders meet specific design requirements and special procedures and handling equipment are used for DU cylinder handling, movement, and stacking. USEC can continue to store depleted uranium in the solid state in these cylinders for an extended period without undue risk. In addition, cylinder inspections are conducted, as described below, to provide evidence of continued cylinder integrity.

The cylinders used for the storage of depleted uranium are inspected prior to being filled. After filling, the cylinder is cooled and then moved to a cylinder yard and stacked in place. After the cylinder is stacked in position, a baseline (initial) storage inspection is conducted at which point any damage to the cylinder is identified. If the cylinder is damaged, supervision is notified promptly and the damage evaluated for any actions required; the range of actions are to be commensurate with the cylinder damage. After the initial inspection, the cylinders are inspected every four years thereafter (except for any cylinders identified in the initial inspection as requiring a more frequent inspection); the condition of each cylinder is documented using a cylinder inspection data sheet.

Initial and quadrennial inspections are conducted on full cylinders that are normally single or double stacked. These inspections, conducted from ground level, with or without visual aids, are made using the following criteria:

- Cylinders positioned incorrectly (e.g., with valves in other than top center position); this often is an indication of potential stacking damage.
- Improperly stacked cylinders with potentially damaging contact (e.g., lifting lug resting on cylinder body, stiffening ring resting on stiffening ring, other criteria as described in the inspection procedure).
- Dents, bulges, cracks, metal loss, apparent by visual inspection, on the longitudinal and circumference welds.
- Dents, bulges, cracks, gouges, stacking damage, excessive scale or rust, apparent by visual inspection, on the cylinder shell.
- Bends, cracks or breaks from shell, impact damage, gouges, apparent by visual inspection, on the stiffening rings.
- Tears, dents, cracks, excessive scale or rust, or plugged weep hole, apparent by visual inspection, on the cylinder skirt (or valve protector).

Depleted uranium in the form of solid UF_6 is suitable for conversion to other chemical forms. For example, the solid UF_6 could be converted to U_3O_8, UF_4, or uranium metal. There are a number of existing and potential uses for depleted uranium, including use in radiation shielding material, armor-piercing projectiles, and counterweights. It is possible that increased energy costs may make recovery of additional ^{235}U from the depleted uranium economically feasible in the future and that other potential uses may also be identified. No credit for any salvage value has been taken, however, in determing USEC's decommissioning funding liabilities. The conversion of the depleted uranium to one of these other forms in the near term could either foreclose other uses and disposition options because of the difficulty of processing some of these uranium compounds and the lack of processing facilities, or increase the cost of the ultimate disposition.

Moreover, the amount of depleted uranium that will be produced by USEC in the near term will be relatively small in comparison with the DOE's existing depleted uranium inventory. DOE is currently storing approximately 500,000 MTU of depleted uranium as solid UF_6 in approximately 60,000 cylinders stored at various locations on the DOE portions of the GDP plant sites. USEC presently anticipates that the bulk of its inventory of depleted uranium will ultimately be dispositioned in the same manner as the larger DOE depleted uranium inventory.

In the meantime, USEC has established agreements with the DOE that affect USEC's liability associated with the disposal of depleted uranium generated by USEC. These agreements are the "Memorandum of Agreement Between the United States Department of Energy and the United States Enrichment Corporation Relating to Depleted Uranium," dated June 30, 1998, the "Agreement Between the U.S. Department of Energy ("DOE") and USEC Inc. ("USEC")," dated June 17, 2002, the "Cooperative Agreement Between Department of Energy and USEC Inc. Concerning the American Centrifuge Demonstration Project," dated March 23, 2010, and the contract between DOE and USEC for DOE acquisition of SWU, dated March 13, 2012.

The "Memorandum of Agreement Between the United States Department of Energy and the United States Enrichment Corporation Relating to Depleted Uranium," dated June 30, 1998 provides for the transfer to DOE of 2,026 48G cylinders containing approximately 16,674,000 Kg of depleted uranium generated by USEC's operations. In accordance with the agreement, USEC made the required full payment of over $50M to DOE, covering the entire quantity of depleted uranium to be transferred. Therefore, the liability to dispose of the full amount of USEC's depleted uranium specified in the agreement now rests with DOE, further reducing the quantity of depleted uranium to be ultimately disposed of by USEC. Within these major parameters of the agreement, USEC and DOE agreed to implement the actual transfer of the material on a schedule covering the period of FY 1999 through 2004. Table 1 reflects the transfer.

The "Agreement Between the U.S. Department of Energy ("DOE") and USEC Inc. ("USEC")," dated June 17, 2002, provided, in part, for the DOE taking title of depleted uranium from USEC operations during USEC's fiscal years 2002 and 2003 and one-half the amount of depleted uranium generated during USEC's fiscal years 2004 and 2005. Therefore, as a result of this June 17, 2002 agreement, USEC's liability associated with the disposal of USEC generated depleted uranium was reduced by the quantity of depleted uranium specified in this June 17, 2002 agreement. The quantity of depleted uranium associated with this agreement is reflected in Table 1.

In 2010, DOE and USEC entered into the "Cooperative Agreement Between Department of Energy and USEC Inc. Concerning the American Centrifuge Demonstration Project," dated March 23, 2010, to provide support for the continued development and demonstration of the American Centrifuge technology. DOE agreed to accept title to 13,312,411 kg of DU to enable USEC to release encumbered funds. The quantity of Depleted Uranium associated with the agreement is reflected in Table 1.

In 2012, DOE and USEC entered into a contract which DOE acquired SWU in exchange for DOE's accepting title to, and eventual disposal responsibility for, 13,073,045 kg of DU. The quantity of DU associated with the agreement is reflected in Table l.

The "Cooperative Agreement Between Department of Energy and USEC Inc. and American Centrifuge Demonstration, LLC Concerning the American Centrifuge Cascade Demonstration Test Program," dated June 12, 2012, transferred title and responsibility for disposition from USEC to DOE of up to 39,200 MT DUF_6 (26,505 MT of DU at USEC tails purity).

In addition to USEC's enrichment operations, USEC also performs contract work for the DOE and DOE contractors. To compensate USEC for incurred costs associated with these contracts, DOE has taken title to depleted uranium further reducing USEC's liability for the disposal of depleted uranium. The quantity of depleted uranium associated with the compensation for these services is reflected in Table 1.

In addition to the foregoing outlets, USEC will, to the extent practicable, continue to market depleted uranium for uses in military applications, counterweights, and shielding applications. Efforts may also be made to develop other commercial uses that could include shielding for high-level waste storage and shipping casks, or multipurpose canisters being developed for the DOE high-level waste program.

The remaining inventory will continue to be stored as solid UF_6 until it can be processed in accordance with the disposition strategy established by DOE for its inventory.

The estimated cost of conversion and disposition of the depleted uranium is provided in the Decommissioning Funding Program, along with a description of the funding mechanisms that will be used to address USEC's funding liabilities.

4.0 ITEMS ADDRESSED BY COMPLIANCE PLAN

Section deleted.

Table 1. Estimated amount of depleted uranium (DU) generated by USEC and its disposition, in metric tons uranium (MTU) for PORTS and PGDP combined.

Year	DU Generated by USEC[1]	DU Transferred to DOE[5]	Other DU[4]	Estimated net cumulative USEC DU[2]	USEC DU at PGDP	USEC DU at PORTS
July 28, 1998-Dec. 31, 2010	-	-	-	31,416[3]	31,017	399
CY2011	5,419	-	(406)	36,429	36,429	0
CY2012	2,463	(38,823)	(5)	64	64	0
CY2013	0	0	0	64	64	0

Notes:

1. Projections are provided through the expiration date of the NRC Certificate of Compliance.
2. DOE retains liability for depleted uranium generated prior to USEC's privatization (July 28, 1998) per USEC Privatization Act (Public Law 104-134, Sec 3109, paragraph (a)(3)).
3. Reflects the cumulative amount of DU since USEC's privatization (July 28, 1998) for which USEC is responsible for disposition.
4. Includes depleted uranium refed to the cascade or sold.
5. DU transfer to DOE in 2012 includes 13,073 MTU related to DOE's acquisition of SWU in exchange for DOE's accepting title to, and eventual disposal responsibility for, a quantity of depleted uranium tails, and 25,750 MTU related to the June 12, 2012 cooperative agreement between DOE and USEC Inc., in which DOE accepted title to and responsibility for the disposition of up to 39,200 MT DUF_6 (26,505 MTU of DU at USEC tails purity).

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1.0 INTRODUCTION

As a condition of certification, 10 Code of Federal Regulations (CFR) 76.35(n) requires the United States Enrichment Corporation (USEC) to submit, as part of its application for an NRC certificate of compliance:

> A description of the funding program to be established to ensure that funds will be set aside and available for those aspects of the ultimate disposal of waste and depleted uranium, decontamination and decommissioning, relating to the gaseous diffusion plants leased to the Corporation by the Department of Energy, which are the financial responsibility of the Corporation.

Section 76.35(n) also requires USEC to establish financial surety arrangements to provide the requisite funding. The funding mechanism must ensure availability of funds for activities required to be completed both before and after the return of the gaseous diffusion plants to the Department of Energy (DOE) in accordance with the July 1, 1993 Lease Agreement between DOE and USEC (Lease Agreement). The funding program must also contain a basis for cost estimates used to establish funding levels, and means of adjusting such cost estimates and associated funding levels over the duration of the lease. Finally, USEC is not required to provide funding for "those aspects of decontamination and decommissioning . . . assigned to the Department of Energy under the Atomic Energy Act of 1954, as amended."

In accordance with 10 CFR 76.35(n), USEC hereby submits a description of its program to ensure adequate funds are available for the disposal of waste and the disposition of depleted uranium generated at PGDP and for which USEC is financially responsible under the Atomic Energy Act (AEA).

2.0 SCOPE OF USEC'S DECOMMISSIONING FINANCIAL RESPONSIBILITY

USEC began to operate the Paducah (PGDP) plant on July 1, 1993, in accordance with the AEA, as amended, and the July 1, 1993 Lease Agreement. Prior to July 1, 1993, DOE operated the plant for about 40 years. Section 1403(d) of the AEA provides that "[t]he payment of any costs of decontamination and decommissioning . . . with respect to conditions existing before the transition date [July 1, 1993], in connection with property of the Department leased under subsection (a), shall remain the sole responsibility of the Department." Accordingly, USEC is not financially responsible for, and this Program Description does not provide funding assurance for, decontamination or decommissioning costs associated with any operations at PGDP prior to July 1, 1993.

Furthermore, PGDP, including the Leased Premises, will ultimately be decommissioned by DOE, which is solely responsible for the conduct of decontamination and decommissioning activities at the plant, and which also bears sole financial responsibility for the bulk of these activities. Section 4.6 of the Lease Agreement states that:

> Except as provided in Section 4.5(c) of this Lease, the Department will be responsible for and will pay the costs of all Decontamination and Decommissioning, including the costs of Decontamination and Decommissioning of the Leased Premises, the Leased Personalty, any personal property found on the Leased Premises, regardless of ownership, and any Capital Improvement.

In addition, Section 4.3(b) of the Lease Agreement states that "[t]he Corporation shall be entitled, should it choose, to leave any of its personal property (including personal property contaminated by radioactive materials) on the Leased Premises at the end of the Lease Term for Decontamination and Decommissioning by the Department."

However, USEC does have certain specific financial responsibilities with respect to some of these activities. Under Section 4.4(c) of the Lease Agreement, USEC is "responsible for the ultimate treatment and disposal of any waste generated by the Corporation, and for which the Department is not responsible . . . ." Under this provision, USEC is financially responsible for, and this Program Description addresses, the disposal of low-level radioactive waste (LLRW) and "mixed" hazardous and radioactive waste generated by USEC at PGDP after the date of privatization, July 28, 1998. [1]

In addition, as discussed above, Section 4.6 of the Lease Agreement provides that the Department will pay the costs of all decontamination and decommissioning, "[e]xcept as provided in Section 4.5(c) of this Lease . . . ." Section 4.5(c) authorizes USEC to remove any capital improvement at PGDP, but "if such removal increases the costs of the Department for the Decontamination and Decommissioning

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1 A more detailed description of USEC's plans to manage and dispose of LLRW and mixed waste generated at PGDP is provided in the Radioactive Waste Management Program, which is included as part of the certificate of compliance application.

of the Leased Premises to which any such Capital Improvement was attached, the Corporation will pay any such increase in Decontamination and Decommissioning costs." At this time, USEC does not anticipate removing any capital improvement from the plant site. Therefore, no financial assurance for Decontamination and Decommissioning cost increases arising out of such removal is currently being provided.

Finally, USEC is generating depleted uranium as a result of its operation of PGDP. Section 3109(a)(3) of the USEC Privatization Act (passed April 1996) states that:

> All liabilities arising out of the disposal of depleted uranium generated by the Corporation between July 1, 1993 and the privatization date shall become the direct liabilities of the Secretary [Secretary of Energy].

Therefore, this Program Description also describes USEC's funding program to ensure funds are available for the ultimate disposition of the depleted uranium generated by USEC's operations after July 28, 1998.[2]

As described in the Depleted Uranium Management Plan, USEC has established agreements with the DOE that affect USEC's liability associated with the disposal of depleted uranium generated by USEC. These agreements are the "Memorandum of Agreement Between the United States Department of Energy and the United States Enrichment Corporation Relating to Depleted Uranium," dated June 30, 1998, the "Agreement Between the U.S. Department of Energy ("DOE") and USEC Inc. ("USEC")," dated June 17, 2002, the "Cooperative Agreement Between Department of Energy and USEC Inc. Concerning the American Centrifuge Demonstration Project," dated March 23, 2010, and the contract between DOE and USEC for DOE acquisition of SWU, dated March 13, 2012.

The "Memorandum of Agreement Between the United States Department of Energy and the United States Enrichment Corporation Relating to Depleted Uranium," dated June 30, 1998 provided for the transfer to DOE of 2,026 48G cylinders containing approximately 16,674,000 Kg of depleted uranium generated by USEC's operations. In accordance with the agreement, USEC made the required full payment of over $50M to DOE, covering the entire quantity of depleted uranium to be transferred. Therefore, the liability to dispose of the full amount of USEC's depleted uranium specified in the agreement now rests with DOE, further reducing the quantity of depleted uranium to be ultimately disposed of by USEC. Within these major parameters of the agreement, USEC and DOE agreed to implement the actual transfer of the material on a schedule covering the period of FY 1999 through 2004.

The "Agreement Between the U.S. Department of Energy ("DOE") and USEC Inc. ("USEC")," dated June 17, 2002, provided, in part, for the DOE taking title of depleted uranium from USEC operations during USEC's fiscal years 2002 and 2003 and one-half the amount of depleted uranium generated during USEC's fiscal years 2004 and 2005. Therefore, as a result of this June 17, 2002 agreement, USEC's liability associated with the disposal of USEC generated depleted uranium was reduced by the quantity of depleted uranium specified in this June 17, 2002 agreement.

The "Cooperative Agreement Between Department of Energy and USEC Inc. Concerning the American Centrifuge Demonstration Project," dated March 23, 2010, transferred title to 13,312,411 kg of DU from USEC to DOE to enable USEC to release encumbered funds to support continued development and demonstration of the American Centrifuge technology.

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2 The Depleted Uranium Management Plan describes in greater detail USEC's plans for the management and disposition of depleted uranium.

In 2012, DOE and USEC entered into a contract in which DOE acquired SWU in exchange for DOE's accepting title to, and eventual disposal responsibility for, 13,073,045 kg of DU.

The "Cooperative Agreement Between Department of Energy and USEC Inc. and American Centrifuge Demonstration, LLC Concerning the American Centrifuge Cascade Demonstration Test Program", dated June 12, 2012, transferred title and responsibility for disposition from USEC to DOE of up to 39,200 MT DUF6 (26,505 MT of DU at USEC tails purity).

The quantity of depleted uranium associated with these agreements, and the transfer schedule for this material, is specified in Table 1 of the Depleted Uranium Management Plan.

In addition to USEC's enrichment operations, USEC also performs contract work for the DOE and DOE contractors. To compensate USEC for incurred costs associated with these contracts, DOE has taken title to depleted uranium further reducing USEC's liability for the disposal of depleted uranium. The quantity of depleted uranium, and the transfer schedule for the depleted uranium associated with the compensation for these contracts, is specified in Table 1 of the Depleted Uranium Management Plan.

3.0 DECOMMISSIONING COST ESTIMATE

In accordance with 10 CFR 76.35(n), USEC has estimated the costs associated with the disposal of LLRW and mixed waste, and the disposition of depleted uranium generated by its operations. These costs are not considered decontamination and decommissioning costs, but rather production costs since they are incurred during the operation and maintenance of the plant. These cost estimates are cumulative, and are calculated one year in advance. The estimated cost for CY 2012 for the disposal of waste and for the disposition of depleted uranium generated by USEC is as follows:

Low Level and Mixed Waste.....	$ 3.84 M
Depleted Uranium.....	$ 0.29 M
Labor Cost.....	$ 0.70 M
CY12 Cost	$ 4.83 M

To account for uncertainties associated with either the estimated volumes or costs associated with the above cost estimates, a contingency factor of 25% is applied to the CY 2012 cost, which is consistent with the recommendations in the NRC's guidance on preparing Decommissioning Funding Plans (NUREG-1757). After application of the 25% contingency, USEC's total projected decommissioning funding liability for CY 2012 is $ 6.04 million.

The bases for these cost estimates are described below in their respective subsection. USEC's cost estimates will be reviewed annually and revised, as necessary, to reflect any change in USEC's projected liability.

3.1 LOW LEVEL AND MIXED WASTE DISPOSAL

USEC generates many types of LLRW and mixed (hazardous and radioactive) waste at PGDP as described in the Radioactive Waste Management Program (RWMP). For the most part, all wastes are routinely treated on-site or treated and disposed of off-site as the wastes are generated. There is a quantity of LLRW that will remain on-site at the end of CY 2012. The LLRW

in storage includes waste that is being processed for off-site disposal. These wastes are being stored in compliance with USEC's Certificate of Compliance. USEC's LLRW and mixed waste decommissioning liability is calculated as the sum of the liability associated with the cost of disposal of that amount of waste estimated to be generated during the calendar year plus the liability associated with the estimated amount of waste that remains in storage at the end of the calendar year. Disposal costs include an additional percentage to cover taxes, processing fees, and transportation costs, but do not include labor, which is addressed in Section 3.3.

Estimated waste generation volumes are based on historical waste generation. Each individual LLRW and mixed waste stream has a different estimated volume and a different disposal cost. For the year, the different volumes of waste generated and their disposal cost estimates are averaged to establish an average disposal cost. USEC's cost estimate is based on the weighted average cost to manage waste. The disposal cost estimate for each waste stream in the weighted average cost is based upon existing contract prices, and historical cost of containers and transportation.

Except for those mixed wastes and LLRW that are stored on-site, as noted above, USEC anticipates that its waste disposal activities will be such that LLRW and most mixed waste generated in any given year will be disposed of within that year, or shortly thereafter. USEC funds this disposal cost out of accrued cash generated from operations. The decommissioning liability associated with the waste that remains in storage at the end of the calendar year at PGDP will be calculated based on the estimated volume of waste in storage at the end of the calendar year.

3.1.1 Low Level Radioactive Waste Disposal

USEC anticipates generating a total of approximately 88,200 ft^3 of LLRW from routine operations and projects at the Paducah plant for CY 2012. USEC has assumed disposal of Paducah's LLRW at various commercial disposal facilities at an average weighted cost of $35/$ft^3$. The disposal cost for LLRW generated by USEC at the Paducah plant for CY 2012 is therefore estimated to be:

Paducah LLRW: 88,200 ft^3 x $35/$ft^3$ = $3.087 million for the year

The cost of disposal of USEC's LLRW for CY 2012 is $3.087 million.

3.1.2 Mixed Waste Disposal

USEC anticipates generating a total of approximately 90ft^3 of mixed waste at Paducah plant in CY 2012. The current average cost estimate for disposing of this mixed waste product at Paducah is \$1700/ft^3. The disposal cost for this mixed waste generated at Paducah plant for CY 2012 is therefore estimated to be:

Paducah Mixed Waste: 90 ft^3 x \$1,700/ft^3 = \$0.153 million for the year

The cost of disposal of USEC's mixed waste for CY 2012 is \$0.153 million.

3.1.3 Deleted

3.1.4 Low-Level Radioactive Waste in Storage

As described earlier, there is an amount of LLRW that will remain in storage at the end of CY 2012. This waste will be disposed at a later date at an estimated cost of $35/ft^3. This disposal cost is determined based on the weighted average cost for this particular waste stream. At Paducah, this LLRW volume is estimated to be 17,000 ft$^{3.}$

The disposal cost for this LLRW that will remain on-site at Paducah at the end or CY 2012 is estimated to be:

Paducah LLRW in storage: 17,000 ft^3 x $35/ft^3 = $0.595 million

Therefore, the cost to dispose of the LLRW in storage in a subsequent calendar year is $0.595 million.

3.2 Depleted Uranium Disposition

The estimate of decommissioning liability for depleted uranium is based on the generation of depleted uranium as described in the Depleted Uranium Management Plan. USEC's examination of the available information has identified that the unit cost to dispose of tails could range between $3.99/kilogram (kg) uranium (U) to $4.53/kg U, depending on a number of factors and assumptions. The unknown factors include: escalation rate(s) of various construction cost components; de-escalation rate(s) of future operating costs (to present day dollars); volume of tails disposed; revenue/avoided disposal cost from sale of conversion products (e.g., hydrogen fluoride) or higher assay tails (tail stripping); construction and operations budget contingencies; allocation of decontamination and decommissioning costs (between USEC and DOE); and DOE oversight costs.

USEC has developed the depleted uranium disposal cost estimate for PGDP based on a methodology and supporting data provided by DOE in support of USEC Inc.'s American Centrifuge Plant (ACP) licensing activities. This DOE methodology and supporting data enabled the development of a specific analysis for the ACP for the purposes of ACP decommissioning funding. The unit cost for disposal of ACP

generated depleted uranium was developed based upon costs associated with processing of the ACP depleted uranium at the DOE's Portsmouth DUF_6 Conversion Facility. USEC used the same methodology and supporting data provided by DOE in support of the ACP licensing activities to develop a PGDP-specific cost estimate to process USEC depleted uranium located at PGDP at the DOE's Paducah DUF_6 Conversion Facility. Based on the information provided by DOE, USEC determined that $4.53/kgU (in 2012 dollars) is a reasonable depleted uranium disposal unit cost for the purposes of decommissioning funding of USEC's depleted uranium located at PGDP.

Based on the Depleted Uranium Management Plan, USEC's projected maximum liability at the end of CY 2012 for the disposition of depleted uranium generated by PGDP operations is 64,000 kilograms (refer to Table 1 in the Depleted Uranium Management Plan).

Total estimated disposal cost, in 2012 dollars, for depleted uranium is then calculated as follows:

Projected Quantity (kgU)	**Unit Cost ($/kgU)**	**Disposal Cost ($)**
64,000	4.53	289,920

The total estimated disposal cost for depleted uranium, after rounding, is $0.29 million.

The above cost estimate includes processing as well as transportation and disposal of any by-product related to processing of the depleted uranium. There are no costs for transporting USEC's depleted uranium inventory to the DOE's Paducah DUF_6 conversion facility as this facility is co-located with PGDP.

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3.3 Labor Costs

To account for labor costs associated with disposal of USEC generated waste, USEC has included provisions for a crew comprised of 1 first line manager, 2 technical staff, 1 health physics technician and 6 waste operators. The labor costs are calculated assuming the crews are available for a six-month duration. Labor costs were estimated based on the 2012 PGDP labor rates. To account for this work being performed by a third party, an overhead rate on direct staff labor of 110%, plus 15% profit on labor and its overheads, was applied. Based on these assumptions, the labor costs associated with disposal of USEC generated waste is $704,822.

4.0 REVIEW AND ADJUSTMENT OF DECOMMISSIONING COSTS AND FUNDING LEVELS

USEC will review the decommissioning cost estimates and associated funding levels over the duration of the lease and adjust them when necessary. These adjustments will take into account such factors as changes in volume and cost estimates, changes in plant conditions, and changes in expected decontamination and decommissioning procedures. USEC will conduct such reviews in October of each year.

5.0 DECOMMISSIONING FUNDING MECHANISM

USEC utilizes payment surety bond(s) and/or letter(s) of credit in conjunction with standby trust agreement(s) to ensure that sufficient funds will be available for waste disposal and depleted uranium disposition as set forth in this Program Description. The instruments are derived from Appendix A, NUREG-1757 Volume 3, "Consolidated NMSS Decommissioning Guidance, *Financial Assurance, Recordkeeping, and Timeliness*", dated September 2003. Non-executed versions are included in this Plan. Executed documents are submitted to the NRC for review as they are revised and reissued.

PAYMENT SURETY BOND - NON--EXECUTED VERSION

Date bond executed: _____

Effective date: _____

Principal: United States Enrichment Corporation
6903 Rockledge Drive
Bethesda, MD 20817

Type of organization: Delaware Chartered Corporation

NRC certificate of compliance number: GDP-1

Name and address of facilities: Paducah Gaseous Diffusion Plant

Amount(s) for decommissioning activity guaranteed by this bond: Estimated at [insert amount]

Surety(ies) [name(s) and business address(es)]

Type of organization: [insert "proprietorship," "joint venture," "partnership" or "corporation"]

State of incorporation: _____ (if applicable)

Surety's qualification in jurisdiction where facility is located.

Surety's bond number _____

Total penal sum of bond: $ _____

Know all persons by these presents, That we, the Principal and Surety(ies) hereto, are firmly bound to the U.S. Nuclear Regulatory Commission (herein called NRC), in the above penal sum for the payment of which we bind ourselves, our heirs, executors, administrators, successors, and assigns jointly and severally; provided that, where the Sureties are corporations acting as co-sureties, we, the Sureties, bind ourselves in such sum "jointly and severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as is set forth opposite the name of such Surety; but if no limit of liability is indicated, the limit of liability shall be the full amount of the penal sum.

WHEREAS, the NRC, an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part 76, applicable to the Principal, which require that the holder of a certificate of compliance for a gaseous diffusion plant, or an applicant for a certificate of compliance for such a facility provide financial assurance that funds will be available when needed for those aspects of the ultimate disposal of waste and disposition of depleted uranium, decontamination and decommissioning of such a facility which are the financial responsibility of such holder or applicant (collectively, "decommissioning");

NOW, THEREFORE, the conditions of the obligation are such that if the Principal shall faithfully, before the beginning of decommissioning of each facility identified above, fund the standby trust fund in the amount(s) identified above for the facility;

Or, if the Principal shall fund the standby trust fund in such amount(s) after an order to begin facility decommissioning is issued by the NRC or a U.S. district court or other court of competent jurisdiction;

Or, if the Principal shall provide alternative financial assurance and obtain the written approval of the NRC of such assurance, within 30 days after the date a notice of cancellation from the Surety(ies) is received by both the Principal and the NRC, then this obligation shall be null and void; otherwise it is to remain in full force and effect.

The Surety(ies) shall become liable on this bond obligation only when the Principal has failed to fulfill the conditions described above. Upon notification by the NRC that the Principal has failed to perform as guaranteed by this bond, the Surety(ies) shall place funds in the amount guaranteed for the facility(ies) into the standby trust fund established by the Principal with [name of trustee] pursuant to the Standby Trust Agreement dated [date].

The liability of the Surety(ies) shall not be discharged by any payment or succession of payments hereunder, unless and until such payment or payments shall amount in the aggregate to the penal sum of the bond, but in no event shall the obligation of the Surety(ies) hereunder exceed the amount of said penal sum.

The Surety(ies) may cancel the bond by sending notice of cancellation by certified mail to the Principal and to the NRC provided, however, that cancellation shall not occur during the 90 days beginning on the date of receipt of the notice of cancellation by both the Principal and the NRC, as evidenced by the return receipts.

The Principal may terminate this bond by sending written notice to the NRC and to Surety(ies) 90 days prior to the proposed date of termination, provided, however, that no such notice shall become effective until the Surety(ies) receive(s) written authorization for termination of the bond from the NRC.

If any part of this agreement is invalid, it shall not affect the remaining provisions which will remain valid and enforceable.

In Witness Whereof, the Principal and Surety(ies) have executed this financial guarantee bond and have affixed their seals on the date set forth above.

The persons whose signatures appear below hereby certify that they are authorized to execute this surety bond on behalf of the Principal and Surety(ies).

Principal: United States Enrichment Corporation

[Signature(s)]

[Name(s)]

[Title(s)]

[Corporate Seal]

Corporate Surety(ies)

[Name and address]

State of incorporation: _____

Liability limit: $ _____

[Signature(s)]

[Name(s) and title(s)]

[Corporate Seal]

[For every co-surety, provide signature(s), corporate seal, and other information in the same manner as for Surety(ies) above.]

Bond premium: $ _____

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December 9, 2011

IRREVOCABLE STANDBY LETTER OF CREDIT NO. [*INSERT NUMBER*]
NON-EXECUTED VERSION

This Credit Expires [*insert date*]

Issued To: U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir or Madam:

We hereby establish our Irrevocable Standby Letter of Credit No. _____ in your favor, at the request and for the account of the United States Enrichment Corporation, 6903 Rockledge Drive, Bethesda, MD 20817, Certificate Number GDP-1, Docket Number 70-7001, up to the aggregate amount of [*insert dollar amount in words*], U.S. dollars $_____ ,
available upon presentation of:

(1) your sight draft, bearing reference to this Letter of Credit No._____ , and

(2) your signed statement reading as follows: "I certify that the amount of the draft is payable pursuant to regulations issued under authority of the U.S. Nuclear Regulatory Commission."

This letter of credit is issued in accordance with regulations issued under the authority of the U.S. Nuclear Regulatory Commission (NRC), an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. NRC has promulgated regulations in title 10, Chapter I of the *Code of Federal Regulations*, Part 76, which require that a holder of, or an applicant for, an NRC certificate of compliance issued under 10 CFR Part 76 provide assurance that funds will be available when needed for decommissioning.

This letter of credit is effective as of [*insert date*] and shall expire on [*insert date at least 1 year later*], but such expiration date shall be automatically extended for a period of [*insert time period of at least 1 year*] on [*insert date*] and on each successive expiration date, unless, at least 90 days before the current expiration date, we notify both you and the United States Enrichment Corporation, by certified mail, as shown on the signed return receipts or overnight courier. If the United States Enrichment Corporation is unable to secure alternative financial assurance to replace this letter of credit within 30 days of notification of cancellation, NRC may draw upon the full value of this letter of credit prior to the then current expiration date. The bank shall give immediate notice to the applicant and NRC of any notice received or action filed alleging (1) the insolvency or bankruptcy of the financial institution or (2) any violation of regulatory requirements that could result in suspension or revocation of the bank's charter or license to do business. The financial institution also shall give immediate notice if the bank, for any reason, becomes unable to fulfill its obligation under the letter of credit unless a court order or other applicable law prevents the giving of such notice.

Whenever this letter of credit is drawn on, under and in compliance with the terms of this letter of credit, we shall duly honor such draft upon its presentation to us within 30 days, and we shall deposit the amount of the draft directly into the standby trust fund of the United States Enrichment Corporation in accordance with your instructions.

Each draft must bear on its face the clause: "Drawn under Letter of Credit No._____ , dated _____, and the total of this draft and all other drafts previously drawn under this letter of credit does not exceed [*insert amount of letter of credit*]."

[*Signature(s) and title(s) of official(s) of issuing institution*]
[*Name, address, and phone number of issuing institution*]
[*Date*]

This credit is subject to [*insert "the most recent edition of the Uniform Customs and Practice for Documentary Credits, published by the International Chamber of Commerce," or "the Uniform Commercial Code"*].

STANDBY TRUST AGREEMENT - NON--EXECUTED VERSION

TRUST AGREEMENT, the Agreement entered into as of [date] by and between the United States Enrichment Corporation, a Delaware chartered corporation, herein referred to as the "Grantor," and [name and address of a national bank or other Trustee acceptable to the U.S. Nuclear Regulatory Commission], the "Trustee."

WHEREAS, the U.S. Nuclear Regulatory Commission (NRC), an agency of the U.S. Government, pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, has promulgated regulations in Title 10, Chapter I of the Code of Federal Regulations, Part 76. These regulations, applicable to the Grantor, require that a holder of, or an applicant for, a Part 76, certificate of compliance provide assurance that funds will be available when needed for required decommissioning activities.

WHEREAS, the Grantor has elected to use a surety bond in combination with a letter of credit to provide such financial assurance for the facilities identified herein; and

WHEREAS, when payment is made under a surety bond and/or letter of credit this standby trust shall be used for the receipt of such payment; and

WHEREAS, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this Agreement, and the Trustee is willing to act as trustee,

NOW, THEREFORE, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement:

(a) The term "Decommissioning" means those aspects of the ultimate disposal of waste and disposition of depleted uranium, decontamination and decommissioning of the Paducah Gaseous Diffusion Plant (GDP) which are the financial responsibility of the Grantor.

(b) The term "Grantor" means the United States Enrichment Corporation and any successors or assigns thereof.

(c) The term "Trustee" means the trustee who enters into this Agreement and any successor Trustee.

Section 2. Costs of Decommissioning. This Agreement pertains to the costs of decommissioning the materials and activities identified in Certificate of Compliance Number GDP-1 issued pursuant to 10 CFR Part 76.

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a standby trust fund (the Fund) for the benefit of the NRC. The Grantor and the Trustee intend that no third party have access to the Fund except as provided herein.

Section 4. Payments Constituting the Fund. Payments made to the Trustee for the Fund shall consist of cash, securities, or other liquid assets acceptable to the Trustee. The Fund is established initially as consisting of the property, which is acceptable to the Trustee, described in Schedule B attached hereto. Such property and any other property subsequently transferred to the Trustee are referred to as the "Fund," together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible nor shall it undertake any responsibility for the amount of, or adequacy of the Fund, nor any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the NRC.

Section 5. Payment for Required Activities Specified in the Plan. The Trustee shall make payments from the Fund to the Grantor upon presentation to the Trustee of the following:

a. A certificate duly executed by the Secretary of the Grantor attesting to the occurrence of the events, and in the form set forth in the attached Specimen Certificate, and

b. A certificate attesting to the following conditions:

(1)that decommissioning is proceeding pursuant to an NRC-approved plan.

(2)that the funds withdrawn will be expended for activities undertaken pursuant to that Plan, and

(3)that the NRC has been given 30 days' prior notice of the Grantor's intent to withdraw funds from the escrow fund.

No withdrawal from the fund can exceed 10 percent of the outstanding balance of the Fund unless NRC approval is attached.

In the event of the Grantor's default or inability to direct decommissioning activities, the Trustee shall make payments from the Fund as the NRC shall direct, in writing, to provide for the payment of the costs of required activities covered by this Agreement. The Trustee shall reimburse the Grantor, or other persons as specified by the NRC, from the Fund for expenditures for required activities in such amount as the NRC shall direct in writing. In addition, the Trustee shall refund to the Grantor such amounts as the NRC specifies in writing. Upon refund, such funds shall no longer constitute part of the Fund as defined herein.

Section 6. Trust Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge its duties with respect to the Fund solely in the interest of the beneficiary and with the care, skill, prudence, and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity

and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; except that:

(a) Securities or other obligations of the Grantor, or any other owner or operator of the facilities, or any of their affiliates as defined in the Investment Company Act of 1940, as amended (15 U.S.C. 80a-2(a)), shall not be acquired or held, unless they are securities or other obligations of the Federal or a State government;

(b) The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the Federal Government, and in obligations of the Federal Government such as GNMA, FNMA, and FHLM bonds and certificates or State and Municipal bonds rated BBB or higher by Standard and Poor's or Baa or higher by Moody's Investment Services; and

(c) For a reasonable time, not to exceed 60 days, the Trustee is authorized to hold uninvested cash, awaiting investment or distribution, without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:

(a) To transfer from time to time any or all of the assets of the fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other trusts participating therein; and

(b) To purchase shares in any investment company registered under the Investment Company Act of 1940 (15 U.S.C. 80a-1 et seq.), including one that may be created, managed, underwritten, or to which investment advice is rendered, or the shares of which are sold by the Trustee. The Trustee may vote such shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretion conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

(a) To sell, exchange, convey, transfer, or otherwise dispose of any property held by it, by public or private sale, as necessary to allow duly authorized withdrawals at the joint request of the Grantor and the NRC or to reinvest in securities at the direction of the Grantor;

(b) To make, execute, acknowledge, and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

(c) To register any securities held in the Fund in its own name, or in the name of a nominee, and to hold any security in bearer form or in book entry, or to combine

certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, to reinvest interest payments and funds from matured and redeemed instruments, to file proper forms concerning securities held in the Fund in a timely fashion with appropriate government agencies, or to deposit or arrange for the deposit of such securities in a qualified central depository even though, where so deposited, such securities may be merged and held in bulk in the name of the nominee or such depository with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the U.S. Government, or any agency or instrumentality thereof, with a Federal Reserve bank, but the books and records of the Trustee shall at all times show that all such securities are part of the Fund;

(d) To deposit any cash in the Fund in interesting-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal government; and

(e) To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 10. Annual Valuation. After payment has been made into this standby trust fund, the Trustee shall annually, at least 30 days before the anniversary date of receipt of payment into the standby trust fund, furnish to the Grantor and to the NRC a statement confirming the value of the Trust. Any securities in the Fund shall be valued at market value as of no more than 60 days before the anniversary date of the establishment of the Fund. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the NRC, shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to the matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting on the advice of counsel.

Section 12. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing with the Grantor. (See Schedule C.)

Section 13. Successor Trustee. Upon 90 days notice to the NRC, the Trustee may resign; upon 90 days notice to NRC and the Trustee, the Grantor may replace the Trustee; but such resignation or replacement shall not be effective until the Grantor has appointed a successor Trustee and this successor accepts the appointment. The successor Trustee shall have the same powers and duties as those conferred upon the

Trustee hereunder. Upon the successor Trustee's acceptance of the appointment, the Trustee shall assign, transfer, and pay over to the successor Trustee the funds and properties then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor Trustee or for instructions. The successor Trustee shall specify the date on which it assumes administration of the trust in a writing sent to the Grantor, the NRC, and the present Trustee by certified mail 10 days before such changes becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this section shall be paid as provided in Section 9.

Section 14. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by such persons as are signatories to this agreement or such other designees as the Grantor may designate in writing. The Trustee shall be fully protected in acting without inquiry in accordance with the grantor's orders, requests, and instructions. If the NRC issues orders, requests, or instructions to the Trustee these shall be in writing, signed by the NRC, or its designees, and the Trustee shall act and shall be fully protected in acting in accordance with such orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor, or the NRC, hereunder has occurred. The Trustee shall have no duty to act in the absence of such orders, requests, and instruction from the Grantor and/or the NRC, except as provided for herein.

Section 15. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee and the NRC, or by the Trustee and the NRC, if the Grantor ceases to exist.

Section 16. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 15, this trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the NRC, or by the Trustee and the NRC, if the Grantor ceases to exist. Upon termination of the trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor or its successor.

Section 17. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this trust, or in carrying out any directions by the Grantor, or the NRC, issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor or from the trust fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 18. This Agreement shall be administered, construed, and enforced according to the laws of the United States.

Section 19. Interpretation and Severability. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement. If any part of this agreement is invalid, it shall not affect the remaining provisions which will remain valid and enforceable.

IN WITNESS WHEREOF the parties have caused this Agreement to be executed by the respective officers duly authorized and the incorporate seals to be hereunto affixed and attested as of the date first written above.

ATTEST:

[Insert name of Grantor]
[Signature of representative
of Grantor]
[Title]

[Title]
[Seal]

[Insert name of Trustee]
[Signature of representative
of Trustee]
[Title]

ATTEST:
[Title]
[Seal]

United States Enrichment Corporation
Standby Trust Agreement

SCHEDULE A

This Agreement demonstrates financial assurance for the following cost estimates for the following licensed activities:

U.S. NUCLEAR REGULATORY COMMISSION CERTIFICATE OF COMPLIANCE NUMBER	GDP-1
NAME AND ADDRESS OF LICENSEE	United States Enrichment Corporation 6903 Rockledge Drive Bethesda, Maryland 20817 5600 Hobbs Road Paducah, Kentucky 42001
COST ESTIMATE FOR REGULATORY ASSURANCES DEMONSTRATED BY THIS AGREEMENT	[Insert amount of agreement]

The cost estimates listed here were submitted to the NRC on [insert date]

The Total Cost of decommissioning the GDP, assuming no liability for decontamination, is as per the decommissioning cost estimate on file with the NRC.

United States Enrichment Corporation _____

Trustee _____

United States Enrichment Corporation
Standby Trust Agreement

SCHEDULE B

AMOUNT:
AS EVIDENCED BY:

United States Enrichment Corporation _____

Trustee _____

United States Enrichment Corporation
Standby Trust Agreement

SCHEDULE C

Trustee will be paid [insert amount] annually for services being provided under the standby trust agreement. This fee will apply whether or not payment has been made to the standby trust fund.

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SUPPLEMENTAL ENVIRONMENTAL INFORMATION

RELATED TO COMPLIANCE PLAN

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1. INTRODUCTION

10 Code of Federal Regulations (CFR) 76.35(c) requires that United States Enrichment Corporation (USEC) provide:

> Any relevant information concerning deviations from the published Environmental Impact Statement, Environmental Assessments, or environmental permits under which the plants currently operate from which the Commission can prepare an environmental assessment related to the compliance plan.

Detailed information concerning USEC's status of compliance with the environmental permits under which the Paducah Plant currently operates is contained in the Environmental Compliance Status Report submitted as part of this application. The additional information required by 10 CFR 76.35(c) is set forth below. This supplemental information demonstrates that: (a) the continued operation of the Paducah Plant in accordance with the application and accompanying Plan for Achieving Compliance (Compliance Plan) will not result in any significant deviation from USEC's existing environmental permits; (b) the environmental impacts associated with the operation of the Paducah Plant in this manner will remain bounded by the impacts described in the Environmental Assessment and Annual Environmental Reports previously prepared in connection with the operation of the Paducah Plant; and (c) correction of the areas of noncompliance described in the Compliance Plan will produce no significant adverse environmental impacts.

2. ENVIRONMENTAL PERMITS

The Environmental Compliance Status Report summarizes USEC's status of compliance with federal, state, and local environmental permits and other environmental quality standards and requirements applicable to the Paducah Plant. As discussed in greater detail in that report, USEC has obtained the necessary federal, state, and local permits required to operate the Paducah Plant and substantially complies with the effluent and emission limitations and other restrictions set forth in these permits. Neither the operation of the Paducah Plant in accordance with the Application and the Compliance Plan nor the actions taken to correct the areas of noncompliance are expected to result in any significant change in the current effluent or emission levels from the plant.

3. ENVIRONMENTAL ASSESSMENT AND REPORTS

Department of Energy (DOE) issued the final Environmental Assessment (EA) for the Paducah Gaseous Diffusion Plant, DOE/EA-0155, in August 1982. EA-0155 contains a detailed description of the environmental impacts associated with uranium enrichment operations and activities conducted at the Paducah Plant at the time the assessment was issued, and DOE issued a Finding of No Significant Impact(FONSI) associated with the continued operation of the Paducah Plant. DOE's Annual Site

Environmental Reports for the Paducah Plant that have been published since EA-0155 serve as a bridge between the 1982 EA and the environmental impacts associated with current plant operations. USEC/EA-95001, Environmental Assessment for the Privatization of the United States Enrichment Corporation, March 1995, and associated FONSI, provides a synopsis of the affected environment surrounding the plant. Moreover, the NRC has determined that there are no significant differences in operations at the Paducah Plant previously evaluated by DOE that would result in current operations having significantly different environmental effects than those already evaluated in the Paducah Plant's EA and Annual Site Environmental Reports (59 Federal Register 48944; September 23, 1994).

The actual emission levels and other environmental impacts associated with USEC's uranium enrichment operations and related activities at the Paducah Plant are generally lower and/or less significant than the emission levels and environmental impacts described in EA-0155. First, federal and state environmental standards applicable to operations at the plant, reflected in the various environmental permits issued to the plant, have become increasingly rigorous since the publication of EA-0155, resulting in lower permissible emission and discharge limits. As shown in the Paducah Environmental Compliance Status Report and the DOE's Annual Site Environmental Reports for the Paducah Plant, the Paducah Plant is in substantial compliance with these standards.

Second, although the uranium enrichment process at the Paducah Plant has not changed significantly since the preparation of EA-0155, certain manufacturing processes and activities supporting uranium enrichment that are described in the EA have been either modified or eliminated, resulting in a reduction in the total site-wide environmental impacts. For example, the Paducah Plant has:

1. Eliminated the use of trichloroethylene as a degreaser;
2. Eliminated the use of chromate as a corrosion inhibiter in the recirculating and chilled water systems, replaced with molybdate;
3. Ceased on-site burial of low level radioactive waste and classified waste;
4. Eliminated several air emission sources, including the C-746-A smelter and C-405 furnace;
5. Substantially reduced chlorine released from outfalls through the use of sodium thiosulfate; and
6. Reduced PCB releases to the environment through the collection of PCB drips in cascade facilities and the removal of PCB-contaminated lube oils.

Finally, certain environmental control and effluent monitoring systems at the Paducah Plant have been expanded and upgraded since EA-0155 was published in 1982. For example:

1. Outfall sample quality and flow measurements have been improved by installing refrigerated autosamplers, specialized flumes, and additional instrumentation;
2. Extensive QA/QC control over environmental sampling has been provided through the development of the Environmental Monitoring Plan; and
3. Improvements to the ambient air monitoring system have been implemented.

DOE's Annual Site Environmental Reports for the Paducah Plant contain site-wide environmental and waste management information including environmental improvements that have been implemented at the site since the publication of EA-0155.

A description of the site-wide environmental monitoring and control systems currently in place at the Paducah Plant may be found in the Paducah Plant's Annual Site Environmental Report for 1993 (ES/ESH-53, KY-ERWM-18), prepared by DOE. In addition, USEC has prepared USEC/EA-95001, Environmental Assessment for the Privatization of the United States Enrichment Corporation, published March 1995. This environmental assessment was also reviewed and considered in the preparation of this supplemental information.

4. ENVIRONMENTAL IMPACTS ASSOCIATED WITH COMPLIANCE PLAN

The NRC has concluded that operation of the Paducah Plant in accordance with 10 CFR 76 would not have a significant impact on the human environment. USEC has determined that the areas of noncompliance and the actions taken to address those noncompliances described in the accompanying Compliance Plan will not adversely affect compliance with current federal, state, and local environmental permits or other environmental quality standards and requirements and will produce no significant adverse environmental impacts.

DOE's Plan for Achieving Compliance with NRC Regulations at the Paducah Gaseous Diffusion Plant and USEC's Recommendations were reviewed. Individual areas of noncompliance were evaluated to determine whether the noncompliant condition, the associated corrective action, or the implementation of the corrective action, could result in any changes to routine air and water emissions, result in any uncontrolled releases, or otherwise adversely affect the environment. The majority of the individual areas of noncompliance identified in the Compliance Plan involve activities by USEC to upgrade plantwide programs, procedures, training, document and record controls, and other related administrative and procedural requirements to conform to applicable NRC requirements. Such administrative noncompliances and the associated corrective actions, by their very nature, will not have an impact on the level of emissions or effluents from plant operations or otherwise adversely affect the environment.

All of the evaluated Compliance Plan actions have been completed. Consequently, no adverse environmental impacts are associated with the Compliance Plan or with operations subsequent to the abatement of the noncompliance.

5. CONCLUSION

The continued operation of the Paducah Plant in accordance with the Application and the Compliance Plan and the actions taken to correct the areas of noncompliance: (a) will not result in any significant deviation from the environmental permits under which the Paducah Plant currently operates; (b) will not result in environmental impacts beyond those previously considered by DOE; and (c) will nothave any significant adverse environmental impact.

6. ITEMS ADDRESSED BY COMPLIANCE PLAN

None identified.

TECHNICAL SAFETY REQUIREMENTS

FOR

PADUCAH GASEOUS DIFFUSION PLANT

UNITED STATES ENRICHMENT CORPORATION
PADUCAH GASEOUS DIFFUSION PLANT

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Approved Technical Safety Requirement Clarification (TSRC) Index

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96C001	4	TSR 2.4.4.1	3/10/05
96C002	0	TSR 2.4.4.1	10/30/96
96C003	1	TSR 2.1.4.20, TSR 2.2.4.11	Cancelled
97C004	0	TSR 2.3.4.7a, TSR 2.3.4.7b	Cancelled
98C002	0	TSR 2.4.1	Cancelled
01C001	0	TSR 2.4.4.4	3/19/01

SECTION 1.0

USE AND APPLICATION

SECTION 1.0 USE AND APPLICATION

1.1 INTRODUCTION

10 CFR 76.87(a) states that "The Corporation shall establish technical safety requirements. In establishing the requirements, the Corporation shall consider the analyses and results of the safety analysis report submitted pursuant to 10 CFR 76.35." These Technical Safety Requirements (TSRs) are intended to fulfill the requirements of 76.87 and set forth approved limitations for operation of the Paducah Gaseous Diffusion Plant (PGDP). The TSRs define the conditions, safe boundaries and the management or administrative controls necessary to ensure safe operation of the facility and are based on the accidents analyzed in the Safety Analysis Report (SAR).

1.2 DEFINITION OF TERMS

1.2.1 **Actions** - That part of a TSR that prescribes required actions to be taken under designated conditions within specified completion times.

1.2.2 **Administrative Controls** - The provisions relating to organization and management, procedures, recordkeeping, reviews and audit, and reporting necessary to ensure operation of the plant in a safe manner.

1.2.3 **Channel Check** - The qualitative assessment of channel behavior during operation. This determination shall be based on observation and shall include, where possible, a comparison of the channel indication and status with other indications and the status derived from independent instrument channels measuring the same parameter.

1.2.4 **Completion Time** - The Completion Time is the amount of time allowed for completing a Required Action. It is referenced to the time of discovery of a situation (e.g., inoperable equipment or variable not within limits) that requires entering an ACTIONS Condition unless otherwise specified, providing the system/component is in a MODE or specified condition stated in the Applicability of the LCO. Required Actions must be completed prior to the expiration of the specified Completion Time. An ACTIONS Condition remains in effect and the Required Actions apply until the Condition no longer exists or the system/component is not within the LCO Applicability.

SECTION 1.0 USE AND APPLICATION

1.2.5 Cylinder Categories - Cylinders are categorized as follows:

Category	UF_6 Cylinder Requirements
A	Cylinders with certified volumes containing less UF_6 than the maximum fill limit for shipment or less UF_6 than the maximum fill limit for in-plant tails storage (if filled with high purity tails), or cylinders, which if heated to 235°F would have void volumes ≥5% or void volumes ≥3% if filled with high purity tails, according to TSR 2.1.4.6 or 2.2.4.4 or cylinders without certified volumes, but with measured and calculated volumes, containing a quantity of UF_6 which, if heated to 235°F would have void volumes ≥7% according to TSR 2.1.4.7 or 2.2.4.5.
B	Cylinders with certified volumes filled beyond the Category A limits, which if heated to 230°F would have void volumes ≥5% or void volumes ≥3% if filled with high purity tails, according to TSR 2.1.4.6 or 2.2.4.4.
C	Damaged cylinders or cylinders filled beyond the limits of Categories A or B.

1.2.6 Design Features (DF) - Those design attributes of structures, systems, and components that passively prevent or mitigate the consequences of radiological accidents that could cause significant consequences.

1.2.7 Fire Patrol - Required to perform monitoring of an area for fire due to a fire suppression system being impaired/inoperable. This monitoring shall be performed at regular intervals not to exceed the interval specified in the facility-specific TSR. The person performing the fire patrol must be instructed on the following:
(1) specifically what system is inoperable and the area to be patrolled, (2) actions to take upon discovering a fire, and (3) procedures for reporting a fire.

1.2.8 Functional Test - The injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify Operability, including required alarms, interlocks, trip functions, and channel failure trips. The Functional Test may be performed by any series of sequential, overlapping, or total channel steps such that the entire channel is tested.

1.2.9 Immediately - Required action shall be pursued without delay and in a controlled manner.

1.2.10 Limiting Conditions for Operation (LCO) - The lowest functional capability or performance levels of structures, systems, components and their support systems required for normal safe operation of the plant.

1.2.11 Limiting Control Setting (LCS) - Settings for automatic alarm or protective devices related to those variables having significant safety functions.

SECTION 1.0 USE AND APPLICATION

1.2.12 Operating Cycle (Autoclave) - The time between the initial entrance into a heating mode and the completion of the intended task (sample or transfer in C-360 or feeding and heeling in C-333-A and C-337-A) inclusive of mode changes allowed by the LCOs and their action statements which might occur during the course of the evolution.

1.2.13 Operable - An SSC shall be operable or have operability when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication, or other auxiliary equipment that are required for the SSC to perform its specified function(s) are also capable of performing their related support function(s).

1.2.14 Planned Expeditious Handling (PEH) - The process of handling equipment that contains more than a safe mass of uranium (relative to ^{235}U assay) as determined by TSR 2.5, Appendix B.

1.2.15 Safety Limit (SL) - Those bounds within which the process variables must be maintained for adequate control of the operation and that must not be exceeded in order to protect the integrity of the physical system that is designed to guard against the uncontrolled release of radioactivity.

1.2.16 Surveillance Requirements (SRs) - Requirements relating to test, calibration, or inspection to ensure that the necessary quality of systems and components is maintained, that plant operation will be within the safety limits, and that the limiting conditions for operation will be met.

1.2.17 UF_6 Cylinder (or cylinder) - Unless otherwise specified, UF_6 cylinder (or cylinder) is intended to be limited to large (2½-ton and larger) UF_6 cylinders.

1.2.18 Uncomplicated Handling - The process of handling equipment that contains a deposit of less than or equal to an always safe mass.

SECTION 1.0 USE AND APPLICATION

1.3 TIME INTERVALS FOR SURVEILLANCE

Interval Designation	Interval Between Consecutive Surveillances	Maximum Interval Between Consecutive Surveillances
Five-year	5 years to the day	5 years to the day (unless specifically stated otherwise)
Biennially	2 years	2 years 6 months
Annually	365 days	456 days
Semiannually	184 days	245 days
Quarterly	92 days	123 days
Monthly	31 days	39 days
Daily	24 hours	30 hours
Shiftly	12 hours	15 hours
Twice Each Shift	6 hours	8 hours

NOTE:

The extension between the standard and maximum surveillance intervals is intended to be used to accommodate operational and maintenance scheduling. The time interval between surveillances on in-service equipment should not routinely extend to the maximum allowable interval.

The extension between the standard and maximum surveillance intervals is 25% of the standard value with the exception of twice each shift, quarterly and semiannual items. The extension on these intervals is 33% consistent with past plant practice which has been in accordance with DOE 5481.1B.

SECTION 1.0 USE AND APPLICATION

1.4 LIST OF ACRONYMS

ANSI	American National Standards Institute
DF	Design Feature
LCO	Limiting Conditions for Operation
LCS	Limiting Control Setting
MAWP	Maximum Allowable Working Pressure
NRC	Nuclear Regulatory Commission
PEH	Planned Expeditious Handling
TSR	Technical Safety Requirements
SAR	Safety Analysis Report
SL	Safety Limit
SR	Surveillance Requirement
SSC	Structure, System, or Component
UH	Uncomplicated Handling

1.5 INTENT OF TERMS

Shall	—	Requirement
Should	—	Recommendation
May	—	Permission

1.6 GENERAL APPLICATION

1.6.1 SAFETY LIMIT

1.6.1.1 Compliance with **SAFETY LIMIT** requirements is required during OPERATIONAL MODES specified in the Applicability statement.

1.6.1.2 If the **SAFETY LIMIT** is exceeded, immediately perform the following:

a. If the conditions do not require evacuation, attempt to bring the affected parameter within the **SAFETY LIMIT** in a manner that leaves the facility/system in an operational mode for which the safety limit is not applicable.

b. If appropriate, notify plant emergency personnel and initiate building evacuation.

c. Conduct a technical evaluation to determine if any damage has occurred and to evaluate the ability of the system to be restarted.

SECTION 1.0 USE AND APPLICATION

1.6.2 OPERATING LIMITS

1.6.2.1 LIMITING CONTROL SETTINGS

a. Compliance with the **LIMITING CONTROL SETTING** requirement is required during the OPERATIONAL MODES specified in the Applicability statement.

1.6.2.2 LIMITING CONDITIONS FOR OPERATION

a. Compliance with the **LIMITING CONDITIONS for OPERATION** contained in these requirements is required during the OPERATIONAL MODES specified in the Applicability statement, except as provided in 1.6.2.2.b.

b. Upon discovery of a failure to meet an LCO, the Required Actions of the associated Conditions shall be met.

c. When a **LIMITING CONDITION for OPERATION** is not met, complete the attendant action steps within the required time interval. If the action steps are not met within the specified time interval, or if none are provided, place the equipment/system in an operating mode for which the LCO does not apply. Action shall be initiated within 1 hour.

Exceptions to this TSR (1.6.2.2.c.) are stated in individual requirements.

Where corrective measures are completed that permit operation in accordance with the LCO or ACTIONS, completion of the actions required by this TSR (1.6.2.2.c.) is not required.

d. Entry into an OPERATIONAL MODE that is applicable to a particular LCO shall not be made unless the conditions for the **LIMITING CONDITIONS for OPERATION** are met without reliance on provisions contained in the **ACTION** statement. Exceptions to this rule are stated in the individual requirements. Additionally, this provision shall not prevent passage through or to OPERATIONAL MODES required or allowed by **ACTION** statements.

e. LCO Completion Times. The completion times for LCO required actions begin when that specific condition is discovered, regardless

of how long that condition may have previously existed. All completion times within a single row of an LCO table are measured from the point of discovery of that condition.

If a Completion Time requires periodic performance on a "once per ..." or "every hour thereafter ..." basis, the 25% time interval extension specified in the Note to TSR USE and APPLICATION Section 1.3 applies to each performance after the initial performance. For Completion Times specified as "once," the 25% time interval extension does not apply.

f. Equipment removed from service or declared inoperable to comply with **ACTIONS** may be returned to service under administrative control solely to perform testing required to demonstrate its **OPERABILITY** or the **OPERABILITY** of other equipment. This is an exception to 1.6.2.2.b. for the system returned to service under administrative control to perform the testing required to demonstrate **OPERABILITY**.

g. Verification of OPERABILITY, as mandated in ACTION statements, may be accomplished by reviewing surveillance records or status boards to ensure that applicable equipment is operable or has not been declared inoperable. Systems and components are assumed to be operable when the associated SURVEILLANCE REQUIREMENTS have been met. However, this specification is not to be construed as implying that systems or components are operable when:

(1) The systems or components are known to be inoperable, although still meeting the SURVEILLANCE REQUIREMENTS, or

(2) The requirements of the surveillance(s) are known not to be met between required surveillance performance.

1.6.3 SURVEILLANCE REQUIREMENTS

1.6.3.1 **SURVEILLANCE REQUIREMENTS** shall be met prior to entering the OPERATIONAL MODES or other conditions specified in the Applicability statement for individual LCS and LCOs unless otherwise stated in an individual **SURVEILLANCE REQUIREMENT**.

1.6.3.2 Each **SURVEILLANCE REQUIREMENT** shall be performed in accordance with Section 2 and within the maximum time interval defined in Section 1.3. Surveillances do not have to be performed on SSCs which are not in, or being prepared to enter, the applicable operating mode(s).

SECTION 1.0 USE AND APPLICATION

1.6.3.3 Failure to perform a **SURVEILLANCE REQUIREMENT** within the maximum acceptable time interval constitutes a failure to meet the **OPERABILITY** requirements for a **LIMITING CONDITION for OPERATION**. Exceptions are stated in the individual requirements.

When it is discovered that a surveillance has not been performed within the maximum acceptable time interval for the frequency specified in Section 2, perform the following within either 24 hours or up to the limit of the specified frequency (whichever is less) of discovery:

a. Perform the required surveillance, or

b. Place the equipment in an operating mode for which the system is not required.

In instances where inoperability is declared due to missed surveillances, this general usage action statement takes precedence over the facility-specific LCO action statement. In the event that the missed surveillance is not performed within the interval provided by this general LCO, the action steps associated with system inoperability shall be immediately initiated in accordance with the facility-specific LCO.

1.6.3.4 Entry into an OPERATIONAL MODE or other specified condition shall not be made unless the **SURVEILLANCE REQUIREMENT(s)** associated with the **LIMITING CONDITION for OPERATION** has been performed within the stated surveillance interval or as otherwise specified in the individual surveillance requirements. This provision shall not prevent passage through or to OPERATIONAL MODES as required or allowed by **ACTION** statements. Exceptions are stated in the individual requirements.

1.6.4 CONDITIONS OUTSIDE TSR

In an emergency, if a situation develops that is not addressed by the TSR, operations personnel should use their training and expertise to take actions to correct or mitigate the situation. Also, operations personnel may take actions that depart from a requirement in the TSR provided that: (a) an emergency situation exists; (b) these actions are needed immediately to protect the public and employee health and safety; and (c) no action consistent with the TSR can provide adequate or equivalent protection. Such actions must be approved by the Incident Commander as defined in the Emergency Plan. If emergency action is taken, both a verbal and written notification shall be made in accordance with 10 CFR 76.120.

SECTION 2.0

FACILITY-SPECIFIC TECHNICAL SAFETY REQUIREMENTS

SECTION 2.1

SPECIFIC TSRs
FOR
TOLL TRANSFER AND SAMPLING FACILITY
(C-360)

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.1 OPERATIONAL MODES:

Mode Number	Mode Name	Definition
1a	Handling of Liquid Cylinders	This mode includes the movement of cylinders containing liquid UF_6 and cylinder insertion into and removal from the autoclaves.
1b	Handling of Empty Cylinders and Cylinders Containing Solid UF_6	This mode includes the movement of empty cylinders including removal from the autoclave and cylinders containing solid UF_6
2	2A: Autoclave Open	This mode is applicable when the autoclave is open and one or more of the following operations may be occurring: cylinder roll/tilt, parent cylinder pigtail connection or disconnection, inspections, testing, cylinder valve operation or autoclave repair.
	2B: Out-of-Service	Autoclave is considered out-of-service when it is open with a cylinder in the autoclave and no operation is in progress.
3	Containment	The autoclave is closed and at least one isolation valve on each autoclave penetration line is closed.
4	Autoclave Closed	This mode is applicable when the autoclave is closed and the steam supply is isolated. Both valves XV-*53 and FV-*05 are closed. Valve XV-*34 or FV-*00 is closed. Various valve operations may occur for alarm investigation, repair, etc.
5	Autoclave Heating	This mode is applicable when a UF_6 cylinder is being heated inside a closed autoclave in preparation for removal of the UF_6. Various valve operations may occur in this mode for alarm investigation, jetting, cylinder burping, etc.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.1 OPERATIONAL MODES (continued):

Mode Number	Mode Name	Definition
6	Transfer Station Operations	The following two modes describe operation of the transfer station.
	6A: Preparation	This mode involves connection and disconnection of the receiving cylinder pigtail. The pigtail and transfer manifold shall be evacuated such that no liquid UF_6 is present in the piping.
	6B: Transfer	This mode is applicable when liquid UF_6 is being transferred from a parent cylinder to another approved (the receiving) cylinder, and when liquid UF_6 exists in the transfer manifold and pigtail prior to evacuation. Sampling of the transferred liquid may occur simultaneously with the transfer operation.
7	Sample	This mode is applicable when liquid UF_6 is being transferred from an autoclave-heated parent cylinder into another approved cylinder (the sample cylinder at the laboratory sample station). The mode starts when PL-*36 or PL-*37 is opened to bring liquid UF_6 into the sample cabinet.
8	Not In Use	Equipment (autoclaves, sampling cabinets, transfer station, scale cart, etc.) is not in use. No UF_6 is present.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.2 SAFETY LIMITS

2.1.2.1 AUTOCLAVE SHELL PRESSURE

SL 2.1.2.1: The autoclave shell pressure shall not exceed 165 psig.

APPLICABILITY: Modes: All

BASIS:

The autoclaves are designed and manufactured under ASME Boiler and Pressure Vessel code Standards. As ASME pressure vessels, the autoclaves were hydrostatically tested at 150 percent of their 150 psig MAWP. The ASME code requires that the pressure transient during relief from this type vessel not exceed 110% of MAWP. Thus, the safety limit is established at 165 psig (110% of MAWP). [SAR Section 3.15.5.8; USQD 92-034]

2.1.2.2 UF6 CYLINDER TEMPERATURE

SL 2.1.2.2: Cylinder temperature shall not exceed the values listed in the table below.

Cylinder Category	Temperature Safety Limit
A	250°F
B	245°F

APPLICABILITY: Modes: All

BASIS:

The only time that the potential exists for a UF_6 cylinder rupture is during the heating of the cylinder. During the heat-up cycle the UF_6 expands in volume. Ullage (or void volume) is lost due to heating a cylinder to an excessive temperature based upon the amount of UF_6 in the cylinder. A cylinder is assumed to fail at some point above its safety limit.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.2 SAFETY LIMITS

2.1.2.2 UF6 CYLINDER TEMPERATURE (continued)

For Category A cylinders, the SL is established at 250°F. For Category B cylinders, the SL is established at 245°F. These safety limits are based on maintaining a minimum of 1% void volume at the safety limit temperature. The maximum autoclave temperature, limited by the autoclave steam pressure control system LCS (LCS 2.1.3.3), is 235°F for Category A and 230°F for Category B cylinders. The limiting Category A or B cylinder, filled with high purity tails, has 3% void volume at the maximum autoclave temperature. When heated to the corresponding safety limit temperature, the limiting cylinder will still have at least 1% void volume.

These safety limits are above the 235°F design temperature of the "thin wall" cylinders. However, the design temperature is established only for the development of cylinder fill limits; it has no significance with respect to material strength.

The saturated steam pressures required to generate the safety limit cylinder temperatures are 12.5 psig and 15 psig for 245°F and 250°F, respectively. [SAR Section 3.15.5.1, 4.3.2.2.2]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM

LCS 2.1.3.1: The autoclave high pressure isolation system actuation pressure shall not exceed 15 psig.

LCO 2.1.3.1: The autoclave containment shall be operable.

APPLICABILITY: Modes: 3, 4, 5

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel and/or one of two isolation valves on one or more isolable autoclave penetration inoperable.	A.1 Restore operability. NOTE: The existing operating cycle, including transition between modes 2, 3, 4, and 5, may be completed.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels and/or both isolation valves on any one autoclave penetration inoperable.	B.1 Place the autoclave in mode 2 or 3.	1 hour
C. Steam leakage from autoclave containment.	C.1 Place the autoclave in mode 2 or 3.	1 hour

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.3.1-1	Visually inspect the autoclave head to shell locking ring for steam leakage.	Upon initial entry to mode 5 for each operating cycle.
SR 2.1.3.1-2	Functional test of each detection/initiation channel. System must actuate at or below 15 psig. Containment valves (except FV-*47, XV-*49, XV-*50, and XV-*52) must close within 15 seconds of pressure switch actuation. Containment valves FV-*47, XV-*49, XV-*50, and XV-*52 must close within 10 seconds of pressure switch activation.	Quarterly
SR 2.1.3.1-3	Autoclave pressure decay test. Starting with an autoclave pressurized with air to a minimum of 90 psig, the maximum acceptable pressure drop is 10 psi in 1 hour. **OR** Autoclave leakrate test. The maximum acceptable leakage shall not exceed 12 scfm at a minimum test pressure of 90 psig. The pressure decay test or the leakrate test shall be conducted twice, with valve positions selected to test the following isolation barriers. The following barriers shall be exposed to the autoclave volume with outboard pressures that are controlled and/or monitored: Inner Barrier / Outer Barrier XV-*52 / PL-*35, FV-*47, XV-*50, XV-*49 XV-*51 / PL-*33, XV-*48 XV-*53 / FV-*24, FV-*05 PSE-*32 FV-*00 / FV-*10, XV-*34, PSV-*20 FV-*03 / FV-*46 XV-511B-* / XV-511C-* XV-511A-* / CKV-511-*, TP-511-*	Quarterly
SR 2.1.3.1-4	Calibration of each detection/initiation channel.	Annually
SR 2.1.3.1-5	Visual inspection of autoclave shell and head.	Annually
SR 2.1.3.1-6	Functional test of the interlock preventing autoclave opening on high pressure.	Quarterly

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM (continued)

BASIS:

A pressure as high as 15 psig is assumed to indicate that a UF_6 release has occurred within the autoclave. This system places the autoclave into the containment mode, thus minimizing an external release of UF_6 (the primary path for which is the condensate drain line). The accident analysis for a limited UF_6 release into a C-360 autoclave while jetting postulates a release from the autoclave by means of the jet exhaust to the environment that will not allow the autoclave pressure to reach the 15 psig actuation pressure. In this case, the autoclave steam pressure control system is credited with isolating the jet from the autoclave, allowing the autoclave high pressure isolation system to sense the rising pressure and place the autoclave into containment. If the release is so small that the setpoint of the autoclave steam pressure control (ASPC) system is not reached, SAR Section 4.3.2.2.13 demonstrates that off-site consequences are within applicable evaluation guidelines. The accident analysis assumes a 15-second valve closure time for the containment valves to minimize the amount of UF_6 and reaction products allowed to leak to the environment through the condensate drain line. However, the accident analysis for a UF_6 release from the ^{99}Tc traps requires the Zone 4 manifold isolation valves (FV-*47, XV-*49, XV-*50, and XV-*52) to close within 10 seconds. Placing the autoclave into the containment mode also minimizes the water available for reaction with UF_6 by isolating the steam supply and condensate drains. The autoclave shell, valves, and external piping out to the second isolation valve were credited in the "cylinder rupture inside an operating autoclave" scenario for containing the reaction products resulting from the release and its reaction with autoclave steam and water. These controls ensure that the containment capability of the autoclave, as demonstrated by the pressure decay and/or leakrate test (SR 2.1.3.1-3), is not compromised.
[SAR Section 3.15.5.1, 3.15.5.2, 3.15.5.3, 4.3.2.2.2, 4.3.2.2.10.1, 4.3.2.2.13, 4.3.2.2.14]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.2 AUTOCLAVE PRESSURE RELIEF SYSTEM

LCS 2.1.3.2: The actuation pressure of the autoclave pressure relief system shall not exceed 157.5 psig.

LCO 2.1.3.2: The autoclave pressure relief system shall be operable.

APPLICABILITY: Modes: 3, 4, 5

ACTIONS:

Condition	Action	Completion Time
A. Pressure between the rupture disc and the relief valve greater than 5 psig.	A.1 Restore pressure to approximately atmospheric pressure. NOTE: Current operating cycle, including transitions between modes 2, 3, 4, and 5, may be completed.	Prior to starting a new operating cycle.
B. Autoclave pressure relief system inoperable.	B.1 Place the autoclave in mode 2 or 3.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.3.2-1	Replace the relief valve with a calibrated valve.	Annually
SR 2.1.3.2-2	Visually inspect the rupture disc for damage.	Annually
SR 2.1.3.2-3	Calibrate the pressure detection/indication channel that indicates the pressure between the rupture disc and relief valve.	Annually

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.2 AUTOCLAVE PRESSURE RELIEF SYSTEM (continued)

BASIS:

This system prevents catastrophic failure of the autoclave, and subsequent uncontrolled UF_6 release, by allowing small (relative to the release associated with autoclave rupture), controlled releases in the unlikely event of concurrent UF_6 release and excessive autoclave water inventory.

The ASME Code requires that overpressure relief be provided by a device stamped at or below the MAWP and sized such that the subsequent transient pressure will be limited to a maximum of 110% of MAWP when a single relief path is used. The ASME Code allows rupture discs to have a ± 5% burst tolerance. Rupture discs stamped at MAWP will therefore burst at or below 105% of MAWP. Thus, the LCS is set at 105% of MAWP. To comply with these standards, pressure relief devices are purchased and installed with stamped ratings at or below the MAWP. [SAR Section 3.15.5.8]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.3 AUTOCLAVE STEAM PRESSURE CONTROL SYSTEM

LCS 2.1.3.3: The actuation pressure of the autoclave steam pressure control system shall not exceed the values listed in the table below.

Cylinder Category	LCS
A	8 psig
B	6 psig

LCO 2.1.3.3: The autoclave steam pressure control system shall be operable.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable, or one steam inlet block valve inoperable.	A.1 Restore operability. NOTE: The existing operating cycle, including transitions between modes 2, 3, 4, and 5, may be completed.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels inoperable, or both steam inlet block valves inoperable or the vent line isolation valve (XV-*34) inoperable.	B.1 Place the autoclave in mode 2 or 3.	1 hour

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.3 AUTOCLAVE STEAM PRESSURE CONTROL SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.3.3-1	Functional test of each detection/initiation channel. System must activate and close the steam inlet block valves and the vent line isolation valve (XV-*34) at a pressure at or below the current LCS pressure	Quarterly
SR 2.1.3.3-2	Reset and functionally test the system trip setpoint to 6 psig or below.	Prior to entering mode 5 with a Category B cylinder (if only one is to be heated) or with the first Category B cylinder of a series of Category B cylinders to be heated.
SR 2.1.3.3-3	Calibrate the autoclave steam pressure control system detection/initiation instrumentation.	Annually

BASIS:

The accident analysis assumed an initial UF_6 cylinder temperature of 240 °F, but due to the design temperature limitations of the "thin wall" 48G cylinder (-40 to 235 °F), the category A cylinder steam pressure is limited to 8 psig (235 °F). By limiting steam pressure to 8 or 6 psig and therefore steam temperature to 235°F or 230°F, this system provides an indirect means of controlling cylinder temperature below the stated safety limits. This in turn limits not only the UF_6 vapor pressure within the cylinder, but also the volume (density) of liquid UF_6, preventing loss of ullage and overpressurization.

The autoclave steam pressure control system is also used to sense an increase in the autoclave pressure due to a limited UF_6 release into the autoclave during jetting operations. Actuation of the system closes the steam inlet block valves terminating the jetting. Once the jet is isolated from the autoclave, the autoclave high pressure isolation system working with the autoclave primary containment system will isolate the autoclave before the release and subsequent exposure exceeds guidelines. If the release is so small that the setpoint of the autoclave steam pressure control (ASPC) system is not reached, SAR Section 4.3.2.2.13 demonstrates that off-site consequences are within applicable evaluation guidelines.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.1.3.3 AUTOCLAVE STEAM PRESSURE CONTROL SYSTEM (continued)

BASIS (continued)

The accident analysis assumes no valve closure time for this system. However, the functional test surveillance requirement associated with TSR 2.1.3.1 verifies valve closure times are within accident analysis assumptions for other accident scenarios on a quarterly basis. [SAR Section 3.15.5.1, 3.15.5.4, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.10, 4.3.2.2.13, 4.3.2.2.14, 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.1 UF6 RELEASE DETECTION SYSTEM - LABORATORY (ZONE 1)

LCO 2.1.4.1: Zone 1 (Laboratory) of the UF_6 release detection system shall be operable.

APPLICABILITY: Modes: 5, 6 and 7

ACTIONS:

Condition	Required Action	Completion Time
A. One Zone 1 detector head inoperable.	A.1 Restore operability. NOTE: The existing operating cycle may be completed.	Prior to entering mode 5 or 7 on a new operating cycle.
B. Both Zone 1 detector heads inoperable.	B.1 Stop operations in mode 5 and 7. AND B.2 Evacuate sample manifold (place the sample cabinet in mode 8 and the autoclave in mode 4).	1 hour 1 hour
C. Valve XV-*48 or XV-*51 inoperable.	C.1 Restore operability. NOTE: The existing operating cycle may be completed.	Prior to entering mode 5 or 7 on a new operating cycle.
D. Valve FV-*47, XV-*49, XV-*50, or XV-*52 inoperable	D.1 Restore operability. See section 2.1.3.1 for impact on the autoclave. NOTE: The existing operating cycle may be completed.	Prior to entering mode 5 or 7 on a new operating cycle
E. Valves XV-*48 and XV-*51 inoperable.	E.1 Stop sample line operations in mode 5 and 7 on the affected autoclave. AND E.2 Evacuate sample manifold (place the sample cabinet in mode 8). See section 2.1.3.1 for impact on the autoclave.	1 hour 1 hour
F. Valve XV-*49 inoperable AND Either valve FV-*47, XV-*50 or XV-*52 inoperable.	F.1 Stop transfer line operations in mode 5, 6 and 7 on the affected autoclave. AND F.2 Evacuate sample manifold (place the sample cabinet in mode 8). See section 2.1.3.1 for impact on the autoclave.	1 hour 1 hour

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.1 UF6 RELEASE DETECTION SYSTEM - LABORATORY (ZONE 1) (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.1-1	Test each Zone 1 UF_6 release detection head to verify it will detect "smoke" and close the appropriate UF_6 manifold isolation valves (FV-*47, XV-*48, XV-*49, XV-*50, XV-*51, and XV-*52).	Quarterly

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." This system detects the presence of this "smoke" in the laboratory area and isolates the parent cylinder from the release point.
To ensure that automatic isolation is initiated the detectors are smoke tested with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration.

The functional test surveillance requirement associated with TSR 2.1.3.1 verifies valve closure times are within accident analysis assumptions on a quarterly basis. SAR Accident Analysis assumes the manifold valves will close in 15 seconds. [SAR Section 3.15.5.2, 4.3.2.2.10]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.2a UF6 RELEASE DETECTION SYSTEM - BASEMENT TRANSFER ROOM (A PORTION OF ZONE 4)

LCO 2.1.4.2a: Zone 4 (Basement transfer room) of the UF_6 release detection system shall be operable.

APPLICABILITY: Modes: 6B

ACTIONS:

Condition	Required Action	Completion Time
A. One basement transfer room detector head inoperable.	A.1 Restore operability. NOTE: The existing operating cycle may be completed.	Prior to entering mode 6B on a new operating cycle with a new parent or daughter cylinder.
B. Both basement transfer room detector heads inoperable.	B.1 Stop operations in mode 6B AND B.2 Evacuate transfer manifold (place the transfer station in mode 8). AND B.3 Place the autoclave in mode 4.	1 hour 1 hour 1 hour
C. Valve FV-*47, XV-*49, XV-*50 or XV-*52 inoperable.	C.1 Restore operability. NOTE: The existing operating cycle may be completed.	Prior to entering mode 6B on a new operating cycle with a new parent or daughter cylinder.
D. Valve XV-*52 inoperable AND Either valve FV-*47, XV-*49, or XV-*50 inoperable.	D.1 Stop operations in mode 6B AND D.2 Evacuate transfer manifold (place the transfer station in mode 8). See 2.1.3.1 for impact on the autoclave.	1 hour 1 hour
E. Valve WV-042 inoperable.	E.1 Stop operations in mode 6B AND E.2 Evacuate transfer manifold (place the transfer station in mode 8) AND E.3 Place the autoclave in mode 4.	1 hour 1 hour 1 hour
F. Receiving cylinder valve emergency valve closer inoperable.	F.1 Stop operations in mode 6B AND F.2 Close the cylinder valve manually (valve closer may be removed) AND F.3 Evacuate transfer manifold (place the transfer station in mode 8) AND F.4 Place the autoclave in mode 4.	1 hour 1 hour 1 hour 1 hour

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.2a UF6 RELEASE DETECTION SYSTEM - BASEMENT TRANSFER ROOM (A PORTION OF ZONE 4) (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.2a-1	Test each Zone 4 (basement transfer room) UF_6 release detection head to verify it will detect "smoke" and close the appropriate UF_6 manifold isolation valves (FV-*47, XV-*49, XV-*50, and XV-*52), the transfer line block valve (WV-042) and the receiving cylinder valve. The transfer line block valve must close within 10 seconds of detection. The receiving cylinder valve must close within 30 seconds of detection.	Quarterly
SR 2.1.4.2a-2	Verify that nitrogen is available to power the receiving cylinder valve closer air motor in order to close the cylinder valve (pressure check).	Quarterly
SR 2.1.4.2a-3	Verify that the automatic transfer from plant air to nitrogen is operable for the receiving cylinder valve closer.	Quarterly
SR 2.1.4.2a-4	Verify that the check valve on the air supply line to the transfer cylinder valve closer air motor just upstream of the nitrogen supply interface is operable.	Quarterly

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." This system detects the presence of this "smoke" in the basement transfer room and isolates the parent and receiving cylinders from the release point. To ensure that automatic isolation is initiated the detectors are smoke tested with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration.

The receiving cylinder valve closer motor is driven by plant air and is backed up by bottled nitrogen in the event plant air header pressure is low concurrent with a demand for receiving cylinder valve closure.

Transfer operations to fill 12B cylinders required the use of an alternate cylinder valve closer motor due to the orientation of the smaller cylinder valve and need to limit the torque applied. The quarterly surveillance test will test both closer motors to demonstrate system operability for 12B cylinders and large cylinders. Prior to the first transfer, the procedure will functionally check that the cylinder emergency valve closer 3-way selector valve is in the correct 12B cylinder position. Following the last transfer to 12B cylinder, the procedure will functionally check that the cylinder emergency valve closer 3-way selector valve is in the correct large cylinder position.

The functional test surveillance requirement associated with TSR 2.1.3.1 verifies valve closure times are within accident analysis assumptions on a quarterly basis. SAR accident analysis assumes the manifold valves will close in 10 seconds. [SAR Section 3.15.5.2, 4.3.2.2.10 and 4.3.2.2.10.1]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.2b UF6 RELEASE DETECTION SYSTEM - AUTOCLAVE HEATED HOUSINGS (ZONES 5-8)

LCO 2.1.4.2b: UF_6 release detection system shall be operable.

APPLICABILITY: Modes: 5, 6, 7

ACTIONS:

Condition	Required Action	Completion Time
A. The UF_6 release detection system is inoperable.	A.1 Perform UF_6 smoke watch on area affected by PGLD detection head inoperability.	Initiate within 1 hour and continuously thereafter until operability restored.
B. Action item A not satisfactorily accomplished.	B.1 Place the autoclave in mode 3.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.4.2b-1 Test each UF_6 release detection head to verify it will detect "smoke."	Quarterly

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." This system detects the presence of this "smoke" and sounds an alarm to alert operating personnel to initiate corrective/mitigative action. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. [SAR Sections 3.15.7.3]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.3 AUTOCLAVE WATER INVENTORY CONTROL SYSTEM

LCO 2.1.4.3: The autoclave water inventory control system shall be operable.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable, one steam inlet block valve inoperable.	A.1 Restore operability. NOTE: The existing operating cycle, including transitions between modes 2, 3, 4, and 5, may be completed.	Prior to initiating a new operating cycle
B. Both detection/initiation channels inoperable.	B.1 Place the autoclave in mode 4.	1 hour
C. Both steam inlet block valves (XV-*53 and FV-*05) inoperable or the vent line block valve (XV-*34) inoperable.	C.1 Place the autoclave in mode 2 or 3.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.3-1	Test the autoclave water inventory control system to verify that each detection/initiation channel will activate and close the steam inlet block valves (XV-*53 and FV-*05) and the vent line block valve (XV-*34) upon detection of standing water in the condensate drain line to the level at or below the autoclave shell.	Quarterly

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.3 AUTOCLAVE WATER INVENTORY CONTROL SYSTEM (continued)

BASIS:

The autoclave water inventory control system limits the amount of water in the autoclave, which is the most effective method of limiting the maximum pressure generated from a large release of UF_6 inside an autoclave. The vent line block valve (XV-*34) closure is required to prevent water/steam back-flow to the autoclave from other autoclaves via the common vent header.

The autoclave water inventory control system also minimizes the possibility of water mixing with fissile uranium in amounts sufficient to cause a criticality incident in the autoclave in the event of a large UF_6 release into the autoclave.

The accident analysis assumes no valve closure time for this system. However, the functional test surveillance requirement associated with TSR 2.1.3.1 verifies valve closure times are within accident analysis assumptions for other accident scenarios on a quarterly basis. [SAR Section 3.15.5.5, 4.3.2.2.13, 4.3.2.2.14]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.4 CYLINDER SCALE CART MOVEMENT PREVENTION SYSTEM

LCO 2.1.4.4: The cylinder scale cart movement prevention system shall be operable.

APPLICABILITY: Modes: 6B

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder scale cart movement prevention system inoperable.	A.1 Verify that the system's key is hanging from the receiving cylinder's pigtail. AND A.2 Tag out the air connector on the supply for the scale cart motor. NOTE: Current operating cycle may be completed.	1 hour 1 hour
B. Scale cart movement prevention system key is discovered not hanging from the receiving cylinder's pigtail without entry into condition A.	B.1.1 Tag out the air connector on the air supply for the scale cart motor. OR B.1.2 Stop operations in mode 6B AND Purge and evacuate the receiving cylinder's pigtail, disconnect the pigtail, and hang the system's key on the pigtail.	1 hour 1 hour

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.4 CYLINDER SCALE CART MOVEMENT PREVENTION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.4-1	Test the system quarterly to verify that the scale cart will not move unless the pigtail is at atmospheric pressure (± 3 psi using installed instrumentation) and the key interlock energized.	Quarterly
SR 2.1.4.4-2	Calibrate the system's detection and initiation pressure instrumentation.	Annually

BASIS:

This system helps prevent receiving cylinder pigtail failure and subsequent UF_6 release by prohibiting scale cart movement if the transfer manifold pressure indicates the potential presence of liquid UF_6 (pressure significantly above atmosphere) or inadequate pigtail purging and evacuation (pressure significantly below atmosphere). [SAR Sections 3.15.6.5 and 4.3.2.2.10]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.5 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.1.4.5a: Criticality accident detection coverage shall be operable.

APPLICABILITY: In areas, equipment, or processes which contain greater than 700 grams of ^{235}U at an enrichment greater than or equal to 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. Areas, equipment, or processes not covered by criticality accident detection.	A.1 Implement the following for areas, equipment, or processes applicable to this LCO and that are not otherwise covered by criticality accident detection. A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Complete the current transfer and/or sampling operation and place transfer or sampling autoclaves processing cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U in Mode 2. AND A.1.3 Roll cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U with valves not in the 12 o'clock position to place the cylinder valve in the 12 o'clock position. AND A.1.4 Discontinue movement of uranium enriched to ≥ 1 wt % ^{235}U.	Immediately
	AND A.2.1 Evacuate area within the area applicable to this LCO not covered by criticality accident detection. AND A.2.2 Restrict access to area evacuated in A.2.1.	Immediately
	AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification, such as a device that will alarm on sensing a 10mr/hr dose rate.	Immediately
B. Areas, equipment, or processes not covered by criticality accident detection.	B.1.1 Restore criticality accident detection by installing portable CAAS unit providing required criticality accident detection and same alarms as fixed unit. OR B.1.2 Restore criticality accident detection to operable status. TSR 1.6.2.2d is not applicable.	Prior to reinitiating activities

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.5 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.5a-1	Calibrate CAAS system equipment.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. The design of the system, three detection modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the C-360 facility are associated with movement of fissionable materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of detection will establish protection.

Requiring the cylinders be rotated to place the cylinder valve in the 12 o'clock position ensures that if the outage continues long enough that UF_6 solidifies in the affected cylinder(s), the cylinder valve will be above the surface of the solid. [SAR Section 3.15.7.1, 4.3.2.6]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.5 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.1.4.5b: Criticality accident alarm shall be operable (audible).

APPLICABILITY: In areas where the maximum foreseeable absorbed dose in free air exceeds 12 rad, except areas in permit-required confined spaces and localized areas of inaudibility.

ACTIONS:

Condition	Required Action	Completion Time
A. Area does not have an audible criticality accident alarm.	A.1 Implement the following for areas, equipment, or processes where a criticality accident could result in a maximum foreseeable dose exceeding 12 rad in the area of inaudibility and LCO 2.1.4.5a applies. A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Complete the current transfer and/or sampling operation and place transfer or sampling autoclaves processing cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U in Mode 2. AND A.1.3 Roll cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U with valves not in the 12 o'clock position to place the cylinder valve in the 12 o'clock position. AND A.1.4 Discontinue movement of uranium enriched to ≥ 1 wt % ^{235}U. AND A.2.1 Evacuate area of inaudibility applicable to this LCO. AND A.2.2 Restrict access to area evacuated in A.2.1. AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification, such as a device that will alarm on sensing a 10mr/hr dose rate, or a radio in constant communication with the Central Control Facility.	Immediately Immediately Immediately
B. Area does not have an audible criticality accident alarm.	B.1 Restore criticality accident alarm to operable status. TSR 1.6.2.2d is not applicable.	Prior to reinitiating activities

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.5 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.5b-1	Test the CAAS and building horns.	Annually
SR 2.1.4.5b-2	Verify that the CAAS air accumulators supply pressure to the building horns is at least 125 psig.	Quarterly
SR 2.1.4.5b-3	Verify that the condition of the battery backups to the electronic horns is sufficient to power the horns for at least 120 seconds.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. Audibility is not provided for areas in permit-required confined spaces and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate. One person remains outside the area and maintains communication with personnel in the area. Evacuation of the area of inaudibility and restricting access to those areas will eliminate the potential for increased consequences due to personnel not hearing an alarm. The design of the system, three detection modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the C-360 facility are associated with movement of fissile materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of alarm will establish protection.

The CAAS air accumulators provide for 120 seconds of horn actuation when at their minimum acceptable pressure of 125 psig. Electronic horns are also installed in some areas. These horns have battery backup power supplies which will provide for at least 120 seconds of horn actuation even if off-site power is lost.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY C-360

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.5 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

BASIS (continued):

Requiring the cylinders be rotated to place the cylinder valve in the 12 o'clock position ensures that if the outage continues long enough that UF_6 solidifies in the affected cylinder(s), the cylinder valve will be above the surface of the solid.

The annual surveillance of the CAAS building horns consists of placing the cluster in the test mode with a keyswitch, and manually causing two detector modules to generate radiation readings above the alarm setpoint. The cluster electronics determines that this meets the high radiation alarm criteria and propagates a high radiation alarm signal to the rest of the system. This signal activates the high radiation alarm light and bell in C-300 and activates the building CAAS horns. Each horn is qualitatively verified to be operating. This test is a horn functional test and each module combination is tested to generate the high radiation signal. [SAR Section 3.15.7.1, 4.3.2.6, 5.2.2.5]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.6 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT

LCO 2.1.4.6: Except as allowed by TSR 2.1.4.7, cylinder accountability (net) weight shall be verified to be less than or equal to the "Max. Fill Limit for Shipment" for cylinders other than tails cylinders and "Max. Fill Limit for In-Plant Tails Storage" for tails cylinders stated in TSR Section 2.1, Appendix A prior to heating the cylinder.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. Accountability weight exceeds the Maximum Fill Limit for Shipment for cylinders other than tails cylinders, or the Maximum Fill Limit for In-Plant Tails Storage for tails cylinders.	A.1 Calculate the cylinder void volume (ullage) at a temperature of 230°F and/or 235°F. Use the stamped water weight as the basis of the actual volume of cylinders with certified volumes. Determine the category of the cylinder based on the following criteria: Cat. A Void volume ≥5% at 235°F or Void volume ≥3% at 235°F for cylinders filled with high purity tails Cat. B Void volume ≥5% at 230°F or Void volume ≥3% at 230°F for cylinders filled with high purity tails Cat. C Void volume <5% at 230°F or Void volume <3% at 230°F for cylinders filled with high purity tails AND A.2.1 Set the Autoclave Steam Pressure Control System setpoint consistent with the cylinder category per TSR 2.1.3.3 for a Category A or B cylinder. The autoclave temperature/pressure controller setpoint shall not be set less than 219.9°F. OR A.2.2 Administratively control the Category C cylinder to prevent heating until such time as cold/controlled feeding is re-instituted as an operating mode. TSR 1.6.2.2(d) is not applicable.	Prior to entering mode 5

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.6 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.6-1	Verify cylinder accountability (net) weight is less than or equal to the "Max. Fill Limit for Shipment" for cylinders other than tails cylinders and "Max. Fill Limit for In-Plant Tails Storage" for tails cylinders stated in TSR Section 2.1, Appendix A.	Prior to the first entry into mode 5 of each operating cycle.

BASIS:

The thermal expansion coefficient of liquid UF_6 is such that the density of the liquid decreases dramatically as the liquid temperature increases. This difference in liquid density could allow more UF_6 to be drained into a cylinder at fill temperatures (typically 160°F) than can fit in the cylinder once it is heated to liquefaction temperature (typically 220°F). As an example, 22,870 lb of liquid UF_6 placed in a 10-ton product cylinder (fill limit = 21,030 lb) at normal cylinder fill temperature would occupy only 102.1 ft^3 of the available 108.9 ft^3. However, when that same cylinder is heated to normal liquefaction temperature, the liquid UF_6 would completely fill the cylinder and could potentially cause hydraulic pressures to develop inside the cylinder.

However, cylinders filled slightly beyond their standard fill limit can still be safely liquefied provided 5% ullage (3% for high-purity tails) is maintained. The standard fill limits (Appendix A) are based upon the cylinder's minimum volume and its design temperature. Thus, it may be the case that (accounting for the cylinder's actual volume determined from the water capacity stamped on the its nameplate) liquefaction at some temperature equal to or less than the cylinder's design temperature may be achieved while still providing the required ullage for safety. [USEC-651, Revision 7, Section 10] The calculations of Required Action A.1 may conclude that the cylinder, based upon its actual volume, has sufficient void volume to permit heating to 235°F. In those cases, Required Action A.2.1 would have the Autoclave Steam Pressure Control system setpoint changed to 8 psig (235°F) which is the normal setpoint for this system (see TSR 2.1.3.3). Required Action A.2.1 becomes unnecessary in these cases provided the surveillance requirements associated with TSR 2.1.3.3 are current.

The minimum autoclave temperature/pressure setpoint established in A.2.1 assures that the nominal autoclave temperature will not fall below 220°F and nominal pressure will remain above 2.5 psig. These values are the actual equipment operating conditions; instrument uncertainty, drift etc., are not to be applied to these values.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.6 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT (continued)

BASIS (continued):

PGDP has temporarily suspended cold feeding at the toll transfer and sampling facility and until such time as an approved TSR and operating procedure have been developed, damaged cylinders will not be heated for sample, or transfer. "Overfilled" cylinders which cannot be safely liquefied using the required actions for Condition A of LCO 2.1.4.6 would typically be emptied by means of controlled/cold feeding if that process were available. However, since there is currently no TSR-approved operating mode for this operation, these cylinders will not be heated for sample, or transfer until such time as an NRC-approved TSR change incorporates the cold/controlled feeding mode as an acceptable practice. [SAR Section 4.3.2.2.6]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.7 CYLINDER HEATING - HEATING LIMITATIONS FOR CERTAIN CYLINDERS WITHOUT CERTIFIED VOLUMES

LCO 2.1.4.7: Heating of the cylinders listed in the table below shall be governed by the limiting conditions specified in the table.

Cylinder Model	Cylinder Serial/Identification Numbers	Limiting Conditions
48 T	5001 - 9230	Do not heat.
48 O	10000 - 16601	Do not heat.
48 OM	16602 - 18801	Verify that the calculated volume of the cylinder, based on measured dimensions, is greater than 135 ft^3 and fill weight of UF_6 is less than 26,000 pounds.
48 OM	100001 - 111820	Verify that the calculated volume of the cylinder, based on measured dimensions, is greater than 135 ft^3 and fill weight of UF_6 is less than 26,000 pounds.
30 A	Concave Hd	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 25.65 ft^3 and fill weight of UF_6 is less than 4,939 pounds.
48 A	1-1000 3001-3365	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 108.9 ft^3 and fill weight of UF_6 is less than 20, 973 pounds.
48 F	9501-9530 9601-9660	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 140 ft^3 and fill weight of UF_6 is less than 26,963 pounds.
48 OM Allied	AC0001-AC0400	Verify that the calculated volume of the cylinder, based on measured cylinder dimensions and UF_6 net weight provides greater than 7% ullage when heated to 235°F.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. 48T or 48O cylinder listed in table above selected for heating or 30A, 48A, 48E, or 48OM cylinder listed in table above selected for heating does not meet the volume or weight requirements specified.	A.1 Administratively control the cylinder to prevent heating until such time as cold/controlled feeding is re-instituted as an operating mode.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Certain serial number ranges of model 48T and 48O cylinders lack a certified volume. The mechanism by which these cylinders would be emptied is by controlled, or "cold," feeding, whereby the material is sublimed out of the cylinder at temperatures below the UF_6 triple point. This "non-liquefaction" heating method has been suspended at the Toll Transfer and Sampling Facility and until such time as it is resumed, the 48T and 48O cylinders listed in the table will not be heated for sample, or transfer.

Certain serial number ranges for 30A, 48A and 48F cylinders also lack certified volumes, but can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Calculations have shown that 30A, 48A, and 48F cylinders respectively containing less than 4939, 20,973, and 26, 963 lbs. and which have a volume greater than 25.65, 108.9 and 140 ft^3 (the values listed in ANSI-N14.1 as the minimum volume for this cylinder class) will contain in excess of 7% ullage when heated to 235°F. Because these cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show the actual volume of the cylinder exceeds the established minimum volume specified above. The 7% ullage assured by the limits of this TSR provides a greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.1.4.6 in order to account for the fact that measured volumes are being used rather than a certified volume.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

Certain serial number ranges for 48 OM cylinders also lack certified volumes but can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Calculations have shown that 48 OM cylinders containing less than 26,000 lbs and which have a volume greater than 135 ft^3 (the value listed in ANSI-N14.1 as the minimum volume for this cylinder class) will contain in excess of 7% ullage when heated to 235°F. Because these cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show the actual volume of the cylinder exceeds 135 ft^3. The 7% ullage assured by the limits of this TSR provides a greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.1.4.6 in order to account for the fact that measured volumes are being used rather than a certified volume.

There is another type of 48 OM cylinders manufactured before ANSI-N14.1 was initially issued in 1971 that also lack certified volumes. These cylinders can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Specifications for the 48 OM Allied cylinders were not included in the ANSI standard until 1987 and required a minimum volume of 140 ft^3. The 48 OM Allied cylinders with serial numbers AC0001 through AC0400 do not meet the 140 ft^3 minimum volume specified in ANSI-N14.1. Measurements and calculations have shown the 48 OM Allied cylinders with serial numbers AC0001 through AC0400 have a cylinder volumes that generally range between 137.06 to 139.37 ft^3. Because the cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show actual volume. Using the NMC&A NuMAS UF_6 net weight and the calculated cylinder volume, and heating UF_6 to 235°F, the actual cylinder ullage can be calculated. The 7% ullage assured by the limits of this TSR provides greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.1.4.6 in order to account for the fact that measured volumes are being used rather than a certified volume.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.8 CYLINDER HEATING AND FILLING: CYLINDER PRE-HEAT AND PRE-FILL INSPECTION

LCO 2.1.4.8: Damaged UF_6 cylinders shall not be heated or filled with UF_6.

APPLICABILITY: Modes: 5 and 6B

ACTIONS:

Condition	Required Action	Completion Time
A. Unacceptable cylinder damage identified by cylinder pre-heat or pre-fill visual inspection.	A.1 Repair and test (if necessary) the cylinder in accordance with SAR Section 3.7.1 and SAR Figure 3.7-1.	Prior to entering mode 5 or mode 6B with the subject cylinder.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.4.8-1 Cylinder visual inspection for damage.	Prior to initial entry into mode 5 and/or 6B of each operating cycle.

BASIS:

Depending upon the degree of damage (detected during the pre-use inspection), a cylinder may or may not be capable of withstanding its hydropressure. A UF_6 cylinder is removed from service for repair or replacement when it has leaks, excessive corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that, in the judgement of the inspector, renders it unsafe or unserviceable. Some types of cylinder damage and/or deformities are acceptable as-is or after repair. [SAR Section 4.3.2.2.9, 4.3.2.2.14]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.9 CYLINDER HEATING - CYLINDER COLD PRESSURE

LCO 2.1.4.9: The cylinder cold pressure shall be less than or equal to 10 psia.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder cold pressure is greater than 10 psia.	A.1 "Cold burp" (or evacuate) cylinder to establish cold pressure less than or equal to 10 psia.	Prior to entering mode 5 with the subject cylinder.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.4.9-1 Determine cylinder cold pressure.	Prior to entering mode 5 with the subject cylinder.
SR 2.1.4.9-2 Calibrate the pressure detection/indication channel used to determine cylinder pressure.	Annually

BASIS:

The cylinder cold pressure check gives a mechanism to detect the presence of excessive amounts of gaseous impurities in the cylinder. Cylinders with cold pressures in excess of 10 psia, when heated to 235°F, could have a pressure as high as 130 psig (well below the cylinders' hydrostatic test pressure). The pressure is due to increased UF_6 vapor pressure and the shrinking available volume for and the temperature increase of the gaseous impurities. The actual cylinder pressure would be lower, however, since some of the typical impurities are soluble in liquid UF_6. The sampling and transfer facility is equipped with traps to control technetium contamination. A cylinder containing liquid UF_6 that has been processed through the transfer or sampling operations (e.g., through the technetium traps) can be immediately loaded into an autoclave for additional transfer or sampling operations. Such a cylinder does not have the potential for overpressurization due to compression of noncondensable or volatile contaminants. The cold pressure checks performed on the parent and daughter cylinders meet the intent of a cold pressure check for a cylinder that contains liquid UF_6 that was processed through the transfer and sampling process and will be immediately reheated in an autoclave. During transfer operations, noncondensable or volatile contaminants will tend to remain in the vapor space of the parent cylinder. Any remaining contaminants will remain in solution as long as the UF_6 remains liquid. [SAR Section 4.3.2.2.7, 4.3.2.2.14]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.10 CYLINDER FILLING - PRE-FILL WEIGHT

LCO 2.1.4.10: UF_6 cylinders shall not be filled with fissile material if they contain greater than 40 pounds of moderating or unknown material until a verification of the cylinder's contents has been performed.

APPLICABILITY: Modes: 6A and 6B

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder being prepared for filling operation involving fissile material discovered to have greater than 40 pounds of moderating or unknown material.	A.1 Reject the cylinder for filling until either its contents are verified or the moderating/unknown material has been removed.	Prior to entering mode 6B.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.4.10-1 Weigh each UF_6 cylinder to be filled.	Prior to entering mode 6B.

BASIS:

Controls for nuclear criticality safety of cylinders containing material enriched to ≥ 1.0 wt % ^{235}U is in the form of moderation control by limiting the amount of potentially moderating material allowed to be present in the cylinder. Cylinders having an excess of 40 pounds of known moderating or unknown material are suspected of having a source of moderation. At 5.5 wt % ^{235}U over 50 pounds of water are required to initiate and sustain a nuclear criticality. [NCSE 3974-05, August 1993] In addition, the same materials that would cause a moderation/criticality concern would also cause a concern due to the vigorous reaction between UF_6 and the hydrogenous contaminant. Verification (by weighing) of the cylinder's contents prior to filling assures that moderating materials have not been inadvertently introduced.
[SAR 4.3.2.2.10]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.11 CYLINDER FILLING - LIMITING NUMBER OF AUTOCLAVES VALVED TO THE TRANSFER STATION IN MODE 6B

LCO 2.1.4.11: Only one autoclave shall be valved to the transfer station (which is in mode 6B) at any given time. Two transfer line isolation valves on each of the other autoclaves shall be administratively controlled in the closed position.

APPLICABILITY: Modes: 6B

ACTIONS:

Condition	Required Action	Completion Time
A. An autoclave discovered with only one transfer isolation valve closed when another autoclave is valved to the mode 6B transfer station.	A.1 Close one additional transfer line isolation valve on the affected autoclave.	Immediately.
B. An autoclave discovered with no transfer line isolation valves closed when another autoclave is valved to the mode 6B transfer station.	B.1 Stop operations in mode 6B. AND B.2 Evacuate the transfer manifold. AND B.3 Close two transfer isolation valves on the affected autoclave(s).	Immediately Immediately Prior to restoring operations in mode 6B.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.11-1	Verify that two transfer line isolation valves on all other autoclaves (besides the one currently being used for transfer operations) are closed and tagged out.	Prior to entering mode 6B.

BASIS:

When one autoclave is valved to the transfer station in mode 6B, the other autoclaves are not precluded from being open. However, the C-360 autoclaves share a common transfer header. This control gives assurance that when one autoclave is valved to the transfer station in mode 6B, the other autoclave tie-ins to the transfer header are blocked, preventing UF_6 release into those autoclaves.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.12 CYLINDER FILLING - CYLINDER FILL LIMIT

LCO 2.1.4.12: The accountability weight of UF_6 drained into the receiving cylinder shall not exceed the standard fill limit (Maximum Fill Limit for Shipment for cylinders other than tails cylinders, or the Maximum Fill Limit for In-Plant Tails Storage for tails cylinders per TSR Section 2.1 Appendix A) for that cylinder.

APPLICABILITY: Modes: 6B

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder filled beyond standard fill limit and discovered prior to removal from the transfer room.	A.1.1 Connect cylinder to UF_6 manifold (if disconnected) AND A.1.2 Evacuate contents to a low pressure source until cylinder net weight is less than the standard fill limit.	Prior to placing the cylinder in the local cylinder yard for cool down (applies to the combination of A.1.1 and A.1.2)
B. Cylinder filled beyond standard fill limit and discovered after removal from the transfer room.	B.1 Identify the cylinder as an overfilled cylinder AND B.2 Allow the cylinder to complete its cool down period.	Immediately Prior to removing from the local cylinder yard

SURVEILLANCE REQUIREMENTS: None.

BASIS:

In the event a cylinder is overfilled during a transfer operation, the excess material can be removed from the cylinder safely by evacuating the cylinder to a low pressure. The hot liquid in the cylinder provides the thermal energy to vaporize UF_6 out of the cylinder to the evacuation low pressure source.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.13 CYLINDER HANDLING - CYLINDER ROLLING AND TILTING

LCO 2.1.4.13: UF_6 cylinders shall be disconnected from the UF_6 manifold during rolling and/or tilting.

APPLICABILITY: Modes: 2A

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder rolled or tilted with the pigtail connected to the UF_6 manifold.	A.1.1 Disconnect and discard the affected pigtail. AND A.1.2 Connect new pigtail.	Immediately.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Rolling or tilting UF_6 cylinders while they are connected to a manifold could potentially result in pigtail damage. The pigtail could be damaged to the point that its integrity is not immediately breached, but its ability to provide UF_6 containment in the future could be significantly degraded. [SAR Section 4.3.2.2.13]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.14 CYLINDER HANDLING - CYLINDER DISCONNECTION

LCO 2.1.4.14: The cylinder valve shall be closed prior to disconnecting the cylinder from the pigtail.

APPLICABILITY: Modes: 2A, 6A

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve cannot be closed.	A.1 Establish cylinder pressure below atmospheric pressure AND A.2. Cap the open connections	Prior to disconnecting either end of the pigtail. After disconnecting either end of the pigtail

SURVEILLANCE REQUIREMENTS: None

BASIS:

Closing the cylinder valve prior to disconnecting the cylinder from the manifold prevents UF_6 release from an open source. On rare occasions, it is discovered that the cylinder valve, for one reason or another, cannot be closed and seated as evidenced by the pigtail pressure rising after evacuation. In those instances, the safest course of action is to allow the cylinder to cool below atmosphere, disconnect the cylinder from the manifold, and cap the open connections to minimize UF_6 outleakage.

The cylinder pressure indication channel used to establish cylinder pressure per Action A.1 is calibrated annually in SR 2.1.4.9-2.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.15 CYLINDER HANDLING - CYLINDER VALVE COVERS

LCO 2.1.4.15: Liquid-filled cylinders shall not be lifted or removed from the high-bay work area without a cylinder valve protector installed.

APPLICABILITY: Modes: 1a

ACTIONS:

Condition	Required Action	Completion Time
A. Liquid-filled cylinder lifted or removed from the high-bay work area without cylinder valve protector installed - discovered while the cylinder is suspended.	A.1 Place the cylinder in a set of cylinder storage saddles (scale cart or fixed) AND A.2 Install a cylinder valve protector.	Immediately Prior to moving the subject cylinder.
B. Liquid-filled cylinder lifted or removed from the high-bay work area without cylinder valve protector installed - discovered after the cylinder has been placed in a set of storage saddles.	B.1 Install a cylinder valve protector.	Prior to moving the subject cylinder.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The extended cylinder valve, although partially protected by the cylinder, is one of the most likely failure points on a cylinder while it is being moved. Installing the cylinder valve protector provides additional protection of the valve against damage that could result in a UF_6 release to the environment. The high-bay work area is the "operating" floor on which the facility autoclaves are found. A cylinder is considered to be "removed from the high-bay work area" when the scale cart on which it rests is placed on the levelator in preparation for lowering the cylinder to ground level or when it is attached to an approved liquid UF_6 cylinder handling crane for transport to the low bay (when the levelator is not used).

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.16 CYLINDER HANDLING - APPROVED CRANES FOR LIQUID CYLINDERS

LCO 2.1.4.16: Liquid-filled cylinders shall be lifted (suspended) only with overhead cranes meeting the conditions set forth in TSR Section 2.1.5.2.

APPLICABILITY: Modes: 1a

ACTIONS:

Condition	Required Action	Completion Time
A. Liquid-filled cylinder lifted (suspended) by equipment other than that specified in section 2.1.5.2 prior to completion of the cylinder cool-down period (3 days for 2½-ton cylinders and 5 days for 10- and 14-ton cylinders) discovered while the cylinder is suspended.	A.1 Place the cylinder in a set of cylinder storage saddles at ground level.	Immediately
B. Liquid-filled cylinder lifted (suspended) by equipment other than that specified in section 2.1.5.2 prior to completion of the cylinder cool-down period (3 days for 2½-ton cylinders and 5 days for 10- and 14-ton cylinders) - discovered after cylinder has been placed in a set of storage saddles.	B.1 Restrict cylinder movement to lifting with an overhead crane approved for liquid cylinder handling (as in 2.1.5.2) for placement in a set of cylinder storage saddles at ground level.	Immediately and until completion of the cylinder cool-down period

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Lifting liquid-filled cylinders only with cranes approved for that use reduces the potential for a cylinder handling mishap that could result in the release of UF_6 to the environment. The 3-day cooldown specified in Condition A and B for 2 ½-ton cylinders includes 12B cylinders. The cooldown period for 12B cylinders is the same as for 2 ½-ton cylinders [SAR Section 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.17 CYLINDER LIFTING RESTRICTION

LCO 2.1.4.17 No UF_6 cylinder shall be moved over another cylinder when either cylinder contains liquid UF_6.

APPLICABILITY: Modes: 1a and 1b when the cylinder being lifted has not been acceptably heeled

ACTIONS:

Condition	Required Action	Completion Time
A. UF_6 cylinders suspended one over the other when at least one of the cylinders contains liquid UF_6.	A.1 Move the suspended cylinder such that the LCO statement is satisfied.	Immediately

BASIS:

The cylinder failure outside autoclave scenario in the accident analysis involving liquid UF_6 cylinders assumes a release source term of 28,000 pounds of UF_6. The prohibition of lifting one cylinder over another if one of the cylinders contains liquid UF_6 preserves the accident analysis assumption of only one cylinder contributing to the release source term (even though the contribution from a solid UF_6 cylinder would be negligible).

A cylinder that has been acceptably heeled will contain no liquid UF_6. SAR Section 3.2.1.4 describes the process of heeling a cylinder. A cylinder will be considered acceptably heeled when its vapor pressure falls below 20 psia for more than 5 minutes during the heeling process. [SAR 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.18 HEATING UF_6 PLUGS

LCO 2.1.4.18: Direct heat sources shall not be applied to UF_6 plugs until flow clarity in the system has been assured.

APPLICABILITY: At all times

ACTIONS:

Condition	Required Action	Completion Time
A. Direct heat source applied to a UF_6 plug.	A.1 Discontinue heating the plug.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Application of external heat to the middle portion of the plug can melt the solid and develop large hydraulic forces in the pipe and ends of the plug, creating the potential for a UF_6 release due to pipe rupture.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.19 CYLINDER HEATING - VALVE CLARITY

LCO 2.1.4.19: Cylinder valve clarity shall be demonstrated prior to initial heating of a cylinder.

APPLICABILITY: Modes: 4, 5

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve clarity cannot be demonstrated prior to initial heating.	A.1 Do not heat cylinder.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The demonstration of cylinder valve clarity assures an open pathway between the cylinder void volume and the feed manifold. The open pathway assures that cylinder heating will not cause an unrelieved pressure buildup. In conjunction with other operating controls on cylinder inventory and heating, this requirement reduces the possibility of cylinder rupture. The methodology and criteria for demonstrating valve clarity are maintained in procedures.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.20 CYLINDER HEATING - VALVE CLARITY/HEATING CYCLE INTERRUPTIONS

LCO 2.1.4.20: During the operating (sampling and/or transfer) cycle, cylinder valve clarity shall be demonstrated immediately prior to heating a cylinder following heating interruptions.

APPLICABILITY: Modes: 4, 5

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve clarity cannot be demonstrated prior to heating following heating interruption.	A.1 Terminate operating cycle. Do not heat cylinder until valve clarity is established.	Immediately

SURVEILLANCE REQUIREMENTS: None

BASIS:

The demonstration of cylinder valve clarity assures an open pathway between the cylinder void and the autoclave UF_6 manifold. The open pathway assures that cylinder heating will not cause an unrelieved pressure buildup. In conjunction with other operating controls on cylinder inventory and heating, this requirement reduces the possibility of cylinder rupture. The methodology and criteria for demonstrating valve clarity are maintained in procedures.

Following an interrupted cylinder heating cycle, it is possible to have liquid UF_6 present inside the cylinder. Therefore, following the demonstration of valve clarity, heating of the cylinder must resume promptly to ensure that the liquid UF_6 does not solidify on the cylinder valve. Re-solidification of the UF_6 could eliminate the pathway between the cylinder void and the autoclave UF_6 manifold.

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.20 CYLINDER HEATING - VALVE CLARITY/HEATING CYCLE INTERRUPTIONS (continued)

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.21 SCALES

LCO 2.1.4.21: The C-360 scale(s) used for verification of cylinder weight per LCOs 2.1.4.6, 2.1.4.10, 2.1.4.12, and 2.2.4.4 shall be operable.

APPLICABILITY: Whenever the C-360 scale(s) is/are used for verification of cylinder weight.

ACTIONS:

Condition	Required Action	Completion Time
A. Scale discovered to be inoperable	A.1 Administratively control scale to prevent use.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.21-1	Calibrate NMC&A scale ID 22 and 23 (normal position near autoclave and basement at transfer station), to an adequate range and tolerance for the item being weighed, in accordance with NMC&A program requirements.	Annually
SR 2.1.4.21-2	Perform functional test of NMC&A scale ID 22 and 23 (normal position near autoclave and basement at transfer station) (i.e., check operation using test weights in accordance with NMC&A program requirements).	Daily

BASIS:

All cylinder weights are assumed to be within the tolerances assumed in the accident analysis. The calibration and testing of the scale to within the tolerances specified in the NMC&A program (which are much more stringent than the tolerances required by the accident analysis) assured that cylinder weights do not invalidate the accident analysis. [SAR Section 3.15.6.4, 4.3.2.2.6, 4.3.2.2.14]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.22 HIGH CYLINDER PRESSURE SYSTEM

LCO 2.1.4.22: The high cylinder pressure system shall be operable.

APPLICABILITY: Mode 5 except when a cylinder is connected to the transfer manifold.

ACTIONS:

Condition	Required Action	Completion Time
A. One of two steam isolation valves inoperable.	A.1 Restore isolation valve to operable status. NOTE: The current operating cycle may be completed.	Prior to initiating a new operating cycle.
B. High cylinder pressure system detection-initiation channel inoperable.	B.1 Place autoclave in Mode 2, 3, or 4.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.22-1	Perform a functional test to verify the autoclave steam supply block valves will close when cylinder pressure exceeds the actuation pressure.	Quarterly
SR 2.1.4.22-2	Perform calibration of the high cylinder pressure system detection-initiation channel. System must actuate at or below 115 psia cylinder pressure.	Annually

BASIS:

The high cylinder pressure system is required to minimize the potential of primary system integrity failures during pressure increase events by tripping the steam supply when the MAWP of the cylinder being heated is reached. The 115 psia actuation pressure for heating all cylinders is based on the lowest MAWP of these cylinders. This system is a single channel system and

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.22 HIGH CYLINDER PRESSURE SYSTEM (continued)

is capable of performing its safety function independent of support systems. The heating of a UF_6 cylinder containing an excessive amount of light gases at normal heating temperatures could result in the internal cylinder pressure exceeding the hydrostatic test pressure and possibly create a UF_6 release in the autoclave.

In addition, in the event an over filled cylinder is heated in the autoclave the high cylinder pressure caused by the reduced void volume may be sufficient to exceed the actuation value and thereby stop the cylinder heating and prevent a possible rupture of the cylinder. Excessive UF_6 pressure for any postulated cause would be detected during initial cylinder heat up to liquefaction. Therefore, the high cylinder pressure system is not required to be operable when a cylinder is connected to the transfer manifold. [SAR Sections 3.15.5.6, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9].

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.1.4.23 CYLINDER FILLING - TECHNETIUM TRAPS

LCO 2.1.4.23: A maximum of one technetium trap bank shall be valved to the transfer station (which is in mode 6B) at any given time. The technetium trap isolation valves on the other trap bank shall be administratively controlled in the closed position.

APPLICABILITY: Modes: 6B

ACTIONS:

Condition	Required Action	Completion Time
A. One inlet or outlet technetium trap isolation valve discovered open when another trap bank is valved to the mode 6B transfer station.	A.1 Close the valve	Immediately
B. Both inlet or outlet technetium trap isolation valves discovered open when another trap bank is valved to the mode 6B transfer station.	B.1 Stop operations in Mode 6B. AND B.2 Evacuate the transfer manifold, including technetium traps. AND B.3 Close both technetium trap isolation valves on the affected trap bank.	Immediately Immediately Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.4.23-1	Verify that the technetium trap isolation valves on the isolated trap bank are closed and tagged out.	Prior to entering Mode 6B.

BASIS:

The accident analysis for the C-360 transfer operations with the technetium traps in service assumes a maximum of one bank of traps is in service at any time. This limits the amount of liquid UF_6 at risk in the event of a transfer line break. [SAR Section 4.3.2.2.10.1]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.1 UF6 CYLINDER SLINGS AND LIFTING FIXTURES

DF 2.1.5.1: UF_6 cylinder slings and lifting fixtures are designed with a structural factor of safety of 5 to 1 based upon the material's ultimate tensile strength.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.5.1-1 Visual inspection for defects	Prior to first use of shift
SR 2.1.5.1-2 Hands-on Inspection (no disassembly required)	Monthly
SR 2.1.5.1-3 Load test at a minimum of 100% of rated capacity.	Biennially

BASIS:

Slings, H-frames, etc used to handle liquid filled UF_6 cylinders are credited for prevention of the liquid cylinder drop and rupture accident scenario. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1 and 2 are performed to meet the requirements of OSHA 1910.184. [SAR Sections 3.15.6.2 and 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.2 CRANE DESIGN

DF 2.1.5.2: The liquid UF_6 cylinder handling cranes are designed and maintained not to fail in a manner to cause primary system integrity failure.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.2-1	Visual inspection for defects	Prior to first use of shift
SR 2.1.5.2-2	Hands-on Inspection (no disassembly required)	Monthly
SR 2.1.5.2-3	Hands-on Inspection (some disassembly required)	Annually
SR 2.1.5.2-4	Load test at a minimum of 100% of rated capacity and verify that the cranes do not allow a load to move (except compensatory movements) upon operator release of the controls.	Biennially

BASIS:

Cranes used to handle liquid filled UF_6 cylinders are credited for prevention of the liquid cylinder drop and rupture accident scenario. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1, 2, and 3 are performed to meet the requirements of OSHA 1910.179. [SAR Sections 3.15.6.2, 4.3.2.2.4, 4.3.2.2.15, 4.3.2.5.2, and 4.3.2.5.3]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.3 UF6 CYLINDERS

DF 2.1.5.3: UF_6 cylinders (2½-ton and larger) are as a minimum designed to a MAWP of 100 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.3-1	UF_6 cylinders (2½-ton and larger) shall be hydrostatically tested at 200% of MAWP prior to filling. Note: Cylinders that are full of UF_6 but have an expired hydrostatic test may be heated for removal of the UF_6, but shall be hydrostatically tested prior to refilling.	5 years

BASIS:

UF_6 cylinder MAWP equal to or greater than 100 psig is an assumption used in several accident analysis scenarios. [SAR Sections 3.15.6.1, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9, 4.3.2.2.10, 4.3.2.5.2, and 4.3.2.5.3]

2.1.5.4 UF_6 CYLINDER PIGTAILS

DF 2.1.5.4: Pigtails are designed to withstand at least 400 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.4-1	Pigtails shall receive a post fabrication inspection and hydrostatic test to at least 400 psig.	Prior to initial use.

BASIS:

This design feature helps minimize the possibility of the initiator of the “pigtail failure” accident scenario (inside or outside an autoclave). [SAR Sections 3.15.5.4, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9, 4.3.2.2.10]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.5 SCALE CART DESIGN

DF 2.1.5.5: The scale carts are designed with a minimum capacity of 20 tons.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.5-1	Visual inspection of the scale cart for structural damage, degradation, cracks, distorted members and loose fasteners.	Biennially

BASIS:

This design feature minimizes the possibility of the "liquid cylinder rupture" accident scenario. [SAR Sections 3.15.6.3, 4.3.2.2.15, and 4.3.2.5.3]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.6 HYDRAULIC LIFTS - LIFT CAPACITY

DF 2.1.5.6: Hydraulic lifts that handle cylinders containing liquid UF_6 are designed with a minimum capacity of 20 tons.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.6-1	Visual inspection to meet ANSI A17.1 requirements.	Quarterly
SR 2.1.5.6-2	Load test at 100% of rated capacity in accordance with ANSI A17.1.	Five Years

BASIS:

This design feature minimizes the possibility of the "liquid cylinder rupture" accident scenario. The surveillance requirements are based upon ANSI A17.1, 1971, including Supplements (a) through (g), Rule 1000.4a and Section 1001. [SAR Section 3.15.6.3, 4.3.2.2.15]

2.1.5.7 HYDRAULIC LIFTS - INTERLOCK WITH SCALE CART AIR SUPPLY

DF 2.1.5.7: The interlock switch between the levelator and the operating floor scale cart air supply prevents scale cart movement if the levelator is not in its full upright position.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.1.5.7-1	Functional test to ensure operating floor scale cart will not move unless the levelator is in the "up" position.	Quarterly

BASIS:

This design feature is one line of assurance against rolling a liquid-filled cylinder off the operating floor. [SAR Section 3.15.6.3, 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

2.1.5 GENERAL DESIGN FEATURES

2.1.5.8 HYDRAULIC LIFTS - RAIL STOPS

DF 2.1.5.8: The rail stops on the levelator prevent rolling the scale cart and its carried cylinder off the end of the lift.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.1.5.8-1 Visual inspection of the rail stops to ensure they are not bent or cracked.	Quarterly

BASIS:

This design feature minimizes the expected frequency of the "liquid cylinder rupture" accident scenario. [SAR Section 3.15.6.3, 4.3.2.2.15]

SECTION 2.1 SPECIFIC TSRs FOR TOLL TRANSFER AND SAMPLING FACILITY (C-360)

TSR 2.1 Appendix A
Maximum weight limits for UF_6 cylinders.

Model No.	Cylinder Nos. or Type	Max. Fill Limit for Shipment[1] (lbs UF_6)	Max. Fill Limit for In-Plant Tails Storage[2] (lbs UF_6)
12B	All	460	475
	Text Removed		
30B	All	5020	—
	Text Removed		
	Text Removed		
	Text Removed		
	Text Removed		
48G	121,926 - 149,999	26840	27920[3]
48G	160,000 and up	26840	27920[3]
48H	151,001- 154,144	27030	28000
48HX	150,001-151,000	27030	28000
48Y	All	27560	28000
48OM	111,821-121,925	26840	27920[3]
	Text Removed		
48X	All	21030	21870

1. All fill limits for shipments are based on 5% free volume, 99.5% purity, and a maximum vaporization temperature of 250°F per USEC-651.
2. Fill limits for in-plant tails storage cylinders are based on 3% free volume and a maximum vaporization temperature of 235°F except for 48Y, 48HX, and 48H cylinders whose in-plant tails storage limits have been further reduced to ensure the maximum amount of UF_6 assumed in the accident analysis (28,000 lbs) is not exceeded.
3. The maximum fill limit for in-plant tails storage for the 48OM and 48G cylinders may be increased to the maximum of 28,000 lbs provided the cylinder will maintain a minimum 3 percent free volume when heated to 235°F based on the actual certified cylinder volume. Cylinders with 8,695-lb water capacity or greater may be filled with 28,000 lbs of high purity UF_6 tails and maintain a minimum 3 percent free volume when heated to 235°F.

SECTION 2.2

SPECIFIC TSRs
FOR
UF_6 FEED FACILITIES
(C-333-A AND C-337-A)

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.1 OPERATIONAL MODES:

Mode Number	Mode Name	Definition
1	Cylinder Handling	This mode includes UF_6 cylinder movements, cylinder insertion to, and removal from autoclave.
2	Autoclave Open	This mode is applicable when the autoclave is open and one or more of the following operations may be occurring: cylinder pigtail connection or disconnection, inspections, or testing, cylinder valve operation or autoclave repair.
	Autoclave Out of Service	Autoclave open with a cylinder in the autoclave. No operation in progress.
3	Containment	The autoclave is closed and at least one isolation valve on each autoclave penetration line is closed.
4	Autoclave Closed	This mode is applicable when the autoclave is closed, and the steam supply and the vent line are isolated. Both valves XV-524 and PV-520 are closed. Valve XV-565 or XV-516 is closed. Various valve operations may occur for alarm investigation, repair, etc.
5	Heating	A UF_6 cylinder is being heated inside a closed autoclave in preparation for removal of the UF_6. Various valve operations may occur for alarm investigation, jetting, cylinder burping, etc.
	Feeding	Transfer of gaseous UF_6 to the enrichment cascade from a cylinder containing liquid UF_6. Various valve operations may occur for alarm investigation, cylinder burping, etc.
	Heeling	Removal of residual quantities of UF_6 gas from a near-empty feed cylinder.
6	Not In Use	Equipment (autoclaves, etc.) is not in use. No UF_6 is present (i.e., for autoclaves, no cylinder is present, for piping, pressure is less than atmospheric).
7	Controlled Feeding	Sublimation of UF_6 from a cylinder under special heating limitations (maximum cylinder skin temperature #142.9°F and maximum cylinder UF_6 vapor pressure <22 psia). Various valve operations may occur for alarm investigation, jetting, cylinder burping, etc.
8	Cold Feeding	Sublimation of UF_6 from a cylinder without adding heat to the cylinder. The autoclave shell may be open or shut. Value XV-565 or XV-516 is closed if the autoclave is shut. Various valve operations may occur for alarm investigation, repair, etc.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.2 SAFETY LIMITS

2.2.2.1 AUTOCLAVE SHELL PRESSURE

SL 2.2.2.1: The autoclave shell pressure shall not exceed 220 psig.

APPLICABILITY: Modes: All

BASIS:

The autoclaves are designed and manufactured under ASME Boiler and Pressure Vessel code standards. As ASME pressure vessels, the autoclaves were hydrostatically tested at 150 percent of their 200 psig MAWP. The ASME code requires that the pressure transient during relief from this type of vessel not exceed 110% of MAWP. Thus, the safety limit is established at 220 psig (110% of MAWP). [SAR Sections 3.15.2.8; USQD 92-034]

2.2.2.2 UF_6 CYLINDER TEMPERATURE

SL 2.2.2.2: Cylinder temperature shall not exceed the values listed in the table below.

Cylinder Category	Temperature Safety Limit
A	250°F
B	245°F

APPLICABILITY: Modes: All

BASIS:

The only time that the potential exists for a UF_6 cylinder rupture is during the heating of the cylinder. During the heat-up cycle the UF_6 expands in volume. Ullage (or void volume) is lost due to heating a cylinder to an excessive temperature based upon the amount of UF_6 in the cylinder. A cylinder is assumed to fail at some point above its safety limit.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.2 SAFETY LIMITS

2.2.2.2 UF_6 CYLINDER TEMPERATURE (continued)

For Category A cylinders, the SL is established at 250°F. For Category B cylinders, the SL is established at 245°F. These safety limits are based on maintaining a minimum of 1% void volume at the safety limit temperature. The maximum autoclave temperature limited by the autoclave steam pressure control system LCS (LCS 2.2.3.3) is 235°F for Category A and 230°F for Category B cylinders. The limiting Category A or B cylinder, filled with high purity tails, has 3% void volume at the maximum autoclave temperature. When heated to the corresponding safety limit temperature, the limiting cylinder will still have at least 1% void volume.

These safety limits are above the 235°F design temperature of the "thin wall" cylinders. However, the design temperature is established only for the development of cylinder fill limits; it has no significance with respect to material strength.

The saturated steam pressures required to generate the safety limit cylinder temperatures are 12.5 psig and 15 psig for 245°F and 250°F respectively. [SAR Section 3.15.2.1, 4.3.2.2.2]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM

LCS 2.2.3.1: The autoclave high pressure isolation system actuation pressure shall not exceed 15 psig.

LCO 2.2.3.1: The autoclave containment shall be operable.

APPLICABILITY: Modes: 3, 4, 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel and/or one of two isolation valves on one or more isolable autoclave penetration inoperable.	A.1 Restore operability. NOTE: The current operating cycle may be completed, including transition between modes 2, 3, 4, and 5 or modes 2, 3, 4, and 7.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels and/or both isolation valves on any one autoclave penetration inoperable.	B.1 Place the autoclave in mode 2 or 3.	1 hour
C. Steam leakage from autoclave containment.	C.1 Place the autoclave in mode 2 or 3.	1 hour

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.3.1-1	Visually inspect the autoclave head to shell locking ring for steam leakage.	Upon initial entry to modes 5 or 7 for each operating cycle.
SR 2.2.3.1-2	Functional test of each detection/initiation channel. System must actuate at or below 15 psig. Containment valves must close within 15 seconds of pressure switch actuation.	Quarterly
SR 2.2.3.1-3	Autoclave pressure decay test. Starting with an autoclave pressurized with air to a minimum of 90 psig, the maximum acceptable pressure drop is 10 psi in 1 hour. **OR** Autoclave leakrate test. The maximum acceptable leakage shall not exceed 12 scfm at a minimum pressure of 90 psig. The pressure decay test or the leakrate test shall be conducted twice, with valve positions selected to test the following isolation barriers. The following barriers shall be exposed to the autoclave volume with outboard pressures that are controlled and/or monitored: Inner Barrier / Outer Barrier PSE-518-* XV-516-* / PSV-517-* XV-565-* XV-524-* / PV-525-* PV-520-* XV-532-* / CV-533-* XV-528-* / FV-529-* XV-503-* / CV-511-* CV-504-* CV-510-* XV-505-*	Quarterly
SR 2.2.3.1-4	Calibration of each detection/initiation channel.	Annually
SR 2.2.3.1-5	Visual inspection of autoclave shell and head.	Annually
SR 2.2.3.1-6	Functional test of the interlock preventing autoclave opening on high pressure.	Quarterly

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.1 AUTOCLAVE HIGH PRESSURE ISOLATION SYSTEM (continued)

BASIS:

A pressure as high as 15 psig is assumed to indicate that a UF_6 release has occurred within the autoclave. This system places the autoclave into the containment mode, thus minimizing an external release of UF_6 (the primary path for which is the condensate drain line). The accident analysis assumes a 15-second valve closure time to minimize the amount of UF_6 and reaction products allowed to leak to the environment through the condensate drain line. This action also minimizes the water available for reaction with UF_6 by isolating the steam supply and condensate drains. The autoclave shell, valves, and external piping out to the second isolation valve were credited in the "cylinder rupture inside an operating autoclave" scenario for containing the reaction products resulting from the release and its reaction with autoclave steam and water.
These controls ensure that the containment capability of the autoclave, as demonstrated by the pressure decay and/or leakrate test (SR 2.2.3.1-3), is not compromised. [SAR Section 3.15.2.1, 3.15.2.3, 4.3.2.2.2, 4.3.2.2.13, 4.3.2.2.14]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.2 AUTOCLAVE PRESSURE RELIEF SYSTEM

LCS 2.2.3.2: The actuation pressure of the autoclave pressure relief system shall not exceed 210 psig.

LCO 2.2.3.2: The autoclave pressure relief system shall be operable.

APPLICABILITY: Modes: 3, 4, 5, 7

ACTIONS:

Condition	Action	Completion Time
A. Pressure between the rupture disc and the relief valve greater than 5 psig.	A.1 Restore pressure to approximately atmospheric pressure. NOTE: The current operating cycle may be completed, including transition between modes 2, 3, 4, and 5 or modes 2, 3, 4, and 7.	Prior to starting a new operating cycle.
B. Autoclave pressure relief system inoperable.	B.1 Place the autoclave in mode 2 or 3.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.3.2-1	Replace the relief valve with a calibrated valve.	Annually
SR 2.2.3.2-2	Visually inspect the rupture disc for damage.	Annually
SR 2.2.3.2-3	Calibrate the pressure detection/indication channel that indicates the pressure between the rupture disc and relief valve.	Annually
SR 2.2.3.2-4	Verify that the block valve downstream from the relief devices is sealed open.	Annually

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.2 AUTOCLAVE PRESSURE RELIEF SYSTEM (continued)

BASIS:

This system prevents catastrophic failure of the autoclave, and subsequent uncontrolled UF_6 release, by allowing small (relative to the release associated with autoclave rupture), controlled releases in the unlikely event of concurrent UF_6 release and excessive autoclave water inventory.

The ASME Boiler and Pressure Vessel (B & PV) Code requires that overpressure relief be provided by a device stamped at or below the MAWP and sized such that the subsequent transient pressure will be limited to a maximum of 110% of MAWP when a single relief path is used. The ASME B & PV Code allows rupture discs to have a ± 5% burst tolerance. Rupture discs stamped at MAWP will therefore burst at or below 105% of MAWP. Thus, the LCS is set at 105% of MAWP. To comply with these standards, pressure relief devices are purchased and installed with stamped ratings at or below the MAWP. [SAR Section 3.15.2.8]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.3 AUTOCLAVE STEAM PRESSURE CONTROL SYSTEM

LCS 2.2.3.3: The actuation pressure of the autoclave steam pressure control system shall not exceed the values listed in the table below.

Cylinder Category	LCS
A	8 psig
B	6 psig

LCO 2.2.3.3: The autoclave steam pressure control system shall be operable.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable, or one steam inlet block valve inoperable.	A.1 Restore operability. NOTE: The existing operating cycle, including transitions between modes 2, 3, 4, and 5, may be completed.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels inoperable, or both steam inlet block valves inoperable, or the thermovent line isolation valve (XV-565-*) inoperable.	B.1 Place the autoclave in mode 2 or 3.	1 hour

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.2.3.3 AUTOCLAVE STEAM PRESSURE CONTROL SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.3.3-1	Functional test of each detection/initiation channel. System must activate and close the steam inlet block valves and the vent line isolation valve (XV-565-*) at a pressure at or below the current LCS pressure.	Quarterly
SR 2.2.3.3-2	Reset and functionally test the system trip setpoint to 6 psig or below.	Prior to entering mode 5 with a Category B cylinder (if only one is to be heated) or with the first Category B cylinder of a series of Category B cylinders to be heated.
SR 2.2.3.3-3	Calibrate the autoclave steam pressure control system detection/initiation instrumentation.	Annually

BASIS:

The accident analysis assumed an initial UF_6 cylinder temperature of 240 °F, but due to the design temperature limitations of the "thin wall" 48 G cylinder (-40 to 235 °F), the category A cylinder steam pressure is limited to 8 psig (235 °F). By limiting steam pressure to 8 or 6 psig and therefore steam temperature to 235°F or 230°F, this system provides an indirect means of controlling cylinder temperature below the stated safety limits. This in turn limits not only the UF_6 vapor pressure within the cylinder, but also the volume (density) of liquid UF_6, preventing loss of ullage and overpressurization.

The accident analysis assumes no valve closure time for this system. However, the functional test surveillance requirement associated with TSR 2.2.3.1 verifies valve closure times are within accident analysis assumptions for other accident scenarios on a quarterly basis. [SAR Section 3.15.2.1, 3.15.2.4, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.10, 4.3.2.2.13, 4.3.2.2.14, 4.3.2.2.15]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.1 UF_6 RELEASE DETECTION SYSTEM - AUTOCLAVE HEATED HOUSINGS, PIPING TRENCH, JET STATION, WEST WALL DETECTORS (C-337-A ONLY)

LCO 2.2.4.1: UF_6 release detection system shall be operable.

APPLICABILITY: Modes: 4, 5, 7, 8

ACTIONS:

Condition	Required Action	Completion Time
A. The UF_6 release detection system is inoperable.	A.1 Perform UF_6 smoke watch on area affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	Initiate within 1 hour and continuously thereafter until operability restored.
B. Action item A not satisfactorily accomplished.	B.1 Place the area affected by the outage in the following mode as applicable: mode 2 or 3 for autoclaves and mode 6 for piping.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.1-1	Test each UF_6 release detection head to verify it will detect "smoke."	Quarterly

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." This system detects the presence of this "smoke" and alarms in the local autoclave area, the OMR, and the associated ACR to alert operating personnel to initiate corrective/mitigative action. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. [SAR Sections 3.15.7.3 and 4.3.2.2.4]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.2 AUTOCLAVE WATER INVENTORY CONTROL SYSTEM

LCO 2.2.4.2: The autoclave water inventory control system shall be operable.

APPLICABILITY: Modes: 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable, or one steam inlet block valve inoperable.	A.1 Restore operability. NOTE: The current operating cycle may be completed, including transition between modes 2, 3, 4, and 5 or modes 2, 3, 4, and 7.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels inoperable.	B.1 Place the autoclave in mode 4 or 2.	1 hour
C. Both steam inlet block valves (XV-524 and PV-520) inoperable or the vent line block valve (XV-565-*) inoperable.	C.1 Place the autoclave in mode 2 or 3.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.2-1	Test the autoclave water inventory control system to verify that each detection/initiation channel will activate and close the steam inlet block valves (XV-524 and PV-520) and the vent line block valve (XV-565-*) upon detection of standing water in the condensate drain line to the level at or below the autoclave shell.	Quarterly

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.2 AUTOCLAVE WATER INVENTORY CONTROL SYSTEM (continued)

BASIS:

The autoclave water inventory control system limits the amount of water in the autoclave, which is the most effective method of limiting the maximum pressure generated from a large release of UF_6 inside an autoclave. The closure of the vent line block valve (XV-565) is required to prevent water/steam backflow to the autoclave from other autoclaves via the common vent header.

The autoclave water inventory control system also minimizes the possibility of water mixing with fissile uranium in amounts sufficient to cause a criticality incident in the autoclave in the event of a large UF_6 release into the autoclave.

The accident analysis assumes no valve closure time for this system. However, the functional test surveillance requirement associated with TSR 2.2.3.1 verifies valve closure times are within accident analysis assumptions for other accident scenarios on a quarterly basis. [SAR Section 3.15.2.5, 4.3.2.2.13, 4.3.2.2.14]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.3 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.2.4.3a: Criticality accident detection coverage shall be operable.

APPLICABILITY: In areas, equipment, or processes which contain greater than 700 grams of ^{235}U at an enrichment greater than or equal to 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. Areas, equipment, or processes not covered by criticality accident detection.	A.1 Implement the following for areas, equipment, or processes applicable to this LCO and that are not otherwise covered by criticality accident detection. A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Cylinder processing with UF_6 enriched to ≥ 1 wt % ^{235}U will be discontinued. [In-progress cylinder operating cycle(s) may be completed, stopped and/or re-started as necessary, as long as the in-progress autoclave(s) remain in mode 5, 7, or 8. However, these autoclaves may be placed in mode 2 at any time.] AND A.1.3 Discontinue movement of uranium enriched to ≥ 1 wt % ^{235}U.	Immediately
	AND A.2.1 Evacuate area within the area applicable to this LCO not covered by criticality accident detection. AND A.2.2 Restrict access to area evacuated in A.2.1.	Immediately
	AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification, such as a device that will alarm on sensing a 10 mr/hr dose rate.	Immediately
B. Areas, equipment, or processes not covered by criticality accident detection.	B.1.1 Restore criticality accident detection by installing portable CAAS unit providing required criticality accident detection and same alarms as fixed unit. OR B.1.2 Restore criticality accident detection to operable status. TSR 1.6.2.2d is not applicable.	Prior to reinitiating activities

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.3 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.3a-1	Calibrate CAAS system equipment.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. The design of the system, three detection modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the feed facilities are associated with movement of fissionable materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of detection will establish protection. [SAR Section 3.15.7.1, 4.3.2.6]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.3 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

LCO 2.2.4.3b: Criticality accident alarm shall be operable (audible).

APPLICABILITY: In areas where the maximum foreseeable absorbed dose in free air exceeds 12 rad, except areas in permit-required confined spaces and localized areas of inaudibility.

ACTIONS:

Condition	Required Action	Completion Time
A. Area does not have an audible criticality accident alarm.	A.1 Implement the following for areas, equipment, or processes where a criticality accident could result in a maximum foreseeable dose exceeding 12 rad in the area of inaudibility and LCO 2.2.4.3a or 2.4.4.2a applies. A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Cylinder processing with UF_6 enriched to ≥ 1 wt % ^{235}U will be discontinued. [In-progress cylinder operating cycle(s) may be completed, stopped and/or re-started as necessary, as long as the in-progress autoclave(s) remain in mode 5, 7, or 8. However, these autoclaves may be placed in mode 2 at any time.] AND A.1.3 Perform Required Actions A.1.1 through A.1.6 of TSR 2.4.4.2b. AND A.1.4 Discontinue movement of uranium enriched to ≥ 1 wt % ^{235}U.	Immediately
	AND A.2.1 Evacuate area of inaudibility applicable to this LCO. AND A.2.2 Restrict access to area evacuated in A.2.1.	Immediately
	AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification, such as a device that will alarm on sensing a 10 mr/hr dose rate, or a radio in constant communication with the Central Control Facility.	Immediately
B. Area does not have an audible criticality accident alarm.	B.1 Restore criticality accident alarm to operable status. TSR 1.6.2.2d is not applicable.	Prior to reinitiating activities

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.3 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.3b-1	Test the CAAS and building horns.	Annually
SR 2.2.4.3b-2	Verify that the CAAS air accumulator supply pressure to the building horns is greater than or equal to that necessary to sound all building horns for at least 120 seconds based on the number of accumulators in service. (Note: The air accumulator supply for C-333-A is in C-333 and the supply for C-337-A is in C-337.) Number of accumulators in service — Minimum pressure 4 — 137 psig 3 — 143 psig	Quarterly

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. Audibility is not provided for areas in permit-required confined spaces and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate. One person remains outside the area and maintains contact with personnel in the area. Evacuation of the area of inaudibility and restricting access to those areas will eliminate the potential for increased consequences due to personnel not hearing an alarm. The design of the system, three detection modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the feed facilities are associated with movement of fissionable materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of alarms will establish protection.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.3 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

BASIS (continued):

The CAAS air accumulators provide for 120 seconds of horn actuation when at their minimum acceptable pressure based on the number of accumulators in service. The air accumulator supply for C-333-A is in C-333 and the supply for C-337-A is in C-337.

The annual surveillance of the CAAS building horns consists of placing the cluster in the test mode with a keyswitch, and manually causing two detector modules to generate radiation readings above the alarm setpoint. The cluster electronics determines that this meets the high radiation alarm criteria and propagates a high radiation alarm signal to the rest of the system. This signal activates the high radiation alarm light and bell in C-300 and activates the building CAAS horns. Each horn is qualitatively verified to be operating. This test is a horn functional test and each module combination is tested to generate the high radiation signal. [SAR Section 3.15.7.1, 4.3.2.6, 5.2.2.5]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.4 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT

LCO 2.2.4.4: Except as allowed by TSR 2.2.4.5, cylinder accountability (net) weight shall be verified less than or equal to the "Max. Fill Limit for Shipment" for cylinders other than tails cylinders and "Max. Fill Limit for In-Plant Tails Storage" for tails cylinders stated in TSR Section 2.2, Appendix A prior to heating the cylinder.

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. Accountability weight exceeds the Maximum Fill Limit for Shipment for cylinders other than tails cylinders, or the Maximum Fill Limit for In Plant Tails Storage for tails cylinders.	A.1 Calculate the cylinder void volume (ullage) at a temperature of 230°F and/or 235°F. Use the stamped water weight as the basis of the actual volume of cylinders with certified volumes. Determine the category of the cylinder based on the following criteria: Cat. A Void volume ≥5% at 235°F or Void volume ≥3% at 235°F for cylinders filled with high purity tails Cat. B Void volume ≥5% at 230°F or Void volume ≥3% at 230°F for cylinders filled with high purity tails Cat. C Void volume <5% at 230°F or Void volume <3% at 230°F for cylinders filled with high purity tails AND A.2.1 Set the Autoclave Steam Pressure Control System setpoint consistent with the cylinder category per TSR 2.2.3.3 for a Category A or B cylinder. OR A.2.2 Administratively control the Category C cylinder to prevent heating in mode 5. NOTE: Category C cylinders may be processed using Mode 7 or Mode 8. TSR 1.6.2.2(d) is not applicable.	Prior to entering mode 5

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.4 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.4-1	Verify cylinder accountability (net) weight is less than or equal to the "Max. Fill Limit for Shipment" for cylinders other than tails cylinders and "Max. Fill Limit for In-Plant Tails Storage" for tails cylinders stated in TSR Section 2.2, Appendix A.	Prior to the first entry into Mode 5 of each operating cycle.

BASIS:

The thermal expansion coefficient of liquid UF_6 is such that the density of the liquid decreases dramatically as the liquid temperature increases. This difference in liquid density could allow more UF_6 to be drained into a cylinder at fill temperatures (typically 160°F) than can fit in the cylinder once it is heated to liquefaction temperature (typically 220°F). As an example, 22,870 lb of liquid UF_6 placed in a 10-ton product cylinder (fill limit = 21,030 lb) at normal cylinder fill temperature would occupy only 102.1 ft^3 of the available 108.9 ft^3. However, when that same cylinder is heated to normal liquefaction temperature, the liquid UF_6 would completely fill the cylinder and could potentially cause hydraulic pressures to develop inside the cylinder.

However, cylinders filled slightly beyond their standard fill limit can still be safely liquefied provided 5% ullage (3% for high-purity tails) is maintained. The standard fill limits (Appendix A) are based upon the cylinder's minimum volume and its design temperature. Thus, it may be the case that (accounting for the cylinder's actual volume determined from the water capacity stamped on its nameplate) liquefaction at some temperature equal to or less than the cylinder's design temperature may be achieved while still providing the required ullage for safety. [USEC-651, Revision 7, Section 10] The calculations of required action A.1 may conclude that the cylinder, based upon its actual volume, has sufficient void volume to permit heating to 235°F. In those cases, required action A.2 would have the Autoclave Steam Pressure Control system setpoint changed to 8 psig (235°F) which is the normal setpoint for this system (see TSR 2.2.3.3). Required Action A.2 becomes unnecessary in these cases provided the surveillance requirements associated with TSR 2.2.3.3 are current. [USEC-651, Revision 7]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.4 CYLINDER HEATING - CYLINDER ACCOUNTABILITY WEIGHT (continued)

BASIS (continued):

The minimum autoclave temperature/pressure setpoint established in A.2.1 assures that the nominal autoclave temperature will not fall below 220°F and nominal pressure will remain above 2.5 psig. These values are the actual equipment operating conditions; instrument uncertainty, drift etc. are not to be applied to these values. [SAR Section 4.3.2.2.6]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.5 CYLINDER HEATING - HEATING LIMITATIONS FOR CERTAIN CYLINDERS WITHOUT CERTIFIED VOLUMES

LCO 2.2.4.5: Heating of the cylinders listed in the table below shall be governed by the limiting conditions specified in the table.

Cylinder Type	Cylinder Serial/Identification Numbers	Limiting Conditions
48 T	5001 - 9230	Do not heat.
48 O	10000 - 16601	Do not heat.
48 OM	16602 - 18801	Verify that the calculated volume of the cylinder, based on measured dimensions, is greater than 135 ft^3 and fill weight of UF_6 is less than 26,000 pounds.
48 OM	100001 - 111820	Verify that the calculated volume of the cylinder, based on measured dimensions, is greater than 135 ft^3 and fill weight of UF_6 is less than 26,000 pounds.
30 A	Concave Hd	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 25.65 ft^3 and fill weight of UF_6 is less than 4939 pounds.
48 A	1 – 1000 3001 - 3365	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 108.9 ft^3 and fill weight of UF_6 is less than 20, 973 pounds.
48 F	9501 – 9530 9601-9660	Verify that the calculated volume of the cylinder, based on measured dimensions is greater than 140 ft^3 and fill weight of UF_6 is less than 26, 963 pounds.
48 OM Allied	AC0001 – AC0400	Verify that the calculated volume of the cylinder, based on measured cylinder dimensions and UF_6 net weight provides greater than 7% ullage when heated to 235°F.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

APPLICABILITY: Modes: 5

ACTIONS:

Condition	Required Action	Completion Time
A. 48T or 48O cylinder listed in table above selected for heating or 30A, 48A, 48F, or 48OM cylinder listed in table above selected for heating does not meet the volume or weight requirements specified.	A.1 Administratively control the category C cylinder to prevent heating in Mode 5. NOTE: Category C cylinders may be processed using Mode 7 or 8.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Certain serial number ranges of model 48T and 48O cylinders lack a certified volume and certain 48OM cylinders may not meet the volume or weight requirements specified. The mechanism by which these cylinders will be emptied is by controlled/cold feeding, whereby the material is sublimed out of the cylinder at temperatures below the UF_6 triple point.

Certain serial number ranges for 30A, 48A and 48F cylinders also lack certified volumes, but can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Calculations have shown that 30A, 48A, and 48F cylinders respectively containing less than 4950, 21,030 and 27,030 lbs. and which have a volume greater than 25.65, 108.9 and 140 ft^3 (the values listed in ANSI-N14.1 as the minimum volume for this cylinder class) will contain in excess of 7% ullage when heated 235°F. Because these cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show the actual volume of the cylinder exceeds the established minimum volume specified above. The 7% ullage assured by the limits of this TSR provides a greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.1.4.6 in order to account for the fact that measured volumes are being used rather than a certified volume.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

Certain serial number ranges for 48 OM cylinders also lack certified volumes but can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Calculations have shown that 48 OM cylinders containing less than 26,000 lbs and which have a volume greater than 135 ft^3 (the value listed in ANSI-N14.1 as the minimum volume for this cylinder class) will contain in excess of 7% ullage when heated to 235°F. Because these cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show the actual volume of the cylinder exceeds 135 ft^3. The 7% ullage assured by the limits of this TSR provides a greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.2.4.4 in order to account for the fact that measured volumes are being used rather than a certified volume.

There is another type of 48 OM cylinders manufactured before ANSI-N14.1 was initially issued in 1971 that also lack certified volumes. These cylinders can be safely liquefied provided there is sufficient margin to hydraulic rupture provided by the ullage in the cylinder. Specifications for the 48 OM Allied cylinders were not included in the ANSI standard until 1987 and required a minimum volume of 140 ft^3. The 48 OM Allied cylinders with serial numbers AC0001 through AC0400 do not meet the 140 ft^3 minimum volume specified in ANSI-N14.1. Measurements and calculations have shown the 48 OM Allied cylinders with serial numbers AC0001 through AC0400 have cylinder volumes that generally range between 137.06 to 139.37 ft^3. Because the cylinders lack a certified volume, established by the manufacturer at the time of construction, the dimensions of each cylinder to be heated must be measured and these dimensions used in a calculation to show actual volume. Using the UF_6 net weight, the calculated cylinder volume, and UF_6 heated to 235°F the actual cylinder ullage is determined. The 7% ullage assured by the limits of this TSR provides greater margin to hydraulic rupture than the 5% and 3% ullage required by TSR 2.1.4.6 in order to account for the fact that measured volumes are being used rather than a certified volume

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.6 CYLINDER HEATING - CYLINDER PRE-HEAT INSPECTION

LCO 2.2.4.6: UF_6 cylinders shall pass cylinder pre-heat inspection.

APPLICABILITY: Modes: 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder fails pre-heat visual inspection.	A.1 Repair/refurbish and test (if necessary) the cylinder in accordance with SAR Section 3.7.1 and SAR Figure 3.7-1. OR A.2. Designate subject cylinder as Category C cylinder.	Prior to entering mode 5 or 7 with the subject cylinder. Prior to entering mode 7 or 8 with the subject cylinder.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.2.4.6-1 Cylinder visual inspection for damage.	Prior to initial entry into mode 5 or 7 of each operating cycle.

BASIS:

Depending upon the degree of damage (detected during the pre-use inspection), a cylinder may or may not be capable of withstanding its hydropressure. A UF_6 cylinder is removed from service for repair or replacement when it has leaks, excessive corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that, in the judgement of the inspector, renders it unsafe or unserviceable. Some types of cylinder damage and/or deformities are acceptable as-is or after repair.

If a cylinder does not pass inspection, an evaluation by qualified personnel (in accordance with SAR 3.7.1) is required before the cylinder is placed back into service. This evaluation will determine if the cylinder can be emptied by heating in the mode 5 as a Category A or B cylinder, emptied by heating in the controlled feed mode 7 as a Category C cylinder, or emptied in the cold feed mode 8 and not heated at all. The evaluation may also require some repair/refurbishment and testing prior to returning the cylinder to service. Cylinders that meet the requirements for Category A or B cylinders may be fed in the controlled feed mode 7 or cold feed mode 8.

Category C cylinders, which are not acceptable for heating to a liquid state in Mode 5, can be emptied by controlled feeding or cold feeding; whereby the material is sublimed out of the cylinder at temperatures below the UF_6 triple point for controlled feeding and at ambient temperature for cold feeding. Category C cylinders must also satisfactorily pass TSR 2.2.4.7 surveillance requirement SR 2.2.4.7-1 (cylinder cold pressure check) before they can be heated in the controlled feeding mode. Passing the cylinder cold pressure check provides confidence that the cylinder integrity is adequate for limited heating that occurs during controlled feeding. A Category C cylinder that does not meet the cold pressure check can be fed using the cold feeding mode. [SAR 4.3.2.2.9, 4.3.2.2.14]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.7 CYLINDER HEATING - CYLINDER COLD PRESSURE

LCO 2.2.4.7: The cylinder cold pressure shall be less than or equal to 10 psia.

APPLICABILITY: Modes: 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder cold pressure is greater than 10 psia.	A.1 "Cold burp" (or evacuate) cylinder to establish cold pressure less than or equal to 10 psia.	Prior to entering mode 5 or 7 with the subject cylinder.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.7-1	Determine cylinder cold pressure.	Prior to entering mode 5 or 7 with the subject cylinder.
SR 2.2.4.7-2	Calibrate the pressure detection/indication channel used to determine cylinder pressure.	Annually

BASIS:

The cylinder cold pressure check gives a mechanism to detect the presence of excessive amounts of gaseous impurities in the cylinder. Cylinders with cold pressures of 10 psia, when heated to 235°F, could have a pressure as high as 130 psig (well below the cylinders' hydrostatic test pressure). The pressure is due to increased UF_6 vapor pressure and the shrinking available volume for and the temperature increase of the gaseous impurities. The actual cylinder pressure would be lower, however, since some of the typical impurities are soluble in liquid UF_6.

Category C cylinders, which are not acceptable for heating to a liquid state in Mode 5, can be emptied by controlled feeding or cold feeding; whereby the material is sublimed out of the cylinder at temperatures below the UF_6 triple point for controlled feeding and at ambient temperature for cold feeding. Category C cylinders must also satisfactorily pass TSR 2.2.4.7 surveillance requirement SR 2.2.4.7-1 (cylinder cold pressure check) before they can be heated in the controlled feeding mode. Passing the cylinder cold pressure check provides confidence that the cylinder integrity is adequate for limited heating that occurs during controlled feeding. A Category C cylinder that does not meet the cold pressure check can be fed using the cold feeding mode. Cylinders that are to be fed with the cold feeding mode do not have to have a cold pressure check. [SAR Section 4.3.2.2.7, 4.3.2.2.14]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.8 CYLINDER HANDLING - CYLINDER DISCONNECTION

LCO 2.2.4.8: The cylinder valve shall be closed prior to disconnecting the cylinder from the pigtail.

APPLICABILITY: Modes: 2

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve cannot be closed.	A.1 Establish cylinder pressure below atmospheric pressure AND A.2 Cap the open connections.	Prior to disconnecting either end of the pigtail. After disconnecting either end of the pigtail.

SURVEILLANCE REQUIREMENTS: None

BASIS:

Closing the cylinder valve prior to disconnecting the cylinder from the manifold prevents UF_6 release from an open source. On rare occasions, it is discovered that the cylinder valve, for one reason or another, cannot be closed and seated as evidenced by the pigtail pressure rising after evacuation. In those instances, the safest course of action is to allow the cylinder to cool below atmosphere, disconnect the cylinder from the manifold, and cap the open connections to minimize UF_6 outleakage.

The cylinder pressure indication channel is calibrated in SR 2.2.4.7-2.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.9 HEATING UF_6 PLUGS

LCO 2.2.4.9: Direct heat sources shall not be applied to UF_6 plugs until flow clarity in the system has been assured.

APPLICABILITY: At all times

ACTIONS:

Condition	Required Action	Completion Time
A. Direct heat source applied to a UF_6 plug.	A.1 Discontinue heating the plug.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Application of external heat to the middle portion of the plug can melt the solid and develop large hydraulic forces in the pipe and ends of the plug, creating the potential for a UF_6 release due to pipe rupture.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.10 CYLINDER HEATING - VALVE CLARITY

LCO 2.2.4.10: Cylinder valve clarity shall be demonstrated prior to initial heating of a cylinder.

APPLICABILITY: Modes: 4, 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve clarity cannot be demonstrated prior to initial heating.	A.1 Do not heat cylinder.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The demonstration of cylinder valve clarity assures an open pathway between the cylinder void volume and the feed manifold. The open pathway assures that cylinder heating will not cause an unrelieved pressure buildup. In conjunction with other operating controls on cylinder inventory and heating, this requirement significantly reduces the possibility of cylinder rupture. The methodology and criteria for demonstrating valve clarity are maintained in procedures.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.11 CYLINDER HEATING - VALVE CLARITY/HEATING CYCLE INTERRUPTIONS

LCO 2.2.4.11: During the operating (feeding and heeling) cycle, cylinder valve clarity shall be demonstrated immediately prior to heating a cylinder following heating interruptions.

APPLICABILITY: Modes: 4, 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve clarity cannot be demonstrated prior to heating following heating interruption.	A.1 Terminate operating cycle. Do not heat cylinder until valve clarity is established.	Immediately

SURVEILLANCE REQUIREMENTS: None

BASIS:

The demonstration of cylinder valve clarity assures an open pathway between the cylinder void and the autoclave UF_6 manifold. The open pathway assures that cylinder heating will not cause an unrelieved pressure buildup. In conjunction with other operating controls on cylinder inventory and heating, this requirement reduces the possibility of cylinder rupture. The methodology and criteria for demonstrating valve clarity are maintained in procedures.

Following an interrupted cylinder heating cycle, it is possible to have liquid UF_6 present inside the cylinder. Therefore, following the demonstration of valve clarity, heating of the cylinder must resume promptly to ensure that the liquid UF_6 does not solidify on the cylinder valve. Re-solidification of the UF_6 could eliminate the pathway between the cylinder void and the autoclave UF_6 manifold.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.11 CYLINDER HEATING - VALVE CLARITY/HEATING CYCLE INTERRUPTIONS (continued)

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.12 SCALES

LCO 2.2.4.12: The feed facility scale(s) used for verification of cylinder weight per LCO 2.2.4.4 and 2.1.4.6 shall be operable.

APPLICABILITY: Whenever the feed facility scale(s) is/are used for verification of cylinder weight.

ACTIONS:

Condition	Required Action	Completion Time
A. Scale discovered to be inoperable	A.1 Administratively control scale to prevent use.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.12-1	Calibrate NMC&A scale ID 19 (C-333-A) and 21 (C-337-A), to an adequate range and tolerance for the item being weighed, in accordance with NMC&A program requirements.	Annually
SR 2.2.4.12-2	Performs functional test of NMC&A scale ID 19 (C-333-A) and 21 (C-337-A) (i.e., check operation using test weights in accordance with NMC&A program requirements).	Daily

BASIS:

All cylinder weights are assumed to be within the tolerances assumed in the accident analysis. The calibration and testing of the scales to within the tolerances specified in the NMC&A program (which are much more stringent than the tolerances required by the accident analysis) assured that cylinder weights do not invalidate the accident analysis. [SAR Section 3.15.6.4, 4.3.2.2.6, 4.3.2.2.14]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.13 AUTOCLAVE MANUAL ISOLATION SYSTEM

LCO 2.2.4.13: The autoclave manual isolation system actuation devices shall be operable.

APPLICABILITY: Modes: 4, 5, 7, 8

ACTIONS:

Condition	Required Action	Completion Time
A. The actuation device located in the OMR is inoperable.	A.1 Position an operator such that the "see-and-flee" path provides access to the actuation device located at the cylinder yard crane bay exit. TSR 1.6.2.2d is not applicable.	4 hours
B. The actuation device located at the cylinder yard crane bay exit is inoperable.	B.1 Provide continuous stationing of an operator in the OMR. TSR 1.6.2.2d is not applicable.	4 hours
C. Both feed facility actuation devices inoperable.	C.1 Restore operability to at least one actuating device. TSR 1.6.2.2d is not applicable.	4 hours
D. Required action C not satisfactorily accomplished.	D.1 Place the autoclave in mode 2. OR D.2 Close containment valves XV-503, CV-504, XV-505, CV-511 and CV-510 on each autoclave. OR D.3.1 Establish radio communication with the associated Area Control Room in order to ensure immediate capability to actuate the Autoclave Manual Isolation System from the ACR in the event of a release. AND D.3.2 Restore operability of the Autoclave Manual Isolation System. TSR 1.6.2.2d is not applicable.	Immediately Immediately Immediately 72 hours
E. The actuation device located in the associated ACR is inoperable.	E.1 Ensure both actuation devices in appropriate feed facility are operable or appropriate required action A or B completed. AND E.2 Restore operability to ACR actuation device. TSR 1.6.2.2d is not applicable.	Immediately 30 days

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.13 AUTOCLAVE MANUAL ISOLATION SYSTEM

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.13-1	Perform functional test of the system actuation devices.	Annually

BASIS:

The autoclave manual isolation system provides the means to remotely isolate all facility autoclaves in the event of a UF_6 release from a line outside the autoclave containment boundary. The system consists of two (within the feed facilities) actuation devices located in the OMR and at the cylinder yard crane bay exit (the most likely point of egress from the autoclave area), and one remotely located actuation device in the associated cascade building ACR. Actuating the system will initiate closure of all containment valves for each of the autoclaves within the affected facility. In the event of a UF_6 release from a line outside the autoclave containment boundary, the operator, while exiting the facility in accordance with the "see-and-flee" policy, would actuate the system to isolate the release point from the UF_6 source and limit the amount of material released. Closure of valves XV-503, CV-504, XV-505, CV-511, and CV-510 isolate a cylinder within an autoclave from piping outside the containment boundary thereby eliminating the source of UF_6 available for release.

The autoclave manual isolation system closes the same containment valves as those described in TSR 2.2.3.1 for the autoclave high pressure isolation system. Therefore, the operability and surveillance requirements for these valves are included in Section 2.2.3.1. TSR surveillance 2.2.4.13-1 is not required to include the actual closure of all of the containment valves on all autoclaves simultaneously. Testing of all autoclaves in a facility will verify operability of the manual isolation system. Containment valve closure is verified quarterly by the performance of the TSR surveillance requirement 2.2.3.1-2.

If condition D is entered and action D.3 is selected from among the three options, the 72 hour time limitation for completing action D.3.2 provides a limit for how long the AMIS may be out of service under Condition D. If Required Action D.3.2 can not be satisfactorily accomplished within the 72 hour time limit, then Required Action D.1 or D.2 shall be taken immediately upon expiration of the 72 hour time period. [Note: Required Action D.1 or D.2 may be taken immediately upon entering Condition D, or any time thereafter to satisfy the required action for Condition D.] [SAR Sections 3.15.2.2, 4.3.2.2.4, and 4.3.2.2.10]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.14 HIGH CYLINDER PRESSURE SYSTEM

LCO 2.2.4.14: The high cylinder pressure system shall be operable.

APPLICABILITY: Modes 5, 7

ACTIONS:

Condition	Required Action	Completion Time
A. One of two steam isolation valves inoperable.	A.1 Restore isolation valve to operable status. NOTE: The current operating cycle may be completed.	Prior to initiating a new operating cycle.
B. High cylinder pressure system detection-initiation channel inoperable (excluding feeding or heeling).	B.1 Place autoclave in Mode 2, 3, or 4.	1 hour
C. High cylinder pressure system detection-initiation channel inoperable (feeding or heeling only).	C.1 Restore operability. NOTE: The current operating cycle may be completed.	Prior to initiating a new operating cycle.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.14-1	Perform a functional test to verify the autoclave steam supply block valves will close when cylinder pressure exceeds the actuation pressure.	Quarterly
SR 2.2.4.14-2	Perform calibration of the high cylinder pressure system detection-initiation channel. System must actuate at or below 115 psia cylinder pressure for mode 5. System must actuate below 22 psia cylinder pressure for mode 7.	Annually

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.14 HIGH CYLINDER PRESSURE SYSTEM (continued)

BASIS:

The high cylinder pressure system is required to minimize the potential of primary system integrity failures during pressure increase events by tripping the steam supply when the MAWP of the cylinder being heated is reached. The 115 psia actuation pressure for heating Category A and B cylinders is based on the lowest MAWP of these cylinders and the below 22 psia actuation pressure for heating Category C cylinders is based on maintaining integrity of a cylinder containing solid/gaseous UF_6 (pressure below triple point). This system is a single channel system and is capable of performing its safety function independent of support systems. The heating of a UF_6 cylinder containing an excessive amount of light gases at normal heating temperatures could result in the internal cylinder pressure exceeding the hydrostatic test pressure and possibly create a UF_6 release in the autoclave.

In addition, in the event an over filled cylinder is heated in the autoclave the high cylinder pressure caused by the reduced void volume may be sufficient to exceed the actuation value and thereby stop the cylinder heating and prevent a possible rupture of the cylinder.

Prior to the controlled feeding (Mode 7) of a Category C cylinder, the normal feed/controlled feed selector switch must be placed in the “Controlled Feed” position to lower actuation pressure to assure that the UF6 does not liquefy.

The accident analysis assumes no valve closure time for this system. However, the functional test surveillance requirement associated with TSR 2.2.3.1 verifies valve closure times are within accident analysis assumptions for other accident scenarios on a quarterly basis. [SAR Sections 3.15.2.6, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9].

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.2.4.15 AUTOCLAVE TEMPERATURE CONTROL SYSTEM

LCO 2.2.4.15: The autoclave temperature control system shall be operable

APPLICABILITY: Mode 7

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable, or one steam inlet block valve inoperable.	A.1 Restore Operability. NOTE: The current operating cycle may be completed.	Prior to initiating a new operating cycle.
B. Both detection/initiation channels inoperable, or both steam inlet block valves inoperable, or the outboard thermovent line isolation valve (XV-565-*) is inoperable.	B.1 Place autoclave in Mode 2, 3, or 4.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.4.15-1	Perform a functional test to verify the autoclave steam supply block valves and the outboard thermovent line isolation valve will close within 15 seconds when the cylinder surface temperature exceeds the actuation temperature.	Quarterly
SR 2.2.4.15-2	Perform calibration of each autoclave temperature control system detection-initiation channel. System must actuate at or below 142.9°F.	Annually

BASIS:

The accident analysis assumed that the UF_6 cylinder temperature would remain below the UF_6 triple point temperature during the controlled feeding mode to ensure UF_6 within the cylinder does not liquefy. By limiting the cylinder surface temperature to 142.9°F or less, the contents will remain in a solid state with UF_6 vapor pressure in the cylinder less than 22 psia. Only cylinders that can successfully pass the cold pressure check (TSR 2.2.4.7 SR 2.2.4.7-1) can be heated in the controlled feeding mode. Passing the cold pressure check provides sufficient confidence that the cylinder integrity is adequate to withstand the low pressures that the cylinder will experience resulting from the limited heating that occurs during controlled feeding. Closure time testing for the steam supply isolation valves and outboard thermovent line isolation valve is accomplished under the surveillance requirements of TSR 2.2.3.1. Category C cylinders that do not pass the cylinder cold pressure check required by TSR 2.2.4.7 SR 2.2.4.7-1 can be fed using the cold feed mode of operation. [SAR 3.15.2.10, 4.3.2.2.2]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.5 GENERAL DESIGN FEATURES

2.2.5.1 UF_6 CYLINDER SLINGS AND LIFTING FIXTURES

DF 2.2.5.1: UF_6 cylinder slings and lifting fixtures are designed with a structural factor of safety of 5 to 1 based upon the material's ultimate tensile strength.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.2.5.1-1 Visual inspection for defects	Prior to first use of shift
SR 2.2.5.1-2 Hands-on Inspection (no disassembly required)	Monthly
SR 2.2.5.1-3 Load test at a minimum of 100% of rated capacity.	Biennially

BASIS:

Slings, H-frames, etc used to handle liquid filled UF_6 cylinders are credited for prevention of the liquid cylinder drop and rupture accident scenario. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1 and 2 are performed to meet the requirements of OSHA 1910.184. [SAR Sections 3.15.6.2 and 4.3.2.2.15]

2.2.5.2 CRANE DESIGN

DF 2.2.5.2: The UF_6 cylinder handling cranes are designed and maintained not to fail in a manner to cause primary system integrity failure.

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A

2.2.5 GENERAL DESIGN FEATURES

2.2.5.2 CRANE DESIGN (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.2.5.2-1	Visual inspection for defects	Prior to first use of shift
SR 2.2.5.2-2	Hands-on Inspection (no disassembly required)	Monthly
SR 2.2.5.2-3	Hands-on Inspection (some disassembly required)	Annually
SR 2.2.5.2-4	Load test at rated capacity and verify that the cranes do not allow a load to move (except compensatory movements) upon operator release of the controls.	Biennially

BASIS:

Cranes used to handle UF_6 cylinders are credited for prevention of dropping a cylinder on a liquid filled cylinder. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1, 2, and 3 are performed to meet the requirements of OSHA 1910.179. [SAR Sections 3.15.6.2, 4.3.2.2.4, 4.3.2.2.10, 4.3.2.2.15, 4.3.2.5.2, and 4.3.2.5.3]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.5 GENERAL DESIGN FEATURES

2.2.5.3 UF_6 CYLINDERS

DF 2.2.5.3: UF_6 cylinders (2½-ton and larger) are as a minimum designed to a MAWP of 100 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.2.5.3-1 UF_6 cylinders (2½-ton and larger) shall be hydrostatically tested at 200% of MAWP. Note: Cylinders that are full of UF_6 but have an expired hydrostatic test may be heated for removal of the UF_6, but shall be hydrostatically tested prior to refilling.	5 years

BASIS:

UF_6 cylinder MAWP equal to or greater than 100 psig is an assumption used in several accident analysis scenarios. [SAR Sections 3.15.6.1, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9, 4.3.2.2.10, 4.3.2.5.2, and 4.3.2.5.3]

2.2.5.4 UF_6 CYLINDER PIGTAILS

DF 2.2.5.4: Pigtails are designed to withstand at least 400 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.2.5.4-1 Pigtails shall receive a post fabrication inspection and hydrostatic test to at least 400 psig.	Prior to initial use.

BASIS:

This design feature helps minimize the possibility of the initiator of the “pigtail failure” accident scenario (inside or outside an autoclave). [SAR Sections 3.15.6.1, 4.3.2.2.2, 4.3.2.2.4, 4.3.2.2.6, 4.3.2.2.7, 4.3.2.2.9, 4.3.2.2.10]

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

2.2.5 GENERAL DESIGN FEATURES

2.2.5.5 C-337-A JET STATION BARRIER FRAME

DF 2.2.5.5: The jet station barrier frame in C-337-A is designed to prevent a horizontal impact from a crane-carried load from resulting in UF_6 primary system failure in the C-337-A jet station piping.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.2.5.5-1 The jet station barrier frame in C-337-A shall be inspected for structural defects.	5 years

BASIS:

The structural design characteristics of the C-337-A jet station barrier frame prevent a horizontal impact from a crane-carried load from causing a UF_6 primary system integrity failure in the C-337-A jet station piping. Analysis of the frame structure determined that a cylinder/barrier frame collision for fast speed conditions could cause the barrier frame to permanently deform, but in all analyzed collision scenarios the frame would not collapse or contact the UF_6 primary sytems piping [SAR Sections 3.15.2.9 and 4.3.2.2.10].

SECTION 2.2 SPECIFIC TSRs FOR UF_6 FEED FACILITIES (C-333-A AND C-337-A)

TSR 2.2 Appendix A
Maximum weight limits for UF_6 cylinders.

Model No.	Cylinder Nos. or Type	Max. Fill Limit for Shipment[1] (lbs UF_6)	Max. Fill Limit for In-Plant Tails Storage[2] (lbs UF_6)
12B	All	460	475
	Text Deleted		
30B	All	5020	—
	Text Deleted		
	Text Deleted		
	Text Deleted		
	Text Deleted		
	Text Deleted		
48G	121,926 - 149,999	26840	27920[3]
48G	160,000 and up	26840	27920[3]
48H	151,001- 154,144	27030	28000
48HX	150,001-151,000	27030	28000
48Y	All	27560	28000
48OM	111,821-121,925	26840	27920[3]
	Text Deleted		
48X	All	21030	21870

1. All fill limits for shipments are based on 5% free volume, 99.5% purity, and a maximum vaporization temperature of 250°F per USEC-651.
2. Fill limits for in-plant tails storage cylinders are based on 3% free volume and a maximum vaporization temperature of 235°F except for 48Y, 48HX, and 48H cylinders whose in-plant tails storage limits have been further reduced to ensure the maximum amount of UF_6 assumed in the accident analysis (28,000 lbs) is not exceeded.
3. The maximum fill limit for in-plant tails storage for the 48OM and 48G cylinders may be increased to the maximum of 28,000 lbs provided the cylinder will maintain a minimum 3 percent free volume when heated to 235°F based on the actual certified cylinder volume. Cylinders with 8,695-lb water capacity or greater may be filled with 28,000 lbs of high purity UF_6 tails and maintain a minimum 3 percent free volume when heated to 235°F.

Text Deleted

SECTION 2.3

SPECIFIC TSRs
FOR
PRODUCT AND TAILS WITHDRAWAL FACILITIES

(C-310 DOWNSTREAM OF NORMETEX PUMP SUCTION AND C-315)

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.1 OPERATIONAL MODES:

Mode Number	Mode Name	Definition
1	Cylinder Preparation or Removal	Movement of UF_6 cylinders to be filled (with crane and scale cart) installation at the withdrawal position, connection of the pigtail, and other activities required prior to draining UF_6 into the cylinder. Disconnection of the pigtail, UF_6 cylinder removal/ movements, and other activities required after draining UF_6 into the cylinder is complete. Starts when cylinder filling is complete and the liquid UF_6 sources are isolated (cylinder valve is closed and one or more of the following valves is closed: liquid block, emergency liquid block, other upstream valve).
2	Withdrawal	UF_6 product or tails is being removed from the enrichment cascade, compressed, condensed, and drained into UF_6 cylinders. Withdrawal system components in this mode may also be running off stream in preparation for or following withdrawal. Due to the nature of the withdrawal system layout, this consists of all or a portion of the following operations: <u>Compression Source</u> UF_6 withdrawal pumps are compressing the UF_6 gas from the enrichment cascade and pumping it to an on-stream UF_6 condenser. <u>Condenser and Accumulator</u> UF_6 condenser is cooling the compressed UF_6 gas to form liquid UF_6 and directing it to the on-stream UF_6 accumulator(s) and/or UF_6 cylinder. UF_6 accumulator is on-stream and may or may not contain liquid UF_6 that is draining or ready to drain to a receiving UF_6 cylinder in the withdrawal room. <u>Withdrawal Station</u> The receiving cylinder is filling with liquid UF_6. Starts when liquid UF_6 is valved to the cylinder and ends when the UF_6 condenser is isolated from the drain manifold and the cylinder valve is closed.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.1 OPERATIONAL MODES (continued):

Mode Number	Mode Name	Definition
3	Standby	Withdrawal system components in standby are idle off-stream, and may or may not contain UF_6. The affected equipment has been isolated from the withdrawal system through either the automatic actions of the withdrawal system protective systems or the manual operation of isolating valve(s) as described below: <u>Compression Source</u> Suction and discharge valves shut, vent valve open or shut, and motor may or may not be running. <u>Condenser and Accumulator</u> Isolated from high pressure UF_6. <u>Withdrawal Station</u> Liquid block and/or emergency liquid block and cylinder valve shut. [Withdrawal position low voltage detector head closes all three valves on the affected position. Withdrawal room ceiling low voltage detector head closes the first two valves on all positions.]
4	Not In Use	Product and tails withdrawal equipment/positions are shut down and are not being used, as well as out of service for repair or testing.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.2 SAFETY LIMITS

2.3.2.1 TEXT DELETED

2.3.2.2 UF6 CONDENSER COOLANT PRESSURE

SL 2.3.2.2: C-310: UF_6 condenser R-114 coolant pressure shall not exceed 220 psig.
C-315: UF_6 condenser R-114 coolant pressure shall not exceed 440 psig.

APPLICABILITY: Modes: All

BASIS:

The UF_6 condensers in C-310 and C-315 withdrawal areas are designed and manufactured under ASME code regulations with a MAWP of 400 psig. These pressure vessels were originally hydrostatically tested at 150 percent of the MAWP and are tested by nondestructive examination every five years to ensure their wall thicknesses meet or exceed the minimum wall thicknesses as specified by code. The safety limits are ultimately based on preserving the structural integrity of the UF_6 condensers. To minimize the potential for failure in the coolant system which could lead to a UF_6 release, the coolant system is designed to meet the ASME code requirement that the pressure transient not exceed 110% of MAWP. Although the UF_6 condenser has an MAWP of 400 psig, the C-310 coolant system safety limit is conservatively based on the R-114 condenser MAWP of 200 psig. Thus, the safety limit is established at 220 psig and 440 psig for the C-310 and C-315 UF_6 condenser R-114 systems, respectively (110% of MAWP). [SAR Sections 3.15.3.4, 3.15.4.6]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.3.3.1 TEXT DELETED

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.3.3.2 R-114 COOLANT OVERPRESSURE CONTROL SYSTEM

LCS 2.3.3.2: C-310: The R-114 coolant rupture discs shall actuate at or below 210 psig.
C-315: The R-114 coolant rupture discs shall actuate at or below 420 psig.

LCO 2.3.3.2: The R-114 coolant overpressure relief system shall be operable.

APPLICABILITY: Modes: 2, 3*, 4* (*Only when liquid R-114 has NOT been drained from the coolant system.)

ACTIONS:

Condition	Required Action	Completion Time
A. R-114 coolant overpressure relief system inoperable.	A.1 Assure the UF_6 condenser and any applicable compressors (C-315 only) are in mode 3 or 4. AND A.2 Drain liquid R-114 coolant from the system.	Immediately Immediately
B. The R-114 coolant overpressure relief system manual isolation valve found unsealed or closed.	B.1 Open the valve or verify it is open. AND B.2 Reseal the valve.	Immediately. 8 hours
C. Action item B not satisfactorily completed.	C.1 Place the UF_6 condenser and any applicable compressors (C-315 only) in mode 3 or 4. AND C.2 Drain liquid R-114 coolant from the system.	Immediately. Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.3.2-1	Visually inspect the R-114 coolant condenser overpressure control system manual isolation valve to ensure it is sealed open.	Quarterly

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.3.3.2 R-114 COOLANT OVERPRESSURE CONTROL SYSTEM (continued)

BASIS:

The ASME code requires that overpressure relief be provided such that the subsequent transient pressure will be limited to a maximum of 110% of MAWP when a single relief path is used. ASME code allows rupture discs stamped with a single rupture value to have a ± 5% burst tolerance. Such rupture discs stamped at MAWP will therefore burst at or below 105% of MAWP. Those rupture discs stamped with a burst pressure range include this tolerance, and the maximum stamped value must not exceed 105% of MAWP. Thus, the LCS is set at 105% of MAWP. To comply with these standards, pressure relief devices are purchased and installed on the coolant condensers with stamped ratings in accordance with the above criteria. To ensure that the R-114 coolant system is not overpressured when the relief system is not operable, the UF_6 condenser and applicable compressors (for C-315 only) are required to be in modes 3 or 4 and the R-114 coolant is drained from the affected system. [SAR Sections 3.15.3.4 and 3.15.4.6]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.1 UF_6 RELEASE DETECTION AND ISOLATION SYSTEM - LOW VOLTAGE ("NEW") SYSTEM AT THE UF_6 WITHDRAWAL STATIONS

LCO 2.3.4.1: The low voltage ("New") withdrawal station UF_6 release detection and isolation system shall be operable.

APPLICABILITY: Modes: When the applicable withdrawal station is in mode 2.

ACTIONS:

Condition	Action	Completion Time
A. The low voltage detector head at the C-310 position 3 or 4 or C-315 withdrawal station is inoperable OR Both low voltage detector heads at the C-310 withdrawal station position 5 are inoperable.	A.1 Ensure the ACR is manned and perform UF_6 smoke watch on area affected by PGLD detection head inoperability. AND A.2 Restore operability to the low voltage detector head. TSR 1.6.2.2(d) is not applicable.	Initiate within 1 hour and maintain continuously. 72 hours
B. One low voltage detector head at the C-310 withdrawal station position 5 is inoperable.	B.1 Restore operability.	72 hours
C. The low voltage detector head at the withdrawal station for C-310 position 3 or 4 or C-315 or both low voltage detector heads for C-310 position 5 are is inoperable and the ACR manual isolation button is inoperable.	C.1 Place the affected withdrawal station in mode 3.	1 hour
D. Either the liquid block valve or the emergency liquid block valve is inoperable.	D.1 Restore operability.	72 hours
E. Action Item A or B or D not satisfactorily accomplished.	E.1 Place the affected withdrawal station in mode 3.	1 hour
F. Both the liquid block valve and the emergency liquid block valve are inoperable.	F.1 Place the affected withdrawal station in mode 3.	1 hour
G. The cylinder valve closer mechanism is inoperable.	G.1 Place the affected withdrawal station in mode 3, closing the cylinder valve manually (valve closer may be removed).	1 hour

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.1 UF_6 RELEASE DETECTION AND ISOLATION SYSTEM - LOW VOLTAGE ("NEW") SYSTEM AT THE UF6 WITHDRAWAL STATIONS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.1-1	Functional test by actuating each detector head with "smoke." Appropriate drain station valves (liquid block and emergency liquid block) must close within 15 seconds of detection. The cylinder valve must close within 30 seconds of detection.	Quarterly
SR 2.3.4.1-2	Functional test of the ACR "containment" push-button for each withdrawal station. Liquid block valve, emergency liquid block valve, and cylinder valve must close.	Quarterly
SR 2.3.4.1-3	Verify that nitrogen or backup air is available to power the receiving cylinder valve closer air motor in order to close the cylinder valve (pressure check).	Quarterly
SR 2.3.4.1-4	Verify that the automatic transfer from plant air to nitrogen is operable for the receiving cylinder valve closer.	Quarterly
SR 2.3.4.1-5	Verify that the check valve on the air supply line to the transfer cylinder valve closer air motor just upstream of the nitrogen or backup air supply interface is operable.	Quarterly

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and $HF*x(H_2O)$ are highly visible as "smoke." The UF_6 release detection safety system is provided on systems which contain gaseous or liquid UF_6 above atmospheric pressure. This system includes (1) automatic detection and isolation, and (2) manual isolation capability. Only the automatic isolation capability is required by the accident analysis to mitigate an event and satisfy the LCO. The system is designed to automatically close the liquid block, emergency liquid block, and cylinder valves if smoke is detected at the withdrawal position. The detection of a UF_6 release is based on detection of the smoke resulting from the reaction UF_6 with moisture in the air. To ensure that automatic isolation is initiated the detectors are smoke tested with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. Failure of the cylinder pigtail during the filling of a cylinder would result in a UF_6 release. Operation of this system to detect a UF_6 release and close the isolation valves (including the cylinder valve) within 30 seconds after

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.1 UF_6 RELEASE DETECTION AND ISOLATION SYSTEM - LOW VOLTAGE ("NEW") SYSTEM AT THE UF6 WITHDRAWAL STATIONS (continued)

BASIS (continued):

detection minimizes the quantity of UF_6 released. This system can be automatically actuated by a low voltage detector over each withdrawal position or it can be initiated manually via containment switches/pushbuttons located in the ACR. In the event the UF_6 detectors are inoperable, a smoke watch is established in the affected area to assure the process is monitored during the period permitted by the LCO. Upon sight or odor detection of a release, the "smoke watch" will contact the ACR operator who will initiate manual activation of the system via switches/pushbuttons located in the ACR. [SAR Sections 3.15.4.1, 4.3.2.2.4 and 4.3.2.2.11]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.2 UF_6 RELEASE DETECTION SYSTEM - LOW VOLTAGE SYSTEM AT THE UF_6 WITHDRAWAL ROOM CEILING

LCO 2.3.4.2: The low voltage ("New") withdrawal room ceiling UF_6 release detection (including at least half of the detector heads) and isolation system shall be operable.

APPLICABILITY: When one or more withdrawal stations is in mode 2.

ACTIONS:

Condition	Action	Completion Time
A.1 Less than half of the low voltage detector heads at the withdrawal room ceiling are operable. AND A.2 Low voltage detector heads in the housings of each withdrawal station in mode 2 are operable.	A.1 Restore operability to the low voltage detector head(s). TSR 1.6.2.2(d) is not applicable.	30 days
B.1 Less than half of the low voltage detector heads at the withdrawal room ceiling are operable. AND B.2 One or more low voltage detector heads in the housings of withdrawal stations in mode 2 are inoperable.	B.1 Assure the smoke watch is established per Action A.1 of TSR 2.3.4.1 AND B.2 Restore operability to the low voltage detector head(s). TSR 1.6.2.2(d) is not applicable.	Immediately 30 days
C. Action item A or B not satisfactorily accomplished.	C.1 Place the withdrawal station in mode 3.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.2-1	Functional test by actuating the detector head with "smoke." Appropriate drain station valves (liquid block, emergency liquid block) must close within 15 seconds of detection.	Quarterly

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.2 UF_6 RELEASE DETECTION SYSTEM - LOW VOLTAGE SYSTEM AT THE UF_6 WITHDRAWAL ROOM CEILING (continued)

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." The UF_6 release detection system is provided on systems which contain gaseous or liquid UF_6 above atmospheric pressure. The UF_6 detection system contains detectors which use an ionization chamber in which air is made conductive by the use of an alpha emitter. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. [SAR Section 3.15.7.3].

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.3 UF_6 RELEASE DETECTION SYSTEM - NORMETEX PUMP

LCO 2.3.4.3: The Normetex pump UF_6 release detection and isolation system shall be operable.

APPLICABILITY: Modes: 2

ACTIONS:

Condition	Action	Completion Time
A. One or more detection heads inoperable and/or the automatic trip/isolation circuits are inoperable.	A.1 Implement the following: A.1.1 Ensure the ACR emergency stop button is operable. AND A.1.2 Perform UF_6 smoke watch on area affected by PGLD detection head and/or the automatic trip/isolation circuits inoperability. AND A.1.3 Ensure ACR is manned. AND A.2 Restore operability to the detection head(s) and/or the automatic trip/isolation circuits. TSR 1.6.2.2(d) is not applicable.	Initiate within 1 hour and maintain continuously. 14 days
B. Action item A not satisfactorily accomplished.	B.1 Place the affected Normetex pump in mode 3.	1 hour
C. The Normetex pump discharge valve is inoperable.	C.1 Place the affected Normetex pump in mode 3. OR C.2 Restrict mode 2 operations for the affected pump to evacuation service or running off-stream.	1 hour 1 hour

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.3 UF_6 RELEASE DETECTION SYSTEM - NORMETEX PUMP (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.3-1	Functional test by actuating each combination of two adjacent detector heads with "smoke." The Normetex pump discharge valve must close and pump must trip.	Annually
SR 2.3.4.3-2	Functional test of the ACR emergency stop button. The Normetex pump discharge valve must close and pump must trip.	Annually

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." The UF_6 release detection safety system is provided on systems which contain gaseous or liquid UF_6 above atmospheric pressure. The UF_6 detection system contains detectors which use an ionization chamber in which air is made conductive by the use of an alpha emitter. The safety function of this system is to trip the pump, limiting the quantity of UF_6 released. The UF_6 detection system typically contains four detector heads for each pump. The UF_6 Release Detection System for the C-310 side withdrawal Normetex pump includes three heads inside the housing and three heads outside, which provides for three different combinations (two out of three) of fired heads at either location capable of tripping the pump. Firing of two adjacent detectors causes the pump to trip. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. In the event that one or more detector heads and/or the automatic trip/isolation circuitry is inoperable, a smoke watch can be utilized for pumps in Mode 2. In the event of a UF_6 release, the smoke watch would detect the release and notify the ACR to utilize the emergency stop button to trip and isolate the pump. [SAR Sections 3.15.4.8, 4.3.2.2.4, and 4.3.2.2.17]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.4 UF_6 RELEASE DETECTION SYSTEM - HIGH VOLTAGE ("OLD") SYSTEM FOR UF_6 CONDENSERS, ACCUMULATORS, AND PIPING HEATED HOUSINGS

LCO 2.3.4.4: The high voltage ("old") UF_6 release detection heads monitoring the subject equipment shall be operable.

APPLICABILITY: Modes: When the applicable equipment is in mode 2* or 3* (*When UF_6 pressure is above atmospheric pressure.)

ACTIONS:

Condition	Action	Completion Time
A. One or more of the detector heads is inoperable.	A.1 Establish a UF_6 smoke watch in the area affected by PGLD head inoperability (but outside any housings) to watch for "smoke" escaping from any UF_6 containing system. TSR 1.6.2.2(d) is not applicable.	Initiate within 1 hour and maintain continuously.
B. Action item A not satisfactorily accomplished.	B.1 Place the affected portion of the withdrawal process in mode 3.	1 hour

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.4-1	"Test fire" the UF_6 release detection system heads	Twice each shift only if operating in a mode specified in the applicability statement.
SR 2.3.4.4-2	Functional test by actuating the detector head with "smoke."	Quarterly

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.4 UF_6 RELEASE DETECTION SYSTEM - HIGH VOLTAGE ("OLD") SYSTEM FOR UF_6 CONDENSERS, ACCUMULATORS, AND PIPING HEATED HOUSINGS (continued)

BASIS:

UF_6 detection is provided above the UF_6 condensers, accumulators, and heated housings. These detectors are on a high-voltage system and when activated sound alarms in the local control room.
(The building alarm will sound for C-315.) Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration.

In the event of a failure of the UF_6 release detection system, the stationing of an operator at the affected equipment would assure monitoring of the system to determine if any outleakage of UF_6 should occur and would provide surveillance capability until the system can be repaired. The real safety hazard is when UF_6 is released into the area inhabited by plant personnel. UF_6 released inside the heated housing is not of significant safety concern unless it leaks from the (non-air tight) housing. Thus, a smoke watch posted outside the housing, watching for "smoke" escaping the heated housing into the occupied spaces, is capable of providing an adequate level of safety. [SAR Section 3.15.7.3]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.5 UF_6 RELEASE DETECTION SYSTEM - HIGH SPEED CENTRIFUGAL PUMPS (C-315 ONLY)

LCO 2.3.4.5: The low voltage ("New") UF_6 release detection system monitoring the C-315 high-speed centrifugal pumps shall be operable.

APPLICABILITY: Modes: 2

ACTIONS:

Condition	Action	Completion Time
A. The low voltage detector head is inoperable.	A.1 Test fire the high voltage detector at the high-speed pump with the manual push-button. TSR 1.6.2.2(d) is not applicable.	Immediately and twice per shift thereafter
B. Action item A satisfactorily accomplished.	B.1 Restore operability to the low voltage detector head. TSR 1.6.2.2(d) is not applicable.	72 hours
C. Action item A not satisfactorily accomplished.	C.1. Perform continuous UF_6 smoke watch on area affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	Initiate within 1 hour and maintain continuously.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.5-1	Functional test by actuating the detector head with "smoke."	Quarterly

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.5 UF_6 RELEASE DETECTION SYSTEM - HIGH SPEED CENTRIFUGAL PUMPS (C-315 ONLY) (continued)

BASIS:

An administrative control is in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls [SAR Section 4.3.2.2.1]. Because of this administrative control, the UF_6 Release Detection System - High Speed Centrifugal Pumps (C-315 Only) used with the C-315 high-speed centrifugal compressors no longer meets the TSR selection criteria specified in Section 4.2.3. However, the existing analysis for the UF_6/hot metal reaction event credits this system for mitigating on-site personnel exposure [SAR Section 4.3.2.2.1] Therefore, the TSR for this system will be retained until the further analyses are completed.

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas. The UO_2F_2 and $HF*x(H_2O)$ are highly visible as "smoke." The UF_6 release detection system is provided on systems which contain gaseous or liquid UF_6 above atmospheric pressure. The UF_6 detection system contains detectors which use an ionization chamber in which air is made conductive by the use of an alpha emitter. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration. [SAR Section 3.15.7.3]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.6 FACILITY ASSAY LIMITS

LCO 2.3.4.6: Product Withdrawal facility and equipment contained therein shall not be operated at assays greater than 5.5 wt % ^{235}U. Tails Withdrawal facility and equipment contained therein shall not be operated at assays greater than or equal to 1.0 wt % ^{235}U.

APPLICABILITY: Modes: At all times

ACTIONS:

Condition	Required Action	Completion Time
A. Assay exceeds analyzed safe limit.	A.1 Initiate actions to reduce assay.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Product Withdrawal Facility has been analyzed for criticality concerns. The C-310/310-A facility, including the UF_6 accumulators, condensers, traps, scale pits, and product cylinders, is approved for operation up to 5.5 wt % ^{235}U. Tails Withdrawal Facility has not been analyzed for criticality concerns. Therefore, the maximum assay in the facility must be limited to less than 1.0 wt % ^{235}U below which nuclear criticality concerns are negligible. [SAR Section 5.2, Appendix A]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.7 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.3.4.7a: Criticality accident detection shall be operable.

APPLICABILITY: In areas, equipment, or processes which contain greater than 700 grams of ^{235}U at an enrichment greater than or equal to 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. Areas, equipment, or processes not covered by criticality accident detection.	A.1 Implement the following for areas, equipment, or processes applicable to this LCO and that are not otherwise covered by criticality accident detection . A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥1.0 wt % ^{235}U. AND A.1.2 NaF traps containing uranium enriched to ≥1.0 wt % ^{235}U shall not be handled. AND A.1.3 Waste containing uranium enriched to ≥1.0 wt % ^{235}U shall not be moved. AND A.1.4 Discontinue maintenance activities that require breach of containment of equipment containing uranium enriched to ≥ 1 wt % ^{235}U. AND A.1.5 Cylinder Filling with UF_6 enriched to ≥ 1 wt % ^{235}U will be discontinued. [In-progress cylinder filling cycle(s) may be completed, stopped, and/or re-started as necessary. Normal operation of withdrawal compressors, condensers, and accumulators is not restricted by this action.] AND A.1.6 Perform Required Actions A.1.1, A.1.2, A.1.3, A.1.4, A.2.1, A.2.2, A.3, B.1.1, B.1.2 of TSR 2.4.4.2a. AND A.2.1 Evacuate area within the area not covered by criticality accident detection. AND A.2.2 Restrict access to area evacuated in A.2.1. AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate.	Immediately Immediately Immediately
B. Areas, equipment, or processes not covered by criticality accident detection.	B.1.1 Restore criticality accident detection by installing portable CAAS unit providing required criticality accident detection and same alarms as fixed unit. OR B.1.2 Restore criticality accident detection to operable status. TSR 1.6.2.2d is not applicable.	48 hours (effective when NRC assumes regulatory authority)

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.7 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.4.7a-1 Calibrate CAAS system equipment.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the product withdrawal facility are associated with the movement of fissionable materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device), restricting operations, or restricting access to the area in the event of the loss of detection will establish protection. [SAR Sections 3.15.7.1, and 4.3.2.6]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.7 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

LCO 2.3.4.7b: Criticality accident alarm shall be operable (audible).

APPLICABILITY: In areas where the maximum foreseeable absorbed dose in free air exceeds 12 rad, except areas in permit-required confined spaces and localized areas of inaudibility.

ACTIONS:

Condition	Required Action	Completion Time
A. Area does not have an audible criticality accident alarm.	A.1 Implement the following for areas, equipment, or processes where a criticality accident could result in a maximum foreseeable dose exceeding 12 rad in the area of inaudibility and LCO 2.3.4.7a applies. A.1.1 Discontinue movement of cylinders containing UF_6 enriched to ≥1 wt % ^{235}U. <u>AND</u> A.1.2 NaF traps containing uranium enriched to ≥1 wt % ^{235}U shall not be handled. <u>AND</u> A.1.3 Waste containing uranium enriched to ≥1 wt % ^{235}U shall not be transported. <u>AND</u> A.1.4 Discontinue maintenance activities that require breach of containment of equipment containing uranium enriched to ≥ 1 wt % ^{235}U. <u>AND</u> A.1.5 Cylinder Filling with UF_6 enriched to ≥ 1 wt % ^{235}U will be discontinued. [In-progress cylinder filling cycle(s) may be completed, stopped, and/or re-started as necessary. Normal operation of withdrawal compressors, condensers, and accumulators is not restricted by this action.] <u>AND</u> A.1.6 Perform Required Actions A.1.1, A.1.2, A.1.3, A.1.4, A.2.1, A.2.2, A.3, B.1 of TSR 2.4.4.2b.	Immediately
	<u>AND</u> A.2.1 Evacuate area of inaudibility <u>AND</u> A.2.2 Restrict access to the area of inaudibility.	Immediately
	<u>AND</u> A.3 Provide personnel allowed to enter the area of inaudibility with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate, or a radio in constant communication with the Central Control Facility.	Immediately
B. Area does not have an audible criticality accident alarm.	B.1 Restore criticality accident alarm to operable status. TSR 1.6.2.2d is not applicable.	48 hours (effective when NRC assumes regulatory authority)

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.7 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.7b-1	Test the CAAS and building horns.	Annually
SR 2.3.4.7b-2	Verify that the CAAS air accumulator supply pressure to the building horns is at least 129 psig.	Quarterly

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. Audibility is not provided for areas in permit-required confined spaces and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate. One person remains outside the area and maintains contact with personnel in the area. Evacuation of the area of inaudibility and restricting access to those areas will eliminate the potential for increased consequences due to personnel not hearing an alarm. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the product withdrawal facility are associated with the movement of fissionable materials. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of alarms will establish protection. [SAR Sections 3.15.7.1 and 4.3.2.6, 5.2.2.5]

The CAAS air accumulators provide for 120 seconds of horn actuation when at their minimum acceptable pressure of 129 psig. Electronic horns are installed in some areas. These horns have battery backup power supplies which will provide for at least 120 seconds of horn actuation even if off-site power is lost.

The annual surveillance of the CAAS building horns consists of placing the cluster in the test mode with a keyswitch, and manually causing two detector modules to generate radiation readings above the alarm setpoint. The cluster electronics determines that this meets the high radiation alarm criteria and propagates a high radiation alarm signal to the rest of the system. This signal activates the high radiation alarm light and bell in C-300 and activates the building CAAS horns. Each horn is qualitatively verified to be operating. This test is a horn functional test and each module combination is tested to generate the high radiation signal.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.8 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM

LCO 2.3.4.8: The automatic fire suppression (sprinkler) systems in process buildings C-310 and C-315 (exclusions: the dry pipe sprinkler system in C-310 and the deluge system for the exterior transformer located adjacent to C-315) shall be operable.

APPLICABILITY: Modes: At all times.

ACTIONS:

Condition	Required Action	Completion Time
A. An automatic fire suppression system or a portion of an automatic fire suppression system is inoperable.	A.1 Restore the automatic fire suppression system to operable status.	2 hours
B. Action Item A not satisfactorily accomplished.	B.1 Conduct a fire patrol for the affected area(s) of the affected building(s). AND B.2 Confirm at least one HPFW hydrant adjacent to the affected building(s) is operable. TSR 1.6.2.2(d) is not applicable.	2 hours and every hour thereafter. 4 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.8 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.8-1	Verify control valves in the required flow paths are open.	Monthly
SR 2.3.4.8-2	Functionally test each automatic fire suppression system.	Annually
SR 2.3.4.8-3	Cycle all control valves in the required flow paths.	Annually
SR 2.3.4.8-4	Flow test at least one HPFWS fire hydrant adjacent to each process building (distribution system test).	Annually

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.8 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM (continued)

BASIS:

As discussed in the SAR accident analysis (Sections 4.3.2.1.9 and 4.3.2.2.16), an unmitigated lube oil fire in process buildings C-310 and C-315 could cause failure of the structural steel followed by localized collapse of the structure. This collapse could damage process piping allowing a release of UF_6. A large fire could also cause a primary system failure due to over temperature. The automatic fire suppression (sprinkler) systems in these buildings will minimize the potential for and mitigate the effects of a large fire.

The portions of the high pressure fire water system (HPFWS) required to mitigate a lube oil fire in buildings C-310 and C-315 include the automatic wet-pipe sprinkler systems in the two buildings; the HPFWS distribution mains, water storage tank and pumps; and the C-631-2 cooling tower basin. The dry pipe sprinkler system in C-310 (canopy area for product withdrawal) and the deluge system located adjacent to C-315 (exterior transformer) are part of the sanitary and fire water system and are not subject to the LCO. They are excluded since a fire within the areas protected by these systems would have no impact upon process piping containing UF_6 .

The sprinkler systems provide primary fire suppression capability for the areas in which they are installed. If an automatic fire suppression system is not functional or has a closed valve, hourly fire patrols will provide backup fire protection capability. Backup fire suppression will be provided by hose streams supplied from fire hydrants located adjacent to the affected building.

Surveillance Requirement 2.3.4.8-2, functional testing of each automatic fire suppression system, includes an inspector test valve (ITV) flow test and a main drain flow test. The ITV test simulates the actuation of a single sprinkler head. The main drain flow test verifies that upstream control valves are open and there are no line blockages in the system's water supply piping. The ITV and main drain flow tests are used during the surveillances to verify that the sprinkler system has adequate water flow.

Positions of indicating control valves and seals on non-indicating control valves will be visually verified monthly. Non-indicating valves with missing or broken seals will be cycled and new seals installed. All control valves will be cycled annually. [SAR Sections 3.15.7.2, 4.3.2.1.9 and 4.3.2.2.16]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.9 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER DISTRIBUTION MAINS

LCO 2.3.4.9: The High Pressure Fire Water System (HPFWS) distribution mains (excluding mains not in the direct flow path to a required sprinkler system) shall be operable.

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.3.4.8.

ACTIONS:

Condition	Required Action	Completion Time
A. A sectional valve in the distribution mains is not in the open position.	A.1 Restore to the open position.	4 hours
B. Action item A not satisfactorily accomplished.	B.1 Confirm water supply is available on both sides of the closed valve.	4 hours
C. Action item B not satisfactorily accomplished.	C.1 Conduct a fire patrol for the affected area(s) of the affected building(s). AND C.2 Provide a temporary water supply for the affected sprinkler systems. TSR 1.6.2.2(d) is not applicable.	2 hours and every hour thereafter. 8 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.9 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER DISTRIBUTION MAINS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.9-1	Verify sectional valves in the flow paths are open.	Monthly
SR 2.3.4.9-2	Cycle all sectional valves in direct flow path.	Annually
SR 2.3.4.9-3	Flow test at least 1 HPFWS fire hydrant adjacent to each process building (distribution system test).	Annually

BASIS:

All required sprinkler systems have at least two supply paths from the HPFWS pumps through the distribution mains. Hence, the closure of one of the sectional valves in Condition A of this TSR will not cause a loss of function of any required sprinkler system. If two or more sectional valves are closed, the ability to supply water to the required sprinkler systems can be lost. This would be identified by Action B. A temporary water supply will be provided consisting of hoses connected between one or more fire hydrants and the fire department connection(s) on the affected sprinkler system(s). The hoses are to be in place and connected to satisfy Condition C. The hoses will only be pressurized with HPFWS water in the event of a fire.

Positions of indicating sectional valves and seals on non-indicating sectional valves will be visually verified monthly. Non-indicating valves with missing or broken seals will be cycled and new seals installed. All sectional valves will be cycled annually. [SAR Sections 3.15.7.2, 4.3.2.1.9 and 4.3.2.2.16]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.10 FIRE PROTECTION SYSTEM - WATER SUPPLY BASIN

LCO 2.3.4.10: The C-631-2 basin shall be operable (water level within 5 feet of basin top when HPFWS pumps 5 or 6 are not operable, and water level within 15 feet of basin top when HPFWS pumps 5 and 6 are both operable).

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.3.4.8.

ACTIONS:

Condition	Required Action	Completion Time
A. Basin water level drops below 5 feet from the basin top.	A.1 Confirm HPFWS pumps 5 and 6 are operable.	Immediately
B. Action Item A not satisfactorily accomplished.	B.1.1 Initiate RCW emergency makeup from the C-611 plant water system AND B.1.2 Restore level to within 5 feet from the basin top. OR B.2.1 Open the RCW crossover valves to provide makeup water from C-633 AND B.2.2 Restore level within 5 feet from the basin top.	Immediately 4 hours Immediately 4 hours
C. Basin water level drops below 15 feet from the basin top.	C.1.1 Initiate RCW emergency makeup from the C-611 plant water system AND C.1.2 Restore level to within 5 feet from the basin top. OR C.2.1 Open the RCW crossover valves to provide makeup water from C-633 AND C.2.2 Restore level within 5 feet from the basin top.	Immediately 4 hours Immediately 4 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.10 FIRE PROTECTION SYSTEM - WATER SUPPLY BASIN (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.10-1	Verify water level in the C-631-2 RCW cooling tower basin is within 5 feet of the top of the basin.	Monthly

BASIS:

The C-631-2 RCW cooling tower basin and the wetwell under the C-631 building are connected by a flume. Their combined volume provides the source of water to all the HPFWS pumps. They will hold over 4 million gallons of water when the level is within 5 feet of the top of the basin. At this level, the usable volume of water available to HPFWS pumps 2 and 3, which take a suction through the side of the basin, will exceed the 825,000 gallons needed to satisfy maximum system demands of 6,875 gpm for a two hour duration. [Note: This requirement is conservative with respect to the system evaluation presented in SAR Section 3.15.7.2.] HPFWS pumps 5 and 6 take a suction from the C-631-1 wetwell. Their suction intakes are at a lower elevation than those of the other two pumps and can draw on more than 3.5 million gallons of water. If the basin level drops to 15 feet from the top of the basin, the suctions of HPFWS pumps 2 and 3 will be uncovered. However, HPFWS pumps 5 and 6 will still have an adequate water volume to meet the maximum system demands for two hours.

Normal makeup flow to the basin is from the plant water system. If the water drops below the required level and can not be restored by normal makeup, emergency makeup will be initiated to dedicate all plant water system output to the basin. If needed, crossover valves can also be opened to supply up to 9,000 gpm from the C-633 basin.

Basin water level is verified by visual observation of a graduated measuring device. [SAR Sections 3.15.7.2, 4.3.2.1.9 and 4.3.2.2.16]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.11 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS

LCO 2.3.4.11: At least two High Pressure Fire Water System (HPFWS) pumps shall be operable.

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.3.4.8.

ACTIONS:

Condition	Required Action	Completion Time
A. One HPFWS pump operable.	A.1 Confirm the HPFWS storage tank is at least 90% full. AND A.2 Provide temporary water source(s) and pump(s) to restore total flow capability to at least 6,875 gpm.	Immediately 8 hours
B. No HPFWS pumps operable OR Action Item A not satisfactorily accomplished.	B.1 Alert offsite fire departments. AND B.2 Provide temporary water source(s) and pump(s) to restore total flow capability to at least 6,875 gpm.	Immediately 72 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.11 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.11-1	Manually start fire water pumps.	Monthly
SR 2.3.4.11-2	Automatic start of fire water pumps on simulated loss of fire system pressure.	Annually
SR 2.3.4.11-3	Calibrate the switches that provide the automatic start signals to the HPFWS pumps.	Annually
SR 2.3.4.11-4	Verify HPFWS pumps 2, 3, 5, and 6 will flow at least 90% of their rated capacity at their rated pressure.	Annually

BASIS:

The HPFWS pumps must be capable of satisfying the maximum sprinkler system and hose stream demands of 4,875 gpm and 2,000 gpm respectively. This results in a combined pumping capacity requirement of 6,875 gpm. [Note: This requirement is conservative with respect to the system evaluation presented in SAR Section 3.15.7.2.]

Pumps 2, 3, 5, and 6 are rated at 125 psi TDH and have rated capacities of 4,625 gpm, 4,625 gpm, 4,500 gpm, and 4,500 gpm respectively. To allow for degradation of the pumps over time, only 90% of the rated pump flow is relied upon to satisfy system flow demands. The two pumps with the smallest flow capacities can supply a combined flow of 8,100 gpm under degraded conditions.

When the HPFWS storage tank is 90% full, it is capable of supplying 2,250 gpm for two hours. This flow combined with the flow from one degraded HPFWS pump would fall short of satisfying maximum system demand by no more than 575 gpm. The short fall can be addressed by the use of a fire pumper truck taking a suction from a cooling tower basin and discharging through a fire hydrant to the system distribution mains. If such a temporary water supply is needed to satisfy

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2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.11 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS (continued)

BASIS (continued):

Condition A, the pumper and required hoses/pipes will be pre-positioned. The hoses/pipes will not be filled with water except in the event of a fire.

When only one HPFWS pump is operable, the C-300 operators will manually start the pump upon notification of a fire. This is necessary since the automatic start of the pump would not occur until after the HPFWS storage tank level drops below 40% full.

If no HPFWS pumps are operable or Condition A cannot be satisfied, the off site fire departments will be alerted so they will be ready to provide assistance if needed. Also, temporary sources of pumping capacity will be sought to restore design capacity within 72 hours.

HPFWS pump 1 is a jockey pump and has a rated capacity of only 200 gpm. It cannot be used to satisfy the TSR Condition Requirements since it will be dead headed when the larger HPFWS pumps are operating. HPFWS pump 4 is not operable and has been abandoned in place.

Level in the HPFWS storage tank is normally maintained by HPFWS pump 1. If water demand on the system exceeds the capacity of this pump, tank level and system pressure will drop. Switches in each of the fire pump controllers will automatically start the fire pumps sequentially until the system demand is satisfied. [SAR Sections 3.15.7.2, 4.3.2.1.9 and 4.3.2.2.16]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.12 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER STORAGE TANK

LCO 2.3.4.12: The HPFWS storage tank shall be operable (at least 90% full and valved to the distribution mains).

APPLICABILITY: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.3.4.8.

ACTIONS:

Condition	Required Action	Completion Time
A. The HPFWS storage tank is not operable.	A.1 Restore the tank to operable status.	2 hours
B. Action item A not satisfactorily accomplished.	B.1 Confirm at least two HPFWS fire pumps are operable. AND B.2 Perform one of the following: B.2.1 **IF** level is less than 90% full due to significant leakage from the tank, isolate the tank and maintain system pressure by continuously operating a HPFWS pump. OR B.2.2 **IF** level is less than 90% full due to water demands from non-fire conditions at locations other than the tank, isolate the water demands and restore level to at least 90% full. OR B.2.3 **IF** the tank is isolated for maintenance or inspection, maintain system pressure by continuously operating a HPFWS pump.	Immediately 4 hours

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2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.12 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER STORAGE TANK (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.12-1	Verify that the HPFWS storage tank contains at least 270,000 gallons of water (filled to at least 90% capacity).	Monthly
SR 2.3.4.12-2	Visual inspection of exterior of HPFWS storage tank.	Annually

BASIS:

For the 300,000 gallon elevated storage tank to be considered operable, its level must be at least 90% full (by volume) and it must be aligned to the HPFWS distribution mains. When operable, it is capable of supplying maximum sprinkler system and hose stream demands of 6,875 gpm [Note: This requirement is conservative with respect to the system evaluation presented in SAR Section 3.15.7.2.] for approximately 39 minutes. It is also capable of supplying 2,250 gpm for a duration of two hours which is slightly greater than 32% of the water required for maximum fire protection demands.

If the tank is not operable, the TSR required actions are intended to address two issues. The first is to verify there are sufficient fire pumps available to supply required firewater demands without having the tank operable. The second is to maintain the HPFWS filled with water and pressurized above automatic start pressures for the fire pumps.

During non-fire conditions, the tank floats on the HPFWS and maintains the required system pressure. Level in the tank is normally controlled by the 200 gpm HPFWS pump 1 (a jockey pump) which is designed to provide routine makeup for water leakage from the system. The jockey pump is controlled by level switches located in the tank. If the jockey pump is inoperable, this level control function can also be performed by manual operation of a fire pump.

During a fire, water demand on the system would exceed the capacity of the jockey pump. The tank level and system pressure will then drop. Pressure switches in the individual fire pump controllers will automatically start the fire pumps sequentially until available flow exceeds the system demand. At this point the tank will start to refill and function as a surge volume as water demand fluctuates during fire fighting efforts. After the fire is extinguished, tank level will be promptly restored above the 90% level.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

BASIS (continued)

If level in the tank falls below 90% during non-fire conditions, either the jockey pump is not functioning properly or there is a water demand on the system that exceeds the capacity of the pump. In either case, one or more of the HPFWS fire pumps will be started automatically or manually and an attempt made to restore tank level above 90%. The cause of the excessive water demand will be investigated. If the demand is due to significant leakage from the storage tank, the tank will be isolated. In this case, pressure on the balance of the HPFWS will be maintained above the fire pump automatic start pressures by continuously operating either the jockey pump or one of the fire pumps. If the excessive demand is from locations in the HPFWS other than the tank, the demand will be isolated. Such demands could be from non-fire conditions such as line breaks, spurious actuation of a sprinkler system, or flow testing and flushing of fire hydrants. Once the demand is isolated, pressure will be restored on the balance of the system by refilling the storage tank and maintaining its level above 90%.

If the tank is isolated for maintenance or inspection, pressure in the HPFWS will be maintained above the fire pump automatic start pressures by continuously operating either the jockey pump or one of the fire pumps. [SAR Sections 3.15.7.2, 4.3.2.1.9 and 4.3.2.2.16]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.13 FIRE PROTECTION SYSTEM - HOT WORK LIMITATIONS

LCO 2.3.4.13 A dedicated, continuous fire watch, equipped with portable fire suppression equipment, shall be posted for hot work operations conducted when LCO 2.3.4.8 is not satisfied.

APPLICABILITY: Modes: All

ACTIONS:

Condition		Required Action		Completion Time
A.	Hot work conducted when LCO 2.3.4.8 is not satisfied without a dedicated fire watch present.	A.1	Stop hot work operations.	Immediately
		AND		
		A.2	Establish dedicated fire watch in accordance with the LCO.	Prior to re-starting hot work operations.

SURVEILLANCE REQUIREMENTS: None

BASIS:

Hot work (welding, cutting, etc.), while a necessary part of plant maintenance and upkeep, introduces a fire hazard not normally present during steady state plant operations. As a good practice, hot work should be avoided when the fixed fire suppression system is inoperable. However, in those cases where hot work is performed when the fixed fire suppression system is inoperable, some mechanism for extinguishing fires which could potentially result from the hot work must be provided. [SAR Section 5.4.1.1]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.14 CYLINDER SCALE CART MOVEMENT PREVENTION SYSTEM

LCO 2.3.4.14: The cylinder scale cart movement prevention system shall be operable.

APPLICABILITY: Modes: 2

ACTIONS:

Condition		Required Action		Completion Time
A.	Cylinder scale cart movement prevention system inoperable.	A.1	Verify that the system's key is hanging from the receiving cylinder's pigtail.	1 hour
		AND		
		A.2	Tag out the air connector on the air supply for the scale cart motor.	1 hour
		NOTE: Current filling cycle, including transitions between modes 2 and 3, may be completed.		
B.	Scale cart movement prevention system key is discovered not hanging from withdrawal cylinder's pigtail without entry into condition A.	B.1.1	Tag out the air connector on the air supply for the scale cart motor.	1 hour
		NOTE: Current filling cycle, including transitions between modes 2 and 3, may be completed.		
		OR		
		B.1.2	Stop operations in mode 2	1 hour
		AND		
			Purge and evacuate the receiving cylinder's pigtail, disconnect the pigtail, and hang the system's key on the pigtail.	

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.14 CYLINDER SCALE CART MOVEMENT PREVENTION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.14-1	Test the system quarterly to verify that the scale cart will not move unless the pigtail is at atmospheric pressure (± 3 psi using installed instrumentation) and the key interlock energized.	Quarterly
SR 2.3.4.14-2	Calibrate the system's detection and initiation pressure instrumentation.	Annually

BASIS:

This system helps prevent receiving cylinder pigtail failure and subsequent UF_6 release by prohibiting scale cart movement if the transfer manifold pressure indicates the potential presence of liquid UF_6 (pressure significantly above atmosphere). The 3 psi tolerance around atmosphere is based purely upon engineering judgement. [SAR Sections 3.15.6.5 and 4.3.2.2.11]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.15 CYLINDER FILLING - PRE-FILL WEIGHT

LCO 2.3.4.15: UF_6 cylinders shall not be filled with ≥ 1% ^{235}U material if they contain greater than 40 pounds of moderating or unknown material until a verification of the cylinder's contents has been performed.

APPLICABILITY: Modes: 1 and 2

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder being prepared for withdrawal operation involving material ≥ 1% ^{235}U discovered to have greater than 40 pounds of moderating or unknown material.	A.1 Reject the cylinder for filling until either its contents are verified or the moderating/unknown material has been removed.	Prior to entering mode 2 with ≥ 1% ^{235}U material.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.4.15-1 Weigh each UF_6 cylinder to be filled.	Prior to entering mode 2.

BASIS:

Controls for nuclear criticality safety of cylinders containing material enriched to ≥1.0 wt % ^{235}U is in the form of moderation control by limiting the amount of potentially moderating material allowed to be present in the cylinder. Cylinders having an excess of 40 pounds of known moderating or unknown material are suspected of having a source of moderation. At 5.5 wt % ^{235}U, over 50 pounds of water are required to initiate and sustain a nuclear criticality. [NCSE 3974-05 (August 1993)]. Verification (by weighing) of the cylinder's contents prior to filling assures that moderating materials have not been inadvertently introduced. [SAR Section 4.3.2.2.11]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.16 CYLINDER FILLING - CYLINDER PRE-FILL INSPECTION

LCO 2.3.4.16: Damaged UF_6 cylinders shall not be filled with UF_6.

APPLICABILITY: Modes: 1 and 2

ACTIONS:

Condition	Required Action	Completion Time
A. Unacceptable cylinder damage identified by cylinder pre-fill visual inspection.	A.1 Repair and test (if necessary) the cylinder in accordance with SAR Section 3.7.1 and SAR Figure 3.7-1.	Prior to entering mode 2 with the subject cylinder.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.4.16-1 Cylinder visual inspection for damage.	Prior to initial entry into mode 2 of each cylinder filling cycle.

BASIS:

Depending upon the degree of damage (detected during the pre-use inspection), a cylinder may or may not be capable of withstanding its hydropressure. A UF_6 cylinder is removed from service for repair or replacement when it has leaks, excessive corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that, in the judgement of the inspector, renders it unsafe or unserviceable. Some types of cylinder damage and/or deformities are acceptable as-is or after repair. [SAR Sections 3.15.6.1 and 4.3.2.2.15]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.17 CYLINDER FILLING - CYLINDER FILL LIMIT

LCO 2.3.4.17: The accountability weight of UF_6 drained into the receiving cylinder shall not exceed the standard fill limit (Maximum Fill Limit for Shipment for cylinders other than tails cylinders, or the Maximum Fill Limit for In-Plant Tails Storage for tails cylinders per TSR Section 2.3, Appendix A) for that cylinder.

APPLICABILITY: Modes: 2

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder filled beyond standard fill limit and discovered prior to removal from the withdrawal room.	A.1 Connect cylinder to UF_6 manifold (if disconnected) AND A.2 Evacuate contents to a low pressure source until cylinder net weight is less than the standard fill limit.	Prior to placing the cylinder in the local cylinder yard for cool down.
B. Cylinder filled beyond standard fill limit and discovered after removal from the withdrawal room.	B.1. Identify the cylinder as an overfilled cylinder AND B.2 Allow the cylinder to complete its cool down period.	Immediately Prior to removing from the local cylinder yard

SURVEILLANCE REQUIREMENTS: None.

BASIS:

In the event a cylinder is overfilled during a transfer operation, the excess material can be removed from the cylinder safely by evacuating the cylinder to a low pressure. The hot liquid in the cylinder provides the thermal energy to vaporize UF_6 out of the cylinder to the evacuation low pressure source.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.18 CYLINDER HANDLING - CYLINDER DISCONNECTION

LCO 2.3.4.18: The cylinder valve shall be closed prior to disconnecting the cylinder from the pigtail.

APPLICABILITY: Modes: 1

ACTIONS:

Condition	Required Action	Completion Time
A. Cylinder valve cannot be closed.	A.1 Establish cylinder pressure below atmospheric pressure AND A.2 Cap the open connections.	Prior to disconnecting either end of the pigtail. After disconnecting either end of the pigtail.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.4.18-1 Calibrate the PI used to monitor cylinder pressure.	Annually

BASIS:

Closing the cylinder valve prior to disconnecting the cylinder from the manifold prevents UF_6 release from an open source. On rare occasions, it is discovered that the cylinder valve, for one reason or another, cannot be closed and seated as evidenced by the pigtail pressure rising after evacuation. In those instances, the safest course of action is to allow the cylinder to cool below atmosphere, disconnect the cylinder from the manifold, and cap the open connections to minimize UF_6 outleakage.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.19 CYLINDER HANDLING - CYLINDER VALVE COVERS

LCO 2.3.4.19: Liquid-filled cylinders shall not be removed from the withdrawal room without a cylinder valve protector installed.

APPLICABILITY: Modes: 1* (*Only if cylinder contains liquid in quantities greater than heel quantities.)

ACTIONS:

Condition	Required Action	Completion Time
A. Liquid-filled cylinder removed from the withdrawal room without cylinder valve protector installed - discovered while the cylinder is suspended.	A.1 Place the cylinder in a set of cylinder storage saddles (scale cart or fixed) AND A.2 Install a cylinder valve protector.	Immediately Prior to re-entering mode 1 with the subject cylinder.
B. Liquid-filled cylinder removed from the withdrawal room without cylinder valve protector installed - discovered after the cylinder has been placed in a set of storage saddles.	B.1 Install a cylinder valve protector.	Prior to re-entering mode 1 with the subject cylinder.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The extended cylinder valve, although partially protected by the cylinder, is one of the most likely failure points on a cylinder while it is being moved. Installing the cylinder valve protector provides additional protection of the valve against damage that could result in a UF_6 release to the environment. [SAR Section 3.15.6.1]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.20 CYLINDER HANDLING - APPROVED CRANES FOR LIQUID CYLINDERS

LCO 2.3.4.20: Liquid-filled cylinders shall be lifted (suspended) only with overhead cranes meeting the conditions set forth in TSR section 2.3.5.2.

APPLICABILITY: Modes: 1* (*Only if cylinder contains liquid in quantities greater than heel quantities.)

ACTIONS:

Condition	Required Action	Completion Time
A. Liquid-filled cylinder lifted (suspended) by equipment other than that specified in section 2.3.5.2 prior to completion of the cylinder cool-down period (3 days for 2½-ton cylinders and 5 days for 10- and 14-ton cylinders) - discovered while the cylinder is suspended.	A.1 Place the cylinder in a set of cylinder storage saddles at ground level.	Immediately
B. Liquid-filled cylinder lifted (suspended) by equipment other than that specified in section 2.3.5.2 prior to completion of the cylinder cool-down period (3 days for 2½-ton cylinders and 5 days for 10- and 14-ton cylinders) - discovered after cylinder has been placed in a set of storage saddles.	B.1 Restrict cylinder movement to lifting with an overhead crane approved for liquid cylinder handling (as in 2.3.5.2) for placement in a set of cylinder storage saddles at ground level.	Immediately and until completion of the cylinder cool-down period

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Lifting liquid-filled cylinders only with cranes approved for that use reduces the potential for a cylinder handling mishap that could result in the release of UF_6 to the environment. [SAR Sections 3.15.6.2, 4.3.2.2.4 and 4.3.2.2.15]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.21 CYLINDER LIFTING RESTRICTION

LCO 2.3.4.21: No UF_6 cylinder shall be moved over another cylinder when either cylinder contains liquid UF_6.

APPLICABILITY: Modes: 1 when the cylinder being lifted has not been acceptably heeled.

ACTIONS:

Condition	Required Action	Completion Time
A. UF_6 cylinders suspended one over the other when at least one of the cylinders contains liquid UF_6.	A.1 Move the suspended cylinder such that the LCO statement is satisfied.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The cylinder drop and puncture scenario in the accident analysis involving liquid UF_6 cylinders (SAR Section 4.3.2.2.15) assume a release source term of 28,000 pounds of UF_6. The prohibition of lifting one cylinder over another if one of the cylinders contains liquid UF_6 preserves the accident analysis assumption of only one cylinder contributing to the release source term (even though the contribution from a solid UF_6 cylinder would be negligible).

A cylinder that has been acceptably heeled will contain no liquid UF_6. A cylinder will be considered acceptably heeled when its vapor pressure falls below 20 psia for more than 5 minutes during the heeling process. [SAR Sections 3.15.6.2 and 4.3.2.2.15]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.22 HEATING UF_6 PLUGS

LCO 2.3.4.22: Direct heat sources shall not be applied to UF_6 plugs until flow clarity in the system has been assured.

APPLICABILITY: Modes: At all times

ACTIONS:

Condition	Required Action	Completion Time
A. Direct heat source applied to a UF_6 plug.	A.1 Discontinue heating the plug.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Application of external heat to the middle portion of the plug can melt the solid and develop large hydraulic forces in the pipe and ends of the plug, creating the potential for a UF_6 release due to pipe rupture.

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.23 SCALES

LCO 2.3.4.23: The withdrawal facility scale(s) used for verification of cylinder weight per LCOs 2.3.4.15, 2.3.4.17, 2.1.4.6, and 2.2.4.4 shall be operable.

APPLICABILITY: Whenever the withdrawal facility scale(s) is/are used for verification of cylinder weight.

ACTIONS:

Condition	Required Action	Completion Time
A. Scale discovered to be inoperable	A.1 Administratively control scale to prevent use.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.23-1	Calibrate NMC&A scale ID 11, 12, and 29 (C-310 positions 3, 4, and 5) and 13, 14, 15, and 16 (C-315 positions 1, 2, 3, and 4), to an adequate range and tolerance for the item being weighed, in accordance with NMC&A program requirements.	Annually
SR 2.3.4.23-2	Perform functional test of NMC&A scale ID 11, 12, and 29 (C-310 positions 3, 4, and 5) and 13, 14, 15, and 16 (C-315 positions 1, 2, 3, and 4) (i.e., check operation using test weights in accordance with NMC&A program requirements).	Prior to placing the cylinder in the withdrawal position when filling 10 or 14 ton cylinders and DAILY when filling 2 ½ ton cylinders.

BASIS:

All cylinder weights are assumed to be within the tolerances assumed in the accident analysis. The calibration and testing of the scale carts to within the tolerances specified in the NMC&A program (which are much more stringent than the tolerances required by the accident analysis) assured that cylinder weights do not invalidate the accident analysis. Because it may take more than one day to fill a 10 or 14 ton cylinder at low withdrawal rates, the frequency of surveillance 2.3.4.23-2 is specified as "prior to placing the cylinder in the withdrawal position" for 10 and 14 ton cylinders. Because 2 ½ ton cylinders require much less time to fill, a "daily" frequency is specified for this cylinder type. If both cylinder types are used on a given scale in the same day, the functional test must be performed twice - once during the calendar day using the 30B test weights and prior to placing the 10 or 14 ton cylinder in the withdrawal position using the 48X test weights. [SAR Sections 3.15.6.4, 4.3.2.2.6, and 4.3.2.2.14]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.24 HIGH SPEED COMPRESSOR MOTOR LOAD INDICATORS

LCO 2.3.4.24: C-315 High Speed UF_6 compressor motor load indicators in the C-331 and C-315 ACRs shall be operable.

APPLICABILITY: Mode 2 when C-315 High Speed UF_6 compressor motors are operating.

ACTIONS:

Condition	Required Action	Completion Time
A. C-331 ACR compressor motor load indicator is inoperable. OR C-331 ACR is evacuated.	A.1 Verify that the applicable motor load indicator in the C-315 ACR is operable. AND A.2 Continuously station an operator at the C-315 ACR. AND A.3 Restore the motor load indicator to operable status. See TSR 2.3.4.25 for additional actions if the C-331 ACR is evacuated. TSR 1.6.2.2.d does not apply.	8 hours 8 hours 7 days
B. C-315 ACR compressor motor load indicator is inoperable.	B.1 Verify that the applicable motor load indicator in the C-331 ACR is operable. AND B.2 Restore the motor load indicator to operable status. TSR 1.6.2.2.d does not apply.	4 hours 7 days
C. Required action A.1 or A.2 or A.3 not accomplished. OR Required action B.1 or B.2 not accomplished. OR Both Condition A and B exist.	C.1 Shut down the affected compressor motor. OR C.2 Place the affected equipment in Mode 3.	1 hour 1 hour

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.24 HIGH SPEED COMPRESSOR MOTOR LOAD INDICATORS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.24-1	Perform a channel check of the C-331 ACR compressor motor load indicator.	Following compressor motor start.
SR 2.3.4.24-2	Perform a channel check of the C-315 ACR compressor motor load indicator.	Following compressor motor start.

BASIS:

Administrative controls are in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls [SAR Section 4.3.2.2.1]. Because of this administrative control, the motor load indicator systems used with the C-315 high-speed centrifugal compressors no longer meet the TSR selection criteria specified in Section 4.2.3. However, the existing analysis UF_6/hot metal reaction event credits this system for mitigating on-site personnel exposure [SAR Section 4.3.2.2.1]. Therefore, the TSR for this system will be retained until the further analyses are completed.

The motor load indicators provide an indication of various types of failures of the compressors. Using ammeter indications in the C-331 ACR for the individual C-315 high speed compressor motors, operators can quickly identify most abnormalities caused by various malfunctions of the process equipment. Operator training is relied upon to distinguish between load changes associated with normal fluctuations, such as inventory changes, and equipment malfunctions. Compressor load changes can be caused by such events as compressor failures or failures of the primary system pressure boundary that cause inleakage or a release of UF_6. If an ammeter should malfunction, the load changes can be seen on the ammeters for the compressor motor in the C-315 ACR. In the event of evacuation of the C-331 ACR, the C-315 ammeter indications can be used to monitor for load changes that could be representative of an equipment malfunction. This detection of an event and mitigative action by the operator will control the primary pressure and temperature increases to minimize UF_6 releases for on-site personnel. This system is not essential for the off-site public protection.

The surveillance requirement is provided to ensure that, after motor start, the ammeter provides nominal indication of motor load. [SAR Section 3.15.4.4]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.25 HIGH SPEED UF_6 COMPRESSOR MOTOR MANUAL TRIP

LCO 2.3.4.25: The high speed UF_6 compressor motor manual trip shall be operable.

APPLICABILITY: Mode 2 when high speed UF_6 compressors are operating.

ACTIONS:

Condition	Required Action	Completion Time
A. C-331 ACR compressor motor stop button inoperable (not due to loss of DC voltage). OR C-331 ACR is evacuated.	A.1 Verify the applicable C-315 ACR compressor motor stop button is operable. AND A.2 Station an operator at the C-315 ACR. OR A.3 Shutdown affected UF_6 compressor motor. OR A.4 Place affected equipment in Mode 3. See TSR 2.3.4.24 for additional actions if the C-331 ACR is evacuated. TSR 1.6.2.2.d does not apply.	Immediately 8 hours 8 hours 8 hours
B. C-315 ACR compressor motor stop button inoperable (not due to loss of DC voltage).	B.1 Verify the applicable C-331 ACR compressor motor stop button is operable. AND B.2 Restore C-315 ACR compressor motor stop button to operable status. TSR 1.6.2.2.d does not apply.	Immediately 7 days
C. Both Condition A and B apply.	C.1 Notify Cascade Coordinator of potential need to utilize alternate means for applicable compressor shutdown. AND C.2 Station an operator at an established alternate motor shutdown location with communications to the C-331 ACR. OR C.3 Shutdown affected UF_6 compressor motors. OR C.4 Place affected equipment in Mode 3.	Immediately 8 hours 8 hours 8 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.25 HIGH SPEED UF_6 COMPRESSOR MOTOR MANUAL TRIP (continued)

ACTIONS: (continued)

Condition	Required Action	Completion Time
D. Battery/connected cell/charger conditions (other than voltage) found outside surveillance parameters.	D.1 If the AC battery charger is inoperable, verify that the applicable battery is operable. AND D.2 If battery/cell conditions are found outside surveillance parameters, restore battery/cell parameters to within limits. TSR 1.6.2.2.d does not apply	8 hours 90 days
E. C-315 DC voltage potential <105 volts at applicable battery room. OR No DC power at the compressor motor breaker.	E.1 Notify Cascade Coordinator of potential need to utilize alternate means for compressor motor shutdown. AND E.2 Station an operator at an established alternate motor shutdown location with communications to the C-331 ACR. OR E.3 Shutdown affected UF_6 compressor motors. OR E.4 Place affected equipment in Mode 3.	Immediately 8 hours 8 hours 8 hours
F. Required action B.2 or D.2 not accomplished.	F.1 Station an operator at an established alternate motor shutdown location with communications to the C-331 ACR. OR F.2 Shutdown affected UF_6 compressor motors. OR F.3 Place the affected equipment in Mode 3.	8 hours 8 hours 8 hours

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.25 HIGH SPEED UF_6 COMPRESSOR MOTOR MANUAL TRIP (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.4.25-1	Verify C-315 DC bus voltage ≥ 105 volts DC.	Daily
SR 2.3.4.25-2	Verify DC power is available at UF_6 compressor motor breakers.	Daily
SR 2.3.4.25-3	Verify that the battery charger output is > 0 DC amps.	Daily
SR 2.3.4.25-4	Inspect battery terminals and racks for evidence of corrosion and for cell leakage of electrolyte.	Quarterly
SR 2.3.4.25-5	Check that the specific gravity of the pilot cell is ≥ 1.180 corrected to 77°F.	Quarterly
SR 2.3.4.25-6	Visually check the cell electrolyte levels to verify that the level is above the low level indication line and no more than 0.25 inches above the high level indication line.	Quarterly
SR 2.3.4.25-7	Check that the specific gravity of the cells is ≥1.180 corrected to 77°F.	Annually
SR 2.3.4.25-8	Perform a channel functional test of the C-331 and C-315 ACR withdrawal high-speed UF_6 compressor motor manual trip systems.	Prior to restart after each planned compressor motor shutdown.

BASIS:

Administrative controls are in place to prevent operation of the C-315 high-speed centrifugal compressors until further analysis has been performed to identify appropriate preventive and/or mitigative controls [SAR Section 4.3.2.2.1]. Because of this administrative control, the motor load indicator systems used with the C-315 high-speed centrifugal compressors no longer meet the TSR selection criteria specified in Section 4.2.3. However, the existing analysis UF_6/hot metal reaction event credits this system for mitigating on-site personnel exposure [SAR Section 4.3.2.2.1]. Therefore, the TSR for this system will be retained until the further analyses are completed.

The compressor motor manual trip system aids in the prevention and mitigation of UF_6 releases during compressor operations by reducing the operating pressure and temperature to minimize the potential for process system integrity failure and to minimize the release of UF_6 after a failure of the system integrity. The C-315 High speed compressor motors can be tripped from the ACRs in both C-315 and C-331. There are several ways available to trip compressors with various breakers that provide power to the motors. In order to demonstrate reliability of both the ACR compressor motor trip functions, motor trips that are not required to mitigate a transient condition will be performed

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.3.4.25 HIGH SPEED UF_6 COMPRESSOR MOTOR MANUAL TRIP (continued)

BASIS (continued):

at either of the two locations, the C-331 or C-315 ACR, utilizing the motor stop button, or the alternate test, (i.e., tripping the motor breakers prior to compressor motor startup). Either method is satisfactory to demonstrate the operability of the motor trip function. Other available shutdown locations, such as the switchyard, are considered alternate shutdown locations. Because of the number of available trip locations, these alternate locations are not tested periodically.

The channel functional test of the C-331 and C-315 ACR withdrawal high-speed UF_6 compressor motor manual trip system may be accomplished by 1) crediting a successful function of the C-331 or C-315 ACR trip system at the time of the compressor shutdown, and 2) testing the function of the trip location that was not utilized during the planned compressor shutdown. It is permissible to verify functionality via tripping the breaker on a deenergized bus, performing combinations of wiring and relay checks and/or tripping the breaker from the “test” position. In determining the appropriate test method, credit may be taken for portions of the circuitry tested during the preceding compressor motor shutdown/breaker trip (e.g., the breaker mechanism does not necessarily need to be cycled twice to test both the C-315 and the C-331 ACR trip buttons).

Internal resistance of the equipment slows repressurization of the shutdown equipment, allowing inleakage rather than outleakage which will mitigate the release until the necessary valve evolutions can take place to isolate the system from any additional supply of UF_6 and to prepare the system for compensatory actions and repair. In order to initiate a compressor motor shutdown, the DC control and trip power circuit must be operable. However, the failure of the local trip circuit to function on demand does not constitute a significant impact on any of the scenarios where shutdown is assumed to occur at sometime during the scenario. This is due to the numerous alternate and independent means available for disrupting power, i.e., breaker manual trip or C-300/switchyard de-energization of electrical feeders, buses, transformer bays, main switchyard lines. The battery surveillances provide additional assurances that the battery system will be able to deliver the power necessary to trip the compressor motor breakers as long as the system voltage is maintained above 105 volts. [SAR Sections 3.15.4.2 and 3.15.4.3]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.5 GENERAL DESIGN FEATURES

2.3.5.1 UF6 CYLINDER LIFTING FIXTURES

DF 2.3.5.1: UF_6 cylinder slings and lifting fixtures are designed with a structural factor of safety of 5 to 1 based upon the material's ultimate tensile strength.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.5.1-1 Visual inspection for damage	Prior to first use of shift
SR 2.3.5.1-2 Hands-on Inspection (no disassembly required)	Monthly
SR 2.3.5.1-3 Load test at a minimum of 100% of rated capacity.	Biennially

BASIS:

Slings, H-frames, etc used to handle liquid filled UF_6 cylinders are credited for prevention of the liquid cylinder drop and rupture accident scenario. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1, 2, and 3 are performed to meet the requirements of OSHA 1910.184 [SAR Sections 3.15.6.2 and 4.3.2.2.15]

2.3.5.2 CRANE DESIGN

DF 2.3.5.2: The liquid UF_6 cylinder handling cranes are designed and maintained not to fail in a manner to cause a primary system integrity failure. [SAR Sections 4.3.2.2.4, 4.3.2.2.15, 4.3.2.5.2, and 4.3.2.5.3]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.5 GENERAL DESIGN FEATURES

2.3.5.2 CRANE DESIGN (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.5.2-1	Visual inspection for damage	Prior to first use of shift
SR 2.3.5.2-2	Hands-on Inspection (no disassembly required)	Monthly
SR 2.3.5.2-3	Hands-on Inspection (some disassembly required)	Annually
SR 2.3.5.2-4	Load test at a minimum of 100% of rated capacity.	Biennially

BASIS:

Cranes used to handle liquid filled UF_6 cylinders are credited for prevention of the liquid cylinder drop and rupture accident scenario. Visual inspection will detect obvious defects which could cause the cylinder drop accident scenario. Surveillance requirements 1, 2, and 3 are performed to meet the requirements of OSHA 1910.179. [SAR Sections 3.15.6.2 and 4.3.2.2.15]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.5 GENERAL DESIGN FEATURES

2.3.5.3 UF_6 CYLINDERS

DF 2.3.5.3: UF_6 cylinders (2½-ton and larger) are as a minimum designed to a MAWP of 100 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.5.3-1 UF_6 cylinders (2½-ton and larger) shall be hydrostatically tested at 200% of MAWP. Note: Cylinders that are full of UF_6 but have an expired hydrostatic test may be heated for removal of the UF_6, but shall be hydrostatically tested prior to refilling.	5 years

BASIS:

UF_6 cylinder MAWP equal to or greater than 100 psig is an assumption used in several accident analysis scenarios. [SAR Sections 3.15.6.1, 4.3.2.2.4, 4.3.2.2.11, 4.3.2.5.2, and 4.3.2.5.3]

2.3.5.4 UF6 CYLINDER PIGTAILS

DF 2.3.5.4: Pigtails are designed to withstand at least 400 psig.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.3.5.4-1 Pigtails shall receive a post fabrication inspection and hydrostatic test to at least 400 psig.	Prior to initial use.

BASIS:

This design feature helps minimize the possibility of the initiator of the “pigtail failure” accident scenario. [SAR Sections 3.15.4.5, 4.3.2.2.4 and 4.3.2.2.11]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

2.3.5 GENERAL DESIGN FEATURES

2.3.5.5 SCALE CART DESIGN

DF 2.3.5.5: The scale carts are designed with a minimum capacity of 20 tons and have a "low boy" design. The scale carts that carry liquid UF_6 are designed and maintained not to fail in a manner that could cause primary system integrity failure.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.5.5-1	Visual inspection of the scale cart for structural damage, degradation, cracks, distorted members and loose fasteners.	Biennially

BASIS:

This design feature minimizes the possibility of the "liquid cylinder rupture" accident scenario. [SAR Sections 3.15.6.3, 4.3.2.2.4, 4.3.2.2.15, and 4.3.2.5.3]

2.3.5.6 UF_6 CONDENSER AND ACCUMULATOR MINIMUM WALL THICKNESS

DF 2.3.5.6: The withdrawal area UF_6 condensers and accumulator vessels have the minimum required metal thicknesses in accordance with ASME requirements.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.3.5.6-1	Visual inspection, including thickness measurements, shall be taken on the withdrawal area UF_6 condensers and UF_6 accumulators at least every five years in order to verify the vessel wall has not been reduced below minimum required metal thicknesses.	Five Years

BASIS:

Ensuring vessel integrity of the UF_6 condensers and accumulators helps prevent a UF_6 release. The minimum thicknesses for the condensers and accumulators were established in accordance with the 1986 edition of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Surveillance frequency and monitoring points are established and inspections conducted in accordance with the current revision of the National Board Inspection Code (NIBC). [SAR Section 3.15.4.5]

SECTION 2.3 SPECIFIC TSRs FOR PRODUCT AND TAILS WITHDRAWAL FACILITIES

TSR 2.3 Appendix A
Maximum weight limits for UF_6 cylinders.

Model No.	Cylinder Nos. or Type	Max. Fill Limit for Shipment[1] (lbs UF_6)	Max. Fill Limit for In-Plant Tails Storage[2] (lbs UF_6)
12B	All	460	475
	Text Deleted		
30B	All	5020	—
	Text Deleted		
	Text Deleted		
	Text Deleted		
	Text Deleted		
48G	121,926 - 149,999	26840	27920[3]
48G	160,000 and up	26840	27920[3]
48H	151,001- 154,144	27030	28000
48HX	150,001-151,000	27030	28000
48Y	All	27560	28000
48OM	111,821-121,925	26840	27920[3]
	Text Deleted		
48X	All	21030	21870

1. All fill limits for shipments are based on 5% free volume, 99.5% purity, and a maximum vaporization temperature of 250°F per USEC-651.
2. Fill limits for in-plant tails storage cylinders are based on 3% free volume and a maximum vaporization temperature of 235°F except for 48Y, 48HX, and 48H cylinders whose in-plant tails storage limits have been further reduced to ensure the maximum amount of UF_6 assumed in the accident analysis (28,000 lbs) is not exceeded.
3. The maximum fill limit for in-plant tails storage for the 48OM and 48G cylinders may be increased to the maximum of 28,000 lbs provided the cylinder will maintain a minimum 3 percent free volume when heated to 235°F based on the actual certified cylinder volume. Cylinders with 8,695-lb water capacity or greater may be filled with 28,000 lbs of high purity UF_6 tails and maintain a minimum 3 percent free volume when heated to 235°F.

SECTION 2.4

SPECIFIC TSRs
FOR
ENRICHMENT CASCADE FACILITIES

(C-331, C-333, C-335, C-337 AND C-310 UP TO NORMETEX PUMP SUCTION)

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.1 OPERATIONAL MODES:

Mode Number	Mode Name	Definition
Cascade 1	Below Atmospheric Pressure	Stage high-side pressure is < 14.5 psia for "000" cells and C-310 cells, and < 13.5 psia for "00" cells.
Cascade 2	Above Atmospheric Pressure	Stage high-side pressure is ≥ 14.5 psia for "000" cells, and C-310 cells, and ≥ 13.5 psia for "00" cells.
Cascade 3	Not In Use	System at UF_6 negative.
F/S 1	Freeze	The freeze mode allows UF_6 from the "B" line to enter the freezer/sublimer vessel at a controlled rate and to be stored in a solid state in a freezer/sublimer vessel.
F/S 2	Sublime	In the sublime mode, UF_6 is returned to the cascade from the freezer/sublimer vessel by subliming solid to gas at a controlled rate.
F/S 3	Cold Standby	The cold standby mode maintains UF_6 in the freezer/sublimer vessel in the frozen state and is generally the standby condition whenever the freezer/sublimer system is not being used. The standby condition is attained by using the R-114 system as in the freeze mode and isolating the UF_6 supply and return.
F/S 4	Hot Standby	The hot standby mode of operation is attained by using the R-114 system as in the sublime mode (except that the R-114 pump is off) and isolating the UF_6 supply and return.
F/S 5	Modified Hot Standby	The modified hot standby mode is designed to occur as the result of a high-high UF_6 weight trip. It is attained by using the R-114 system as in the sublime mode (except that the R-114 pump is off), isolating the process supply lines, and opening the return valve, vent valve, and the UF_6 weight control valve.
F/S 6	Out of Service	R-114 drained from vessel.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.2 SAFETY LIMITS

2.4.2.1 FREEZER/SUBLIMER UF_6 WEIGHT LIMIT

SL 2.4.2.1: 10MW Vessel: The UF_6 weight shall not exceed 11,900 pounds.
20MW Vessel: The UF_6 weight shall not exceed 22,400 pounds.

APPLICABILITY: Modes: All F/S Modes

BASIS:

The potential exists for the stress rupture of the freezer/sublimer vessel or R-114 tubes due to the overfilling of the freezer/sublimer vessel with UF_6 and subsequent reheating. Studies have shown that limiting freezer/sublimer UF_6 inventory to 11,900 pounds or less for a 10MW freezer/sublimer, and 22,400 pounds for a 20MW vessel, is sufficient to prevent bridging of solid UF_6 between adjacent R-114 tubes or between R-114 tubes and the vessel during the freeze mode of operation. Absence of bridging removes the danger of stress rupture of the R-114 tubes or the freezer/sublimer vessel (due to thermal expansion of the UF_6) during the sublime mode of operation. [SAR Section 3.15.3.5.3]

2.4.2.2 COOLANT (R-114) OVERPRESSURE PROTECTION SYSTEMS

SL 2.4.2.2: Coolant pressure shall not exceed the values specified in the following table:

Equipment Specification	Safety Limit (psig)
C-331, C-333, C-335, and C-337 Cascade Cell Coolant	330 (300 psig MAWP)
C-337 “B” Boosters, C-331 and C-335 Surge and Waste Boosters	330 (300 psig MAWP)
C-335 “A” Boosters, C-333 “B” Booster, C-331 #3 Low Speed P&E Pump, C-331 and C-333 High Speed P&E Pumps, C-335 and C-337 Dual Speed P&E Pumps	330 (300 psig MAWP)
C-310 Cascade Cell Coolant	220 (200 psig MAWP)
C-331 “A” Booster, C-331 #1&#2, C-333, and C-337 Low Speed P&E Pumps	220 (200 psig MAWP)

APPLICABILITY: Modes: All Cascade Modes

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.2 SAFETY LIMITS

2.4.2.2 COOLANT (R-114) OVERPRESSURE PROTECTION SYSTEMS (continued)

BASIS:

Overpressurization and rupture of the coolant system into the UF_6 system could result in the subsequent loss of UF_6 containment due to overpressurization of the UF_6 enrichment system. There is reasonable assurance the integrity of the coolant system will not be breached at the ASME Boiler and Pressure Vessel (B & PV) Code, Section VIII, maximum allowable pressure during the relief transient (110 percent of the Maximum Allowable Working Pressure [MAWP]) [SAR Section 3.15.3.4.3].

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.2 SAFETY LIMITS

2.4.2.3 CASCADE PRESSURE LIMIT

SL 2.4.2.3 Cascade pressures shall be less than 40 psia.

APPLICABILITY: All Cascade modes.

BASIS:

Overpressurization and rupture of the cascade system could result in a release of UF_6 to the cell housing and potentially to the atmosphere. This safety limit is based on a postulated cascade system rupture pressure of 40 psia. This value is less than 110% of the design pressure of the limiting cascade system components, the rupture of which could release significant quantities of UF_6. Given the normal maximum system operating pressure of 25 psia, there is reasonable assurance that the cascade system will remain below this safety limit during anticipated transients.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.1 FREEZER/SUBLIMER HIGH-HIGH WEIGHT TRIP SYSTEM

LCS 2.4.3.1: 10MW Vessel: The freezer/sublimer high-high weight trip system actuation net weight (UF_6 and R-114) shall not exceed 10,000 pounds.
20MW Vessel: The freezer/sublimer high-high weight trip system actuation net weight (UF_6 and R-114) shall not exceed 20,000 pounds.

LCO 2.4.3.1: The freezer/sublimer high-high weight trip system shall be operable.

APPLICABILITY: Modes: F/S 1, F/S 3

ACTIONS:

Condition	Required Action	Completion Time
A. One detection/initiation channel inoperable.	A.1 Restore operability. NOTE: Completion of current freeze cycle and subsequent cold standby storage (mode F/S 3) is permitted.	Prior to re-entry into mode F/S 1.
B. Both detection/initiation channel(s) inoperable.	B.1 Place the freezer/sublimer in mode F/S 4, F/S 5 or F/S 6 AND B.2 Restore operability.	1 hour Prior to re-entering mode F/S 1 or F/S 3
C. A-line motor-operated valve is disabled in the closed position. **NOTE:** The A-line motor-operated valve shall not be intentionally disabled in mode F/S 1. This may only occur in mode F/S 3.	C.1 Initiate operator monitoring of freezer/sublimer weight. OR C.2 Place the freezer/sublimer in mode F/S 4. OR C.3 Place the freezer/sublimer in mode F/S 6.	Immediately Immediately Immediately
D. The system is inoperable due to other component inoperability.	D.1 Place the freezer/sublimer in mode F/S 4. OR D.2 Place the freezer/sublimer in mode F/S 6.	4 hours 4 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.1 FREEZER/SUBLIMER HIGH-HIGH WEIGHT TRIP SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.3.1-1	10MW Vessel: Test the freezer/sublimer high-high weight trip system to verify that each detection/initiation channel will activate and place the freezer/sublimer in the modified hot standby mode at or below 10,000 pounds net weight.	Quarterly
SR 2.4.3.1-2	20MW Vessel: Test the freezer/sublimer high-high weight trip system to verify that each detection/initiation channel will activate and place the freezer/sublimer in the modified hot standby mode at or below 20,000 pounds net weight.	Quarterly
SR 2.4.3.1-3	Calibrate the freezer/sublimer high-high weight trip system detection/initiation instrumentation.	Annually

BASIS:

The potential exists for the stress rupture of the R-114 tubes due to the overfilling of the freezer/sublimer vessel with UF_6 and subsequent reheating. For this reason, the freezer/sublimer systems have dual weight monitoring systems designated as safety systems. Upon activation of the high-high weight trip, the freezer/sublimer system will automatically be placed in the modified hot standby mode, thus precluding any additional accumulation of material. [SAR Section 3.15.3.5.3]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.2 FREEZER/SUBLIMER UF6 VENT LINE MANUAL BLOCK VALVE

LCO 2.4.3.2: The freezer/sublimer UF_6 vent line manual block valve shall be sealed in the open position.

APPLICABILITY: Modes: F/S 1, F/S 3, F/S 5

ACTIONS:

Condition	Required Action	Completion Time
A. The UF_6 vent line manual block valve is discovered unsealed and/or closed.	A.1 Ensure the valve is open.	Immediately.
B. Action item A satisfactorily completed.	B.1 Reseal the valve.	8 hours
C. Action item A or action item B not satisfactorily completed.	C.1 Place the freezer/sublimer in mode F/S 6.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.4.3.2-1 Visually inspect the UF_6 vent line manual block valve to verify it is sealed open.	Quarterly

BASIS:

Any noncondensible gases are allowed to return to the cascade cell "A" bypass through one-inch automatic UF_6 vent valve and a two-inch vent line. If the automatic UF_6 vent valve fails to open, a rupture disc is provided as a means of pressure relief for the UF_6 side of the freezer/sublimer. Without the manual vent valve open to the rupture disc and the automatic vent valve, this relief protection for the freezer/sublimer is not provided.

The block valve is sealed open, except for maintenance, to assure the rupture discs are provided with a relief path to the A-line of the cascade. This assures the pressure relief system can vent unwanted pressure upon activation. [SAR Section 3.15.3.4.3]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.3 FREEZER/SUBLIMER R-114 VENT LINE MANUAL BLOCK VALVE

LCO 2.4.3.3: The freezer/sublimer R-114 vent line manual block valve shall be sealed in the open position.

APPLICABILITY: Modes: F/S 1, F/S 3

ACTIONS:

Condition	Required Action	Completion Time
A. The R-114 vent line manual block valve is discovered unsealed and/or closed.	A.1 Ensure the valve is open.	Immediately.
B. Action item A satisfactorily completed.	B.1 Reseal the valve.	8 hours
C. Action item A or action item B not satisfactorily completed.	C.1 Place the freezer/sublimer in mode F/S 6.	Immediately

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.4.3.3-1 Visually inspect the R-114 vent line manual block valve to verify it is sealed open.	Quarterly

BASIS:

The block valve is sealed open to assure the rupture discs are exposed to system pressure. This assures the availability of the pressure relief system to activate in the presence of unwanted pressure. [SAR Section 3.15.3.8]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.4 R-114 COOLANT OVERPRESSURE CONTROL SYSTEM

LCS 2.4.3.4: The R-114 coolant rupture discs shall actuate at or below the location-specific values tabulated below:

Equipment Specification	LCS (psig)
C-331, C-333, C-335, and C-337 Cascade Cell Coolant	315 (300 psig MAWP)
C-337 “B” Boosters, C-331 and C-335 Surge and Waste Boosters	315 (300 psig MAWP)
C-335 “A” Boosters, C-333 “B” Booster, C-331 #3 Low Speed P&E Pump, C-331 and C-333 High Speed P&E Pumps, C-335 and C-337 Dual Speed P&E Pumps	315 (300 psig MAWP)
C-310 Cascade Cell Coolant	210 (200 psig MAWP)
C-331 “A” Boosters, C-331 #1 & #2, C-333, and C-337 Low Speed P&E Pumps	210 (200 psig MAWP)

LCO 2.4.3.4: The R-114 coolant overpressure control system shall be operable.

APPLICABILITY: Modes: Cascade 1*, Cascade 2* (* - Only when process motors are energized and an R-114 negative has not been established on the affected cell[s].)

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.4 R-114 COOLANT OVERPRESSURE CONTROL SYSTEM (continued)

ACTIONS:

Condition	Required Action	Completion Time
A. R-114 coolant overpressure control system inoperable for reason other than B or D below.	A.1 An operator shall continuously monitor the R-114 system pressure/temperature in order to take action to lower pressure.	Immediately
B. The R-114 coolant overpressure control system manual isolation valve found unsealed or closed.	B.1 Ensure the valve is open. AND B.2 Reseal the valve.	Immediately 8 hours
C. Action item B not satisfactorily completed.	C.1 An operator shall continuously monitor the R-114 system pressure/temperature in order to take action to lower pressure.	Immediately
D. The cavity vent port between tandem-mounted rupture discs (not all locations have this feature) is discovered not open to atmosphere.	D.1 Restore opening.	4 hours
E. Action item D not satisfactorily completed.	E.1 An operator shall continuously monitor the R-114 system pressure/temperature in order to take action to lower pressure.	Immediately

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.4 R-114 COOLANT OVERPRESSURE CONTROL SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.3.4-1	Visually inspect the R-114 coolant overpressure control system manual isolation valve to ensure it is sealed open.	Quarterly
SR 2.4.3.4-2	Visually inspect the cavity vent port between tandem-mounted rupture discs to ensure it is open to atmosphere.	Quarterly

BASIS:

The ASME code requires that overpressure relief be provided by a device stamped at or below the MAWP and sized such that the subsequent transient pressure will be limited to a maximum of 110% of MAWP when a single relief path is used. ASME Boiler and Pressure Vessel (B & PV) code allows rupture discs to have a ± 5% burst tolerance. Rupture discs stamped at MAWP will therefore burst at or below 105% of MAWP. Thus, the LCS is set at 105% of MAWP. To comply with these standards, pressure relief devices are purchased and installed on the cascade cell coolant condensers with stamped ratings at or below the MAWP. If the R-114 coolant overpressure control system is inoperable per Conditions A, C, or E, the Required Actions for an operator to continuously monitor the R-114 system pressure/temperature as allowed by ASME code will be in accordance with procedures to provide pressure relief protection during the time when the system is inoperable. The procedure shall ensure that when the system does not have an operable pressure relief path, an operator shall continuously monitor the pressure/temperature conditions of the R-114 system and shall be capable of responding promptly to reduce the pressure. [SAR Section 3.15.3.4.2]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

2.4.3.5 Text Deleted

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.1 UF_6 RELEASE DETECTION SYSTEM

LCO 2.4.4.1: At least the minimum number of the UF_6 release detection heads inside the areas of the cascade stated in the ACTIONS table below shall be operable prior to steady state operations above atmospheric pressure.

APPLICABILITY: Modes: Cascade Mode 2. Other cascade associated equipment, steady state operations above atmospheric pressure.

ACTIONS:

Condition	Action	Completion Time
A. Fewer than the minimum of 3 of the UF_6 release detection heads for each cell housing roof and cell exhaust duct in buildings C-331 and C-335 are operable.	A.1 Perform a continuous UF_6 smoke watch on the cell or cells affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
B. Fewer than the minimum of 3 of the UF_6 release detection heads for each cell housing roof and inter cell housing in buildings C-333 and C-337 are operable.	B.1 Perform a continuous UF_6 smoke watch on the cell or cells affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
C. Fewer than the minimum of 3 of the UF_6 release detection heads in each defined section of the cell bypass are operable.*	C.1 Perform a continuous UF_6 smoke watch on the cell bypass or bypasses affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
D. Fewer than the minimum of 3 of the UF_6 release detection heads in each defined section of the unit bypass are operable.*	D.1 Perform a continuous UF_6 smoke watch on the unit bypasses affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
E. Either of the minimum of 2 UF_6 detector heads (the detector head located in a B Booster Pump housing, or the detector head located over the pump) inoperable.	E.1 Perform a continuous UF_6 smoke watch on the B Booster Pump affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
F. Fewer than the minimum of 1 of the UF_6 release detection heads in each end of the interbuilding tie-line housing are operable.	F.1 Perform a continuous UF_6 smoke watch on the interbuilding tie-line housing end(s) affected by the PGLD inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour

*"Defined Section" defined in Basis.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.1 UF_6 RELEASE DETECTION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.1-1	"Test fire" the UF_6 release detection system heads.	Twice each shift.
SR 2.4.4.1-2	Physically actuate ("smoke test") the UF_6 release detector heads to verify alarms.	Annually

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as "smoke." This system detects the presence of this "smoke" and sounds alarms in the ACR. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration.

In the event of a failure of the UF_6 release detection system, the stationing of an operator at the affected equipment would assure monitoring of the system to determine if any outleakage of UF_6 occurs and would provide the surveillance capability until the system could be repaired or the UF_6 process equipment brought below atmospheric pressure. The real safety hazard is when UF_6 is released into the area inhabited by plant personnel. UF_6 released inside the heated housing is not of significant safety concern unless it leaks from the (non-air-tight) housing. Thus, a smoke watch posted outside the housing, watching for "smoke" escaping the heated housing into the occupied spaces, is capable of providing an adequate level of safety.

Firing the heads at least once in an eight-hour interval will maintain sensitivity of the heads in elevated temperatures such as that found in the cell housings. Detector heads are fired by supplying voltage to the head until it alarms. This can be done by suppling voltage sufficient to fire the detector head. The firing of the heads will be recorded; this action discovers heads which are failed.

Normal operational pressure transients may temporarily take the local process pressure to a value consistent with mode Cascade 2 values. These pressure transients typically work their way through those portions of the cascade that, by the optimized gradient, operate at mode Cascade 1 pressures quickly. This LCO is not intended to require UF_6 release detection operability to accommodate these transients. Instead, this LCO is intended to require system operability prior to intentionally increasing cascade pressure to mode Cascade 2 values.

The cell bypass is perpendicular to cells and traverses the length of the individual unit. "Defined section" means that portion of the cell bypass housing between any pair of opposite cells. Opposite cells are defined as 1 and 2, 3 and 4, 5 and 6, etc.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.1 UF_6 RELEASE DETECTION SYSTEM (continued)

BASIS (continued):

The unit bypass are perpendicular to the cell bypasses. "Defined section" of the unit bypass means that portion of the unit bypass between centerlines of adjacent units or from the centerline of the first or the last unit to the end of the housing. [SAR Section 3.15.7.3, 4.3.2.1.1, 4.3.2.1.2, 4.3.2.1.3, 4.3.2.1.7]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.2 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.4.4.2a: Criticality accident detection shall be operable.

APPLICABILITY: In areas, equipment, or processes which contain greater than 700 grams of ^{235}U at an enrichment ≥ 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. Areas, equipment, or processes not covered by criticality accident detection.	A.1 Implement the following for areas, equipment, or processes applicable to this LCO and that are not otherwise covered by criticality accident detection. A.1.1 Discontinue cell maintenance activities that require breach of the containment boundary of cells containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Monitor temperatures/pressures in the cascade cells containing UF_6 enriched to ≥ 1 wt % ^{235}U hourly to maintain UF_6 in the gaseous state. AND A.1.3 Waste containing uranium enriched to ≥ 1 wt % ^{235}U shall not be handled. AND A.1.4 Wet air pumps shall not be used for evacuation of cells containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.5 Monitor temperature and pressure of surge drums containing UF_6 enriched to ≥ 1 wt % ^{235}U hourly to maintain inventory in gaseous state. AND A.1.6 Place freezer/sublimers containing UF_6 enriched to ≥ 1 wt % ^{235}U in mode F/S 3, F/S 4, F/S 5 or F/S 6. AND A.1.7 When implementing these actions in C-310, perform Required Actions A.1.1, A.1.2, A.1.3, A.1.4, A.1.5, A.2.1, A.2.2, A.3, B.1.1 and B.1.2, of TSR 2.3.4.7a.	Immediately
	AND A.2.1 Evacuate area within the area not covered by detection capability. AND A.2.2 Restrict access to area evacuated in A.2.1.	Immediately
	AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate.	Immediately
B. Areas, equipment, or processes not covered by criticality accident detection.	B.1.1 Restore criticality accident detection by installing portable CAAS unit providing required criticality accident detection and same alarms as fixed unit. OR B.1.2 Restore criticality accident detection to operable status. TSR 1.6.2.2(d) is not applicable.	48 hours (effective when NRC assumes regulatory authority)

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.2 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.4.4.2a-1 Calibrate CAAS system equipment.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the cascade involve freeze-out of UF_6 and moderator introduction. The action items maintain the cascade in steady state operations to limit the potential for these concerns to the extent possible. Ceasing the movement of fissionable waste prevents a criticality associated with waste storage. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of detection will establish protection. [SAR Sections 3.15.7.1 and 4.3.2.6]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.2 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.4.4.2b: Criticality accident alarm shall be operable (audible).

APPLICABILITY: In areas where the maximum foreseeable absorbed dose in free air exceeds 12 rad, except areas in permit-required confined spaces, cell housings associated with cells that are running, and localized areas of inaudibility.

ACTIONS:

Condition	Required Action	Completion Time
A. Area does not have an audible criticality accident alarm.	A.1 Implement the following for areas, equipment, or processes where a criticality accident could result in a maximum foreseeable dose exceeding 12 rad in the area of inaudibility and LCO 2.4.4.2a or 2.2.4.3a applies. A.1.1 Discontinue cell maintenance activities that require breach of the containment boundary of cells containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.2 Monitor temperatures/pressures in the cascade cells containing UF_6 enriched to ≥ 1 wt % ^{235}U hourly to maintain UF_6 in the gaseous state. AND A.1.3 Waste containing uranium enriched to ≥ 1 wt % ^{235}U shall not be handled. AND A.1.4 Wet air pumps shall not be used for evacuation of cells containing UF_6 enriched to ≥ 1 wt % ^{235}U. AND A.1.5 Monitor temperature and pressure of surge drums containing UF_6 enriched to ≥ 1 wt % ^{235}U hourly to maintain inventory in gaseous state. AND A.1.6 Place freezer/sublimers containing UF_6 enriched to ≥ 1 wt % ^{235}U in mode F/S 3, F/S 4, F/S 5 or F/S 6. AND A.1.7 Perform Required Actions A.1.1 and A.1.2 of TSR 2.2.4.3b. AND A.1.8 When implementing these actions in C-310, perform Required Actions A.1.1, A.1.2, A.1.3, A.1.4, A.1.5, A.2.1, A.2.2, A.3, and B.1 of TSR 2.3.4.7b. AND A.2.1 Evacuate area of inaudibility. AND A.2.2 Restrict access to area evacuated in A.2.1. AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate, or a radio in constant communication with the Central Control Facility.	Immediately Immediately Immediately
B. Area does not have an audible criticality accident alarm.	B.1 Restore criticality accident alarm to operable status. TSR 1.6.2.2(d) is not applicable.	48 hours (effective when NRC assumes regulatory authority)

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.2 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.2b-1	Test the CAAS and building horns.	Annually
SR 2.4.4.2b-2	Verify that the CAAS air accumulator supply pressure to the building horns is greater than or equal to that necessary to sound all building horns for at least 120 seconds based on the number of accumulators in service. C-333/C-337 Number of accumulators in service — Minimum pressure 4 — 137 psig 3 — 143 psig C-331/C-335 Number of accumulators in service — Minimum pressure 2 — 129 psig C-331/C-335 Tie Line Number of accumulators in service — Minimum pressure 1 — 121 psig	Quarterly

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. Audibility is not provided for areas in permit-required confined spaces, cell housings associated with cells that are running, and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate. One person remains outside the area and maintains contact with personnel in the area. Evacuation of the area of inaudibility and restricting access to those areas will eliminate the potential for increased consequences due to personnel not hearing an alarm. Criticality concerns with the cascade involve freeze-out of UF_6 and moderator introduction. The action items maintain the cascade in steady state operations to limit the potential for these concerns to the extent possible. Ceasing the movement of fissile waste prevents a criticality associated with waste storage. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster. Providing

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.2 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

BASIS (continued):

another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of inaudibility will establish protection. [SAR Sections 3.15.7.1, 4.3.2.6, 5.2.2.5]

The CAAS air accumulators provide for 120 seconds of horn actuation when at their minimum acceptable pressure based on the number of accumulators in service. Electronic horns are also installed in some areas. These horns have battery backup power supplies which will provide for at least 120 seconds of horn actuation even if off-site power is lost.

The annual surveillance of the CAAS building horns consists of placing the cluster in the test mode with a keyswitch, and manually causing two detector modules to generate radiation readings above the alarm setpoint. The cluster electronics determines that this meets the high radiation alarm criteria and propagates a high radiation alarm signal to the rest of the system. This signal activates the high radiation alarm light and bell in C-300 and activates the building CAAS horns. Each horn is qualitatively verified to be operating. This test is a horn functional test and each module combination is tested to generate the high radiation signal.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.3 CASCADE EQUIPMENT ASSAY LIMITATIONS

LCO 2.4.4.3: Cascade ^{235}U assay shall not exceed the values listed in the table below:

Equipment	Assay Limit (wt % ^{235}U)
20-MW Freezer/Sublimer Vessels	2.35
24-inch Alumina Traps	1.80
All other equipment	5.5 or follow NCSA applicable to the facility, operation or item of equipment

APPLICABILITY: Modes: All

ACTIONS:

Condition	Required Action	Completion Time
A. Assay exceeds stated limit.	A.1 Initiate actions to reduce assay.	Immediately.

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.4.4.3-1 Measure product stream assay.	Twice per shift

BASIS:

NCS analyses have shown these assay limits to be safe and NCSA controls are in place to prevent exceeding these limits [SAR Section 5.2, Appendix A]. Periodic measurement of the product stream assay, which has the greatest potential for variation with time, provides reasonable assurance that overall plant assays are within limits.

The on-line machines are point calibrated using an assay sample standard incorporated into the machine. The calibration is essentially continuous, so no periodic calibrations are specified.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE

LCO 2.4.4.4: Moderation control shall be maintained when deposits of UO_2F_2 in a pipe or component listed in TSR 2.4, Appendix A are estimated to be greater than the safe mass as determined by TSR 2.4, Appendix B.

APPLICABILITY: Modes: Cascade 1 and 2 when uranium assay is ≥ 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. UO_2F_2 deposit greater than the safe mass with the deposit in a fluorinated (including chemical treatment) environment.	A.1 Continue to maintain a fluorinating environment for the deposit. AND A.2 Initiate actions to determine the cause of the deposit and its significance. AND A.3 Establish and document a plan of action. TSR 1.6.2.2(d) is not applicable.	Immediately Immediately 30 Days
B. UO_2F_2 deposit greater than the safe mass with the deposit not in a fluorinated environment (cascade cell off-stream)	B.1.1 Establish a dry gas blanket at ≥14 psia. AND B.1.2 Remove equipment containing the deposit from the cascade in accordance with TSR 2.5 OR B.2.1 Establish a dry gas blanket at ≥14 psia. AND B.2.2 Repair the leak in accordance with the requirements of the NCSA for the repair, maintaining the dry gas blanket as specified. AND B.2.3. Initiate chemical treatment activities or continue ACTION A.1 or B.1, with removal of equipment to be completed within 135 days.	Within 8 hours after a fluorinating environment is removed (UF_6 negative). 180 days Within 8 hours after a fluorinating environment is removed (UF_6 negative). 45 days Immediately following completion of the repair and removal of dry gas blanket.
C. UO_2F_2 deposit greater than the safe mass not in a fluorinated environment, system is in a shutdown mode, and coolant pressure ≤ RCW pressure.	C.1 Increase coolant pressure to > RCW pressure. OR C.2 Drain RCW from coolant condenser.	4 hours 16 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.4-1	Verify that cell coolant pressure is > building RCW pressure	Each shift when a UO_2F_2 deposit greater than the safe mass exists and RCW not drained.
SR 2.4.4.4-2	Monitor the system pressure and adjust pressure to ≥ 14 psia.	Each shift when dry gas blanket required by Condition B.
SR 2.4.4.4-3	Monitor the size of the deposit.	Quarterly when a UO_2F_2 deposit greater than the safe mass exists in a fluorinated environment (Condition A)
SR 2.4.4.4-4	Non-destructive assay survey of unit bypasses, unit drops, cell bypasses, and cell drops for the presence of uranium deposits.	Quarterly

BASIS:

The uranium enrichment cascade (that portion operating above 1.0 wt % ^{235}U) is an operation which relies on moderation control to ensure subcriticality. Within the large geometries offered by the process equipment, the only parameter being controlled is moderation. Cascade deposits of UO_2F_2 and freezeout of UF_6 are an expected result of normal operation. Within the range of enrichments possible at PGDP, criticality of a deposit is not possible regardless of the deposit size provided the deposit remains unmoderated.

If deposits of UO_2F_2 form in equipment other than that specified in Appendix A or if the UO_2F_2 deposit has a uranium mass less than the safe mass as determined by Appendix B, then there are no NCS concerns and the deposit may be remediated at the discretion of the operating organization. Deposits determined by process parameters and/or other indications to be freezeouts of UF_6 may also be remediated at the discretion of the operating organization.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

BASIS (continued):

UF_6, F_2, and ClF_3 react with available water more readily than UO_2F_2 absorbs water; thus, any water entering the cascade will preferentially react with UF_6 to form more UO_2F_2 rather than react with UO_2F_2 to form hydrates (moderated forms) of UO_2F_2. HF gas formed as a byproduct of the water-UF_6 reaction cannot liquify to moderate a deposit. Thus, a UO_2F_2 deposit cannot become moderated if it is being continuously fluorinated (i.e., with UF_6), and moderation is not a concern until the cell is taken off-stream and evacuated of UF_6. Thus, provided the wet air in-leakage is of small enough magnitude to be tolerated by the operating equipment (without unacceptable compressor surging, etc.), continued fluorination of the deposit provides nuclear criticality safety by preventing moderation of the deposit. The cell chemical treatment process also provide the same level of moderation control. For a non-fluorinating environment laboratory studies show that ambient conditions (i.e., relative humidity, temperature) limit the hydrogen to uranium ratio (H/U) in a deposit to a maximum of 4.

The fact that a UO_2F_2 deposit in an operating cell is not a nuclear criticality safety concern also explains the limited scope of and frequency for the surveillance requirement. Wet air in-leakage in an operating cell would readily announce itself (in the form of changing motor loads, compressor surging, line recorders, stage control valve positions, A-suction pressures, etc.). Since larger wet air in-leakages announce themselves readily and continuously fluorinated UO_2F_2 deposits of any magnitude pose no criticality safety concern, a quarterly surveillance for UO_2F_2 deposits is appropriate for early detection of such deposits and followup surveys for prudent remediation.

Once identified, the growth of a deposit is monitored quarterly to assure that the deposit does not become sufficiently large to become an operational problem or a cascade structural concern. The maximum allowable size of the deposit is primarily dependent on its location and will be determined as a part of the surveillance of the deposit. Operational experience suggests that quarterly surveillance by NDA methods is adequate to monitor the size of the deposit in process piping, expansion joints and valves. NDA is of limited value (e.g., quantification of deposit size) for compressors, converters, process gas coolers and freezer sublimers. The size of a deposit in a freezer sublimer can be determined by the remaining weight when the F/S has been emptied of UF6. Deposits in axial and centrifugal compressors are detected by the damage the deposits cause to the impeller or by deblading. Deposits in the converters are determined by the impact of the deposit on the pressure drop across the converter. Deposits in the process gas cooler are identified by the operator as degraded performance and are located by radiation survey.

For shutdown cells moderation control can also be provided by a dry gas (plant air or nitrogen) blanket over the deposit. Once a system has been isolated from the cascade and filled to atmospheric pressure with a dry gas blanket, normal atmospheric pressure fluctuations will cause minor in and out flow through any existing system leaks. Analyses have demonstrated that this

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

BASIS (continued):

"breathing" of the cell will not significantly affect deposit moderation even over a period much longer than the 180 days to which this condition is limited. The daily surveillance demonstrates that the gas blanket is maintained as assumed in the analyses.

The potential for moderation from RCW system water is precluded by the two physical barriers (RCW to coolant and coolant to cascade) and either by maintaining the coolant system pressure greater than the RCW pressure or by draining the coolant condenser.

If the cascade component(s) with the deposit are removed from the cascade, the control of the component(s) is in accordance with the provisions of TSR 2.5 [SAR Section 5.2, Appendix A]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.5 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM

LCO 2.4.4.5: The automatic fire suppression (sprinkler) systems in process buildings C-331, C-333, C-335 and C-337 (exclusions: the dry-pipe sprinkler systems in C-333-A and C-337-A) shall be operable.

APPLICABILITY: Modes: Cascade 1 through Cascade 3.

ACTIONS:

Condition	Required Action	Completion Time
A. An automatic fire suppression system or a portion of automatic fire suppression system is inoperable.	A.1 Restore the automatic fire suppression system to operable status.	2 hours
B. Action Item A not satisfactorily accomplished.	B.1 Conduct a fire patrol for the affected area(s) of the affected building(s). AND B.2 Confirm at least one HPFW hydrant adjacent to the affected building(s) is operable. TSR 1.6.2.2(d) is not applicable.	2 hours and every hour thereafter. 4 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.5 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.5-1	Verify control valves in the required flow paths are open.	Monthly
SR 2.4.4.5-2	Functionally test each automatic fire suppression system.	Annually
SR 2.4.4.5-3	Cycle all control valves in the required flow paths.	Annually
SR 2.4.4.5-4	Flow test at least one HPFWS fire hydrant adjacent to each process building (distribution system test).	Annually

BASIS:

As discussed in the SAR accident analysis (Section 4.3.2.1.9), an unmitigated lube oil fire in process buildings C-331, C-333, C-335, and C-337 could cause failure of the structural steel followed by localized collapse of the structure. This collapse could damage process piping allowing a release of UF_6. A large fire could also cause primary system failure due to over temperature. The automatic fire suppression (sprinkler) systems in these buildings will minimize the potential for, and mitigate the effects of a large fire.

The portions of the high pressure fire water system (HPFWS) required to mitigate a lube oil fire in buildings C-331, C-333, C-335, and C-337 include the automatic wet-pipe sprinkler systems in the four buildings; the HPFWS distribution mains, water storage tank and pumps; and the C-631-2 cooling tower basin. The dry pipe sprinkler systems in C-333-A and C-337-A are part of the sanitary and fire water system and are not subject to the LCO. They are excluded since a fire within the areas protected by these systems would have no impact upon process piping containing UF_6.

The sprinkler systems provide primary fire suppression capability for the areas in which they are installed. If an automatic fire suppression system is not functional or has a closed valve, hourly fire patrols will provide backup fire protection capability. Backup fire suppression will be provided by hose streams supplied from fire hydrants located adjacent to the affected building.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.5 FIRE PROTECTION SYSTEM - BUILDING SPRINKLER SYSTEM (continued)

BASIS (continued):

Surveillance Requirement 2.4.4.5-2, functional testing of each automatic fire suppression system, includes an inspector test valve (ITV) flow test and a main drain flow test. The ITV test simulates the actuation of a single sprinkler head. The main drain flow test verifies that upstream control valves are open and there are no line blockages in the system's water supply piping. The ITV and main drain flow tests are used during the surveillances to verify that the sprinkler system has adequate water flow.

Positions of indicating control valves and seals on non-indicating control valves will be visually verified monthly. Non-indicating valves with missing or broken seals will be cycled and new seals installed. All control valves will be cycled annually. [SAR Sections 3.15.7.2 and 4.3.2.1.9]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.6 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER DISTRIBUTION MAINS

LCO 2.4.4.6: The High Pressure Fire Water System (HPFWS) distribution mains (excluding mains not in the direct flow path to a required sprinkler system) shall be operable.

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.4.4.5.

ACTIONS:

Condition	Required Action	Completion Time
A. A sectional valve in the distribution mains is not in the open position.	A.1 Restore to the open position.	4 hours
B. Action Item A not satisfactorily accomplished.	B.1 Confirm water supply is available on both sides of the closed valve.	4 hours
C. Action Item B not satisfactorily accomplished.	C.1 Conduct a fire patrol for the affected area(s) of the affected building(s). AND C.2 Provide a temporary water supply for the affected sprinkler systems. TSR 1.6.2.2(d) is not applicable.	2 hours and every hour thereafter. 8 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.6 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER DISTRIBUTION MAINS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.6-1	Verify sectional valves in the flow paths are open.	Monthly
SR 2.4.4.6-2	Cycle all sectional valves in direct flow path.	Annually
SR 2.4.4.6-3	Flow test at least 1 HPFWS fire hydrant adjacent to each process building (distribution system test).	Annually

BASIS:

All required sprinkler systems have at least two supply paths from the HPFWS pumps through the distribution mains. Hence, the closure of one of the sectional valves in Condition A of this TSR will not cause a loss of function of any required sprinkler system. If two or more sectional valves are closed, the ability to supply water to the required sprinkler systems can be lost. This would be identified by Action B. A temporary water supply will be provided consisting of hoses connected between one or more fire hydrants and the fire department connection(s) on the affected sprinkler system(s). The hoses are to be in place and connected to satisfy Condition C. The hoses will only be pressurized with HPFWS water in the event of a fire.

Positions of indicating sectional valves and seals on non-indicating sectional valves will be visually verified monthly. Non-indicating valves with missing or broken seals will be cycled and new seals installed. All sectional valves will be cycled annually. [SAR Sections 3.15.7.2 and 4.3.2.1.9]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.7 FIRE PROTECTION SYSTEM - WATER SUPPLY BASIN

LCO 2.4.4.7: The C-631-2 basin shall be operable (water level within 5 feet of basin top when HPFWS pumps 5 or 6 are not operable, and water level within 15 feet of basin top when HPFWS pumps 5 and 6 both operable).

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required tobe operable per TSR 2.4.4.5.

ACTIONS:

Condition	Required Action	Completion Time
A. Basin water level drops below 5 feet from the basin top.	A.1 Confirm HPFWS pumps 5 and 6 are operable.	Immediately
B. Action Item A not satisfactorily accomplished.	B.1.1 Initiate RCW emergency makeup from the C-611 plant water system AND B.1.2 Restore level to within 5 feet from the basin top. OR B.2.1 Open the RCW crossover valves to provide makeup water from C-633 AND B.2.2 Restore level within 5 feet from the basin top.	Immediately 4 hours Immediately 4 hours
C. Basin water level drops below 15 feet from the basin top.	C.1.1 Initiate RCW emergency makeup from the C-611 plant water system AND C.1.2 Restore level to within 5 feet from the basin top. OR C.2.1 Open the RCW crossover valves to provide makeup water from C-633 AND C.2.2 Restore level within 5 feet from the basin top.	Immediately 4 hours Immediately 4 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.7 FIRE PROTECTION SYSTEM - WATER SUPPLY BASIN (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.7-1	Verify water level in the C-631-2 RCW cooling tower basin is within 5 feet of the top of the basin.	Monthly

BASIS:

The C-631-2 RCW cooling tower basin and the wetwell under the C-631 building are connected by a flume. Their combined volume provides the source of water to all the HPFWS pumps. They will hold over 4 million gallons of water when the level is within 5 feet of the top of the basin.
At this level, the usable volume of water available to HPFWS pumps 2 and 3, which take a suction through the side of the basin, will exceed the 825,000 gallons needed to satisfy maximum system demands of 6,875 gpm for a two hour duration. [Note: These requirements are conservative with respect to the system evaluation presented in SAR Section 3.15.7.2]. HPFWS pumps 5 and 6 take a suction from the C-631-1 wetwell. Their suction intakes are at a lower elevation than those of the other two pumps and can draw on more than 3.5 million gallons of water. If the basin level drops to 15 feet from the top of the basin, the suctions of HPFWS pumps 2 and 3 will be uncovered. However, HPFWS pumps 5 and 6 will still have an adequate water volume to meet the maximum system demands for two hours.

Normal makeup flow to the basin is from the plant water system. If the water drops below the required level and can not be restored by normal makeup, emergency makeup will be initiated to dedicate all plant water system output to the basin. If needed, crossover valves can also be opened to supply up to 9,000 gpm from the C-633 basin.

Basin water level is verified by visual observation of a graduated measuring device. [SAR Sections 3.15.7.2 and 4.3.2.1.9]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.8 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS

LCO 2.4.4.8: At least two HPFWS pumps shall be operable.

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.4.4.5.

ACTIONS:

Condition	Required Action	Completion Time
A. One HPFWS pump operable.	A.1 Confirm the HPFWS storage tank is at least 90% full. AND A.2 Provide temporary water source(s) and pump(s) to restore total flow capability to at least 6,875 gpm.	Immediately 8 hours
B. No HPFWS pumps operable OR Action Item A not satisfactorily accomplished.	B.1 Alert offsite fire departments. AND B.2 Provide temporary water source(s) and pump(s) to restore total flow capability to at least 6,875 gpm.	Immediately 72 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.8 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.8-1	Manually start fire water pumps.	Monthly
SR 2.4.4.8-2	Automatic start of fire water pumps on simulated loss of fire system pressure.	Annually
SR 2.4.4.8-3	Calibrate the switches that provide the automatic start signals to the HPFWS pumps.	Annually
SR 2.4.4.8-4	Verify HPFWS pumps 2, 3,5, and 6 will flow at least 90% of their rated capacity at their rated pressure.	Annually

BASIS:

The HPFWS pumps must be capable of satisfying the maximum sprinkler system and hose stream demands of 4,875 gpm and 2,000 gpm respectively. This results in a combined pumping capacity requirement of 6,875 gpm. [Note: These requirements are conservative with respect to the system evaluation presented in SAR Section 3.15.7.2]

Pumps 2, 3, 5, and 6 are rated at 125 psi TDH and have rated capacities of 4,625 gpm, 4,625 gpm, 4,500 gpm, and 4,500 gpm respectively. To allow for degradation of the pumps over time, only 90% of the rated pump flow is relied upon to satisfy system flow demands. The two pumps with the smallest flow capacities can supply a combined flow of 8,100 gpm under degraded conditions.

When the HPFWS storage tank is 90% full, it is capable of supplying 2,250 gpm for two hours. This flow combined with the flow from one degraded HPFWS pump would fall short of satisfying maximum system demand by no more than 575 gpm. The short fall can be addressed by the use of a fire pumper truck taking a suction from a cooling tower basin and discharging through a fire hydrant to the system distribution mains. If such a temporary water supply is needed to satisfy Condition A, the pumper and required hoses/pipes will be pre-positioned. The hoses/pipes will not be filled with water except in the event of a fire.

When only one HPFWS pump is operable, the C-300 operators will manually start the pump upon notification of a fire. This is necessary since the automatic start of the pump would not occur until after the HPFWS storage tank level drops below 40% full.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.8 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER PUMPS (continued)

BASIS (continued):

If no HPFWS pumps are operable or Condition A cannot be satisfied, the off site fire departments will be alerted so they will be ready to provide assistance if needed. Also, temporary sources of pumping capacity will be sought to restore design capacity within 72 hours.

HPFWS pump 1 is a jockey pump and has a rated capacity of only 200 gpm. It cannot be used to satisfy the TSR Condition Requirements since it will be dead headed when the larger HPFWS pumps are operating. HPFWS pump 4 is not operable and has been abandoned in place.

Level in the HPFWS storage tank is normally maintained by HPFWS pump 1. If water demand on the system exceeds the capacity of this pump, tank level and system pressure will drop. Switches in each of the fire pump controllers will automatically start the fire pumps sequentially until the system demand is satisfied. [SAR Sections 3.15.7.2 and 4.3.2.1.9]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.9 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER STORAGE TANK

LCO 2.4.4.9: The HPFWS storage tank shall be operable (at least 90% full and valved to the distribution mains).

APPLICABILITY: Modes: Whenever any one of the building sprinkler systems is required to be operable per TSR 2.4.4.5.

ACTIONS:

Condition	Required Action	Completion Time
A. The HPFWS storage tank is not operable.	A.1 Restore the tank to operable status.	2 hours
B. Action item A not satisfactorily accomplished.	B.1 Confirm at least two HPFWS fire pumps are operable. AND B.2 Perform one of the following: B.2.1 **IF** level is less than 90% full due to significant leakage from the tank, isolate the tank and maintain system pressure by continuously operating a HPFWS pump. OR B.2.2 **IF** level is less than 90% full due to water demands from non-fire conditions at locations other than the tank, isolate the water demands and restore level to at least 90% full. OR B.2.3 **IF** the tank is isolated for maintenance or inspection, maintain system pressure by continuously operating a HPFWS pump.	Immediately 4 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.9 FIRE PROTECTION SYSTEM - HIGH PRESSURE FIRE WATER STORAGE TANK (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.9-1	Verify that the HPFWS storage tank contains at least 270,000 gallons of water (filled to at least 90% capacity).	Monthly
SR 2.4.4.9-2	Visual inspection of exterior of HPFWS storage tank.	Annually

BASIS:

For the 300,000 gallon elevated storage tank to be considered operable, its level must be at least 90% full (by volume) and it must be aligned to the HPFWS distribution mains. When operable, it is capable of supplying maximum sprinkler system and hose stream demands of 6,875 gpm [Note: These requirements are conservative with respect to the system evaluation provided in SAR Section 3.15.7.2] for approximately 39 minutes. It is also capable of supplying 2,250 gpm for a duration of two hours which is slightly greater than 32% of the water required for maximum fire protection demands.

If the tank is not operable, the TSR required actions are intended to address two issues. The first is to verify there are sufficient fire pumps available to supply required firewater demands without having the tank operable. The second is to maintain the HPFWS filled with water and pressurized above automatic start pressures for the fire pumps.

During non-fire conditions, the tank floats on the HPFWS and maintains the required system pressure. Level in the tank is normally controlled by the 200 gpm HPFWS pump 1 (a jockey pump) which is designed to provide routine makeup for water leakage from the system. The jockey pump is controlled by level switches located in the tank. If the jockey pump is inoperable, this level control function can also be performed by manual operation of a fire pump.

During a fire, water demand on the system would exceed the capacity of the jockey pump. The tank level and system pressure will then drop. Pressure switches in the individual fire pump controllers will automatically start the fire pumps sequentially until available flow exceeds the system demand. At this point the tank will start to refill and function as a surge volume as water demand fluctuates during fire fighting efforts. After the fire is extinguished, tank level will be promptly restored above the 90% level.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

BASIS (continued)

If level in the tank falls below 90% during non-fire conditions, either the jockey pump is not functioning properly or there is a water demand on the system that exceeds the capacity of the pump. In either case, one or more of the HPFWS fire pumps will be started automatically or manually and an attempt made to restore tank level above 90%. The cause of the excessive water demand will be investigated. If the demand is due to significant leakage from the storage tank, the tank will be isolated. In this case, pressure on the balance of the HPFWS will be maintained above the fire pump automatic start pressures by continuously operating either the jockey pump or one of the fire pumps. If the excessive demand is from locations in the HPFWS other than the tank, the demand will be isolated. Such demands could be from non-fire conditions such as line breaks, spurious actuation of a sprinkler system, or flow testing and flushing of fire hydrants. Once the demand is isolated, pressure will be restored on the balance of the system by refilling the storage tank and maintaining its level above 90%.

If the tank is isolated for maintenance or inspection, pressure in the HPFWS will be maintained above the fire pump automatic start pressures by continuously operating either the jockey pump or one of the fire pumps. [SAR Sections 3.15.7.2 and 4.3.2.1.9]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.10 FIRE PROTECTION SYSTEM - HOT WORK LIMITATIONS

LCO 2.4.4.10 A dedicated, continuous fire watch, equipped with portable fire suppression equipment, shall be posted for hot work operations conducted when LCO 2.4.4.5 is not satisfied.

APPLICABILITY: Modes: All

ACTIONS:

Condition	Required Action	Completion Time
A. Hot work conducted when LCO 2.4.4.5 is not satisfied without a dedicated fire watch present.	A.1 Stop hot work operations. AND A.2 Establish dedicated fire watch in accordance with the LCO.	Immediately Prior to re-starting hot work operations.

SURVEILLANCE REQUIREMENTS: None

BASIS:

Hot work (welding, cutting, etc.), while a necessary part of plant maintenance and upkeep, introduces a fire hazard not normally present during steady state plant operations. As a good practice, hot work should be avoided when the fixed fire suppression system is inoperable. However, in those cases where hot work is performed when the fixed fire suppression system is inoperable, some mechanism for extinguishing fires which could potentially result from the hot work must be provided. [SAR Section 5.4.1.1]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.11 CASCADE PRESSURE LIMITATION

LCO 2.4.4.11 The cascade stage high side pressure shall be ≤ 25 psia.

APPLICABILITY: Modes: Cascade 1, 2

ACTIONS:

Condition	Required Action	Completion Time
A. Cascade stage high side pressure discovered > 25 psia	A.1 Establish pressure ≤ 25 psia.	Immediately

SURVEILLANCE REQUIREMENTS

Surveillance		Frequency
SR 2.4.4.11-1	Verify operating cells have high-side pressures ≤ 25 psia.	Daily
SR 2.4.4.11-2	Calibrate unit, cell, and freezer/sublimer datum.	Annually

BASIS:

The accident analysis provided in SAR Section 4.3.2.1.3 and 4.3.2.1.7 assume that cascade high pressure accidents proceed to their conclusion which, in many cases, results in some form of breach in the cascade system. It is at this point that the consequences are evaluated and the identification of any mitigating actions takes place. It should be noted that the cascade was not designed to directly measure cell pressures in the ACR or to measure pressures that approach 40 psia. Motor load and other process indicators in the ACR alert the operator to significant cascade transients which require appropriate actions be taken, including cell shutdown, to preclude cascade pressures from exceeding 40 psia which is the postulated rupture pressure of cascade piping. The monitoring of the cell pressures from the local cell panels is sufficient to ensure that the steady state pressures do not exceed 25 psia. Due to the ability to perform a channel check across the 8 to 10 stage pressure indicating controllers (PICs) per cell and the fact that within an operating cell any stage high side pressure increase will quickly cascade throughout the cell (i.e., raise the other stage high side pressure), it is not necessary that all the PICs are functional to determine the cell pressure. The calibration of the unit, cell, and freezer/sublimer datums will ensure an adequate level of accuracy (cell averaging) and therefore the calibration of individual PICs is not necessary. As part of the cascade

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.11 CASCADE PRESSURE LIMITATION (continued)

BASIS (continued):

inventories there are several data comparisons made that provide the information needed to identify any out of tolerance PIC without doing a calibration. This is accomplished by analyzing stage compression ratios and the comparison of motor amperage verses stage high side pressure against known process relationships.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.12 CASCADE CELL TRIP FUNCTION

LCO 2.4.4.12 The cell trip system for UF_6 stage motors shall be operable.

APPLICABILITY: Modes: Cascade 1 and 2 when stage motors are energized.

ACTIONS:

Condition	Required Action	Completion Time
A. DC voltage < 210 volts	A.1 Notify Cascade Coordinator of potential need to utilize alternate means of cell shutdown. AND A.2 Restore DC voltage to ≥ 210 volts	Immediately 48 hours
B. Required action A. not satisfactorily accomplished.	B.1 Shutdown affected cascade cell(s). AND B.2 Verify cell isolation.	8 hours
C. Air header pressure feeding a group of "000" air circuit breakers is less than the minimum required to actuate those breakers.	C.1 Notify Cascade Coordinator of potential need to utilize alternate means of cell shutdown. AND C.2 Restore air pressure to greater than the minimum required breaker actuation pressure.	Immediately 48 hours
D. Required action C. not satisfactorily accomplished.	D.1 Shutdown affected cascade cell(s). AND D.2 Verify cell isolation.	8 hours
E. Individual battery (cell)/charger parameters (other than voltage) for any connected cell are outside limits established in surveillance requirements.	E.1 Restore the individual battery (cell) parameters to within limits. AND E.2 If the AC battery charger is inoperable, verify applicable battery is operable. TSR 1.6.2.2(d) is not applicable.	90 days 8 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.12 CASCADE CELL TRIP FUNCTION (continued)

Condition	Required Action	Completion Time
F. CCF DC bus voltage potential is< 105 volts DC	F.1 Verify that Condition A is not in effect. AND F.2 Verify that the applicable ACR compressor motor stop button is operable. AND F.3 Restore CCF DC bus voltage potential ≥ 105 volts DC. TSR 1.6.2.2(d) is not applicable.	Immediately Immediately 7 days
G. ACR compressor motor stop button for “00" and “000" compressors inoperable (not due to loss of DC voltage or air header pressure for “000" cells). OR The C-331, C-333, C-335, or C-337 ACR is evacuated.	G.1 Verify that the applicable CCF compressor motor stop button is operable. AND G.2 Restore ACR compressor motor stop button to operable status.	Immediately 7 days
H. CCF compressor motor stop button for “00" and “000" compressors inoperable (not due to loss of DC voltage or air header pressure for “000" cells).	H.1 Verify that the applicable ACR compressor motor stop button is operable. AND H.2 Restore CCF compressor motor stop button to operable status. TSR 1.6.2.2(d) is not applicable.	Immediately 7 days

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.12 CASCADE CELL TRIP FUNCTION (continued)

Condition	Required Action	Completion Time
I. Both Condition G. and H. apply	I.1 Notify Cascade Coordinator of potential need to utilize alternate means of cell shutdown. AND I.2 Station an operator at an established alternate shutdown location with communications to the ACR or CCF. OR I.3 Shutdown affected cascade cell(s).	Immediately 8 hours 8 hours
J. Required action F.1, F.2, F.3, G.2 or H.2 not satisfactorily accomplished.	J.1 Station an operator at an established alternate shutdown location with communications to the ACR or CCF. OR J.2 Shutdown affected cascade cell(s).	8 hours 8 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.12 CASCADE CELL TRIP FUNCTION (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.12-1	Verify DC voltage ≥ 210 volts at the battery DC charger.	Daily
SR 2.4.4.12-2	Verify "000" air circuit breaker air header pressure is greater than the minimum required actuation pressure.	Daily
SR 2.4.4.12-3	Inspect battery terminals and racks for evidence of corrosion and for leakage of electrolyte.	Quarterly
SR 2.4.4.12-4	Check that the specific gravity of the pilot cell is ≥ 1.180 corrected to 77°F.	Quarterly
SR 2.4.4.12-5	Verify the battery charger output is > 0 DC amps	Daily
SR 2.4.4.12-6	Visually check the cell electrolyte levels to verify that the level is above the low level indication and no more than 0.25 inches above the high indication line.	Quarterly
SR 2.4.4.12-7	Check that the specific gravity of the cells is ≥1.180 corrected to 77°F.	Annually
SR 2.4.4.12-8	Perform a functional test of the ACR and CCF manual cell shutdown function for "00" and "000" cells, and of the LCP manual cell shutdown function for C-310 cells. Note: Performance of this surveillance to demonstrate system operability is not required for any cell in operation until the next planned shutdown.	Prior to cell startup following a planned cell shutdown
SR 2.4.4.12-9	Verify CCF DC bus voltage ≥105 volts DC.	Daily

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.12 CASCADE CELL TRIP FUNCTION (continued)

BASIS:

The accident analysis presented in SAR chapter 4 discusses numerous cascade cell-related scenarios (e.g.,4.3.2.1.1, 4.3.2.1.2, 4.3.2.1.3, 4.3.2.1.5, 4.3.2.1.7, and 4.3.2.1.8) in which operating personnel respond to certain process conditions and alarms by de-energizing the process motors ("tripping the cell"), thus bringing the cell below atmospheric pressure. In order to initiate a cell shutdown, the DC control and trip power circuit must be functional. The cascade cell trip function is also referred to as the cell remote manual shutdown system and it is a subset of the UF_6 compressor motor manual trip system.

The functional test of the ACR and CCF manual cell shutdown function for "00" or "000" cells prior to cell startup may be accomplished by 1) crediting a successful function of the ACR or CCF trip system at the time the cell was shutdown, and 2) testing the function of the trip location that was not utilized during the planned cell shutdown. It is permissible to verify functionality via tripping the breaker on a deenergized bus, performing combinations of wiring and relay checks, and/or tripping the breaker from the "test" position. In determining the appropriate test method, credit may be taken for portions of the circuitry tested during or since the previous cell shutdown (e.g., the breaker mechanism does not necessarily need to be cycled twice to test both the ACR and the CCF trip buttons).

The functional test of the LCP manual cell shutdown function for C-310 cells prior to cell startup may be accomplished by crediting successful function of the LCP trip system at the time the cell was shutdown. Planned cell shutdowns must be initiated at the local control panel for C-310 cells because an ACR trip button is not provided for C-310 cells.

Note that planned cell shutdown is defined as the process of manually de-energizing the process motors in accordance with approved procedures. Unplanned cell shutdown is therefore any automatic trip of the process motors.

The minimum air pressure required to trip the "000" breakers varies with the breaker type. For all cells in C-337 and cells C-333-2.2, C-333-5.1, C-333-5.3, C-333-6.5, and C-333-6.7, 190 psig is the required air pressure; and for all the other cells in C-333, 118 psig is the required air pressure.

The alternate means of cell shutdown referred to in the required action (e.g., A.1) could include local cell panel trip, breaker manual trip, or C-300/switchyard deenergization of electrical feeders, buses, transformer bays, main switchyard lines. Because of the number of available trip locations, these alternate locations are not required to be tested periodically. [SAR Section 3.15.3.1 and 3.15.3.2]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.13 HEAVY EQUIPMENT HANDLING

LCO 2.4.4.13: In process buildings where equipment is operating above atmospheric pressure, movement of large process equipment shall not occur above/around process equipment that is operating above atmospheric pressure and shall not occur without communication between the lift location and the ACR (ACR operator and/or shift supervisor).

APPLICABILITY: Modes: Cascade 2 (any portion of the building)

ACTIONS:

Condition	Required Action	Completion Time
A. Large process equipment moved over process equipment without communication between lift location and the ACR.	A.1 Establish communication OR A.2 Move the suspended equipment to a location away from operating process equipment.	Immediately Immediately
B. Large process equipment moved above/around process equipment that is operating above atmospheric pressure.	B.1 Move equipment to a location that is not above/around process equipment operating above atmospheric pressure	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

A fully informed ACR (ACR operator and/or shift supervisor) will be able to take quick action in order to mitigate the consequences of an accidental equipment drop in the cascade facilities. This administrative control assures the shift supervisor is fully informed of the nature and location of the proposed equipment movement. Heavy equipment may be transported in a building that contains equipment operating in cascade modes 1 or 2, however movement of heavy equipment above/around cascade equipment operating in cascade mode 2 is not allowed. [SAR Sections 3.15.9.2.3, 4.3.2.1.8]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.14 HEATING UF_6 PLUGS

LCO 2.4.4.14 Direct sources shall not be applied to UF_6 plugs until flow clarity in the system has been assured.

APPLICABILITY: At all times

ACTIONS:

Condition	Required Action	Completion Time
A. Direct heat source applied to a UF_6 plug.	A.1 Discontinue heating the plug.	Immediately

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Application of external heat to the middle portion of the plug can melt the solid and develop large hydraulic forces in the pipe and ends of the plug, creating the potential for a UF_6 release due to pipe rupture. [USEC-651]

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.15 MOTOR LOAD INDICATORS

LCO 2.4.4.15 Cascade UF_6 stage compressor motor load indicators for "00" and "000" compressor motors shall be operable.

APPLICABILITY: Modes: Cascade 1 and 2 when "00" or "000" stage motors are energized.

ACTIONS:

Condition	Required Action	Completion Time
A. ACR stage compressor motor load indicator inoperable.	A.1 Verify that the stage compressor motor load indicators for the adjacent stages are operable. Note: If more than one ACR indicator is inoperable, perform this action for each inoperable indicator. TSR 1.6.2.2(d) is not applicable.	4 hours
B. ACR stage compressor motor load indicators inoperable for ≥ 2 adjacent stage motors. OR The C-331, C-333, C-335, or C-337 ACR is evacuated	B.1 Verify that the applicable cell compressor motor load indicator in the CCF is operable. AND B.2 Restore at least one of the adjacent ACR stage compressor motor load indicators to operable status.	4 hours 7 days
C. CCF cell compressor motor load indicator inoperable	C.1 Verify that the applicable ACR stage compressor motor load indicator(s) are operable. OR C.2 Verify required action A.1 is complete. TSR 1.6.2.2(d) is not applicable.	4 hours 4 hours
D. Required action B.1 or B.2, or C.1 and C.2 not satisfactorily accomplished.	D.1 Station an operator at the LCC to monitor cell parameters with communications to the ACR or CCF. OR D.2 Shutdown affected UF_6 compressor motor(s).	8 hours 8 hours

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.15 MOTOR LOAD INDICATORS (continued)

SURVEILLANCE REQUIREMENTS:

SURVEILLANCE		FREQUENCY
SR 2.4.4.15-1	Perform a CHANNEL CHECK of the ACR stage compressor motor load indicators.	Following compressor motor start

BASIS:

The motor load indicators provide an indication of various types of failures of the compressor(s)[SAR Sections 4.3.2.1.1, 4.3.2.1.2, 4.3.2.1.3, and 4.3.2.1.5]. Using ammeter indications in the ACR for the individual compressor motors, operators can quickly identify various abnormalities caused by malfunctions of the process equipment. Operator training is relied upon to distinguish between load changes associated with normal fluctuations such as cascade power increases, and equipment malfunctions. Compressor load changes can be caused by such events as compressor failures, inadvertent closures of B-stream block valves or stage control valves, or failures of the primary system pressure boundary that cause inleakage or a release of UF_6. Compressor surging will produce large swings in the loads. If an ammeter should malfunction, the load changes can be seen on the ammeters for the compressor motors in stages that are adjacent to the stage that is experiencing the compressor malfunction. Motor indicators in the ACRs are used to detect large load changes for cell compressor motors in the enrichment cascade. Load indications in the CCF are used to detect large load changes for cell compressor motors (i.e., CCF indicator provides total load for all of the stages in a particular cell). These CCF indicators are not required to satisfy the LCO unless the ACR indicator is inoperable. In the event of evacuation of an ACR, the ammeter indications in the CCF can be used to monitor for large load changes that could be representative of a pressure increase. Although the monitors in the CCF are less sensitive than those in the ACR, they are able to indicate significant compressor load changes. This indication of an event and mitigative action by the operator (1) controls the primary system pressure and temperature increases to minimize the potential for primary system integrity failures and (2) reduces the primary system pressure to minimize UF_6 releases for on-site personnel. This system is not essential for off-site public protection. The surveillance requirement is provided to ensure that, after motor start, the ammeter provides qualitative (or relative) indication of motor load. It is appropriate to perform this surveillance after sufficient UF_6 is introduced into the cell so that a nominal reading on the ammeter can be obtained. [SAR Section 3.15.3.6]

2.4.5 GENERAL DESIGN FEATURES

There are no special design features associated with enrichment cascade operations.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

TSR 2.4 APPENDIX A

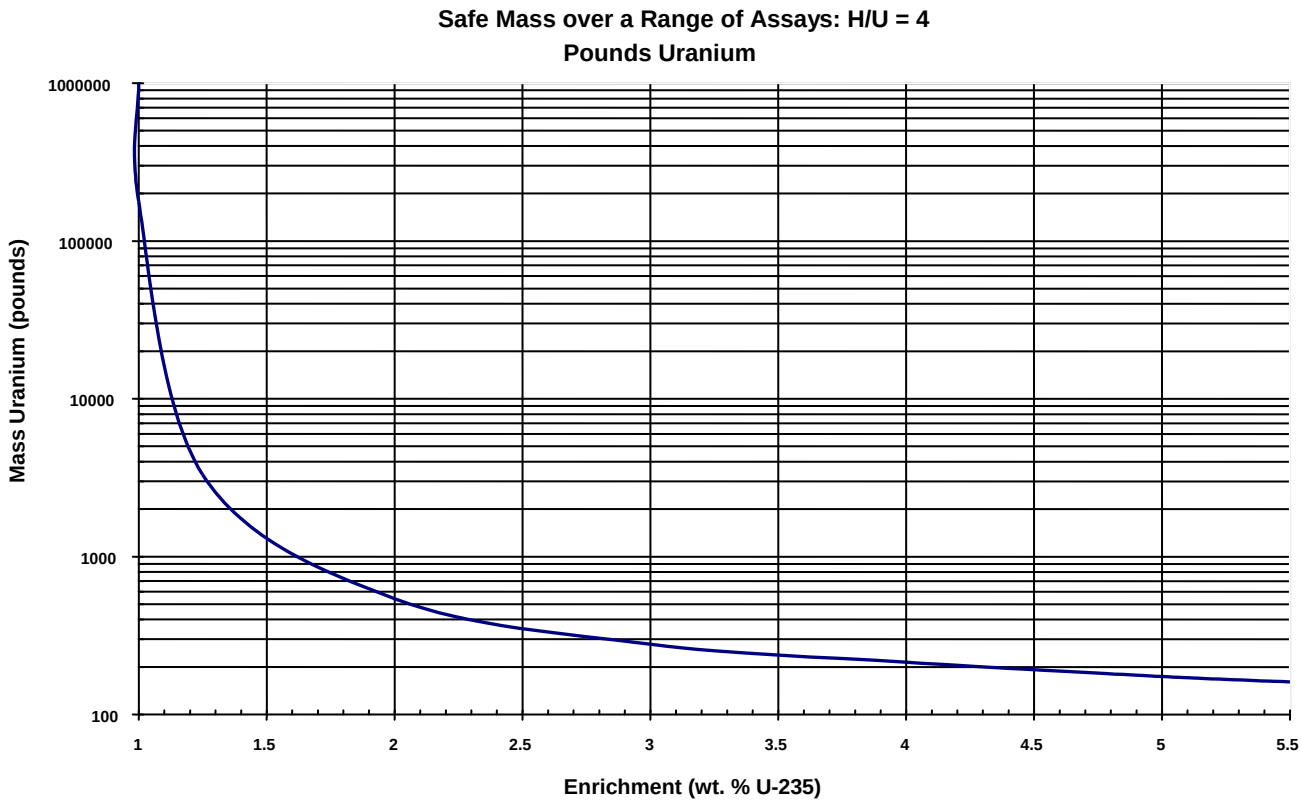
APPLICABILITY TABLE FOR EQUIPMENT REMOVAL TSRs

Equipment Type	Size (if applicable)
Axial Compressors	N/A
Centrifugal Compressors/Pumps	N/A
Converters[5]	N/A
Process Gas Coolers	N/A
Freezer/Sublimers	N/A
Process Gas Valves	(greater than 4-inches)
Process Gas Pipe	(greater than or equal to 5-inches)
Expansion Joints	(greater than or equal to 5-inches)

5. Gradual “plugging” of the barrier is excluded.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

TSR 2.4 APPENDIX B



NOTE:

1. Diagram assumes (1) H/U = 4, (2) cylindrical geometry, (3) interaction with an AQ-NCS maximum 5.5 gallon drum loaded with 1500g UO_2F_2/l at 5.5 wt. % ^{235}U, (4) reflected by at least 6 inches full density water positioned on concrete.

2. This curve is not to be used for equipment removal activities.

SECTION 2.5

SPECIFIC TSRs
FOR
EQUIPMENT REMOVAL ACTIVITIES

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.1 OPERATIONAL MODES

Due to the intricate nature of the equipment removal and decontamination process, operational modes are not specified. Sufficient information to determine the applicability of the requirements set forth in this TSR is provided in the individual LCOs.

2.5.2 SAFETY LIMITS

There are no safety limits associated with Equipment Removal operations.

2.5.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

There are no LCSs associated with Equipment Removal operations.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.1 PRE-REMOVAL EXAMINATION

LCO 2.5.4.1: An analysis or Non-Destructive Assay (NDA) survey shall be performed to determine the level of handling restrictions to be applied (PEH or UH).

APPLICABILITY: Prior to beginning removal of equipment listed in TSR 2.5 Appendix A which contains uranium enriched to ≥ 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. Applicable equipment removed prior to analysis or NDA.	A.1.1 Equipment openings shall be covered or closed	Immediately and until Action A.2 completed.
	AND	
	A.1.2 Establish and maintain a dry atmosphere within the equipment.	Immediately and until Action A.2 completed.
	AND	
	A.2 Establish special case-specific NCSA requirements for handling equipment.	Prior to beginning decontamination evolution.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

Determining the mass of any uranium deposits in the equipment allows segregation and controlled handling of equipment containing amounts of ^{235}U that require additional controls to prevent the formation of an unsafe mass/geometry. [SAR Section 5.2, Appendix A]

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.2 POST-REMOVAL EXAMINATION

LCO 2.5.4.2: Equipment categorized and removed as UH shall have the categorization verified with a post-removal visual or NDA inspection within 24 hours.

APPLICABILITY: After completion of the removal of equipment listed in TSR 2.5 Appendix A which contains uranium enriched to ≥ 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. UH categorization not properly verified.	A.1.1 Equipment openings shall be covered or closed	Immediately and until Action A.2 completed.
	AND	
	A.1.2 Establish and maintain a dry atmosphere within the equipment.	Immediately and until Action A.2 completed.
	AND	
	A.2 Establish special case-specific NCSA requirements for handling equipment.	Prior to beginning decontamination evolution.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

The initial inspection is verified by a second inspection to prevent mishandling of equipment containing amounts of ^{235}U that require additional controls to prevent the formation of an unsafe mass/geometry. [SAR Section 5.2, Appendix A]

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.3 PEH EQUIPMENT OPENINGS

LCO 2.5.4.3: PEH equipment openings shall be covered with fireproof covers and gasket seals.

APPLICABILITY: Removal and handling of equipment involving a PEH deposit, in the removed equipment or in the remaining system. (Equipment listed in TSR 2.5 Appendix A)

ACTIONS:

Condition	Required Action	Completion Time
A. Planned cutting, removal, and handling activities involving applicable PEH equipment, equipment being removed and in the remaining system, with uncovered opening(s).	A.1.1 A person shall be stationed to isolate the local sprinkler system, if inadvertently actuated, any time the system opening(s) are uncovered. If isolated, the applicable LCO actions for fire protection system inoperability shall be performed.	Prior to opening the system in any way that would allow moderation and until Action A.1.3 completed.
	AND	
	A.1.2 If conditions develop, such as a solution leak/release, where a moderating material can begin to enter uncovered equipment, cover openings with pre-staged waterproof covers.	Immediately and until Action A.1.3 completed.
	AND	
	A.1.3 Equipment openings shall be covered or closed with fireproof covers and gasket seals.	As soon as cutting and removal activities permit.
	AND	
	A.1.4 Establish and maintain a dry atmosphere within the equipment.	Immediately after Action A.1.3 completed.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.3 PEH EQUIPMENT OPENINGS (continued)

ACTIONS: (continued)

Condition	Required Action	Completion Time
B. Applicable removed PEH equipment discovered with uncovered opening(s) while not being decontaminated, remediated, or being visually inspected.	B.1.1 Equipment openings shall be covered or closed with fireproof covers and gasket seals. AND B.1.2 Establish and maintain a dry atmosphere within the equipment. AND B.2 Establish special case-specific NCSA requirements for handling equipment.	Immediately and until Action B.2 completed. Immediately and until Action B.2 completed. Prior to resuming decontamination or remediation evolution.
C. Applicable PEH remaining system discovered with uncovered opening(s) while not being decontaminated, remediated, being visually inspected, or equipment being removed or reinstalled.	C.1.1 Remaining system openings shall be covered or closed with fireproof covers and gasket seals. AND C.1.2 Establish and maintain a dry atmosphere within the equipment.	Immediately and until equipment is reinstalled. Immediately and until equipment is reinstalled.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.3 PEH EQUIPMENT OPENINGS (continued)

ACTIONS: (continued)

Condition	Required Action	Completion Time
D. Applicable removed PEH equipment or PEH remaining system covers removed for equipment being decontaminated, remediated, visually inspected or being reinstalled.	D.1.1 Equipment openings shall be constantly attended by personnel performing activity.	Immediately and until Action D.2 completed.
	AND D.1.2 Removed covers shall be staged so they can be reinstalled if conditions develop, such as a solution leak/release, where a moderating material can begin to enter uncovered equipment.	Immediately and until Action D.2 completed.
	AND D.2 Covers shall be reinstalled when activity is complete or if openings are not constantly attended.	Upon termination of activity.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.5.4.3-1	Inspect removed PEH equipment and the PEH remaining system to verify openings are covered or closed when not being decontaminated, visually inspected, remediated, or equipment being reinstalled.	Daily

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.3 PEH EQUIPMENT OPENINGS (continued)

BASIS:

Covering or closing equipment openings minimizes the introduction of moderator into the equipment from atmospheric moisture or external sources (e.g. overhead sprinklers, solution leaks, releases, etc.). Protection from moderation is required until the covers are installed and personnel will provide that protection by isolation of the sprinkler system in case of an inadvertent sprinkler actuation and placing pre-staged waterproof covers over equipment openings to protect PEH deposits from a moderation source. Remediation involves those activities necessary for disposition of the PEH deposit in accordance with approved NCSAs. The remaining system referred to above is the region that extends from the opening created for equipment removal purposes to the point of isolation.

This TSR provides moderation control for PEH deposits that may be exposed to a moderation source during equipment removal activities. The PEH deposit may be in the removed equipment, or remaining system isolated for the equipment to be removed, and exposed to potential moderation in either case by the opening created by removing the equipment. When equipment removal activities create an opening that potentially subjects a PEH deposit to moderation, it is intended that the openings be covered as soon as the equipment is cool enough to work with and can be positioned where covers can be safely installed without interference from handling or other nearby equipment. Having pre-staged waterproof covers and someone available to isolate the local fire sprinkler system in the event of inadvertent actuation ensures that moderation of the deposit can be prevented until the fireproof covers are installed. [SAR Chapter 5.2, Appendix A, Section 1.2]

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.4 PEH DECONTAMINATION TIME LIMITS

LCO 2.5.4.4: Applicable equipment categorized and removed as PEH shall be decontaminated to a safe mass or below within 72 hours from the start of equipment removal or 24 hours from the start of decontamination, whichever is sooner.

APPLICABILITY: After removal of equipment categorized as PEH (equipment listed in TSR 2.5 Appendix A which contains more than a safe mass of uranium as determined by TSR 2.5 Appendix B)

ACTIONS:

Condition	Required Action	Completion Time
A. Decontamination to a safe mass or less not achieved within 72 hours	A.1.1 Equipment openings shall be covered or closed	Immediately and until Action A.2 completed.
	AND	
	A.1.2 Establish and maintain a dry atmosphere within the equipment.	Immediately and until Action A.2 completed.
	AND	
	A.2 Establish special case-specific NCSA requirements for handling equipment.	Prior to resuming decontamination evolution.

SURVEILLANCE REQUIREMENTS: None

BASIS:

This control minimizes the potential for exposure of the UF_6/UO_2F_2 to external moderating sources, such as humid air or other external water sources (fire protection system), that could result in a critical reaction by ensuring that there exists a barrier to the external water source. The decontamination evolution involves any actual disassembly and deposit removal that can be temporarily interrupted due to work area levels of HF but will proceed to completion once initiated. [SAR Section 5.2, Appendix A]

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.5 PEH SPACING REQUIREMENTS

LCO 2.5.4.5: Applicable equipment categorized and removed as PEH shall be spaced 10 feet edge to edge from other PEH equipment and 6 feet edge to edge from fissile or potentially fissile equipment or containers until uranium decontamination to below safe mass.

APPLICABILITY: Removed equipment categorized as PEH (equipment listed in TSR 2.5 Appendix A).

ACTIONS:

Condition	Required Action	Completion Time
A. PEH equipment discovered improperly spaced.	A.1.1 Notify Nuclear Criticality Safety. AND A.1.2 Establish proper spacing using NCS remediation guidelines.	Immediately Prior to any other handling of discovered equipment.

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.5.4.5-1	Inspect equipment to verify 10-foot edge to edge spacing from other PEH equipment and 6-foot edge to edge spacing from fissile or potentially fissile equipment or containers is maintained.	Daily

BASIS:

This control minimizes the potential for interaction that could result in a critical reaction by ensuring that a safe distance is maintained between PEH equipment and any other equipment or containers of fissile or potentially fissile material. The decontamination evolution restores the equipment to a condition where spacing requirements contained in this LCO are no longer needed. Initial spacing requirements for PEH equipment are established during the removal activity.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.6 PEH EQUIPMENT TRANSPORTATION OUTSIDE CAAS COVERAGE

LCO 2.5.4.6: Equipment categorized and removed as PEH shall be within CAAS coverage while being moved to different locations.

APPLICABILITY: When transporting equipment categorized as PEH (equipment listed in TSR 2.5 Appendix A).

ACTIONS:

Condition	Required Action	Completion Time
A. Transporting equipment categorized as PEH outside CAAS coverage.	A.1 Equipment shall be transported one at a time.	Immediately and until Action A.7 is completed.
	AND A.2 Equipment shall be restrained during movement.	Prior to movement and until Action A.7 is completed.
	AND A.3 Equipment shall be transported over a planned route.	During movement and until Action A.7 is completed.
	AND A.4 Other vehicle traffic shall be excluded from the immediate area of the vehicle during transport.	During movement and until Action A.7 is completed.
	AND A.5 Transport vehicle speed shall be restricted to 10 miles per hour or less.	During movement and until Action A.7 is completed.
	AND A.6 Personnel involved in transportation of equipment shall wear personal alarming dosimeters and have a radio.	Immediately and until Action A.7 is completed.
	AND A.7 Equipment shall be returned to CAAS coverage.	Within 12 hours.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.6 PEH EQUIPMENT TRANSPORTATION OUTSIDE CAAS COVERAGE(continued)

ACTIONS: (continued)

Condition	Required Action	Completion Time
B. Transport vehicle carrying PEH equipment is involved in accident where equipment restraint or cover is lost while outside CAAS coverage.	B.1 Notify PSS of the accident. AND B.2 Evacuate all unnecessary personnel within 200-foot distance of PEH equipment if a criticality is suspected. AND B.3 If the introduction of moderator is suspected, NCS will evaluate prior to movement. AND B.4 Stabilize PEH equipment and verify covers are in place. AND B.5 Repair or replace transport vehicle and move PEH equipment to vehicle, if applicable.	Immediately. Initiate evacuation immediately and until Action B.3 is completed. Prior to initiating Action B.4. Prior to initiating Action B.5. Initiate upon completion of Action B.4.

SURVEILLANCE REQUIREMENTS: None.

BASIS:

These controls minimize the potential for exposing PEH deposits to a moderation source during equipment transportation outside CAAS coverage. Protection from moderation is required while the equipment is being transported. Controls are necessary to help prevent an accident where the equipment is disturbed in such a way that moderation of the PEH deposit could occur. In the event that a transportation accident does occur, steps shall also be taken to minimize the chance of moderation and a resulting criticality. Additionally, actions shall be taken to minimize the exposure risk from a criticality to personnel in the vicinity of the equipment.

Transporting equipment one at a time over the same planned route reduces the likelihood of interaction with other deposits. Equipment will be restrained in accordance with normal rigging practices. There is no intent to dedicate or impose a safety classification on the restraints. Personnel performing the rigging will be trained. The intent is to keep equipment in place and prevent any movement during routine transportation.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.6 PEH EQUIPMENT TRANSPORTATION OUTSIDE CAAS COVERAGE(continued)

Transporting equipment over a planned route will help ensure appropriate personnel are aware of the move and prepared. A pre-move briefing of parties involved in the transportation is expected. The planning will be in accordance with approved procedures. A planned route does not mean dedicated route. A planned route can vary from movement to movement. Planning means that thought has been given to how, when and where the movement will occur.

The transportation plan will include actions to exclude other motorized vehicle traffic from the immediate area of the transport vehicle during moment. Other motorized traffic may cross ahead and behind the transport vehicle as long as sufficient distance is maintained such that all vehicles can safely stop and avoid collision. Pedestrian and non-motorized vehicles are exempt from this exclusion.

Limiting transport vehicle speed to 10 miles per hour or less is designed to ensure the vehicle can safely stop to avoid any collision. The speed limit is also imposed to ensure safe control of the vehicle can be maintained during turns, stops, and other vehicle maneuvers. A low speed helps ensure equipment stability is maintained. The 10 mph speed limit is not a precisely calculated safety limit and the vehicle speed measuring devices do not need to be classified as safety equipment nor have their instrument uncertainties factored into the implementation of this limit.

The wearing of personal alarming dosimeters (PADs) by personnel involved in the equipment movement will provide an ability to alert them that radiation levels are higher than normal. The PAD will only be required by those individuals traveling with the equipment in or on the vehicle. A radio is required so that personnel can contact the Central Control Facility, Area Control Rooms and other facilities to warn of a potential problem.

The movement of PEH equipment outside CAAS coverage must be completed within 12 hours. The 12 hours was chosen primarily because of the worker shift length. Extending the movement beyond a shift would require a turnover if additional personnel are to be briefed. In most cases, equipment can be moved around the site within this time frame. An expedient move will be required to stay within the remediation time limit specified by TSR 2.5.4.4.

Condition B is established to prevent moderation of PEH equipment in the event of a vehicle accident and to restore the equipment to a safe and stable environment where criticality is unlikely.

Personnel involved in the equipment movement shall notify the PSS of any vehicle accident where equipment restraint or cover is lost. This action will allow the PSS to notify support organizations and the E-squad as appropriate.

A suspected criticality can be determined by multiple PAD alarms, CAAS alarms and other means recommended by NCS.

If a criticality is suspected, personnel will be evacuated by the PSS immediately. E-squad and PSS personnel will ensure people are evacuated from within the 12-rad distance from the equipment. Based

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.5.4.6 PEH EQUIPMENT TRANSPORTATION OUTSIDE CAAS COVERAGE (continued)

on NCS recommendations, the PSS may allow individuals to re-enter for purposes of ensuring criticality safety. Based on calculations, this is equivalent to a 200-foot radius from the criticality source. Calculations documented in KY/S-210, "Immediate Evacuation Distance Requirements for Criticality Accident Alarm System Actuation," September 1993, result in a 12-rad exposure at 200 feet in 50 minutes.

Prior to returning equipment to vehicle or resuming transportation, the PSS is responsible for ensuring the equipment is stable. This means the equipment is safe to move without undue risk of a criticality and that radiation levels from the equipment are at safe levels. NCS should evaluate to ensure the introduction of moderator has not caused the equipment to be at an unacceptable level of risk for a criticality. The PSS should rely upon NCS and the E-squad for recommendations on stability. The PSS will also ensure covers are securely fastened in accordance with the applicable NCSA. The equipment will also be restrained in accordance with normal rigging practices, procedures and applicable NCSAs.

In the event of an accident, the PSS has the option of repairing the vehicle before resuming transport or placing the equipment on another vehicle for transport. These options must be considered and implemented within the overall time constraint of 12 hours for the move. The PSS should also be cognizant to the TSR time limit for remediation. The PSS should also be aware that during and after the PEH equipment is moved to a new transport vehicle or the vehicle is repaired (while in Condition B), the restrictions of Condition A are still in effect until the PEH equipment is moved back into CAAS coverage. [SAR Section 5.2.2]

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

2.5.5 GENERAL DESIGN FEATURES

There are no general design features associated with Equipment Removal operations.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

TSR 2.5 APPENDIX A

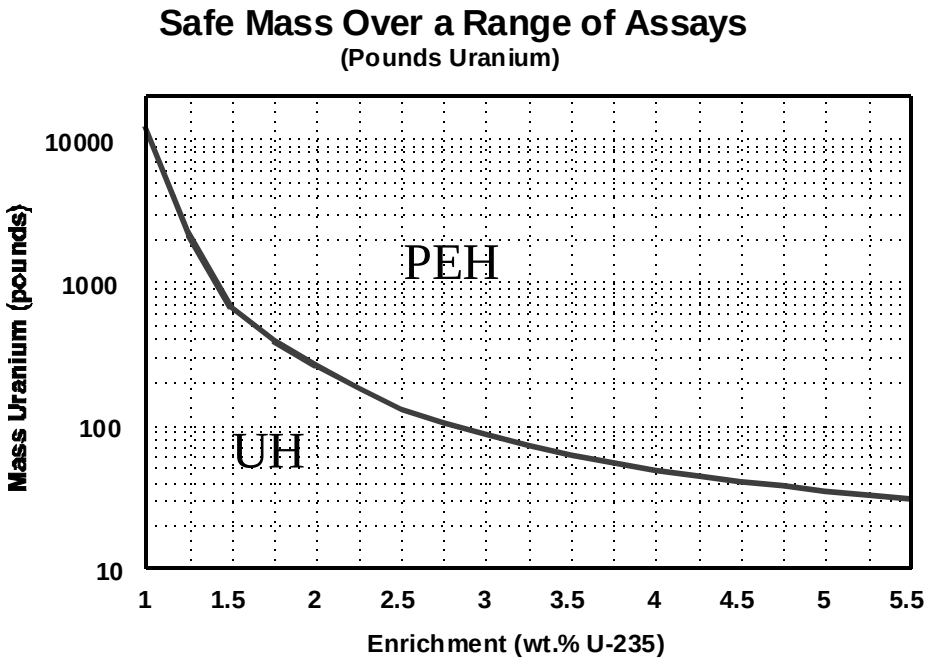
APPLICABILITY TABLE FOR EQUIPMENT REMOVAL TSRs

Equipment Type	Size (if applicable)
Axial Compressors	N/A
Centrifugal Compressors/Pumps	N/A
Converters[4]	N/A
Process Gas Coolers	N/A
Freezer/Sublimers	N/A
Process Gas Valves	(greater than 4-inches)
Process Gas Pipe	(greater than or equal to 5-inches)
Expansion Joints	(greater than or equal to 5-inches)

4. Gradual “plugging” of barrier is excluded.

SECTION 2.5 SPECIFIC TSRs FOR EQUIPMENT REMOVAL ACTIVITIES

TSR 2.5 APPENDIX B



NOTE:

Diagram assumes (1) optimum moderation, (2) optimum geometry, (3) full water reflection.

SECTION 2.6

SPECIFIC TSRs
FOR
CRITICALITY ACCIDENT ALARM SYSTEM
(NON-CASCADE FACILITIES)

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.1 OPERATIONAL MODES

Due to the intricate nature of the processes covered by the Criticality Accident Alarm System, operational modes are not specified. Sufficient information to determine the applicability of the requirements set forth in this TSR is provided in the individual LCOs.

2.6.2 SAFETY LIMITS

There are no safety limits associated with Criticality Accident Alarm System.

2.6.3 LIMITING CONTROL SETTINGS, LIMITING CONDITIONS FOR OPERATION, SURVEILLANCES

There are no LCSs associated with the Criticality Accident Alarm System.

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM

LCO 2.6.4.1a: Criticality accident detection shall be operable.

APPLICABILITY: In areas, equipment, or processes in the facilities listed in the table below which contain greater than 700 grams of ^{235}U at an enrichment greater than or equal to 1.0 wt % ^{235}U.

Building/Facility Number	Building/Facility Name and/or Function	CAAS Cluster
C-400	Cleaning Building	D, E
C-409	Stabilization Building	P, AE
C-710	Technical Services Building	AM, AN, AP, AQ, AR
C-720	Maintenance and Stores Buildings	AL
C-720-C	Converter Shop Addition	AL
C-745-X	Equipment Storage	AD
C-746-Q-1	High Assay Waste Storage	AD

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

ACTIONS:

Condition	Required Action	Completion Time
A. Areas, equipment, or processes not covered by criticality accident detection.	A.1 Discontinue operations with fissile material. [Handling, transporting, analyzing, or processing of assay samples necessary for compliance with TSR 2.4.4.3 is not restricted by this action.]	Immediately
	AND	
	A.2.1 Evacuate area within the area applicable to the LCO not covered by criticality accident detection.	Immediately
	AND	
	A.2.2 Restrict access to area evacuated in A.2.1.	
	AND	
	A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate.	Immediately
B. Areas, equipment, or processes not covered by criticality accident detection.	B.1.1 Restore criticality accident detection by installing portable CAAS unit providing required criticality accident detection and same alarms as fixed unit.	Prior to reinitiating activities
	OR	
	B.1.2 Restore criticality accident detection to operable status.	
	TSR 1.6.2.2d is not applicable.	

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.6.4.1a-1	Calibrate CAAS system equipment.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the listed facilities are associated with the handling of fissile materials. Assay sampling required by TSR 2.4.4.3 is not restricted during CAAS outages due to the small quantities of material involved and the low risk associated with sample analysis. The NCSA that governs the handling of assay sampling tubes limits the number of tubes to a batch which is less than safe mass and volume. The only fissile material operations that will be allowed during the CAAS outage are those which involve the handling, transporting, analyzing, or processing of assay samples which are needed for TSR compliance. The movement of fissile material, such as carboys or waste drums, is prohibited while the LCO actions are in effect. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster, and by sounding in some locations a local horn associated with each individual cluster. The building horns for C-709 and C-710 are configured in two separate networks, either of which can independently sound the required evacuation signal. The building horn configuration in C-709 and C-710 allows the CAAS for those buildings to remain operable even when one of the independent horn networks is temporarily out of service. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of detection will establish protection. [SAR Sections 3.15.7.1 and 4.3.2.6]

Facilities containing criticality accident alarm systems (other than those covered by TSR Sections 2.1-2.4) include C-400, C-409, C-710, C-720, C-720M, C-720K, C-720R, C-720S, C-720-C, C-728, and C-746-Q-1.

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

LCO 2.6.4.1b: Criticality accident alarm shall be operable (audible).

APPLICABILITY: In areas in the facilities listed in 2.6.4.1a where the maximum foreseeable absorbed dose in free air exceeds 12 rad, except areas in permit-required confined spaces and localized areas of inaudibility.

ACTIONS:

Condition	Required Action	Completion Time
A. Area does not have an audible criticality accident alarm.	A.1 Discontinue operations with fissile material. [Handling, transporting, analyzing, or processing of assay samples necessary for compliance with TSR 2.4.4.3 is not restricted by this action.] AND A.2.1 Evacuate area of inaudibility AND A.2.2 Restrict access to the area of inaudibility. AND A.3 Provide personnel allowed into the area that would be restricted under Action A.2.1 with an alternate means of criticality alarm notification such as a device that will alarm on sensing a 10mr/hr dose rate, or a radio in constant communication with the Central Control Facility.	Immediately Immediately Immediately
B. Area does not have an audible criticality accident alarm.	B.1 Restore criticality accident alarm to operable status. TSR 1.6.2.2d is not applicable.	Prior to reinitiating activities

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.6.4.1b-1	Test the CAAS and building horns.	Annually
SR 2.6.4.1b-2	Verify that the CAAS air accumulator supply pressure to the building horns is greater than or equal to that necessary to sound all building horns for at least 120 seconds based on the number of accumulators in service. C-400 Number of accumulators in service — Minimum pressure 2 — 125 psig 1 — 145 psig C-409 Number of accumulators in service — Minimum pressure 1 — 125 psig	Quarterly
SR 2.6.4.1b-3	Verify that the condition of the battery backups to the electronic horns are sufficient to power the horns for at least 120 seconds.	Annually

BASIS:

The CAAS is used to warn plant personnel of a criticality or radiation accident. This system is designed to detect radiation and provide a distinctive, audible signal which will alert personnel to move from those work areas which are potentially affected. Audibility is not provided for areas in permit-required confined spaces and localized areas of inaudibility resulting from temporary activities that generate high noise levels. A “buddy system” is used to ensure personnel working in these areas are notified of alarms in order to evacuate. One person remains outside the area and maintains contact with personnel in the area. Evacuation of the area of inaudibility and restricting access to those areas will eliminate the potential for increased consequences due to personnel not hearing an alarm. The design of the system, three detector modules per cluster, provides protection for criticality events even with partial losses of required equipment. The CAAS also provides detection coverage in most areas by using an overlapping pattern of individual cluster units. Criticality concerns with the listed facilities are associated with the handling of fissile materials.

SECTION 2.6 SPECIFIC TSRs FOR CAAS (NON-CASCADE FACILITIES)

2.6.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.6.4.1 CRITICALITY ACCIDENT ALARM SYSTEM (continued)

BASIS (continued):

Assay sampling required by TSR 2.4.4.3 is not restricted during CAAS outages due to the small quantities of material involved and the low risk associated with sample analysis. The NCSA that governs the handling of assay sampling tubes limits the number of tubes to a batch which is less than safe mass and volume. The only fissile material operations that will be allowed during the CAAS outage are those which involve the handling, transporting, analyzing, or processing of assay samples which are needed for TSR compliance. The movement of fissile material, such as carboys or waste drums, is prohibited while the LCO actions are in effect. The action items maintain the facility in steady state operations to limit the potential for these concerns to the extent possible. The alarm signal is provided by sounding building horns which sound upon a signal from any cluster. The building horns for C-709 and C-710 are configured in two separate networks, either of which can independently sound the required evacuation signal. The building horn configuration in C-709 and C-710 allows the CAAS for those buildings to remain operable even when one of the independent horn networks is temporarily out of service. Providing another means of coverage (i.e., portable detector/alarm, personal alarm device, etc.), restricting operations, or restricting access to the area in the event of the loss of alarms will establish protection.

Facilities containing criticality accident alarm systems (other than those covered by TSR Sections 2.1-2.4) include C-400, C-409, C-710, C-720, C-720M, C-720K, C-720R, C-720S, C-720-C, C-728, and C-746-Q-1. [SAR Sections 3.15.7.1, 4.3.2.6, 5.2.2.5]

The CAAS air accumulators provide for 120 seconds of horn actuation when at their minimum acceptable pressure based on the number of accumulators in service. Electronic horns are also installed in some areas. These horns have battery backup power supplies which will provide for at least 120 seconds of horn actuation even if off-site power is lost.

The annual surveillance of the CAAS building horns consists of placing the cluster in the test mode with a keyswitch, and manually causing two detector modules to generate radiation readings above the alarm setpoint. The cluster electronics determines that this meets the high radiation alarm criteria and propagates a high radiation alarm signal to the rest of the system. This signal activates the high radiation alarm light and bell in C-300 and activates the building CAAS horns. Each horn is qualitatively verified to be operating. This test is a horn functional test and each module combination is tested to generate the high radiation signal.

SECTION 3.0

ADMINISTRATIVE CONTROLS

SECTION 3.0 ADMINISTRATIVE CONTROLS

3.1 RESPONSIBILITY

3.1.1 The Vice President, Operations shall have corporate responsibility for overall gaseous diffusion plant safety and shall have authority to take any measures needed to ensure acceptable performance of the staff in operating, maintaining, and providing technical support to the plant to ensure nuclear safety.

3.1.2 The General Manager shall be responsible for the overall safe operations of the plant and shall take any measures required to ensure the plant remains in a safe condition. The General Manager or his/her designee shall approve, prior to implementation, each proposed test, experiment, or modification to systems or equipment that affect nuclear safety. The General Manager shall delegate in writing the succession to this responsibility during his/her absence from plant site.

3.1.3 The Plant Shift Superintendent (PSS) shall be responsible for the operational aspects of the plant, and for the central control room command function. During any absence from the central control room while the plant is operational, an authorized designee shall be named and be present in the central control room. The term designee means a person who has been trained to execute plant emergency procedures. The designee shall have the capability to be in contact with the PSS using the plant communication systems when the PSS is absent from the central control facility.

3.1.4 The Organization Manager shall be responsible for the operations conducted within the facilities affected by this TSR for which he/she is responsible, and shall delegate in writing the succession of responsibility during absence from plant site.

3.2 ONSITE AND OFFSITE ORGANIZATION

3.2.1 Onsite and Offsite

Onsite and offsite organizations shall be established for facility operation and corporate management, respectively. The onsite and offsite organizations shall include the positions for activities affecting the nuclear safety of the gaseous diffusion plant and are described in Section 6.1 of the SAR.

a. Lines of authority, responsibility, and communications shall be established and defined for the highest management levels through intermediate levels to include operating organization positions. These relationships shall be documented and updated, as appropriate, in the form of organizational charts, functional descriptions of organization responsibilities and relationships, and job descriptions for positions down to and including first-line managers.

SECTION 3.0 ADMINISTRATIVE CONTROLS

b. Individuals who perform training, health physics, quality assurance, nuclear criticality safety, and/or other safety functions shall have sufficient organizational freedom to ensure their independence from operating pressures.

3.2.2 FACILITY STAFF

a. Minimum staffing requirements for each facility are shown in Table 3.2.2-1. These staffing levels do not apply under conditions requiring facility evacuation.

b. Administrative procedures shall be developed, implemented, and maintained to limit the working hours of facility staff who perform safety functions (e.g., operators, health physics personnel, maintenance personnel), in accordance with the following guidelines.

Adequate shift coverage shall be maintained without routine heavy use of overtime. The objective shall be to have personnel work an 8-hour or 12-hour workday [i.e., a nominal 40 hour (can be as much as 48 hours) work week]. In the event that overtime must be used on a temporary basis, the following guidelines shall be used:

1. An individual should not be permitted to work more than 16 straight hours, excluding shift turnover;

2. An individual should not be permitted to work more than 16 hours in any 24 hour period, nor more than 26 hours in any 48 hour period, nor more than 72 hours in any 7 day period, all excluding shift turnover time;

3. A break of at least 8 hours should be allowed between work periods; the 8 hours may include shift turnover

4. Except during outage periods, the use of overtime should be considered on an individual basis and not for the entire staff on a shift.

Any deviation from the above guidelines shall be authorized in advance by the General Manager or his designee, in accordance with approved administrative procedures and with documentation of the basis for granting the deviation. Routine deviation from the above guidelines is not authorized.

Management will assess on a monthly basis the application of overtime for facility staff who perform safety functions to ensure consistency with the overtime guidelines stated above.

SECTION 3.0 ADMINISTRATIVE CONTROLS

Table 3.2.2-1 Minimum Staffing Requirements[a]

Facility Function	Mode/Operation	Staffing Requirements	Work Area Definition
C-300	All	3	PSS on the plant site with designee in C-300. Cascade Coordinator on plant site. Power Operator in C-300.
C-360[b]	1b, 3, 4, 5	1	In the facility or immediately surrounding grounds to include the guard station and the local cylinder yard.
	2A, 6	1	In the facility or immediately surrounding grounds to include the guard station and the local cylinder yard.
	7	1	One person in the Laboratory.
	1a	2	In the facility or immediately surrounding grounds to include the guard station and the local cylinder yard.
C-333-A[b]	1, 2, 5, 7	2	Two persons in the operating facility or immediately surrounding grounds including the local cylinder yard.
C-337-A[b]	3, 4, 8	1	One person in the facility or immediately surrounding grounds including the local cylinder yard.
C-310	Product withdrawal 1, 2, 3, 4 Cascade 1, 3	2[c]	At least one person in the ACR. One person in the facility or immediately surrounding grounds including the local cylinder yard.
C-315	1, 2, 3, 4	2[c]	Two persons in the facility or immediately surrounding grounds including the local cylinder yard.
C-331	Cascade 1, 2, 3 F/S 1, 2, 3, 4, 5	2	At least one person in the ACR.
C-335			
C-333	Cascade 1, 2, 3 F/S 1, 2, 3, 4, 5	3	At least one person in the ACR.
C-337			
Health Physics	At all times	1	Onsite.
Power Operations	At all times	4	Onsite.
Utilities Operations	At all times	4	Onsite.
Fire Services	At all times	4[d]	Onsite[d].
Security Services	At all times	4	Onsite.

a. Staffing may be less than the minimum requirement listed for a period of a time not to exceed four hours in order to accommodate unexpected absence of on-duty shift members provided immediate action is taken to restore the shift manning requirements to within the minimum requirements. The C-331, C-333, C-335, and C-337 ACRs shall always be manned. The ACRs for C-310, C-315, C-333-A, and C-337-A shall be manned when required by operating mode. Manning not required during emergency conditions requiring building/area evacuation.

b. Manning requirement is zero if, 1) all C-333-A or C-337-A autoclaves are in MODE 6 (Not In Use), or 2) all C-360 autoclaves are in Mode 2B (out of service) or MODE 8 (Not In Use) and the Transfer Station is in MODE 8 (Not in Use).

c. When withdrawal process equipment is brought below atmospheric pressure, or to a UF_6 negative in the NOT IN USE (Mode 4) operating mode then the staffing requirements for the appropriate withdrawal facility do not apply.

d. In accordance with footnote “a”, Fire Services personnel making an unexpected run to deliver an individual to a local hospital are allowed to be offsite and are considered to be on duty and available.

SECTION 3.0 ADMINISTRATIVE CONTROLS

3.3 FACILITY STAFF QUALIFICATION

Facility positions are filled with persons whose experience and/or training qualify them for their respective positions. The minimum qualifications, functions, and responsibilities for key staff positions are described in the Safety Analysis Report.

3.4 TRAINING

The Training Program shall ensure that individuals relied upon to operate, maintain, or modify the plant in a safe manner are properly trained to do so. The training program shall be based on a systems approach to training and shall consist of the following basic components:

a. Systematic analysis of jobs to be performed

b. Learning objectives derived from the analysis that describe desired performance after training

c. Training design and implementation based on the learning objectives

d. Evaluation of trainee mastery of the objectives during training

e. Evaluation and revision of the training based on the performance of trained personnel in the job setting.

The training program shall be established, implemented, and maintained as described in Section 6.6 of the SAR.

3.5 REVIEWS, ASSESSMENTS, AND AUDITS

A system of reviews, assessments, and audits shall be implemented as defined in the Quality Assurance Program and Section 6.8 of the SAR to ensure the health, safety, and environmental programs are being conducted in accordance with regulatory requirements and commitments and for on-going assurance that these programs are adequate and effectively implemented.

3.6 TECHNICAL SAFETY REQUIREMENTS (TSR) BASES CONTROL

Changes to the TSR Basis statements shall be reviewed and approved in accordance with the plant change control process as described in Section 6.3 of the SAR.

SECTION 3.0 ADMINISTRATIVE CONTROLS

3.7 EFFECTS OF NATURAL PHENOMENA

Emergency response procedures shall be established, implemented, and maintained to prescribe plant response to the following natural phenomena events:

- Earthquake
- Tornado/High Winds
- Flooding/Intense Precipitation

3.8 PROCESS VENTILATION AND OFF-GAS

Control of radioactive emissions shall be established implemented and maintained as described in Section 5.1 of the SAR.

3.9 PROCEDURES

3.9.1 SCOPE

Written procedures shall be prepared, reviewed, approved, implemented, and maintained (except for a limited time as specified in the Compliance Plan) to cover the following:

a. Activities described in SAR Section 6.11.4.1 and listed in Appendix A to SAR Section 6.11;

b. Operator actions and administrative controls to prevent or mitigate the consequences of accidents described in SAR Chapter 4; and

c. Programs specified and described in TSRs 3.11 through 3.19, and 3.23.

3.9.2 REVIEW AND APPROVAL

a. Each new procedure required by TSR 3.9.1 shall be reviewed by the PORC in accordance with TSR 3.10.

b. Each proposed change to the procedures required by TSR 3.9.1 shall be reviewed by the PORC in accordance with TSR 3.10 if:

   1. The proposed change requires a written safety analysis in accordance with 10 CFR 76.68; or

   2. The proposed change results in a change to the documents listed in TSR 3.10.5.b, c, and d; or

3. The proposed change constitutes an intent change (i.e., a change in scope, method, or acceptance criteria that has safety significance).

c. Each procedure required by TSR 3.9.1 and changes thereto shall be approved in accordance with approved administrative procedures prior to implementation and reviewed periodically as set forth in administrative procedures.

3.9.3 TEMPORARY CHANGES

Temporary changes to procedures required by TSR 3.9.1 may be made provided:

a. The temporary change does not require a written safety analysis in accordance with 10 CFR 76.68; and

b. The temporary change does not result in a change to the documents listed in TSR 3.10.5.b, c, and d; and

c. The temporary change does not constitute an intent change (i.e., a change in scope, method, or acceptance criteria that has safety significance); and

d. The change is approved by two members of the plant management staff, at least one of whom is the Plant Shift Superintendent; and

e. The change is documented, reviewed, and approved in accordance with TSR 3.9.2 within 14 days of implementation.

3.10 PLANT OPERATIONS REVIEW COMMITTEE (PORC)

A Plant Operations Review Committee shall be constituted and shall function to perform multi-discipline reviews of day-to-day and proposed plant activities (as described in this TSR) to ensure that these activities are/will be conducted in a safe manner.

3.10.1 MEMBERSHIP

a. The PORC shall consist of a minimum of ten people (including the chair) and designated alternates. No more than a minority of the members shall have direct responsibility for plant operations.

SECTION 3.0 ADMINISTRATIVE CONTROLS

b. PORC membership shall be multi-disciplinary and shall have the necessary qualifications, competence and experience to provide reviews of the following functional areas:

- Cascade and Chemical Operations
- Engineering
- Maintenance
- Nuclear Safety
- Nuclear Criticality Safety Engineering
- Radiological Safety
- Chemical, Industrial, and Environmental Safety
- Quality Assurance
- Safeguards

3.10.2 QUALIFICATIONS

PORC members shall have:

a. A minimum of bachelors degree in engineering or the physical sciences, or equivalent technical experience as defined in the Safety Analysis Report.

b. Four years of nuclear experience with a minimum of 6 months experience in a gaseous diffusion plant.

c. The member which has the expertise in Nuclear Criticality Safety Engineering shall have the qualifications of a Senior Criticality Safety Engineer as defined in the Safety Analysis Report.

3.10.3 MEETING FREQUENCY AND QUORUM

a. The PORC shall meet at a minimum of once per calendar month.

b. A PORC meeting quorum shall consist of the chair plus six members, of which no more than two may be alternates. The quorum shall include members with technical competence in the following areas:

- Operations
- Engineering
- Nuclear Criticality Safety Engineering
- Radiological Safety
- Quality Assurance

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3.10.4 FUNCTIONS

The PORC shall, as a minimum, incorporate functions that:

a. Advise the General Manager on matters related to nuclear safety;

b. Recommend to the General Manager approval or disapproval of items considered under TSR 3.10.5 prior to their implementation except as provided in TSR 1.6.4 and TSR 3.9.3;

c. Determine whether each item considered under TSR 3.10.5 requires prior NRC approval before implementation per 10 CFR 76.68 and 76.45.

d. Notify the Vice President, Operations of any safety significant disagreement between the PORC and the General Manager within 24 hours. However, the General Manager shall have responsibility for resolution of such disagreements pursuant to TSR 3.1.2.

3.10.5 RESPONSIBILITIES

The PORC shall be used to conduct, as a minimum, reviews of the following:

a. All proposed procedures and procedure changes as required by TSR 3.9.2;

b. All proposed changes to the Safety Analysis Report;

c. All proposed changes to the Emergency Plan, Quality Assurance Program Description, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic Significance, Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance, Security Plan for the Protection of Classified Matter, Fundamental Nuclear Materials Control Plan, Radioactive Waste Management Program, Depleted Uranium Management Plan, Decommissioning Funding Program Description, Environmental Compliance Status Report, and Supplemental Environmental Information Related to Compliance Plan that are included in the certification application.

d. All proposed changes to the TSRs, the TSR basis statements, the Certificate of Compliance, or the Compliance Plan;

e. All proposed changes to the plant or the plant's operations, including tests and experiments, that require a written safety analysis in accordance with 10 CFR 76.68.

SECTION 3.0 ADMINISTRATIVE CONTROLS

f. All nuclear criticality safety evaluations and approvals except editorial changes;

g. All proposed Requests for Enforcement Discretion;

h. NRC-required event reports.

3.10.6 RECORDS

Written records of PORC reviews shall be maintained. As a minimum, these records shall include:

a. Results of the activities conducted under the provisions of TSR 3.10;

b. Recommended approval or disapproval of items considered under TSR 3.10.5;

c. Determination of whether each item considered under TSR 3.10.5 requires prior NRC approval before implementation per 10 CFR 76.68 and 76.45.

d. Minutes of PORC meetings, as approved by the chair or his/her designee.

e. Appointments of PORC members and alternates.

3.11 NUCLEAR CRITICALITY SAFETY PROGRAM

3.11.1 A Criticality Safety Program shall be established, implemented, and maintained as described in the Safety Analysis Report and shall address the following elements:

- Adherence with ANSI/ANS Standards
- Nuclear Criticality Safety Responsibilities
- Process Evaluation and Approval
- Identification of SSCs and support systems necessary to meet the double contingency principle
- Design Philosophy and Review
- Criticality Accident Alarm System Coverage
- Procedure Requirements
- Posting and Labeling Requirements
- Change Control
- Operation Surveillance and Assessment
- Technical Aspects

SECTION 3.0 ADMINISTRATIVE CONTROLS

3.11.2 All operations involving uranium enriched to 1.0 wt % or higher U-235 and 15 g or more of U-235 shall be based upon a documented nuclear criticality safety evaluation and shall be performed in accordance with a documented nuclear criticality safety approval.

3.11.3 A minimum margin of subcriticality of 0.02 in k_{eff}, shall be used to establish the acceptance criteria for criticality calculations.

3.11.4 The k_{eff} for criticality calculations shall be $\leq$ 0.9634 which includes the bias, uncertainty, and the margin of subcriticality.

3.11.5 The double contingency principle, as described in the Safety Analysis Report, shall be used as the basis for the design and operation of processes using fissionable materials. In those instances where double contingency is not met, TSRs shall be established, implemented, and maintained to prevent criticality from occurring.

3.12 FIRE PROTECTION PROGRAM

A Fire Protection Program shall be established, implemented, and maintained as described in SAR Section 5.4 and shall address the following elements:

- Fire Hazard Description and Evaluation
- Fixed Fire Suppression and Fire Detection Systems
- Mobile and Portable Equipment
- Testing and Inspection
- Staffing
- Fire Investigation, Permits, and Procedures
- Nuclear Criticality Safety Aspects of Firefighting

The Fire Protection Program shall specifically contain the following elements that must be applied to the removal of equipment containing PEH deposits from the cascade (TSR Section 2.4) or the Product Withdrawal Area (TSR Section 2.3) or C-400 Chemical Decontamination Facility. This is for Nuclear Criticality Safety and will ensure the prevention of a fire large enough to initiate sprinkler operation which could become a source of moderation for a PEH deposit. The other NCS aspects of equipment removal are addressed in TSR Section 2.5.

- Issue and use a welding/burning/hotwork permit before the start of welding, burning or other hotwork activities whenever PEH activities are being performed concurrent with the hotwork and these activities will result in a deposit being unprotected from water that could be present from sprinkler piping damage or sprinkler activation.

SECTION 3.0 ADMINISTRATIVE CONTROLS

- The permit shall specifically ensure that:

  Combustible Materials will be removed or protected if within the immediate vicinity during hot work, burning or welding.

  No portable flammable liquid containers will be allowed within the immediate vicinity during hot work, burning or welding.

  Quantities of flammable gas or oxygen cylinders will be limited to a one day supply for the work being conducted.

  Flammable gas or oxygen cylinders will be secured to prevent them from being knocked over. This can include being mounted in an acceptable cart.

  Flammable gas or oxygen cylinders will be isolated or protected from sparks, slag or flame resulting from the hot work.

  When flammable gas or oxygen cylinders are not in use, the cylinder valves will be isolated and if regulators are not installed for use, the cylinder caps will be installed.

- A dedicated, continuous fire watch, equipped with portable CO_2 or dry chemical fire suppression equipment shall be posted for welding, burning or hotwork operations when PEH equipment is not covered in accordance with TSR 2.5.4.3.

- When equipment containing a PEH deposit is uncovered in C-400, the sprinkler system protecting the area where the equipment is located shall be isolated and drained.

- Pre-fire plans for all buildings containing fissile/potentially fissile material shall address nuclear criticality safety requirements for building entry during situation evaluation and fire fighting activities.

3.13 RADIATION PROTECTION PROGRAM

A Radiation Protection Program shall be established, implemented, and maintained as described in SAR Section 5.3 and shall address the following elements:

- HP Technician Training and Qualifications
- Personnel Exposure Control and Measurement
- Contamination Control
- Radioactive Material Control
- Radiological Protection Instruments and Equipment
- Records and Reports

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3.14 RADIOACTIVE WASTE MANAGEMENT PROGRAM

A Radioactive Waste Management Program shall be established, implemented, and maintained as described in the program description provided as a part of the Application and shall address the following elements:

- Radiological Characterization
- Waste Packaging and Labeling
- Radioactive Waste Processing and Storage
- Off-Site Waste Shipments
- Waste Disposal

3.15 MAINTENANCE

A Maintenance Program shall be established, implemented, and maintained as described in SAR Section 6.4 and shall address the following program elements:

- Training
- Maintenance Procedures
- Maintenance Programs
- Work Control
- Post Maintenance Testing
- Procurement, Receipt Inspection, Control, and Issuance of Q and AQ Items, Repair Parts, Materials and Services
- Control of Measuring and Test Equipment
- Maintenance History

3.16 ENVIRONMENTAL PROTECTION PROGRAM

An Environmental Protection Program shall be established, implemented, and maintained as described in SAR Section 5.1 and shall address the following program elements:

- Emission and Effluent Control Systems
- Air Emission Monitoring
- Meteorological Monitoring
- External Gamma Radiation Monitoring
- Water Monitoring
- Biological Monitoring
- Soil and Sediment Monitoring
- Methods of Evaluation and Demonstration of Compliance

SECTION 3.0 ADMINISTRATIVE CONTROLS

3.17 PACKAGING AND TRANSPORTATION PROGRAM

A packaging and transportation quality assurance program shall be established, implemented, and maintained as described in the NRC-approved version of UEO-1041, "Radioactive Material Packaging and Transportation Quality Assurance Program."

3.18 CHEMICAL SAFETY PROGRAM

A Chemical Safety Program shall be established, implemented, and maintained as described in SAR Section 5.6.

3.19 OPERATIONS

An Operations Program shall be established, implemented, and maintained as described in SAR Section 6.5 and shall address the following program elements:

- Shift Operations
- Cascade Operations Organization and Administration
- Chemical/Utilities/Power Organization and Administration
- Operator Responsibility, Authority and Shift Routines
- Operations Procedures, Operator Aids, and System Labeling
- Permits and Logging
- Management Monitoring of Operations
- Control of Equipment

3.20 ACCIDENT ANALYSIS

The Accident Analysis is presented in SAR Chapter 4. Changes to the Accident Analysis shall be reviewed and approved in accordance with the plant design change control process in Section 6.3 of the SAR.

3.21 SHARING OF FACILITIES, STRUCTURES, SYSTEMS, AND COMPONENTS

Facilities, structures, systems, and components relied upon in Section 2 of the TSRs are controlled by USEC. The corporation is not dependent upon outside agencies to provide the level of safety described in this TSR.

3.22 UTILITIES ESSENTIAL TO RADIOLOGICAL SAFETY

System boundary documents prepared as part of the Configuration Management Program shall identify utilities required by SSCs to perform their intended safety function.

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3.23 WORKER PROTECTION FROM UF_6 PROCESS HAZARDS

Worker protection measures shall be established, implemented, and maintained to minimize the risk of and mitigate the consequences of releases of UF_6, UF_6 reaction products with moist air (e.g., UO_2F_2 and HF), and other associated process chemicals during normal, off-normal, and emergency conditions. Such measures shall address the radiation hazards presented by radioactive materials; the toxic (chemical) risk posed by radioactive materials and their reaction products with moist air; and plant conditions, including chemical hazards, that may adversely impact radiation risk or increase the probability of the release of radioactive materials. Other plant conditions including chemical hazards which may result in an occupational risk but which do not affect the safety of radioactive materials are subject to OSHA requirements and not addressed below. Such measures shall address the following elements:

a. Measuring workplace exposures as described in the radiation protection and chemical safety sections of the Safety Analysis Report, and maintaining those exposures at or below the levels specified in the Safety Analysis Report for soluble uranium and applicable requirements for hydrogen fluorides, fluoride, chlorides, refrigerating agents, and acid gases.

b. Implementing and maintaining contamination control measures for radioactive materials as described in the radiation protection section of the Safety Analysis Report.

c. Providing, and ensuring the use of, personal protective equipment as described in the radiation protection and chemical safety sections of the Safety Analysis Report.

d. Providing chemical hazard information and training to workers (HAZCOM) as described in the chemical safety section of the Safety Analysis Report to ensure that they will react correctly to chemical hazards and releases.

e. Training workers to comply with alarm response procedures in the event of a release of UF_6, UO_2F_2, HF or other chemicals identified in the chemical safety section of the Safety Analysis Report and ensuring their compliance with the plant "see and flee" policy as described in the Safety Analysis Report.

f. Controlling work and entry into locations where UF_6 may be present as described in the chemical safety and radiation protection sections of the Safety Analysis Report.

g. For buildings C-310, C-315, C-331, C-333, C-333-A, C-335, C-337, C-337-A, C-360, C-400, C-409, C-710, C-720, and C-746-Q1:

(1) Controlling work in process areas where choice and freedom of emergency egress routes may be limited, for example, cranes or tunnels, by eliminating the source of the hazard or by providing personnel protective equipment or taking other protective measures as described in work control documents, work permits, or procedures as appropriate.

(2) Identifying and marking emergency egress routes in process areas and maintaining them free of obstruction.

(3) Providing illumination in process areas with battery backup for emergency egress. Where illumination with battery backup is not functional, not available, or not feasible, personnel shall be provided with functional portable lights.

3.24 RECORDS RETENTION

The following records will be retained for the specified durations. The administration of the records retention program is addressed in SAR Section 6.10.

3.24.1 The following records shall be retained for at least 2 years:

a. Changes in programs, plans, policies, procedures, and operations, including copies of the safety analysis on which the changes were based.

3.24.2 The following records shall be retained for at least 4 years:

a. Records of surveillance activities, inspections, and calibrations required by the TSRs

b. Records of maintenance activities associated with systems, structures, or components, related to nuclear safety.

3.24.3 The following records shall be retained until the end of the duration of the lease:

a. Records and drawing changes of plant changes made to systems and equipment described in the SAR.

b. The results of the review of any exceedance of a safety limit

c. The results of the review of any automatic alarm or protective device that does not function as required during operation

SECTION 3.0 ADMINISTRATIVE CONTROLS

d. The results of the review of any failure to meet a limiting condition for operation.

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.4**

TSR Title: **Cascade Wet Air Inleakage**

Clarification Subject: **Restrictions on Use of TSR 2.4, Appendix B, Safe Mass Curve**

I. Statement of Requested Clarification

Clarify which safe mass curve is to be used upon entry into LCO 2.4.4.4, Conditions A, B, and C. If the conditions in Condition C of LCO 2.4.4.4 are met, the Safe Mass Curve contained in TSR 2.5, Appendix B must be used for PEH determination instead of the Safe Mass Curve contained in TSR 2.4, Appendix B that TSR 2.4.4.4 currently references. In addition, if neutronically coupled deposits exist in equipment covered by Conditions A and B, the safe mass curve contained in TSR 2.5 Appendix B must be used unless the safe mass value is appropriately adjusted to account for double batching.

II. Background Information

Amendment 12 to the PGDP Certificate of Compliance, issued to USEC by the NRC on March 16, 2001, imposes a condition to the certificate that is more restrictive than LCO 2.4.4.4, if LCO 2.4.4.4, Condition C is entered, and potentially more restrictive if Conditions A and B are entered.

Conditions A and B in TSR 2.4.4.4 establish required actions for deposits in a fluorinating environment and a non-fluorinating environment, where the hazard is moderation from wet air inleakage. With wet air inleakage as the only source of moderation, safe mass H/U ratio has been demonstrated not to exceed 4 for the period of coverage. The new curve which is based on an H/U=4 is acceptable unless there are deposits which might be neutronically coupled, in which case the NDA group will provide the mass determination using 45 percent of the maximum subcritical mass value. Condition C applies to shutdown equipment with deposits in a non-fluorinating environment when the R-114 coolant pressure is not greater than the Recirculating Cooling Water (RCW) pressure. There are specific time limits established for either increasing the R-114 pressure, or draining the RCW. The requirement that the R-114 pressure is greater than the RCW pressure is a barrier against the introduction of liquid water, which can lead to an H/U ratio which is greater than 4. Therefore, basing the determination of PEH on the curve in TSR 2.4, Appendix B could be non-conservative for Condition C because the H/U=4 is not a bounding assumption for liquid inleakage.

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: 2.4.4.4

TSR Title: Cascade Wet Air Inleakage

Clarification Subject: Restrictions on Use of TSR 2.4, Appendix B, Safe Mass Curve

II. Background Information (continued)

In addition, deposits may be found in the cascade equipment in close proximity to each other. Even when each deposit is less than a safe mass individually, the combination of deposits could exceed a safe mass in a given area and may require criticality safety controls for greater than safe mass deposits when neutron interactions are taken into account. Conditions A, B, and C apply to discrete portions of the cascade that could contain multiple deposits and the TSR 2.4 mass curve may not apply since multiple deposits were not considered.

The NRC approved the safe mass curve in TSR 2.4, Appendix B, for the purposes of determining entry into Conditions A and B of TSR 2.4.4.4. However, because the safe mass curve does not account for double batching, it should not be applied to co-located deposits (i.e., those not neutronically isolated). The NRC did not recommend approval of the new safe mass curve for the purposes of determining entry into Condition C of TSR 2.4.4.4.

The condition to the certificate amendment states the following and this condition will be met by following the requirements of this TSR clarification.

Notwithstanding the requirements of TSR 2.4.4.4, USEC shall use the safe mass curve in TSR 2.5 Appendix B, instead of the safe mass curve in TSR 2.4 Appendix B, for determining entry into TSR 2.4.4.4 Condition C. The combined mass of all deposits in the affected equipment shall be used in making this determination if double batching is not considered.

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.4**

TSR Title: **Cascade Wet Air Inleakage**

Clarification Subject: **Restrictions on Use of TSR 2.4, Appendix B, Safe Mass Curve**

III. Clarification

TSR 2.4.4.4 provides the actions that must be accomplished when a UO_2F_2 deposit exists in cascade equipment and the equipment is not going to be removed. When it is recognized, and confirmed by NDA measurement, that a UO_2F_2 deposit exists in equipment, the mass must be quantified to determine if it is Uncomplicated Handling (UH) or Planned Expeditious Handling (PEH). For TSR 2.4.4.4, entry conditions A and B, the UH/PEH determination curve provided in TSR 2.4, Appendix B can be used for a single UO_2F_2 deposit. If multiple deposits are identified, the NDA group will make the determination using 45 percent of the maximum subcritical mass value. For TSR 2.4.4.4, entry condition C, the UH/PEH determination curve provided in TSR 2.5, Appendix B must be used. The following table summarizes proper use of the safe mass determination curves for TSR 2.4.4.4.

TSR 2.4.4.4 Condition	Safe Mass Determination Curve
<u>Single Deposit</u> A. UO_2F_2 deposit greater than the safe mass with the deposit in a fluorinated (including chemical treatment) environment.	TSR 2.4, Appendix B
<u>Multiple Deposits</u> A. UO_2F_2 deposit greater than the safe mass with the deposit in a fluorinated (including chemical treatment) environment.	NDA determines if UH or PEH using 45% of the maximum subcritical mass value

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.4**

TSR Title: **Cascade Wet Air Inleakage**

Clarification Subject: **Restrictions on Use of TSR 2.4, Appendix B, Safe Mass Curve**

TSR 2.4.4.4 Condition	Safe Mass Determination Curve
<u>Single Deposit</u> B. UO_2F_2 deposit greater than the safe mass with the deposit not in a fluorinated environment (cascade cell off-stream)	TSR 2.4, Appendix B
<u>Multiple Deposits</u> B. UO_2F_2 deposit greater than the safe mass with the deposit not in a fluorinated environment (cascade cell off-stream)	NDA determines if UH or PEH using 45% of the maximum subcritical mass value
<u>All Deposit(s)</u> C. UO_2F_2 deposit greater than the safe mass not in a fluorinated environment, system is in a shutdown mode, and coolant pressure ≤ RCW pressure.	TSR 2.5, Appendix B

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE

LCO 2.4.4.4: Moderation control shall be maintained when deposits of UO_2F_2 in a pipe or component listed in TSR 2.4, Appendix A are estimated to be greater than the safe mass as determined by TSR 2.4, Appendix B.

APPLICABILITY: Modes: Cascade 1 and 2 when uranium assay is ≥ 1.0 wt % ^{235}U.

ACTIONS:

Condition	Required Action	Completion Time
A. UO_2F_2 deposit greater than the safe mass with the deposit in a fluorinated (including chemical treatment) environment.	A.1 Continue to maintain a fluorinating environment for the deposit. AND A.2 Initiate actions to determine the cause of the deposit and its significance. AND A.3 Establish and document a plan of action. TSR 1.6.2.2(d) is not applicable.	Immediately Immediately 30 Days
B. UO_2F_2 deposit greater than the safe mass with the deposit not in a fluorinated environment (cascade cell off-stream)	B.1.1 Establish a dry gas blanket at ≥14 psia. AND B.1.2 Remove equipment containing the deposit from the cascade in accordance with TSR 2.5 OR B.2.1 Establish a dry gas blanket at ≥14 psia. AND B.2.2 Repair the leak in accordance with the requirements of the NCSA for the repair, maintaining the dry gas blanket as specified. AND B.2.3. Initiate chemical treatment activities or continue ACTION A.1 or B.1, with removal of equipment to be completed within 135 days.	Within 8 hours after a fluorinating environment is removed (UF_6 negative). 180 days Within 8 hours after a fluorinating environment is removed (UF_6 negative). 45 days Immediately following completion of the repair and removal of dry gas blanket.
C. UO_2F_2 deposit greater than the safe mass not in a fluorinated environment, system is in a shutdown mode, and coolant pressure ≤ RCW pressure.	C.1 Increase coolant pressure to > RCW pressure. OR C.2 Drain RCW from coolant condenser.	4 hours 16 hours

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SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

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SURVEILLANCE REQUIREMENTS:

Surveillance		Frequency
SR 2.4.4.4-1	Verify that cell coolant pressure is > building RCW pressure	Each shift when a UO_2F_2 deposit greater than the safe mass exists and RCW not drained.
SR 2.4.4.4-2	Monitor the system pressure and adjust pressure to ≥ 14 psia.	Each shift when dry gas blanket required by Condition B.
SR 2.4.4.4-3	Monitor the size of the deposit.	Quarterly when a UO_2F_2 deposit greater than the safe mass exists in a fluorinated environment (Condition A)
SR 2.4.4.4-4	Non-destructive assay survey of unit bypasses, unit drops, cell bypasses, and cell drops for the presence of uranium deposits.	Quarterly

BASIS:

The uranium enrichment cascade (that portion operating above 1.0 wt % ^{235}U) is an operation which relies on moderation control to ensure subcriticality. Within the large geometries offered by the process equipment, the only parameter being controlled is moderation. Cascade deposits of UO_2F_2 and freezeout of UF_6 are an expected result of normal operation. Within the range of enrichments possible at PGDP, criticality of a deposit is not possible regardless of the deposit size provided the deposit remains unmoderated.

If deposits of UO_2F_2 form in equipment other than that specified in Appendix A or if the UO_2F_2 deposit has a uranium mass less than the safe mass as determined by Appendix B, then there are no NCS concerns and the deposit may be remediated at the discretion of the operating organization. Deposits determined by process parameters and/or other indications to be freezeouts of UF_6 may also be remediated at the discretion of the operating organization.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

BASIS (continued):

UF_6, F_2, and ClF_3 react with available water more readily than UO_2F_2 absorbs water; thus, any water entering the cascade will preferentially react with UF_6 to form more UO_2F_2 rather than react with UO_2F_2 to form hydrates (moderated forms) of UO_2F_2. HF gas formed as a byproduct of the water-UF_6 reaction cannot liquify to moderate a deposit. Thus, a UO_2F_2 deposit cannot become moderated if it is being continuously fluorinated (i.e., with UF_6), and moderation is not a concern until the cell is taken off-stream and evacuated of UF_6. Thus, provided the wet air in-leakage is of small enough magnitude to be tolerated by the operating equipment (without unacceptable compressor surging, etc.), continued fluorination of the deposit provides nuclear criticality safety by preventing moderation of the deposit. The cell chemical treatment process also provide the same level of moderation control. For a non-fluorinating environment laboratory studies have shown that ambient conditions (i.e., relative humidity, temperature) limit the hydrogen to uranium ratio (H/U) in a deposit to a maximum of 4.

The fact that a UO_2F_2 deposit in an operating cell is not a nuclear criticality safety concern also explains the limited scope of and frequency for the surveillance requirement. Wet air in-leakage in an operating cell would readily announce itself (in the form of changing motor loads, compressor surging, line recorders, stage control valve positions, A-suction pressures, etc.). Since larger wet air in-leakages announce themselves readily and continuously fluorinated UO_2F_2 deposits of any magnitude pose no criticality safety concern, a quarterly surveillance for UO_2F_2 deposits is appropriate for early detection of such deposits and followup surveys for prudent remediation.

Once identified, the growth of a deposit is monitored quarterly to assure that the deposit does not become sufficiently large to become an operational problem or a cascade structural concern. The maximum allowable size of the deposit is primarily dependent on its location and will be determined as a part of the surveillance of the deposit. Operational experience suggests that quarterly surveillance by NDA methods is adequate to monitor the size of the deposit in process piping, expansion joints and valves. NDA is of limited value (e.g., quantification of deposit size) for compressors, converters, process gas coolers and freezer sublimers. The size of a deposit in a freezer sublimer can be determined by the remaining weight when the F/S has been emptied of UF6. Deposits in axial and centrifugal compressors are detected by the damage the deposits cause to the impeller or by deblading. Deposits in the converters are determined by the impact of the deposit on the pressure drop across the converter. Deposits in the process gas cooler are identified by the operator as degraded performance and are located by radiation survey.

For shutdown cells moderation control can also be provided by a dry gas (plant air or nitrogen) blanket over the deposit. Once a system has been isolated from the cascade and filled to atmospheric pressure with a dry gas blanket, normal atmospheric pressure fluctuations will cause minor in and out flow through any existing system leaks. Analyses have demonstrated that this

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.4 CASCADE WET AIR INLEAKAGE (continued)

BASIS (continued):

"breathing" of the cell will not significantly affect deposit moderation even over a period much longer than the 180 days to which this condition is limited. The daily surveillance demonstrates that the gas blanket is maintained as assumed in the analyses.

The potential for moderation from RCW system water is precluded by the two physical barriers (RCW to coolant and coolant to cascade) and either by maintaining the coolant system pressure greater than the RCW pressure or by draining the coolant condenser.

If the cascade component(s) with the deposit are removed from the cascade, the control of the component(s) is in accordance with the provisions of TSR 2.5 [SAR Section 4.4.1.1 and 5.2]

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TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

I. Statement of Requested Clarification

Clarify which UF_6 detector heads are required to detect UF_6 out leakage from cell bypass piping and clarify the definition of unit bypass centerline. Clarify which UF_6 detector heads are required to detect UF_6 out leakage from unit bypass piping.

II. Background Information

For the cell bypass, a section is defined as Athat portion of the cell bypass housing between any pair of opposite cells. Opposite cells are defined as 1 and 2, 3 and 4, 5 and 6, etc.@ Clarifying this definition to specifically define which particular detectors are required to be operable to meet the LCO condition in a particular section is desirable.

Clarification of the definition of unit bypass centerline and identification of the particular detectors required to be operable to meet the LCO condition in a particular section of the unit bypass is also desirable.

III. Clarification

The first two tables provide definition of the detector heads in each defined section of cell bypass housing. Notice that for the ›000' buildings some detectors are shared by adjacent defined sections and are therefore included in both sections. These heads have been verified installed in the C-333 cell bypasses. The heads defined will be verified installed in C-337, C-331, and C-335 prior to steady state operation above atmospheric pressure.

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

Cell Bypass Section Definitions for C-333 and C-337 - ›000' Buildings				
Three detectors in each of the following sections must be operable or LCO action steps shall be taken.				
Section 1	Section 2	Section 3	Section 4	Section 5
U-2-YE-16	U-3-YE-16	U-6-YE-16	U-7-YE-16	U-9-YE-16
U-2-YE-17	U-3-YE-17	U-6-YE-17	U-7-YE-17	U-9-YE-17
U-3-YE-16	U-4-YE-16	U-7-YE-16	U-8-YE-16	U-10-YE-29
U-3-YE-17	U-4-YE-17	U-7-YE-17	U-8-YE-17	U-10-YE-30
U-C-YE-XX - ›U= indicates unit number; ›C= indicates cell number; ›XX= indicates detector designation on instrument drawings.				

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

Cell Bypass Section Definitions for C-331 and C-335 - ›00' Buildings Unit 1 Only				
Three detectors in each of the following sections must be operable or LCO action steps shall be taken.				
Section 1	Section 2	Section 3	Section 4	Section 5
1-2-YE-18	1-4-YE-18	1-6-YE-18	1-8-YE-18	1-10-YE-18
1-2-YE-19	1-4-YE-19	1-6-YE-19	1-8-YE-19	1-10-YE-19
1-2-YE-20 (C-331 Only)	1-6-YE-20	1-8-YE-22	1-8-YE-20	1-10-YE-20
1-2-YE-21 (C-331 Only)	1-6-YE-21	1-8-YE-23	1-8-YE-21	1-10-YE-22
1-4-YE-20			1-10-YE-21	1-10-YE-23
1-4-YE-21				
1-4-YE-22 (C-335 Only)				
1-4-YE-23 (C-335 Only)				
U-C-YE-XX- ›U= indicates unit number; ›C= indicates cell number; ›XX= indicates detector designation on instrument drawings.				

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

Cell Bypass Section Definitions for C-331 and C-335 - ›00' Buildings Units 2, 3 and 4 Only				
Three detectors in each of the following sections must be operable or LCO action steps shall be taken.				
Section 1	Section 2	Section 3	Section 4	Section 5
U-1A-YE-18	U-3-YE-18	U-5-YE-18	U-7-YE-18	U-9-YE-18
U-1A-YE-19	U-3-YE-19	U-5-YE-19	U-7-YE-19	U-9-YE-19
U-1A-YE-20	U-5-YE-20	U-7-YE-22	U-7-YE-20	U-9-YE-20
U-1A-YE-21	U-5-YE-21	U-7-YE-23	U-7-YE-21	U-9-YE-22
U-3-YE-20			U-9-YE-21	U-9-YE-23
U-3-YE-21				
U-C-YE-XX - ›U= indicates unit number; ›C= indicates cell number; ›XX= indicates detector designation on instrument drawings.				

Unit Bypass sections are defined as Athat portion of the unit bypass between centerlines of adjacent units or from the centerline of the first or the last unit to the end of the housing.@ The centerline of a unit is the center of the cell bypass where it ties into the unit bypass. This divides the unit bypass into 5 sections in ›00' buildings and 4 sections in the ›000' buildings.

The following tables provide definition of the detector heads in each defined section of unit bypass housing.

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

Unit Bypass Section Definitions for C-333 and C-337 - ›000' Buildings			
Three detectors in each of the following sections must be operable or LCO action steps shall be taken.			
Section 1	Section 2	Section 3	Section 4
6-2-YE-18 (C-337 Only)	1-1B-YE-20 (C-333 Only)	2-1-YE-20 (C-333 Only)	3-1-YE-20 (C-333 Only)
6-2-YE-28	6-1-YE-16	2-2-YE-21	3-2-YE-28
6-2-YE-29	6-1-YE-17	2-2-YE-22	3-2-YE-29
6-2-YE-30	6-1-YE-18	2-2-YE-23	3-2-YE-30
1-1B-YE-16	2-1-YE-16	2-2-YE-18	
1-1B-YE-17	2-1-YE-17	2-2-YE-19	
1-1B-YE-18	2-1-YE-18	2-2-YE-20	
1-1B-YE-19 (C-333 Only)	2-1-YE-19 (C-333 Only)	3-1-YE-16	
		3-1-YE-17	
		3-1-YE-18	
		3-1-YE-19 (C-333 Only)	
U-C-YE-XX - ›U= indicates unit number; ›C= indicates cell number; ›XX= indicates detector designation on instrument drawings.			

Unit Bypass Section Definitions for C-331 and C-335 - ›00' Buildings
Three detectors in each of the following sections must be operable or LCO action steps shall be

TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **UF_6 Release Detection System - Definition of Cell and Unit Bypass Sections**

taken.		
Section 1	Section 2	Section 3
4-1B-YE23	3-1B-YE23	2-1B-YE23
4-1B-YE24	3-1B-YE24	2-1B-YE24
4-1B-YE25	3-1B-YE25	2-1B-YE25
4-1B-YE26	3-1B-YE26	2-1B-YE26
4-1B-YE27	3-1B-YE27	2-1B-YE27
4-1B-YE28	3-1B-YE28	2-1B-YE28
4-1B-YE29	3-1B-YE29	2-1B-YE29
4-1B-YE30	3-1B-YE30	2-1B-YE30
4-1B-YE31	3-1B-YE31	2-1B-YE31
4-1A-YE22		
3-1A-YE22	2-1A-YE22	1-2-YE22
U-C-YE-XX - ›U= indicates unit number; ›C= indicates cell number; ›XX= indicates detector designation on instrument drawings.		

2.4.4.1 UF_6 RELEASE DETECTION SYSTEM (continued)

SURVEILLANCE REQUIREMENTS:

Surveillance	Frequency
SR 2.4.4.1-1 ATest fire@ the UF_6 release detection system heads.	Twice each shift.
SR 2.4.4.1-2 Physically actuate (Asmoke test@) the UF_6 release detector heads to verify alarms.	Annually

BASIS:

The reaction of UF_6 and water (free atmospheric humidity) in the case of a UF_6 release produces uranyl fluoride (UO_2F_2) as particulates and hydrogen fluoride (HF) as a gas which will hydrate. The UO_2F_2 and HF*x(H_2O) are highly visible as Asmoke.@ This system detects the presence of this Asmoke@ and sounds alarms in the ACR. Proper actuation of the detector heads is ensured by smoke testing with a known maximum concentration of smoke. The relationship of the test smoke to UF_6 outleakage is also known with regard to particle size and mass concentration.

In the event of a failure of the UF_6 release detection system, the stationing of an operator at the affected equipment would assure monitoring of the system to determine if any outleakage of UF_6 occurs and would provide the surveillance capability until the system could be repaired or the UF_6 process equipment brought below atmospheric pressure. The real safety hazard is when UF_6 is released into the area inhabited by plant personnel. UF_6 released inside the heated housing is not of significant safety concern unless it leaks from the (non-air-tight) housing. Thus, a smoke watch posted outside the housing, watching for Asmoke@ escaping the heated housing into the occupied spaces, is capable of providing an adequate level of safety.

Firing the heads at least once in an eight-hour interval will maintain sensitivity of the heads in elevated temperatures such as that found in the cell housings. Detector heads are fired by supplying voltage to the head until it alarms. This can be done by suppling voltage sufficient to fire the detector head. The firing of the heads will be recorded; this action discovers heads which are failed.

Normal operational pressure transients may temporarily take the local process pressure to a value consistent with mode Cascade 2 values. These pressure transients typically work their way through those portions of the cascade that, by the optimized gradient, operate at mode Cascade 1 pressures quickly. This LCO is not intended to require UF_6 release detection operability to accommodate these transients. Instead, this LCO is intended to require system operability prior to intentionally increasing cascade pressure to mode Cascade 2 values.

The cell bypass is perpendicular to cells and traverses the length of the individual unit. ADefined section@ means that portion of the cell bypass housing between any pair of opposite cells. Opposite cells are defined as 1 and 2, 3 and 4, 5 and 6, etc.

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2.4.4.1 UF_6 RELEASE DETECTION SYSTEM (continued)

BASIS (continued):

The unit bypass are perpendicular to the cell bypasses. ADefined section@ of the unit bypass means that portion of the unit bypass between centerlines of adjacent units or from the centerline of the first or the last unit to the end of the housing. [SAR Section 3.15.7.3, 4.3.2.1.1, 4.3.2.1.2, 4.3.2.1.3, 4.3.2.1.7]

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TECHNICAL SAFETY REQUIREMENT CLARIFICATION

Paducah Gaseous Diffusion Plant

TSR Section: **2.4.4.1**

TSR Title: **UF_6 Release Detection System**

Clarification Subject: **Operability Requirements for Cell Housing and Intercell Housing UF_6 Release Detection Heads**

I. Statement of Requested Clarification

Clarification is requested to define which cell housing and intercell housing UF_6 release detection heads are required to be operable to satisfy General Limiting Condition for Operation 2.4.4.1, Condition B.

II. Background Information

General Limiting Condition for Operation 2.4.4.1, Condition B states that at least three UF_6 release detection heads must be operable in the '000' cell housing roof and intercell housing, or LCO action steps shall be initiated. This requirement applies to Buildings C-333 and C-337. The specific UF_6 release detection heads required to be operable to satisfy this requirement has been in question.

III. Clarification

The General Limiting Condition for Operation 2.4.4.1, Condition B refers to the four cell housing roof UF_6 release detection heads (YE-9, YE-10, YE-11, and YE-12) and the intercell housing UF_6 release detection head (YE-14) associated with the cell in question. All five UF_6 release detection heads are physically wired to the signal conditioner associated with the cell in question.

Thus, if the YE-14 UF_6 release detection head connected to a particular cell signal conditioner is inoperable, then at least three of the four cell housing roof UF_6 release detection heads connected to that same signal conditioner must be operable. Likewise, if two cell housing roof UF_6 release detection heads connected to a signal conditioner are inoperable, then the remaining two cell housing roof UF_6 release detection heads plus the intercell housing UF_6 release detection head (YE-14) connected to that cell conditioner must be operable.

SECTION 2.4 SPECIFIC TSRS FOR ENRICHMENT CASCADE FACILITIES

2.4.4 GENERAL LIMITING CONDITIONS FOR OPERATION

2.4.4.1 UF6 RELEASE DETECTION SYSTEM

LCO 2.4.4.1: At least the minimum number of the UF_6 release detection heads inside the areas of the cascade stated in the ACTIONS table below shall be operable prior to steady state operations above atmospheric pressure.

APPLICABILITY: Modes: Cascade Mode 2. Other cascade associated equipment, steady state operations above atmospheric pressure.

ACTIONS:

Condition	Action	Completion Time
A. Fewer than the minimum of 3 of the UF_6 release detection heads for each cell housing roof and cell exhaust duct in buildings C-331 and C-335 are operable.	A.1 Perform a continuous UF_6 smoke watch on the cell or cells affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
B. Fewer than the minimum of 3 of the UF_6 release detection heads for each cell housing roof and inter cell housing in buildings C-333 and C-337 are operable.	B.1 Perform a continuous UF_6 smoke watch on the cell or cells affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
C. Fewer than the minimum of 3 of the UF_6 release detection heads in each defined section of the cell bypass are operable.*	C.1 Perform a continuous UF_6 smoke watch on the cell bypass or bypasses affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
D. Fewer than the minimum of 3 of the UF_6 release detection heads in each defined section of the unit bypass are operable.*	D.1 Perform a continuous UF_6 smoke watch on the unit bypasses affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour
E. Either of the minimum of 2 UF_6 detector heads (the detector head located in a B Booster Pump housing, or the detector head located over the pump) inoperable.	E.1 Perform a continuous UF_6 smoke watch on the B Booster Pump affected by PGLD detection head inoperability. TSR 1.6.2.2(d) is not applicable.	1 hour

*"Defined Section" defined in Basis.

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