(NRC)

NUCLEAR REGULATORY COMMISSION CERTIFICATION PORTSMOUTH GASEOUS DIFFUSION PLANT USEC-02 REMOVE/INSERT INSTRUCTIONS REVISION 68 Effective 11/21/03	
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Remove all tabs and all sections.	**Replace with new tabs and sections.**
Volume 2 (SAR)	
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Table of Contents: (do not remove tab) Remove entire TOC section	**Table of Contents: (do not remove tab)** Replace entire TOC section
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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 Portsmouth Gaseous Diffusion Plant (PORTS) in accordance with section 1701(c) 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 PORTS 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 PORTS. 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 utilizes an operating contractor, Lockheed Martin Utility Services, Inc. (LMUS), to operate the plants in accordance with USEC direction. USEC is ultimately responsible for the operation, maintenance, modification, design, fabrication, and testing of the GDPs.

The mailing address for PORTS is:

United States Enrichment Corporation
Portsmouth Gaseous Diffusion Plan
P. O. Box 628
Piketon, Ohio 45661

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. William H. Timbers
President and Chief Executive Officer

Mr. Dennis R. Spurgeon
Executive Vice President and Chief Operating Officer

Mr. J. Morris Brown
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 3.9, "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 — As used in the uranium enrichment industry, the ^{235}U isotopic concentration relative to total uranium in a uranium-bearing material, typically stated in wt % (e.g., 2.75% assay).

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.

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 Section 3.0 applies to each performance after the initial performance. For Completion Times specified as "once," the 25% time interval extension does not apply.

Independent Assessment - A determination of the capabilities, performance and overall effectiveness of the a program performed by persons not associated with the program or topic being assessed.

Nuclear materials (NMs) — Materials such as uranium, uranium bearing material, thorium, neptunium, or ^{233}U for which accountability is required by NRC.

Safeguards — An integrated system of physical protection, accountability, and material control measures designed to deter, prevent, detect, and respond to unauthorized possession and/or use of SNM.

Tails — Depleted UF_6 below normal assay, which is withdrawn from the "bottom" of the cascade and placed into long-term storage.

Inspect - Inspect, unless specifically stated otherwise, is intended in the standard usage of the word, i.e., visual evaluation for acceptability.

UF_6 Cylinder (or cylinder) - Unless otherwise specified, UF_6 cylinder (or cylinder) is intended to be limited to large (2 1/2- ton and larger) UF_6 cylinders.

2.0 LIST OF ACRONYMS

The following is a list of acronyms used throughout the USEC Application.

ACL	-	Administrative Control Level
ALARA	-	As Low As Reasonably Achievable
ANSI	-	American National Standards Institute
AQ	-	Augmented Quality
ARA	-	Airborne Radioactivity Area

CCZ	-	Contamination Control Zone
CFR	-	Code of Federal Regulations
CM	-	Corrective Maintenance
DOE	-	United States Department of Energy
EAL	-	Emergency Action Level
ECSR	-	Environmental Compliance Status Report
E&H	-	Environmental and Health
EOC	-	Emergency Operations Center
EPA	-	Environmental Protection Agency
EPIP	-	Emergency Plan Implementing Procedure
ERO	-	Emergency Response Organization
FNMCP	-	Fundamental Nuclear Materials Control Plan
GERT	-	General Employee Radiological Training
GET	-	General Employee Training
HP	-	Health Physics
HRA	-	High Radiation Area
JCO	-	Justification for Continued Operations
LAW	-	Low Assay Withdrawal
LEU	-	Low Enriched Uranium
MBA	-	Material Balance Area
NCS	-	Nuclear Criticality Safety
NDA	-	Nondestructive Assay
NIST	-	National Institute of Standards and Technology
NM	-	Nuclear Material
NMC&A	-	Nuclear Material(s) Control and Accountability
NMSS	-	NRC Office of Nuclear Materials Safety and Safeguards
NRC	-	Nuclear Regulatory Commission
NS&Q	-	Nuclear Safety and Quality
PGDP	-	Paducah Gaseous Diffusion Plant
PM	-	Preventive Maintenance
PORC	-	Plant Operations Review Committee
PORTS	-	Portsmouth Gaseous Diffusion Plant
PRB	-	Procedures Review Board
PSS	-	Plant Shift Superintendent
PW	-	Product Withdrawal
QAP	-	Quality Assurance Program
RA	-	Radiation Area
RMA	-	Radioactive Material Area
RP	-	Radiation Protection
RWMP	-	Radioactive Waste Management Program
RWP	-	Radiological Work Permit
S&S	-	Safeguards and Security
SAE	-	Site Area Emergency

SAR	-	Safety Analysis Report
SM	-	Source Material
SNM	-	Special Nuclear Material
SOP	-	Standard Operating Procedure
SPP	-	Standard Practice Procedure
SSC	-	Structures, Systems and Components
SWU	-	Separative Work Unit
TSR	-	Technical Safety Requirements
UE	-	Uranium Enrichment
UF_6	-	Uranium Hexaflouride
USEC	-	United States Enrichment Corporation

3.0 FREQUENCIES

Interval Designation (Frequency)	Interval Between Consecutive Actions	Maximum Interval Between Consecutive Actions
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
Per Shift	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 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% which is consistent with past plant practice.

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CHAPTER 1

INTRODUCTION AND GENERAL DESCRIPTION OF THE FACILITY

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1. INTRODUCTION AND GENERAL DESCRIPTION OF THE FACILITY

1.1 INTRODUCTION

The Code of Federal Regulations, Title 10 CFR 76.35(a) requires that the United States Enrichment Corporation (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 Portsmouth Gaseous Diffusion Plant (PORTS) is located at 39°00′30″ N. latitude and 83°00′00″ W. longitude measured at the center of the plant, on an approximately 3,708-acre Federally owned reservation in Pike County, Ohio. The site is generally in a rural area, and was previously farmland and the watershed for several intermittent streams. The largest cities within a 50-mile radius are Portsmouth, Ohio, located approximately 27 miles to the south, and Chillicothe, Ohio, located approximately 27 miles to the north. Portions of 24 counties are located within a 50-mile radius of the plant, 18 of which are in Ohio, 5 in Kentucky, and 1 in West Virginia.

PORTS occupies approximately 700 security-fenced acres about 1.5 miles east of U. S. Route 23 and 2 miles south of State Route 32, and 2 miles east of the Scioto River.

1.3 FACILITIES LEASED BY USEC

Exhibit A to the Lease [Lease Agreement between the United States Department of Energy (DOE) and USEC, dated July 1, 1993, as amended, hereafter referred to as The Lease) identifies the facilities leased by USEC for PORTS.

1.4 PURPOSE OF OPERATION AND OPERATING PARAMETERS

PORTS enriches uranium using the gaseous diffusion process. A description of this process is provided in Chapter 3 of this SAR.

PORTS is designed to operate at a capacity of 8.6 million separative work units (SWUs) annually at its rated power level of 2260 MW. PORTS may produce uranium enriched up to 10 percent ^{235}U by weight.

1.5 POSSESSION LIMITS

The possession limits for NRC-regulated source material, by-product 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 of this SAR.

1.7 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 Restricted 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 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.

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 5.3-2.

Table 1-1 Table Deleted

Table 1-2 Table Deleted

Table 1-3 Possession Limits for NRC-Regulated Materials and Substances

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
A. Source Material[d,f]	92	Solid, liquid, and gas	UF_6, UF_4, UO_2F_2, oxides, metal and other compounds	300,000 MTU[a]	Uranium (including natural, depleted and recycled) and daughter products and process contaminants and wastes Laboratory chemicals Analysis of samples[c] Instrument calibration and check sources
B. Source Material	90	Solid and liquid	Soluble and insoluble chemicals, metal	10 Ci	Laboratory chemicals, instrument calibration sources, plated metallic sources, instrument check sources Analysis of samples[c]
C. Special Nuclear Material[b,d,f]	92	Solid, liquid, and gas	UF_6, UF_4, UO_2F_2, oxides, metal and other compounds	300,000 MTU	Uranium (including recycled) enriched in isotope 235 up to 10 percent by weight, uranium daughter products and process contaminants and wastes, to include: (1) laboratory chemicals, (2) analysis of samples[c], (3) instrument calibration and check sources, or (4) material that may be held up in facilities and equipment from previous operations
	92	Solid, liquid and gas	UF_6, UF_4, UO_2F_2, oxides, metal and other compounds	10,000 g ^{235}U[g]	Uranium enriched in isotope 235 from 10 percent up to 20 percent by weight, to include: (1) material that may be held up in uninstalled equipment and facilities from previous operations and in equipment received from other facilities, (2) laboratory chemicals, (3) analysis of samples[c], or (4) instrument calibration and check sources.

Table 1-3 (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
	92	Solid, liquid and gas	UF_6, UF_4, UO_2F_2, oxides, metal and other compounds	1,000 g ^{235}U[g]	Uranium enriched in isotope 235 to 20 percent and up to 98 percent by weight,to include: (1) material that may be held up in uninstalled equipment and facilities from previous operations and in equipment received from other facilities, (2) laboratory chemicals, (3) analysis of samples[e], or (4) instrument calibration and check sources.
Special Nuclear Material	94	Sealed source		50 Ci	Instrument calibration sources, NDA
		Sealed glass ampules		3 Ci	Instrument calibration sources, NDA
		Unsealed sources		0.5 Ci	Laboratory chemicals Analysis of samples[e]
	94	Any	Any	That resulting from the feed of recycled or FSU[c] uranium	Process contaminants and wastes, material held in equipment from previous operations
D. By-Product Material	3-89, 91	Sealed source		1 Ci with no single isotope to exceed 100 mCi, except as noted below	Calibration, instrument internal source Instrument calibration and check sources
		Unsealed source		1 Ci with no single isotope to exceed 100 mCi, except as noted below	Laboratory chemicals Analysis of samples[e]

Table 1-3. (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Description	Possession Limit
	27Co-57	Sealed Source		Calibration, internal Instrument standard, NDA	10 Ci
	27 Co-60	Sealed Source		Calibration, NDA, Process sources	450 Ci
		Unsealed Source		Laboratory chemicals Analysis of samples[e]	0.5 Ci
	28 Ni-63	Sealed Source		Process sources, internal instrument standards	10 Ci
	38 Sr-90	Sealed Source		Calibration	0.5 Ci
		Unsealed Source		Laboratory chemicals, Analysis of samples[e]	0.5 Ci
	43 Tc-99	Sealed Source		Calibration	10 Ci
		Unsealed Source		Laboratory chemicals, Analysis of samples[e]	5 Ci
		Any	Any	Process contaminants and wastes, material held in equipment from previous operations	That resulting from the feed of recycled or FSU[c] uranium
	55 Cs-137	Sealed Source		Calibration, NDA, Process sources	2,000 Ci
		Unsealed Source		Laboratory chemicals Analysis of samples[e]	0.5 Ci
	61 Pr-147	Sealed Source		Calibration	0.5 Ci
	70 Yb-169	Sealed Source		Calibration, NDA	5.0 Ci
	81 Tl-207	Sealed Source		Calibration	1.0 Ci
	88 Ra-226	Sealed Source		Calibration	15 Ci

Table 1-3 (Continued)

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
	93,96,97,99,100	Sealed source Unsealed source		0.5 Ci 1.0 Ci	Calibration Laboratory chemicals Analysis of samples[e]
	93, 95-100	Any	Any	That resulting from the feed of recycled or FSU uranium[f]	Process contaminants and wastes, material held in equipment from previous operations
	95	Sealed source Unsealed source	Oxides, metals Oxides, metals, solutions	15 Ci 0.5 Ci	Calibration, process source Analysis of samples[e] Laboratory chemicals
	98	Sealed source Unsealed source	Oxides, metals Oxides, metals, solutions	10 Ci 0.5 Ci	Calibration, NDA Analysis of samples[e] Laboratory chemicals

a. MTU - Metric Tons Uranium

b. See 10 CFR Part 76 definitions: Special nuclear material means: (1) Plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of Section 51 of the act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched in any of the foregoing, but does not include source material.

c. FSU meets the ASTM Standard C996, Standard Specification for Uranium Hexafluoride Enriched to Less Than 5 percent ^{235}U; UF_6 for enrichment meets the ASTM Standard C787, Standard Specification for Uranium Hexafluoride for Enrichment.

d. Recycled uranium includes the feed and processing of Paducah Product and the "stockpile" UF_6 transferred from DOE to USEC for enrichment.

e. "Analysis of samples" refers to the analysis of samples related to enrichment activities or site remediation, (PORTS, PGDP, DOE-OR) activities utilizing existing facilities and analytical techniques to process low-level radioactivity samples bounded by the possession limits stated in this table.

f. Except for Paducah Product and the "stockpile" UF_6 transferred from DOE to USEC for enrichment, 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 for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds UF_6) associated with sampling, subsampling, and analyses required to establish receiver's values.

g. These possession limits do not include material in USEC leased space from previous DOE operations to include retained inventory of uranium plated out on the inside surfaces of both shutdown and operating equipment in the X-326 facility; specific components in the X-326 cascade that need to be removed for maintenance or other operational purposes; material and equipment such as alumina traps, seal exhaust oil and GP containers from always-safe vacuums that are generated as part of ongoing operations in X-326; or material held up in X-705 equipment (some of which may have to be removed for maintenance).

FSU - Former Soviet Union

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

Material Class	Authorized Use
A. Source Material, Element 92[a, b]	1. Enrichment of uranium up to 10 percent enrichment by weight ^{235}U
	2. Receipt, storage, inspection, and acceptance sampling of cylinders containing uranium
	3. Filling and storage of cylinders of natural uranium and uranium depleted in ^{235}U
	4. Cleaning and inspection of cylinders used for the storage and transport of process product and tails containing source or SNM
	5. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products
	6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes
	7. Radiation protection, process control and environmental sample collection, analysis, instrument calibration, and operation checks
	8. Maintenance, repair, and replacement of process equipment
	9. Laboratory analysis and testing
	10. Heating cylinders and feeding contents into the diffusion process
	11. Controlled feeding of cylinders
	12. Transfer between cylinders
B. Source Material, Element 90	1. Calibration and use of portable radiation protection and fixed laboratory equipment
	2. Laboratory analysis and testing
	3. Process, characterize, package, ship, or store low-level radioactive and mixed wastes

Table 1-4. (Continued)

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

Table 1-4. (Continued)

Material Class	Authorized Use
D. By-product Material, Elements 3-89, 91	1. Radiation protection, process control, and environmental sample collection, analysis, instrument calibration, and operation checks
	2. 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 as a result of feeding recycled uranium
	6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes
Elements 93, 95 to 100	1. Calibration and use of portable radiation protection and fixed laboratory equipment
	2. 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 as a result of feeding recycled uranium
	6. Process, characterize, package, ship, or store low-level radioactive and mixed wastes
$^{43}_{99}Tc$	1. That remaining in equipment and facilities as a result of feeding recycled uranium
	2. Storage of process wastes as a result of feeding recycled uranium

a. Except for Paducah Product and the "stockpile" UF_6 transferred from DOE to USEC for enrichment, 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 Hexafluroide 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 for storage and subsequent dispositioning but will not be introduced to the cascade, with the exception of small amounts (e.g., 50 pounds UF_6) associated with sampling, subsampling, and analyses required to establish receiver's values.
b. Includes the feed and processing of Paducah Product and the "stockpile" UF_6 transferred from DOE to USEC for enrichment.

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 PORTS 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 Hexafluoride - Packaging for Transport, 1995 Edition

PORTS satisfies the requirements of this standard, except for those portions superseded by Federal Regulations, with the following clarifications:

a. New 48-inch cylinders are purchased to ANSI N14.1-1990. 48-inch cylinders that were already owned and operated by PORTS and were not purchased to ANSI N14.1-1990 were manufactured to meet the version of the ANSI standard or specification in effect at the time of the placement of the purchase order. In addition, all 48-inch cylinders satisfy Sections 4, 5, 6.2.2 - 6.3.5, 7, and 8 of ANSI N14.1-1995, except 48X cylinders used in the Paducah Tiger overpack which satisfy Sections 4, 5, 6.2.2 - 6.3.5, 7, and 8 of ANSI N14.1-1990.

b. New cylinders (other than new 48-inch cylinders) satisfy the requirements of ANSI N14.1-1995. Cylinders (other than 48-inch cylinders) that were already owned and operated by PORTS and were not purchased to ANSI N14.1-1995 were manufactured to meet the version of the ANSI standard or specification in effect at the time of the placement of the purchase order and satisfy only Sections 4, 5, 6.2.2 - 6.3.5, 7, and 8 of ANSI N14.1-1995.

c. New 1-inch cylinder valves are purchased to ANSI N14.1-1990. (1-inch cylinder valves are not procured to ANSI N14.1-1995 because a wording error identified in ANSI N14.1-1995 relating to the allowable hardness of valve bonnet material restricts the use of all acceptable material.) 1-inch cylinder valves that were already in use at PORTS and were not purchased to ANSI N14.1-1990 were manufactured to meet the version of the ANSI standard or specification in effect at the time of the placement of the purchase order.

d. New cylinder valves (other than 1-inch) are purchased to ANSI N14.1-1995. Cylinder valves (other than 1-inch) that were already in use at PORTS and were not purchased to ANSI N14.1-1995 were manufactured to meet the version of the ANSI standard or specification in effect at the time of placement of the purchase order.

e. Tinning of cylinder valve and plug threads: ANSI N14.1 - 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. Cylinder valve and plug threads are tinned with solder alloys meeting the requirements of ASTM B32. Tinning is performed with nominal 50% tin alloy or with a mixture of alloys with nominal tin content from 40% to 50%, with a lower limit of 46% tin in the mix.

f. Section 5.2.1 - For U.S. Department of Transportation 7A Type A packaging, satisfy U.S. Department of Energy (DOE) evaluation document DOE/RL-96-57, Revision 0, Volume 1, which supersedes DOE/00053-H1.

g. Use of steel or aluminum-bronze plugs in UF_6 cylinders is acceptable at PORTS for the following operations: heating, feeding, sampling, filling, transferring between cylinders and onsite transport and storage.

For references to this standard, see SAR Table 3.2-2, Section 3.3.1.3.2.4, Section 3.8, Section 4.3.2.2.

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

PORTS 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.

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

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

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1.4 ANSI/ANS 6.4, Guildelines for Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants, 1977 Edition

PORTS satisfies the requirements of this standard for the Radiation Calibration (RADCAL) facility.

For references to this standard, see SAR Section 3.5.1.1.1.1.

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

PORTS 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, 5.2.3.1 -Mass, 5.2.3.1-Concentration, 5.2.3.2, 5.2.4.2, and Table 6.9-1.

1.6 NASI/ANS 8.3, Criticality Accident Alarm System, 1986 Edition [1]

PORTS satisfies the requirements of this standard with the following exceptions:

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

Section 4.4.4 - A limit on the sound level emitted from the signal generator is not provided.

Section 4.5.3 - Emergency power supplies for AQ and NS alarm systems are not provided. Abattery backup serves as the backup power supply for the cluster and local nitrogen horn.

Section 5.3 - The CAAS is not designed to withstand seismic stresses.

Section 5.7.2 - This section recommends that the alarm trip point be more than 10 mrad/hr above normal background. PORTS uses a lower value because normal neutron background is small.

Section 6.3 - The testing frequency for the clusters is specified in the Techical Safety Requirements.

Section 6.4 - The testing frequency for the audible alarms is specified in the Technical Safety Requirements.

[1] In describing criticality accident conditions, SAR Chapter 4 makes comparisons to ANSI/ANS 8.3, 1979 Edition. Commitments to the 1986 Edition bound these comparisons.

Section 7.1 - Posting in accordance with this section is not provided. Instructions to site personnel regarding response to alarm signals are provided in General Employee Training.

Section 7.2.3 - The testing frequency for the audible alarms is specified in the Technical Safety Requirements. Additionally, evacuation and familiarization drills are conducted in accordance with the Emergency Plan.

For references to this standard, see SAR Sections 3.6.2.2.1.1; 3.8, 4.3.2.6.

1.7 ANSI/ANS 8.5, Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material, 1986 Edition

PORTS satisfies the following sections of this standard:

Sections 4.1, 4.3, and 4.4 - Satisfy the requirements of these sections if raschig rings are replaced. See SAR Section 5.2.3.1 - Neutron Absorption.

Sections 4.1, 6.2.3, 6.3.2, and 6.4 - Satisfy the testing requirements in these sections if a release occurs exposing existing rings to a corrosive environment. See SAR Section 5.2.3.1 - Neutron Absorption.

Section 6.1 - Satisfy the surveillance requirements in this section as described in the Technical Safety Requirements, SAR Section 5.2, and Nuclear Criticality Safety Approvals (NCSAs). The inspection for raschig rings damage described in SAR Section 5.2 is accomplished by inspecting and replacing rings when the cumulative addition would become equal to 10% of the original loading.

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

PORTS 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.

Section 5.1 - PORTS 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 Sections 5.2.2.1 and 5.2.4.2.

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

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Sections 5.2.2.1 and 5.2.4.2.

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

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Sections 6.6.1.1, 6.6.4.2, and 6.6.11.

1.11 ANSI N13.22, Bioassay Programs for Uranium, 1995 Draft

PORTS satisfies only Section 6.1.1 of this standard regarding the calculational method for action levels for the PORTS internal dosimetry program.

For references to this standard, see SAR Section 5.3.2.3.

1.12 ANSI B30.2, Overhead and Gantry Crane Design & Inspection, 1990 Edition (including Addenda A, 1991)

PORTS satisfies the requirements of the following sections of this standard for liquid UF_6 handling cranes and enrichment process building cranes used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

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

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

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

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

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

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

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

1.15 ANSI B30.20, Below the Hook Rigging Devices, 1993 Edition

PORTS satisfies the requirements of the following sections of this standard for lifting fixtures used to handle liquid UF_6 cylinders and used to transport heavy equipment above/around cascade equipment that is intended to be operated above atmospheric pressure:

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

1.16 ANSI NB-23, National Board Inspection Code, 1992 Edition

PORTS satisfies the requirements of this code as described below:

Autoclave shell and head are visually inspected to section U-110.1 of this standard.

PORTS utilizes Chapter V of this code as guidance to develop the inspection program for ASME pressure vessels.

1.17 ANSI N323, Radiation Protection Instrumentation Test and Calibration, 1978 Edition.

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

For references to this standard, see SAR Sections 3.5.1.1.1.1 and 5.3.5.

1.18 ANSI N509, Nuclear Power Plant Air Cleaning Units and Components, 1989 Edition

New and existing fixed HEPA filter systems needed to ensure compliance with release limits or to control worker radiation exposure satisfy the requirements of this standard with the following exceptions and clarifications:

Section 5.2 - Do not satisfy. No credit is taken for adsorbers.

Section 5.5 - Do not satisfy requirements for air heaters.

Section 8.0 - Quality assurance requirements for applicable systems are identified in SAR Section 3.8 and the Quality Assurance Program Description

Appendix A - Do not sample adsorbents.

Appendix B - Do not use allowable leakage guidance.

Appendix C - Do not use manifold design guidelines.

Appendix D - The manifold qualification program uses this appendix as guidance only.

For references to this standard, see SAR Section 5.1.4.

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

New and existing fixed HEPA filter systems that satisfy the requirements of ANSI N509 and are needed to ensure compliance with release limits or to control worker radiation exposure satisfy the requirements of this standard with the following exceptions and clarifications:

Section 6.0 - Only satisfy this section for new seal-welded duct systems or for connections to a system where this section has been previously applied.

Section 7.0 - Do not use guidance for monitoring frame pressure leak tests.

Existing fixed HEPA filter systems that do not satisfy the requirements of ANSI N509 will be tested using the requirements of this standard or another industry accepted standard as guidance only.

For references to this standard, see SAR Sections 5.1.4 and 5.3.2.10.

1.20 ANSI N543, General Safety Standard for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, 1974 Edition

PORTS satisfies Sections 3.2, 7, and 8.1.2 of this standard for the X-326 Radiographic Facility,as they apply to Enclosed Installations.

For references to this standard, see SAR Section 3.5.1.6.1.

2.0 American Society of Mechanical Engineers (ASME)

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

PORTS 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 6.6.12, 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

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

Section VIII - The following pressure vessel components and systems satisfy the requirements of Section VIII of this code for the edition in effect at the time of fabrication: freezer/sublimer; condenser/reboiler; autoclave; cell coolant condenser; nitrogen system (relief devices only); cell coolant pressure relief; ClF_3 and F_2 tanks used in X-330/X-333 and X-342, respectively; and UF_6 cylinders except that UF_6 cylinders do not have pressure relief devices.

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

For references to this standard, see SAR Sections 3.1.3.2.1.1, 3.1.3.2.2.1, 3.2.1.1.1.2.11, 3.2.1.3.1.2.11, 3.4.3.3, and 3.9.6.

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. PORTS 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, Standard for the Installation of Sprinkler Systems, 1989 Edition

The requirements of this standard were used as guidance only for the design and installation of wet and dry pipe automatic sprinkler systems. In addition, the process buildings meet the definition of Ordinary Hazard Occupancies (Group 2) as stated in this standard and the fire protection system exceeds the sprinkler discharge density for this type of occupancy. PORTS 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 3.3.1.8.4, 3.5.1.1.1.2, 3.6.1.2.1, 3.8, and 5.4.1, 5.4.1.1.

3.3 NFPA 15, Water Spray Systems, 1990 Edition

PORTS 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

As described in SAR Section 3.6.1.1.2.4, all underground piping for the high-pressure fire water system was installed and is maintained using the requirements of this standard for guidance only. PORTS 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 3.6.1.1.2.4 and 5.4.1.

3.5 NFPA 30, Flammable Liquids, 1990 Edition

As identified in SAR Table 3.5-2, aboveground storage tanks were installed using the requirements of this standard for guidance only. In addition, as described in SAR Section 5.4.1.1, the requirements of this standard are used as guidance only for the handling of flammable liquids. PORTS 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 Table 3.5-2 and Sections 5.4.1 and 5.4.1.1.

3.6 NFPA 101, Life Safety Code, 1991 Edition

PORTS 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.

3.7 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, Revision 2, 1977

The extent to which PORTS satisfies the requirements of this regulatory guide will be determined as part of the SAR Upgrade activity.

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

4.2 Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50 Appendix I, October 1988

PORTS uses the food chain models in this standard to evaluate public radiation dose due to waterborne radioactive effluent via potable water and aquatic food pathways, as described in SAR Section 5.1.3.2.

For references to this standard, see SAR Section 5.1.3.2.

4.3 Regulatory Guide 3.34, Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant, Revision 1

PORTS uses formulas from this document to calculate doses from criticality accidents, as described in SAR Section 4.1. Other methods may also be used to calculate these doses.

For references to this standard, see SAR Sections 4.3.2.6.

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

PORTS satisfies the requirements of this standard.

For references to this standard, see SAR Section 5.3.2.2.

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

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

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

PORTS uses examples provided in the Regulatory Guide, Appendix A, to develop Emergency Action Levels.

For references to this regulatory guide, see the Summary and Section 3.0 of the Emergency Plan.

4.7 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."

PORTS uses examples from the Regulatory Guide to develop Physical Security Plans for the Transportation of Special Nuclear Material of Low Strategic Significance and the Physical Security Plans for the Protection of Special Nuclear Material of Low Strategic Significance.

For reference to this regulatory guide, see Chapter 1, Introduction of the Physical Security Plan for the Transportation of Special Nuclear Material of Low Strategic Significance and Chapter 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 Hexafluoride: A Manual of Good Handling Practices, Revision 7, January 1995

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

Section 3.3 - all; cylinders with heels greater than Table 3 limits are shipped in accordance with the requirements of 49 CFR 173.

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

Section 5.3 - all

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Section 5.4 - all

Section 7.1 - only the sixth paragraph

Section 10.0 - all except as follows:

First paragraph - Not all PORTS shipping cylinders meet the requirements of the most recent version of ANSI N14.1 (1995 Edition). These cylinders were manufactured prior to the date of ANSI N14.1-95. (See item 1.1, ANSI N14.1)

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

Section 13.0 - all

For references to this document, see SAR Sections 3.2.2.6 - Cylinder Change; 3.8; and the Transportation Security Plan, Section 6.4.

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

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

PORTS uses the data contained in Tables 2-1 and 2-2 of this document to calculate dose conversion factors for radionuclides of concern. This data is also used to calculate the Derived Air Concentrations (DACs) listed in SAR Table 5.3-5.

For references to this standard, see SAR Section 5.3.2.3.

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

PORTS 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

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

For references to this standard, see Section 5.5.1.2 of the Emergency Plan.

5.6 ICRP-26, Internal Dose, 1977

The concepts described in this standard were used as guidance only in developing the PORTS radiation protection program described in SAR Section 5.3. PORTS is required to meet the requirements of 10 CFR 20.

For references to this standard, see SAR Section 5.3.2.3.

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

The concepts described in this standard were used as guidance only in developing the PORTS radiation protection program described in SAR Section 5.3. PORTS is required to meet the requirements of 10 CFR 20.

For references to this standard, see SAR Section 5.3.2.3, and Table 5.3.10.

5.8 ANSI/ISA-S67.04, Setpoints for Nuclear Safety Related Instrumentation, 1988 Edition

PORTS satisfies the requirements of this standard for setpoint calculations for Q systems.

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

PORTS satisfies the requirements of this standard as described in SAR Tables 1-3 (footnotes c and f) and 1-4 (footnote a) 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.

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

PORTS satisfies the requirements of this standard as described in SAR Tables 1-3 (footnotes c and f) and 1-4 (footnote a) 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.

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

PORTS 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.

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2. SITE CHARACTERISTICS OF THE PORTSMOUTH GASEOUS DIFFUSION PLANT (PORTS)

This chapter provides information on the location and site characteristics of the Portsmouth Gaseous Diffusion Plant (PORTS) as specified in 10 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. These assumptions include the contribution of external and natural phenomena to initiation of events and 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),
2. Local population location and density (Section 2.1),
3. Nearby industrial, transportation, and military activities (Section 2.2), and
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 PORTS site location and description, surrounding populations, and use of nearby land and waters.

2.1.1 Site Location

PORTS is located in rural Pike County, a sparsely populated area in south central Ohio. The facility is about 70 miles south of Columbus, Ohio, and 75 miles east of Cincinnati, Ohio, the two closest metropolitan areas. The cities of Portsmouth and Chillicothe, Ohio, are located approximately 25 miles from the facility (south and north, respectively). The location of the site, relative to major cities in Ohio, is depicted in Figure 2.1-1. Figures 2.1-2 and 2.1-3 depict the nearby communities of Piketon and Waverly, both north of PORTS, along with major highways, railways, and bodies of water.

The Scioto River Valley is 1 mile west of the facility. The Scioto River (Figure 2.1-3) is a tributary of the Ohio River, and their confluence is approximately 20 miles south of PORTS. With the exception of the Scioto River floodplain, which is farmed extensively, the area around PORTS consists of marginal farmland and forested hills.

The specific location of PORTS (i.e., a central point of the facility near the process buildings) is latitude 39°0'30" N and longitude 83°0'00" W. In Universal Transverse Mercator coordinates, this location is N 4,319,410 m and E 326,829 m (Zone 17).

2.1.2 Site Description

PORTS is located on a 3,708-acre Department of Energy (DOE) Reservation as shown in Figure 2.1-3. The plant occupies 500 acres and consists of 109 buildings. Figure 2.1-4 identifies the primary buildings at the PORTS site. As shown in this figure, the site consists of facilities and areas leased to USEC, leased and uncertified, 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 State of Ohio (see Section 2.2.5). Also, activities conducted by USEC and its agents in areas within the perimeter road, 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 State of Ohio (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. A listing of facilities leased to the United States Enrichment Corporation (USEC) and those facilities retained by DOE at the PORTS site are shown in Figures 2.1-5a and 2.1-5b. Some leased facilities at the site contain areas that are deleased. A listing of leased facilities is maintained onsite and will be updated on annual basis with the Safety Analysis Report (SAR) update.

2.1.2.1 Topography

South central Ohio lies in the steep to gently rolling Appalachian foothills. The elevation of the PORTS site is approximately 120 ft above the Scioto River flood plain. The site is located in the valley of a tributary of the ancient Teays River.

The predominant landform in the site area is the relatively broad, level, filled valley of a preglacial river. This valley is oriented north-to-south and is bounded on the east and west by ridges or low-lying hills. Another significant landform is the small valley formed by Little Beaver Creek, which flows in a northwesterly direction across PORTS just north and east of the main plant area.

2.1.2.2 Vegetative Cover

The area within the perimeter road (Figure 2.1-4) is a fully developed industrial area. As such, the grounds are maintained as lawns, and support various species of grasses and herbaceous divots. The vegetation of surrounding Pike County consists primarily of hardwood forests. Field crops constitute the other major category of vegetative cover in the surrounding area.

2.1.2.3 Onsite Transportation and Transmission Systems

No U.S. or state highways enter the PORTS reservation. Vehicular traffic can enter the reservation from all four sides through several access roads that intersect the plant's perimeter road; these roads are shown in Figure 2.1-4.

The Seaboard System Railway, Inc. (CSX), provides rail access to the PORTS site. This CSX line intersects rail lines supported by CSX and Norfolk and Southern Railway (N&S).

Although PORTS once maintained a landing strip for air transportation, the strip is now obstructed with earthen berms. The southern end of the landing strip is maintained as a helicopter pad. The Plant Shift Superintendent coordinates helicopter approaches to ensure they do not fly over process buildings or hazardous material storage areas.

Onsite utility transmission systems include those for communications, water, electricity, natural gas and wastewater. Major waste-water sources and systems are shown in Figure 2.1-6. Discharge of waste-water is made to the Scioto River and its tributaries, Little Beaver Creek and Big Run Creek.

Electricity is provided by the Ohio Valley Electric Company (OVEC) through its Don Marquis Substation located on the northwest side of PORTS just outside the plant's security area on the DOE Reservation. Fuel and flammable gases (e.g., propane and acetylene) are contained in commercial cylinders and are delivered to PORTS by truck. The cylinders are stored at area X-742, the gas cylinder storage facility (see Figure 2.1-4).

2.1.2.4 Site Boundary

The entire DOE Reservation on which PORTS is located is marked and bounded by signs and fences, either chain link or barbed wire (in the wooded areas). Where roads cross the boundary, gates are in place to serve as barriers if needed. DOE controls activities in and regulates access to this reservation area. The DOE reservation and its boundaries are identified in Figure 2.1-3.

Most buildings and activities of PORTS are located within the next level of control--a Controlled Access Area/Limited Area surrounded by a security fence as described in Gaseous Diffusion Plant Security Program, Chapter 1, Physical Security Plan for the Protection of Special Nuclear Material of Low Strategic, Section 4.2.1. Access to buildings within this area is gained only with an appropriate badge. Activities in this area are limited to plant operation, maintenance, management, and associated construction activities.

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. This boundary is identified in Figure 2.1-3. Adequate measures to limit access to the controlled area, such as utilizing existing gates, can be implemented as directed in site procedures. Some areas within the reservation, particularly in the limited area, currently have ground contamination caused by prior DOE operations. Health Physics maintains a listing and data for areas currently identified.

2.1.3 Population

2.1.3.1 On-Site Population

Total employment of the operating contractor was 1294 as of August 2002. In addition, there were 397 USEC, DOE and DOE contractor and tenant employees onsite. Approximately 68 employees of OVEC work at the neighboring office building on the main access road (within the DOE Reservation), while the OVEC substation (Don Marquis Substation) is not staffed.

In addition to the employees discussed above, other persons may be onsite for various reasons. These individuals include construction contractors, consultants, vendors, maintenance workers, and visitors. It is estimated that approximately 550 such persons are at PORTS each weekday.

2.1.3.2 Area Residential Population

The permanent residential population of Pike County was 27,695 in 2000. The population of Pike County increased 19.3 percent between 1970 and 1980, 6.3 percent between 1980 and 1990 and 14.2 percent between 1990 and 2000 (U.S.

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Bureau of the Census, 1973; 1988; 1992; 2000). Current population density in the county is approximately 63 people/square mile. Population growth has occurred largely in the unincorporated areas of the county. Waverly has experienced population decreases during the last three decades, and in 2000 had a population of 4,433. Piketon grew 28.1 percent between 1970 and 1980, but its population remained stable between 1980 and 1990 and increased between 1990 and 2000 and is now 1,907. Pike County's population is expected to continue to grow over the next decade at a rate comparable to the 1980-1990 rate but then slow during the following decade to a growth rate of less than 1 percent (Ohio Data Users Center, 1991).

The 2000 population within 5 miles of the PORTS centerpoint is approximately 5,140 (see Figure 2.1-7 and Table 2.1-1). The geographic distribution of this population is shown in a radial-sector map in Figure 2.1-7, which represents an aggregation into 22.5-degree sectors, with each sector centered on 1 of the 16 compass points. The sectors are divided at radii of 1, 2, 3, 4, and 5 miles.

Historic and projected population density within a 5-mile radius of PORTS are presented in Table 2.1-1.

2.1.3.3 Significant Transient and Special Populations

In addition to the residential population, there are institutional, transient, and seasonal populations in the PORTS area.

Schools

The two school systems in the area are the Pike County Schools and the Scioto County Schools. However, only Pike County has school facilities within 5 miles of the facility: two elementary schools, one high school, and a vocational school. The combined enrollment of these schools for the year 2002 was approximately 1,857. The total school population within 5 miles, including faculty and staff, is 2,089. The proximity of these schools to PORTS and their enrollments are shown in Figure 2.1-8.

Two facilities within 5 miles of PORTS provide day care or schooling for preschool-aged children and after-school care for school-aged children (Ohio Department of Human Services, 1992; Barker, 1993). One facility, licensed to accommodate 320 children, is located in Piketon; the other, licensed to accommodate 70 children, is located near the DOE reservation boundary. A number of these positions are filled by school aged children present only during after-school hours. The locations of these facilities are shown in Figure 2.1-8.

Hospitals and Nursing Homes

Pike Community Hospital is the hospital closest to PORTS, located approximately 7.5 miles north of the facility on State Highway 104 south of Waverly (Pfeifer, 1993). The facility has 37 licensed beds. No other acute care facilities are located in Pike County (Pfeifer, 1993). The location of Pike Community Hospital is shown in Figure 2.1-8.

Two licensed nursing homes are in Piketon, one to the East of PORTS, and one home for the mentally retarded is in Wakefield; all are located within 5 miles of PORTS. The largest of these facilities is a 201-bed facility in Piketon (Ohio Department of Health, 1991). A total of 332 beds are at the facilities within 5 miles of PORTS. Figure 2.1-8 depicts these facilities and shows the number of beds per facility.

Recreation Areas and Recreational Events

No significant recreational areas are on the PORTS site; recreational activities for employees are held offsite (Gideon, 1993).

Offsite recreational areas include the Brush Creek State Forest, a 0.5 square mile portion of which is within 5 miles southwest of PORTS. Usage of this area is extremely light and is estimated to be 20 persons/year, primarily hunters and mushroom pickers (Gamble, 1993b). The location of Brush Creek State Forest is identified in Figure 2.1-8.

Usage of Lake White State Park (Figure 2.1-8), located approximately 7.5 miles north of PORTS, is occasionally heavy and concentrated on the 107 acres of land closest to the lake. The number of visitors in 1992 was 55,876 (Patrick, 1993); daily average was 153. On Labor Day 1992, 7,000 people visited Lake White State Park. When usage is weighted for heavy summer use (assuming 75 percent of all use, except Labor Day usage, occurs during the summer months of June, July, and August), average daily summertime use of the Park is estimated at 407 people. There are 38 campsites for primitive overnight camping (Ohio Department of National Resources, n.d.).

2.1.4 Uses of Nearby Land and Waters

Land within 5 miles of PORTS is used primarily for farms, forests, and urban or suburban residences. Figure 2.1-11 shows these land uses. About 25,430 acres of farmland, including cropland, wooded lot, and pasture, lie within 5 miles of PORTS. The cropland is located mostly on or adjacent to the Scioto River flood plain and is farmed extensively, particularly with grain crops. The hillsides and terraces are used for cattle pasture. Both beef and dairy cattle are raised in the PORTS area.

Approximately 24,400 acres of forest lie within 5 miles of PORTS (Kornegay et al., 1991, p.12). This includes some commercial woodlands and a very small portion of Brush Creek State Forest.

A relatively small area of urban land, about 510 acres, is also located within 5 miles of PORTS. This is located primarily in and around Piketon, approximately 3.5 miles north of the centerpoint of PORTS.

All or part of 18 Ohio counties, 5 Kentucky counties, and 1 West Virginia county are within 50 miles of PORTS. Almost 2.5 million acres of farmland are within that area (U.S. Bureau of the Census, 1987). This accounts for about 49 percent of the area within this radius. Approximately 65 percent of the farmland is cropland; the remaining farmland is woodland or range and pasture land or is occupied by farm-related buildings.

A notable portion of the land within 50 miles of PORTS is held in the public trust as forest land or for recreational use. State parks of Ohio and Kentucky occupy over 38,000 acres of land within 50 miles of PORTS (OHDNR, n.d.; Hardy, 1993). The Ohio Department of Natural Resources (OHDNR) also manages approximately 165,000 acres of land as state forests, natural preserves, and wildlife areas (OHDNR, 1992). Wayne National Forest occupies approximately 120,000 acres of land within 50 miles of PORTS (R. Jones 1993).

Very few urban areas are located within 50 miles of PORTS. The cities of Chillicothe, Ohio (2000 population of 21,796), and Portsmouth, Ohio (2000 population of 20,909), lie approximately 25 miles away, and the metropolitan area comprising primarily Huntington, West Virginia (pop. 51,475), and Ashland, Kentucky (pop. 21,981), lies approximately 50 miles southeast of PORTS.

No known public or private water supply draws from the Scioto River downstream of PORTS discharge (Kornegay et al., 1991, p. vii).

Table 2.1-1. Historic and projected population density within 5 miles of PORTS (person/mi^2)

Year	Persons per square mile
1990	86.3
2000	65.4
2010	104.4
2020	114.5
2030	125.9

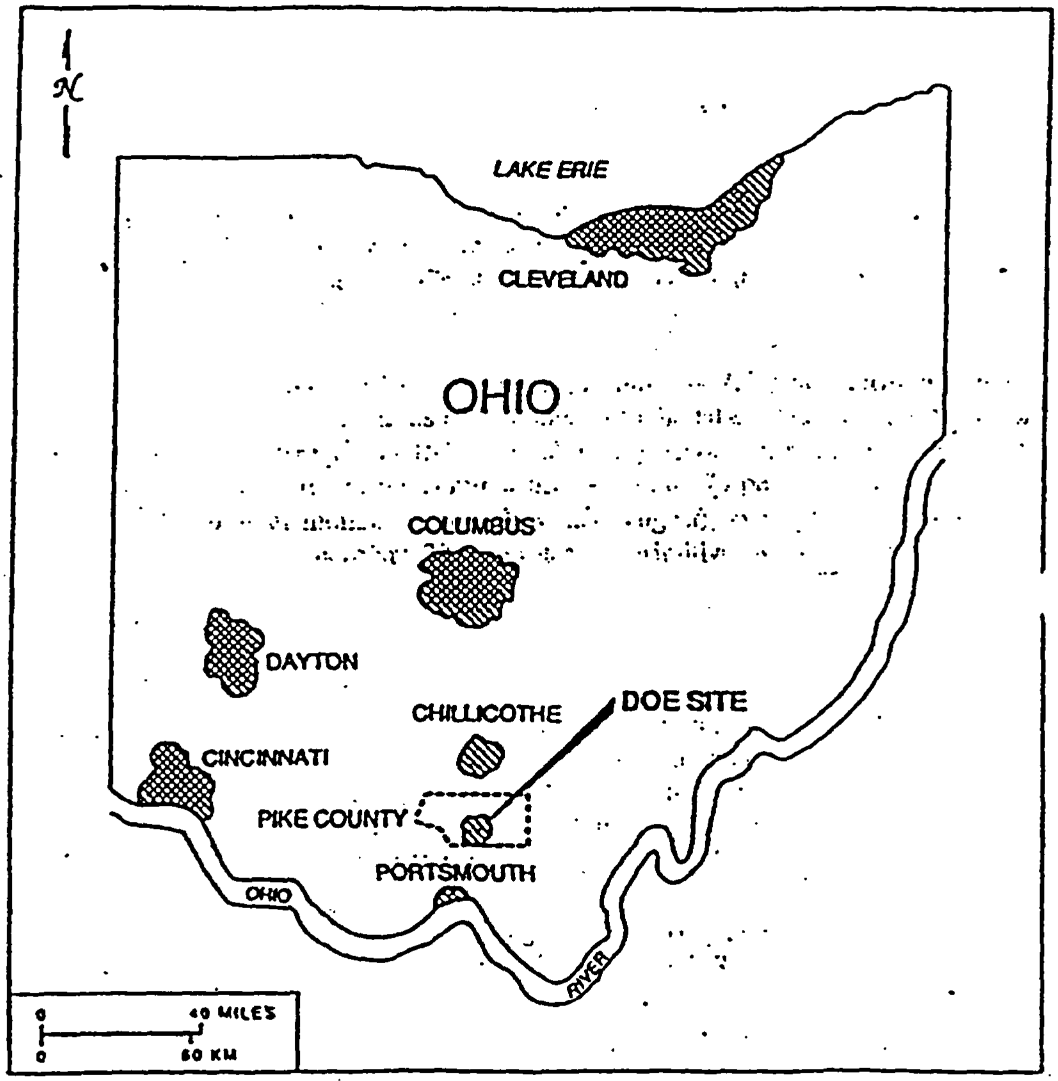


Figure 2.1-1. The location of PORTS.

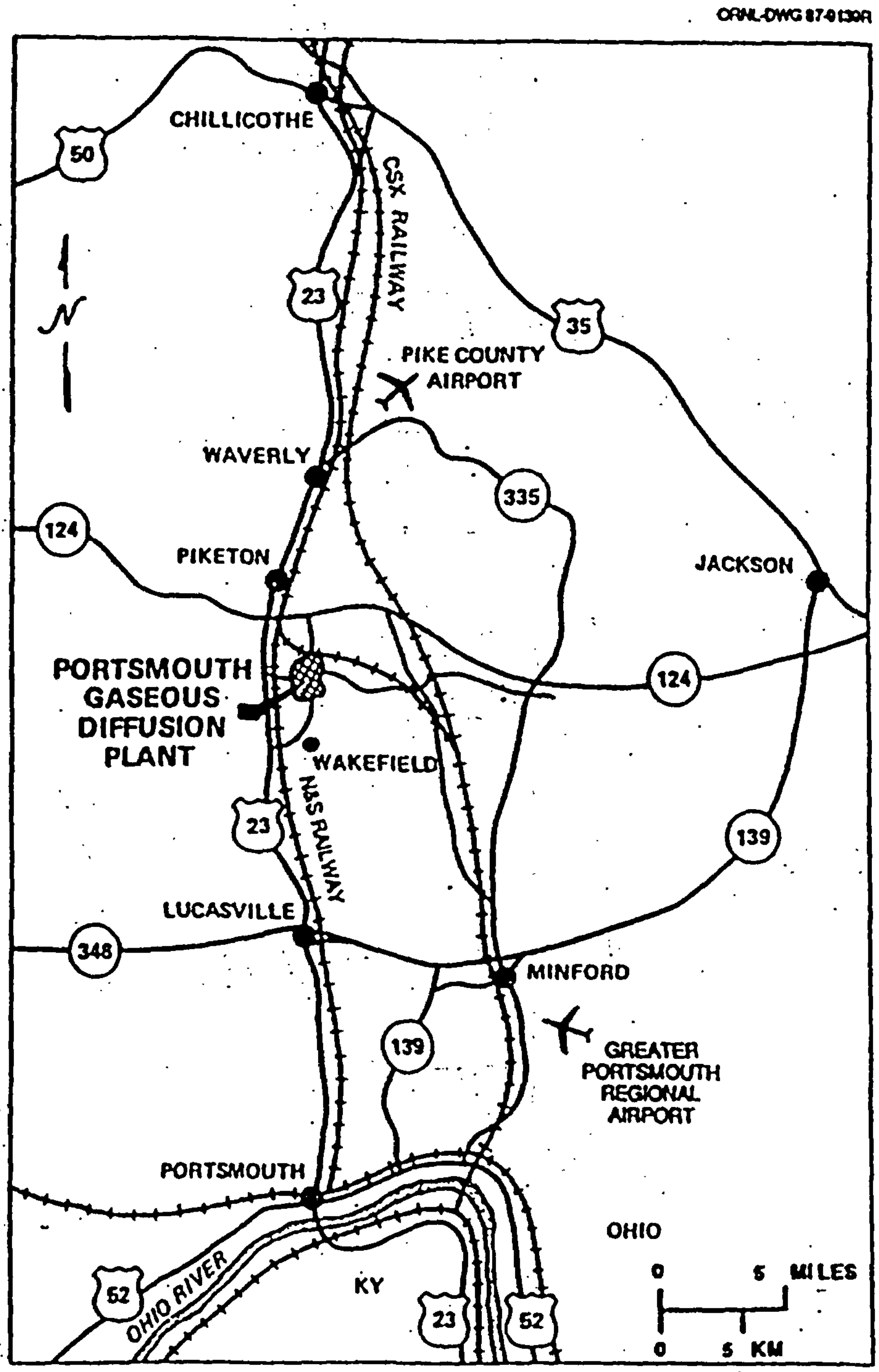


Figure 2.1-2. PORTS and the surrounding region.

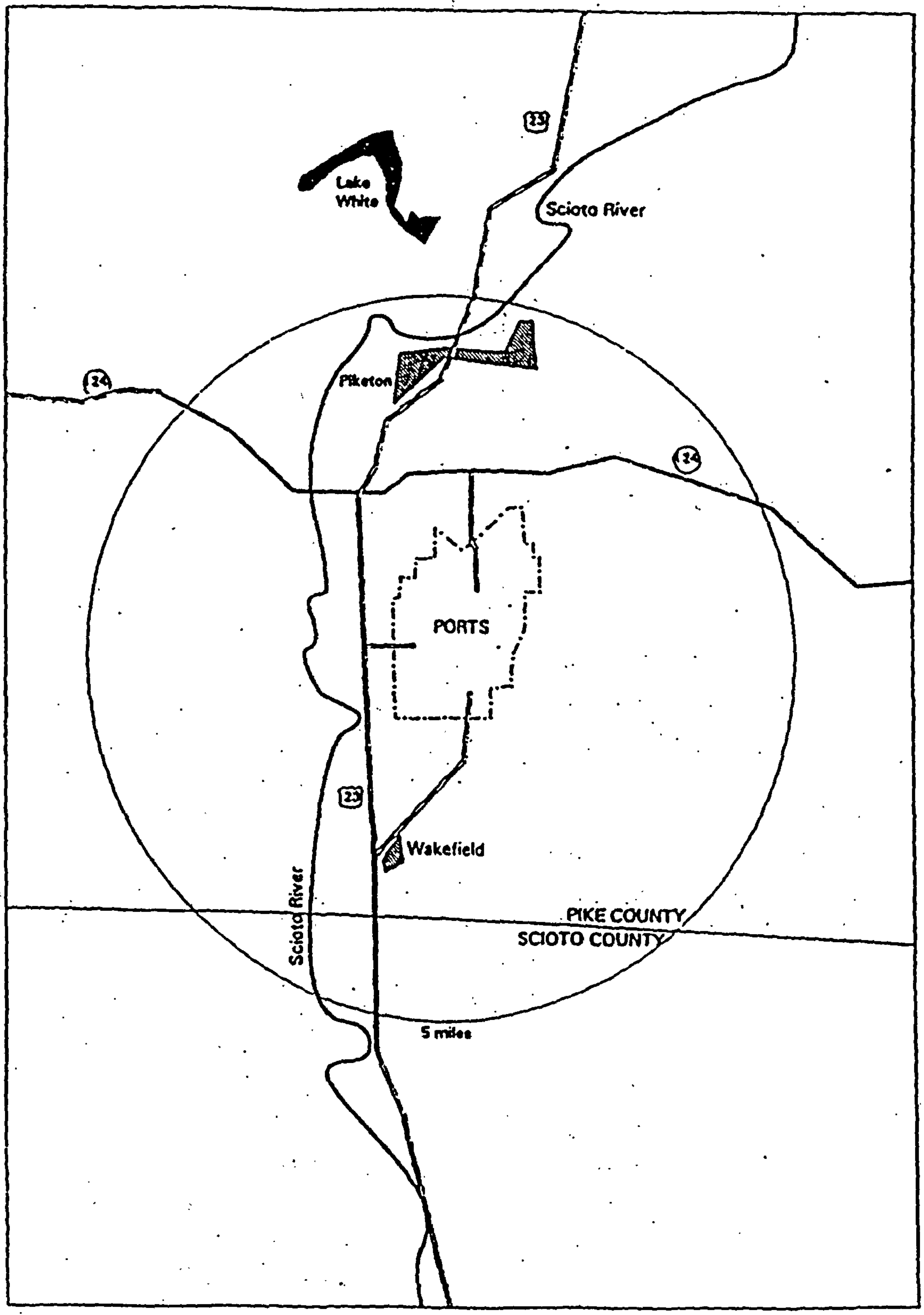
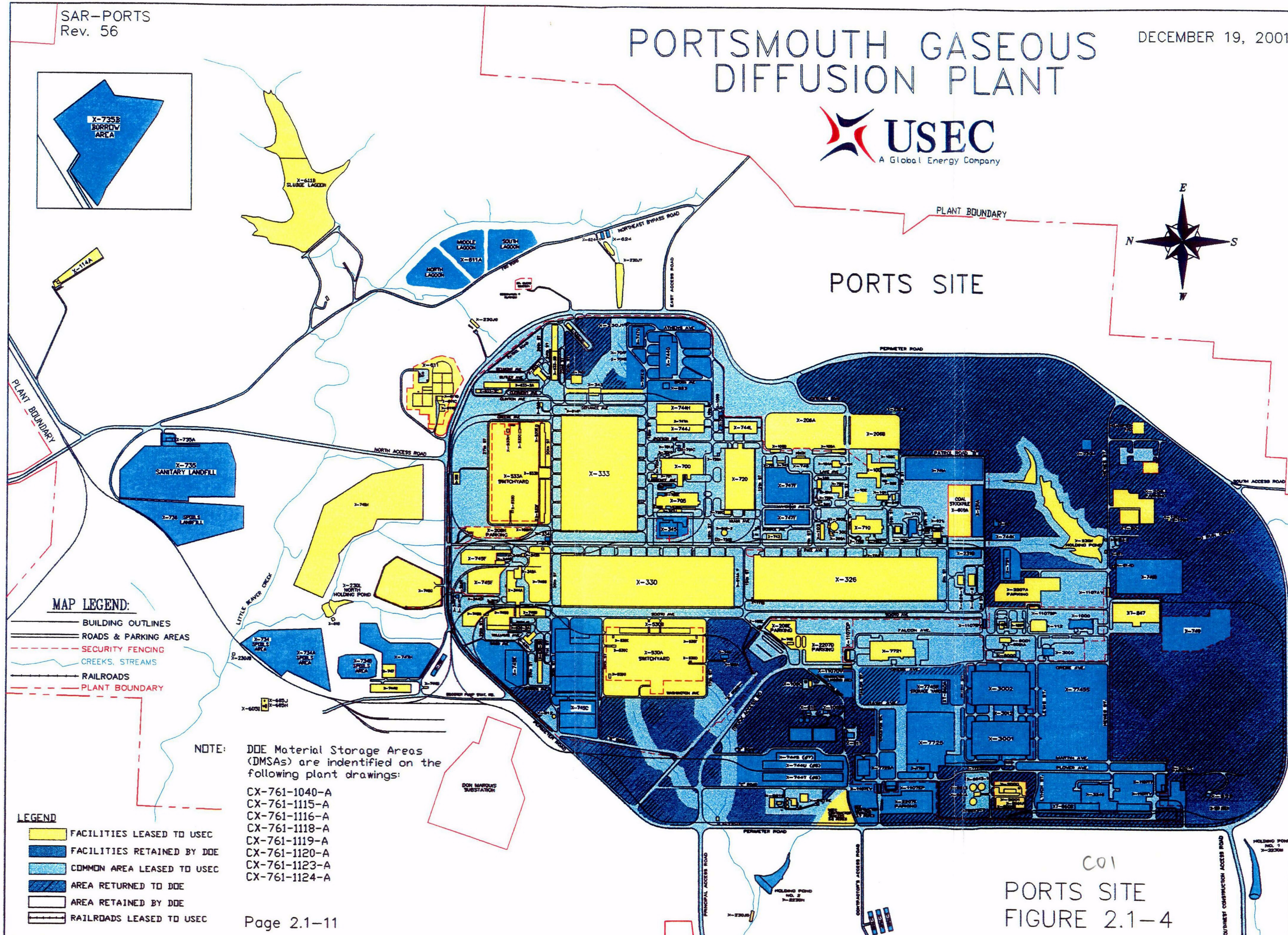


Figure 2.1-3. DOE property boundary, nearby communities, roads, and bodies of water.



PORTS SITE
FIGURE 2.1-4

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Facility Number	Facility Description	Facility Number	Facility Description
X-100	Administration Building	X-605	Sanitary Water Control House
X-100B	Air Conditioning Equipment Building	X-605A	Sanitary Water Wells
X-100L	Environmental Control Trailer	X-605H	Booster Pump House and Appurtenances
X-101	Health Services	X-605I	Chlorinator Building
X-102	Cafeteria	X-605J	Diesel Generator Building
X-103	Aux. Office Building	X-608	Raw Water Pump House
X-104	Guard Headquarters	X-608A	Raw Water Wells (1 to 4)
X-104A	Indoor Firing Range	X-608B	Raw Water Wells (5 to 15)
		X-611	Water Treatment Plant and Appurtenances
X-106	Tactical Response Building	X-611B	Sludge Lagoon
X-106B	Fire Training Building	X-611C	Filter Building
X-108A	South Portal and Shelter	X-611D	Recarbonization Instrument Building
X-108B	North Portal and Shelter	X-612	Elevated Water Tank
X-108E	Construction Portal	X-614A	Sewage Pumping Station
X-108H	Pike Avenue Portal	X-614B	Sewage Lift Station
X-109A	Personnel Monitoring Station	X-614D	South Sewage Lift Station
X-109B	Personnel Monitoring Station	X-614P	Northeast Sewage Lift Station
X-109C	Personnel Monitoring Station		
X-111A	SNM Monitoring Portal (X-326)	X-617	South PH Control Facility
X-111B	SNM Monitoring Portal (NW X-326)	X-618	North Holding Pond Storage Building
X-112	Data Processing Building	X-621	Coal Pile Runoff Treatment Facility
X-114A	Outdoor Firing Range		

Figure 2.1-5a. Facilities leased to USEC at PORTS site (per agreement dated July 1, 1993).

Note: This list (facilities leased to USEC) excludes certain DOE Material Storage Areas (DMSAs) within selected facilities which have been retained by DOE. See supplement to Exhibit A of the Lease Agreement which distinguishes DMSAs for PGDP and PORTS and plant drawings CX-761-1115-A, CX-761-1116-A, and CX-761-1118-A.

Facility Number	Facility Description	Facility Number	Facility Description
X-120H	Meteorological Tower	X-626-1	Recirculating Water Pump House
X-200	Site Prep, Grading, Landscaping	X-626-2	Cooling Tower
X-201	Land and Land Rights	X-630-1	Recirculating Water Pump House
X-202	Roads	X-630-2A	Cooling Tower
X-204	Railroad and Railroad Overpass	X-630-2B	Cooling Tower
X-206A	Main Parking Lot (N)	X-630-3	Acid Handling Station
X-206B	Main Parking Lot (S)	X-633-1	Recirculating Water Pump House
X-206E	Construction Parking	X-633-2A	Cooling Tower
X-206H	Pike Avenue Parking Lot	X-633-2B	Cooling Tower
X-206J	South Office Parking Lot	X-633-2C	Cooling Tower
X-208	Security Fence	X-633-2D	Cooling Tower
		X-640-1	Firewater Pump House
X-210	Sidewalks	X-640-2	Elevated Water Tank
X-215A	Electrical Distribution to Process Buildings	X-700	Converter Shop and Cleaning Building
X-215B	Electrical Distribution to Other Areas	X-700A	Air Conditioning Equipment Building
X-215C	Exterior Lighting		
X-215D	Electric Power Tunnel		
X-220A	Instrumentation Tunnels	X-705	Decontamination Building (Note)
X-220B1	Process Instrumentation Lines	X-705D	Heating Booster Pump Building
X-220B2	Carrier Communication Systems	X-710	Technical Services Building
X-220B3	Water Supply Telemetering Lines	X-710A	Technical Services Gas Manifold Shed
X-220C	Superior American Alarm System	X-710B	Explosion Test Facility
X-220D1	General Telephone	X-720	Maintenance & Stores Building
X-220D2	Process Telephone		

Figure 2.1-5a. (Continued)

Note: The oxide conversion area (X-705E) will not be leased.

Facility Number	Facility Description	Facility Number	Facility Description
X-220D3	Emergency Telephone System	X-720B	Radio Base Station Building
X-220E1	Evacuation Public Address System	X-720C	Paint & Oil Storage Building
X-220E2	Process Public Address System	X-721	Radiation Instrument Calibration Facility
X-220E3	Power Public Address System	X-741	Oil Drum Storage Facility
X-220F	Plant Radio System	X-742	Gas Cylinder Storage Facility
X-220G	Pneumatic Dispatch System	X-743	Lumber Storage Shed
X-220H	MuCulloh Alarm System	X-744B	Salt Storage Building
X-220J	Radiation Alarm System	X-744H	Bulk Storage Building
X-220K	Cascade Automatic Data Processing System		
X-220L	Cascade Automatic Data Processing System	X-744J	Bulk Storage Building
X-220N	Security Alarm and Surveillance System	X-744L	Stores and Maintenance
X-220P	Maintenance Work Authorization and Control System	X-744W	Surplus and Salvage Warehouse
X-220R	Public Warning Siren System	X-745B	Toll Enrichment Process Gas Yard-UEA
X-220S	Power Operations SCADA System	X-745D	Cylinder Storage Yard
X-230	Water Supply Line		
X-230A	Sanitary and Fire Water Distribution System	X-745F	North Process Gas Stockpile Yard
		X-745G	Cylinder Storage Yard
		X-745H	DU Storage Yard (Note)
		X-746	Materials Receiving & Inspection Building

Figure 2.1-5a. (Continued)

Note: This area (approximately 5 acres) has been identified as a potential site for DU cylinder storage for USEC.

Facility Number	Facility Description	Facility Number	Facility Description
		X-747A	Material Storage Yard
		X-747B	Material Storage Yard
		X-747C	Material Storage Yard
		X-747D	Material Storage Yard
X-230B	Sanitary Sewers		
X-230C	Storm Water Sewers		
X-230D	Soften Water Distribution System		
X-230E	Plant Water System (Makeup to Cooling Towers)		
X-230F	Raw Water Supply Lines		

Figure 2.1-5a. (Continued)

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Facility Number	Facility Description	Facility Number	Facility Description
X-230G	RCW System	X-747E	Material Storage Yard
X-230H	Fire Water Distribution System		
		X-747J	Decontamination Storage Yard
X-230J2	South Holding Pond Effluent Monitoring Station	X-748	Truck Scale Facility
X-230J3	West Environmental Monitoring Building	X-750	Mobile Equipment Maintenance Shop
		X-750A	Garage Storage Building
X-230J5	West Environmental Sampling Building	X-760	Chemical Engineering Building
X-230J6	Northeast Monitoring Facility		
X-230J7	East Monitoring Facility (Note)	X-1007	Fire Station
		X-1020	Emergency Operations Center (EOC)
X-230J9	North Environmental Sampling Station	X-1107A	Administrative Portal
X-230K	South Holding Pond		
X-230L	North Holding Pond	X-1107BP	Admin. Portal
X-232A	Nitrogen Distribution System	X-1107D	NE Portal
X-232B	Dry Air Distribution System		
X-232C1	Tie Line No. 1 X-342 to X-330		
X-232C2	Tie Line No. 2 X-330 to X-326		
X-232C3	Tie Line No. 3 X-330 to X-333	X-2202	Roads (GCEP)
X-232C4	Tie Line No. 4 X-326 to X-370	X-2204	GCEP Railroads
X-232C5	Tie Line No. 5 X-343 to X-333	X-2207A	GCEP Administrative Parking Lot
X-232D	Steam and Condensate System	X-2207D	Northwest Parking Lot
X-232E	Freon Distribution Lines	X-2208	Security Fence

Figure 2.1-5a. (Continued)

Note: If a RCRA closure is required in the future, DOE will be responsible for the RCRA closure. USEC will continue to be responsible for maintenance on the NPDES aspect of the facility. Discharge responsibilities after closure depend on who discharges.

Facility Number	Facility Description	Facility Number	Facility Description
X-232F	Fluorine Distribution System		
X-232G	Supports For Distribution Lines	X-2215A	Underground Electrical Distribution to Process Buildings
X-240A	RCW System (Cathodic Protection)	X-2215B	Electrical Distribution to Areas Other Than Process Buildings
X-300	Plant Control Facility	X-2215C	Exterior Light Fixtures
X-300A	Process Monitoring Building	X-2220C	Fire and Supervisory Alarm System
X-300B	Plant Control Facility Carport	X-2220D	Telephone System
X-300C	Emergency Antenna	X-2220L	Classified Computer System
X-326	Process Building (Note)	X-2220N	Security Access Control and Alarm System
X-330	Process Building	X-2230A	Sanitary Water Distribution System
X-333	Process Building	X-2230B	GCEP Sanitary Sewers
		X-2230C	Storm Sewers
X-342A	Feed, Vaporization Fluorine Generation Building	X-2230F	Raw Water Supply Line
X-342B	Fluorine Storage Building	X-2230G	Recirculating Water System
		X-2230H	Fire Water Distribution System
X-343	Feed, Vaporization and Sampling Facility	X-2230J	Liquid Effluent System
X-344A	UF6 Sampling Facility		
X-344B	Maintenance Storage Building		
		X-2230T1	Recirculation Heating Water System
X-501	Substation		
X-501A	Substation	X-2232B	Dry Air Distribution System
X-502	Substation	X-2232D	Steam and Condensate System
X-515	330 KV Tie Line	X-2232G	Supports for Distribution Lines

Figure 2.1-5a (Continued)

Note: The seven areas permitted to contain RCRA Waste in X-326 (2 of which are caged) and the glove box room area adjacent to East L-caged area will not be leased.

Facility Number	Facility Description	Facility Number	Facility Description
X-530A	Switch Yard	X-3001	Process Building (S. Half including Transfer Corridor
X-530B	Switch House	X-3002	Process Building (S. Half including Transfer Corridor
X-530C	Test & Repair Facility	X-5000	GCEP Switch House
X-530D	Oil House	X-5001	Substation
X-530E	Valve House	X-5001A	Valve House
X-530F	Valve House	X-5001B	Oil Pumping Station
X-530G	GCEP Oil Pumping Station	X-5015	HV Electrical System
X-533	Transformer Storage Pad	X-6000	GCEP Cooling Tower Pump House
X-533A	Switch Yard	X-6001	Cooling Tower
X-533B	Switch House	X-6001A	Valve House
X-533C	Test & Repair Facility	X-6609	Raw Water Wells
X-533D	Oil House	X-6613	Sanitary Water Storage Tank
X-533E	Valve House	X-6614E	Sewage Lift Station
X-533F	Valve House	X-6614G	Sewage Lift Station
X-533H	Gas Reclaiming Cart Garage	X-6614H	Sewage Lift Station
X-540	Telephone Building	X-6614J	Sewage Lift Station
X-600	Steam Plant	X-6619	Sewage Treatment Plant
X-600A	Coal Pile Yard	X-6643	Fire Water Storage Tanks #1 & #2
X-600B	Steam Plant Shop	X-6644	Fire Water Pump House
X-600C	Ash Wash Treatment Building	X-7721	Maintenance Stores Training Building (Training)
XT-801	South Office Building		
XT-847	Waste Management Staging Facility		

Figure 2.1-5a. (Continued)

Facility Number	Facility Description	Facility Number	Facility Description
X-105	Electronic Maintenance Building	X-744S	Warehouse S - Non UEA
X-120	South Weather Station	X-744T	Warehouse T - Non UEA
X-208-A	Boundary Fence	X-744U	Warehouse U - Non UEA
X-208B	SNM Security Fences X-326 and X-345	X-744Y	Waste Storage Yard
X-230M	Clean Site NE of XT-801	X-745C	West Depleted Storage Yard
X-230J1	Environmental Monitoring Station	X-745E	NW DU Storage Yard
X-230J4	Environmental Air Monitoring Station	X-747F	Miscellaneous Material Storage Yard
X-230J8	Environmental Monitoring Building	X-747G	Northeast Contaminated Storage Yard
X-231A	Southeast Oil Biodegradation Plot	X-747H	Northwest Surplus and Scrap Yard
X-231B	Southwest Oil Biodegradation Plot	X-749	South Contaminated Materials Storage Yard
X-235	South Ground Water Collection System	X-749A	South Classified Burial Yard
X-237	Little Beaver Ground Water Collection System	X-751	Mobile Equipment Maintenance Shop OANG
X-326-A L-Cage	L-Cage and Glove Box Area	X-752	Warehouse
X-342-C	Waste HF Neutralization Pit	X-770	Mechanical Test
X-334	Transformer Cleaning Building	X-1000	Administration Building
X-344C	HF Storage Building	X-1107-B(V)	Interplant Vehicle Portal
X-344D	HF Neutralization Pit	X-1108-B(V)	Interplant Vehicle Portal
X-344E	Gas Ventilation Stack	X-1107-E (V&P)	Northwest Vehicle and Pedestrian Portals
X-344F	Safety Building	X-1107-F (V&P)	South Vehicle and Pedestrian Portals
X-344G	Trailer For Russian Transparency, Located North of X-344-A and West of X-745F	X-2200	Site Preparation, Grading and Landscaping
X-345	SNM Storage Building	X-2207-E	Northwest Parking Lot

Figure 2.1-5b. Facilities retained by DOE at PORTS site.

Facility Number	Facility Description	Facility Number	Facility Description
X-611A	Lime Sludge Lagoons (North, Middle, South)	X-2207-F	South Parking Lot
X-615	Old Sewage Treatment Plant	X-2210	Sidewalks
X-616	Liquid Effluent Control Building	X-2230-M	Holding Pond #1
X-622	South Ground Water Treatment Building	X-2230-N	Holding Pond #2
		X-2230-T2	Recirculating Heating Water System
X-622T	Carbon Filtration (X-705 Sump Water)	X-2232A	Nitrogen Distribution System
		X-3000	Office Building
		X-3001	Process Building (N. Half)

Figure 2.1-5b. (Continued)

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Facility Number	Facility Description	Facility Number	Facility Description
X-623	North Ground Water Treatment Building	X-3002	Process Building (N. Half)
X-624	Little Beaver Ground Water Treatment Facility	X-3012	Process Support Building (except transfer corridor which is leased to USEC as a "common area")
X-624-1	Little Beaver Groundwater Treatment Facility	X-3346	Feed and Withdrawal Facility
X-701A	Lime House		
X-701B	Holding Pond (Drained)	X-7725	Recycle/Assembly
X-701C	Neutralization Pit and Tank	X-7725A	Waste Accountability Facility
X-701D	Water Deionization Building		
X-701E	Neutralization Building	X-7726	Centrifuge Training and Test Facility
X-705A	Incinerator	X-7727	Interplant Transfer Corriders
X-705B	Contaminated Burnable Storage Facility	X-7745R	Recycle/Assembly Storage
X-720A	Maintenance and Stores Gas Manifold Shed		
X-734	Old Sanitary Landfill	X-7745S	Area South of X-3001/X-3002
X-735	Sanitary Landfill	Z-SWMU-QUAD-IV	Southern end of railroad spur which is used as drum storage area
X-735A	Landfill Utility Building	Z-SWMU-QUAD-IV	Chemical and petroleum containment tanks east of X-533C
X-736	West Construction Spoils Landfill	Z-SWMU-X701	Northeast oil biodegradation plot area, which was formerly used for the disposal of X-615 sludge
X-740	Waste Oil Storage Facility	Z-SWMU-X710	Inactive "hot pit" in the area of X-710 that was once used for the storage of radioactive wastewater
X-744G	Bulk Storage Building	Z-SWMU-X734A	Inactive construction spoils disposal area
X-744K	Warehouse K	Z-SWMU-X734B	Inactive construction spoils disposal area
X-744N	Warehouse N - Non UEA	Z-SWMU-X744	Retrievable waste storage area

Facility Number	Facility Description	Facility Number	Facility Description
X-744P	Warehouse P - Non UEA	Z-SWMU-XXXX	Solid Waste Management Units, as identified on Portsmouth Environmental Information Management System Drawing, printed 2/9/93.
X-744Q	Warehouse Q - Non UEA	Contractor Laydown Area	Triangular area about 3 acres northwest of X-7721, west of X-2207D, southeast of Construction Road and west of Truck Access Road
		Peter Kiewit Area	Approximately 10.5 acres located east of XT-847--does not include leased Facility X-614D
		X-120 Area	About 5 acres located south of X-2207F, bounded on the west and south by railroad and on the east by a line drawn south from the west end of X-2207F Parking Lot to the railroad and adjacent to Perimeter Road/Railroad
		USEC Contractor Trailer Area	About 2 acres located north of X-2207E and northwest of X-7725

a) Use of facility includes area necessary for ingress, egress, and proper maintenance of facility.

b) All existing and future DOE monitoring wells, piezometers, extraction wells, and borings (temporary or permanent) used for the purposes 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. The nonleased facility associated with each monitoring well, etc., will include all land within 10 feet of the well, etc. DOE/USEC 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.

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

Figure 2.1-5b (Continued)

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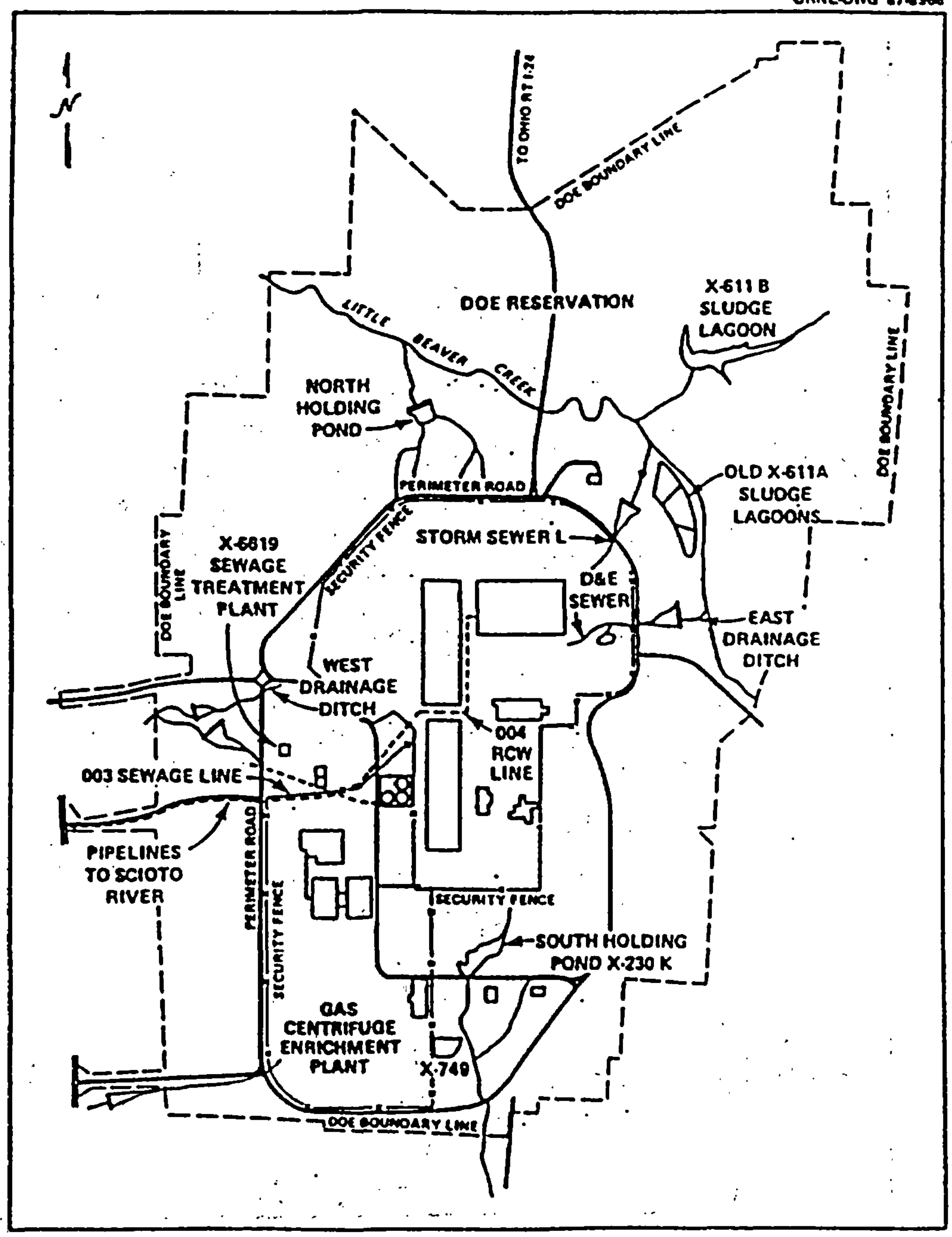

Figure 2.1-6. Major wastewater systems and sources at PORTS.

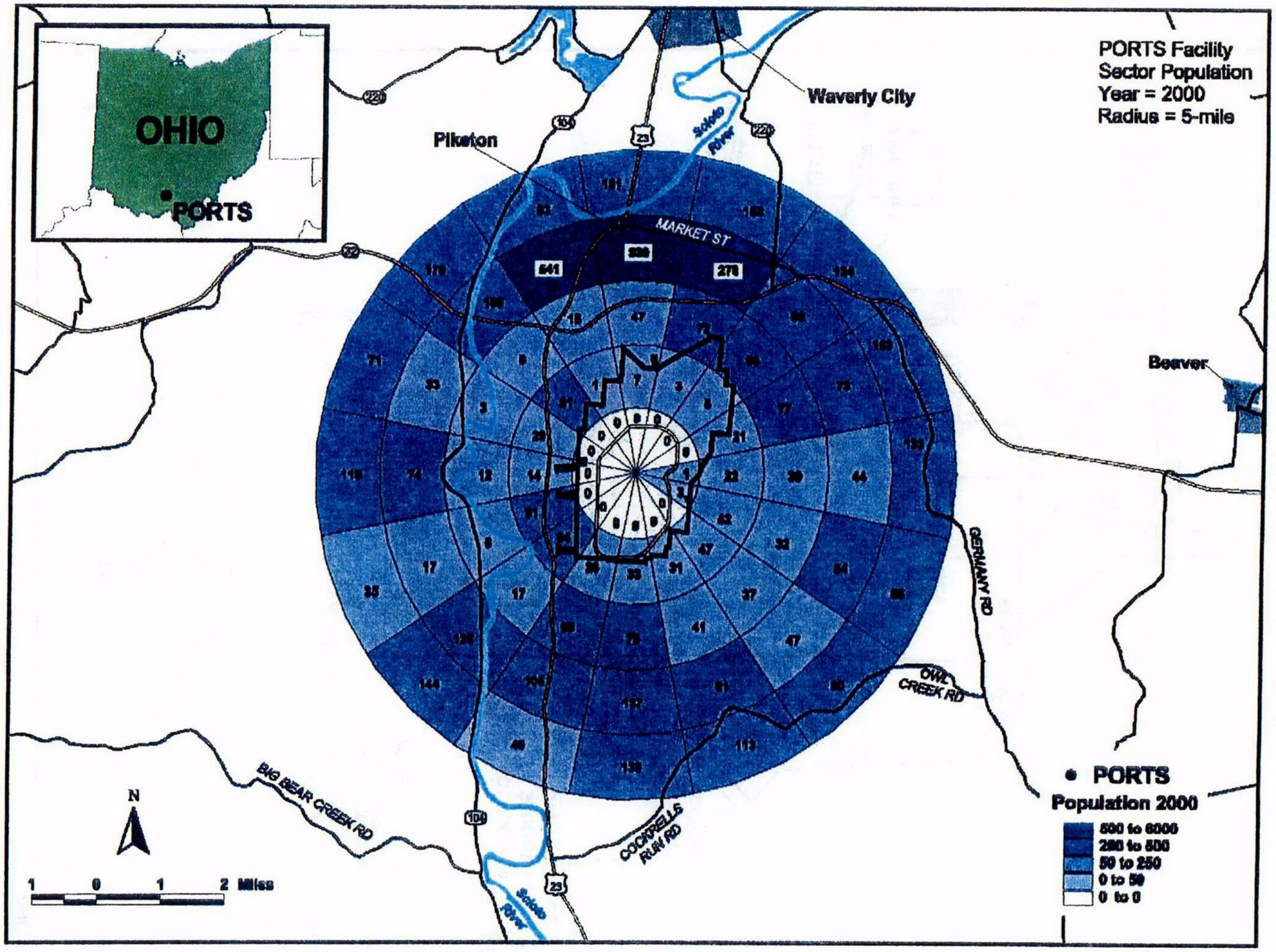

Figure 2.1-7
Population within 5-Mile Radius of PORTS

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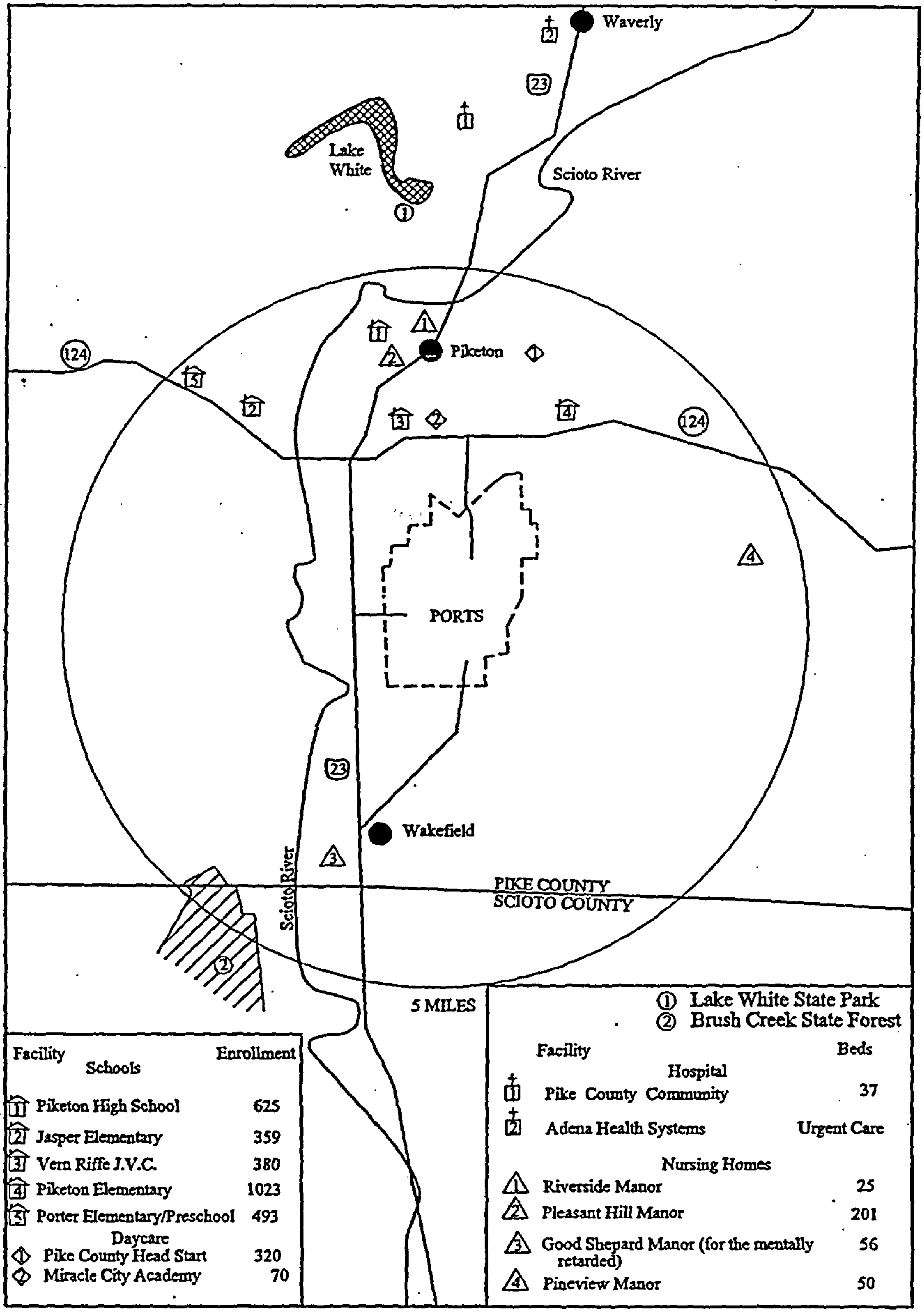

Figure 2.1-8 Special Population Centers within 5 miles of PORTS.

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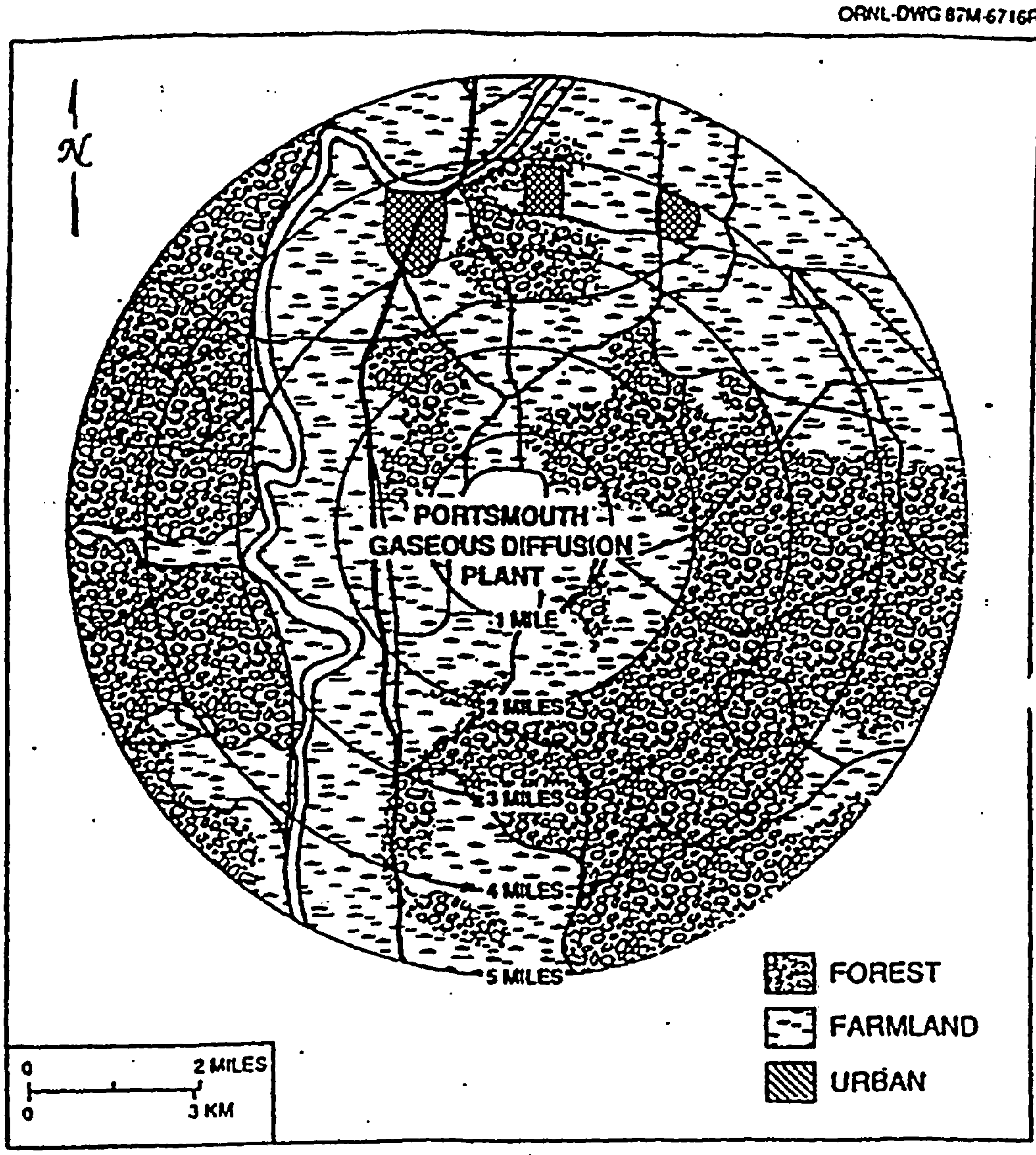

Figure 2.1-11. Land uses within 5 miles of PORTS.

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY ACTIVITIES

2.2.1 Industrial Facilities

Economic activity in the vicinity near PORTS consists primarily of farming, lumbering, and small businesses. In addition, a gravel quarry is located west of PORTS, adjacent to the Scioto River. The quarrying is done by surface extraction; no explosives are used.

The only significant industry in the vicinity is located in an industrial park south of Waverly (see Figure 2.1-2). The industries include a cabinet manufacturer (2,000 employees) and an automotive parts manufacturer (200 employees). It is not expected that these activities would have any impact on PORTS operations.

2.2.2 Transportation Systems and Routes

Transportation routes and systems are depicted in Figure 2.1-2. The primary roadways near PORTS are U.S. Highway 23 and State Highway 335, which traverse a roughly north-south course, and State Highway 124 (same as State Highway 32), which traverses an east-west course just north of PORTS.

Rail transportation in the area is provided by the N&S Railway and the CSX Railway.

The Pike County Airport is located approximately 11 miles north-northeast of PORTS. No commercial flights or cargo shipping occurs there. The 4,900-ft runway supports single and twin engine planes and small jets. The Greater Portsmouth Regional Airport, located approximately 15 miles southeast of PORTS, provides only light plane service (Class I airport). The nearest commercial airports are Port Columbus International Airport in Columbus, Ohio, approximately 70 miles away, and the airport at Huntington, West Virginia (87 miles away).

2.2.3 Military Activities

The Ohio National Guard maintains an area on the Portsmouth site for the reconditioning and storage of equipment. This equipment primarily consists of mobile equipment that contains no armament; no ordnance is permitted at this location. The maintenance and reconditioning of this equipment is accomplished in and around the X-751 facility, located on the south end of the site.

Although PORTS once maintained a landing strip for air transportation, the strip is now obstructed with earthen berms. The southern end of the landing strip is maintained as a helicopter pad. The Plant Shift Superintendent coordinates helicopter approaches to ensure they do not fly over process buildings or hazardous material storage areas.

2.2.4 DOE Activities

In addition to administrating the lease agreement with USEC, DOE conducts various operations on the reservation including environmental restoration, decontamination and decommissioning (D&D), remedial activities [Resource Conservation and Recovery Act (RCRA)]; waste management, treatment, storage, and shipment of low-level radioactive waste (LLRW) and mixed waste; manages DOE non-leased facilities; and is responsible for regulating highly enriched uranium.

As part of DOE activities required to make GCEP Process Building X-3001 eventually available for the Lead Cascade centrifuge project, USEC has temporarily leased the South half of X-3001 and X-3002 and the interconnecting transfer cooridor (common area to both USEC and DOE/DOE contractors). USEC personnel working under DOE regulatory authority will at a minimum remove certain DOE materials and equipment from X-3001 to X-3002 and refurbish the overhead cranes.

Due to the USEC decision to discontinue uranium enrichment at PORTS, it is necessary to provide an alternative heat source for DOE facilities that had been heated by the Recirculating Heating Water (RHW) System. The DOE alternative heating system (RHW Boiler System) consists of two hot work boilers, pumps, controls, and associated equipment in the northeast corner of the X-3002 GCEP Process Building. A natural gas pipeline will be installed from the Pike Natural Gas Company pipeline near the East Access road and buried about four feet underground to supply fuel for the boilers. The natural gas pipeline will be reduced in pressure to 100 psig when entering the PORTS site and is reduced east of X-622 to 30-40 psig for supply to the boilers in the X-3002 building. No. 2 fuel oil will be used to fire the boilers until the natural gas pipeline is installed and operable and will remain as a backup fuel supply. The Fuel Oil Storage Area is located approximately 250 feet east of the boilers and consists of three 40,000 gallons fuel oil tanks and a concrete containment dike surrounding and separating these tanks.

DOE has performed analyses (ASA-SM-3002-0001) for the natural gas pipeline, the fuel oil storage, and the X-3002 RHW Boiler System operation. These analyses show that there would be no significant impact from accidents involving explosions or fire at the natural gas pipeline on USEC facilities containing or processing NRC regulated materials. While there could be some minor structural damage and injury to personnel, a fire or explosion would not affect the function of any USEC facilities (with the exception of the X-1107BV vehicle portal which could suffer damage and possible irreversible health consequences to personnel in the portal in the event of an explosion). The analyses show that a fire at the fuel oil storage would not impact any USEC facilities containing or processing NRC regulated materials; a large fire could require evacuation of the USEC X-7721 facility, however, it is unlikely that the facility would be damaged.

DOE has installed emergency shutoff valves at the site boundary to stop gas flow on detection of low pressure/high flow rate condition due to a pipeline rupture (these valves also have overpressure protection). The gas pipeline route is clearly identified to minimize the potential for excavation initiated accidents. The pressure reducing valve (100 psig to 30-40 psig) with a second emergency shutoff valve is installed at least 125 feet east of the X-622 facility.

2.2.5 Ohio Department of Health - License for Radioactive Material

USEC conducts laboratory and associated support activities under a license for radioactive material operations from the State of Ohio (Ohio Department of Health - License for Radioactive Material). This license covers laboratory analyses, in field analyses for radioactive material deposits and health physics survey and characterization activities as they relate to radioactive materials that are not of diffusion plant(s) origin. Direct support activities such as shipping, receiving and waste management are also covered under this radioactive materials license from the State of Ohio as they relate to materials that are not of diffusion plant(s) origin. The NRC Certificate possession limits are governing for all operations onsite including those associated with the State of Ohio Radioactive Materials License.

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2.3 METEOROLOGY

This section provides a meteorological description of PORTS and its surrounding area. The purpose is to provide meteorological information necessary to understand the regional weather phenomena of concern for the PORTS operation and to understand the dispersion analyses performed (DOE 1994, p. 25). Meteorological conditions that influence the design and operation of the facility are identified in Section 2.7.

2.3.1 Regional Climatology

Located west of the Appalachian Mountains, the region around PORTS has a climate essentially continental in nature, characterized by moderate extremes of heat and cold and wetness and dryness (Ruffner 1985, p. 843). Figure 2.3-1 graphically portrays monthly mean temperatures averaged over the period from 1951 to 1980 (Ruffner 1985, p. 863) at Waverly, Ohio, which is about 8 miles north of PORTS. Daily maximum and minimum temperatures averaged over the period from 1951 to 1980 are also shown in the figure. July is the hottest month, with an average monthly temperature of 74°F, and January is the coldest month with an average temperature of 30°F. The highest and lowest daily temperatures from 1951 to 1980 were 103 and -25°F on July 14, 1954, and February 3, 1951, respectively. For the results presented above, data from Waverly are used because of the availability of published long-term data.

Moisture in the area is predominantly supplied by air moving northward from the Gulf of Mexico (Ruffner 1985, p. 863). Precipitation is abundant from March through August and sparse in October and February (Figure 2.3-2). The average annual precipitation at Waverly, Ohio, for the period from 1951 to 1980 was 40.4 in. (Ruffner 1985, p. 863). The greatest daily rainfall during this period was 3.38 in., occurring on June 26, 1971. Snowfall occurrence varies from year to year, but is common from November through March (see Figure 2.3-3). The average annual snowfall for the area is about 22 in., based on the 1951-1980 data. During that time period, the maximum monthly snowfall was 25.4 in., occurring in January 1978.

Occasionally, heavy amounts of rain associated with thunderstorms or low pressure systems will fall in a short period of time. The U.S. Weather Bureau has published values of the total precipitation for durations from 30 min to 24 h and return periods from 1 to 100 yr (Hershfield 1963). The results for the geographic locale including PORTS are summarized in Table 2.3-1. A local drainage analysis for extreme storms at PORTS has been performed (see Johnson et al. 1993).

The predominant winds at PORTS blow from the south or southwest and at times from the north (ERDA 1977, p. 3-18). The average wind speed is about 5 mph. On the average, from 1953 to 1989, 14 tornadoes per year were reported in Ohio, but the total varies widely from year to year (e.g., 43 in 1973 and 0 in 1988) (Bair 1992, p. 110). Pike County, where PORTS is located, had two tornadoes during the 20-yr period from 1953 to 1972 (Davis 1973).

2.3.2 On-Site Meteorological Measurements Program

PORTS maintained a single 131 ft meteorological tower (Building X-120; plant coordinates: E 8500 ft, N 4100 ft located south of XT-801) before 1995. It was equipped with instrument packages at the 33- and 105-ft (10- and 32-m) levels that measure air temperature, relative humidity, and wind speed and direction (Kornegay et al. 1994, p. 5-10). [Results labeled as 131 or 105 ft (40 or 32 m) in this section were all measured at 105 ft (32 m)]. Prior to 1995, not all the meteorological instrumentation at PORTS might be reliable (Kornegay et al. 1994, p. 5-11). Since January 1995, a new 200-ft (60-m) tower has been in use. It is equipped with instrument packages at the 33, 98, and 200 ft (10, 30, and 60 m) levels. In addition, ground-level instrumentation measures solar radiation, barometric pressure, precipitation, and soil temperatures at 1- and 2-ft depths.

2.3.3 Local Meteorology

Hourly temperatures at 33- and 105-ft (10- and 32-m) (labeled as 40-m) levels above the ground were recorded at the PORTS meteorological tower before 1995. The results for 1994 are shown in Figure 2.3-4. At each level, 8555 of the possible 8760 data points are available. The seasonal temperature variation and the daily temperature fluctuations are consistent with the long-term averages shown in Figure 2.3-1 for Waverly, Ohio. The two sets of temperature readings at the PORTS meteorological tower are highly correlated, as one would expect. Since January 1995, temperatures at 33, 98, and 200 ft (10, 30, and 60 m) have been measured at the new tower.

Hourly relative humidity data at PORTS for 1994 are plotted in Figure 2.3-5. Out of the possible 8760 data points, 8629 are available. The average relative humidity from this period, 85.3%, is not typical for this region. For example, the average annual relative humidities at Lexington (Kentucky), Cincinnati and Columbus (Ohio), and Charleston (West Virginia) are all very close to 70% (Bair 1992, pp. 553, 689, 697, and 821). Among the 8629 data points shown in Figure 2.3-5, 3143 have the value of 100%. The high relative humidity readings might have been caused by a near by creek, which is only about 500 ft west of the meteorological tower, or by an incorrectly calibrated instrument.

Hourly wind speed and wind direction data for 1994 obtained from PORTS (Blythe 1995) are plotted in Figures 2.3-6 and 2.3-7, respectively. Out of 8760 possible hourly data sets, 8430 are available for wind speed and 8423 for wind direction. The average wind speeds were 3.7 and 6.0 mph at 33- and 105-ft (10- and 32-m) levels, respectively. Wind roses at 33 and 105 ft (labeled as 131 ft) [10 and 32 m (labeled as 40 m)] at PORTS constructed from the 1993 data are compared in Figure 2.3-8. Average wind roses constructed from 1992-1994 data are shown in Figures 2.3-9 and 2.3-10 for 33- and 105-ft (10- and 32-m) levels, respectively.

Joint frequency distribution of atmospheric stability, wind direction, and wind speed at 33-ft and 105-ft (10- and 32-m) above ground at PORTS for 1993 were provided by PORTS (Blythe 1994 and 1995). Sigma theta data (standard deviations of the wind direction) were used when available and $\Delta T/\Delta Z$ values were used otherwise. These distributions are shown in Tables 2.3-2 and 2.3-3.

Table 2.3-1. Precipitation in inches as a function of recurrence interval and storm duration for the PORTS area

Recurrence interval (yr)	Storm duration (h)						
	0.5	1	2	3	6	12	24
1	0.85	1.06	1.34	1.44	1.75	2.04	2.43
2	1.04	1.28	1.57	1.71	2.02	2.44	2.70
5	1.36	1.66	1.98	2.14	2.52	2.98	3.41
10	1.52	1.93	2.30	2.52	2.98	3.40	3.90
25	1.76	2.24	2.64	2.92	3.38	3.91	4.55
50	1.96	2.51	2.97	3.16	3.78	4.20	4.93
100	2.16	2.73	3.22	3.48	4.00	4.88	5.26

1 in. = 2.54 cm.
Source: Johnson et al. 1993, p. 4-2.

Table 2.3-2. Joint frequency distribution, in %, of atmospheric stability, wind direction, and wind speed at 10 m above ground at PORTS for 1993

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2–4	4–6	6–8	8–10	>10	Total
A	N	0.86	0.60	0.23	0.02	0	0	1.71
	NNE	0.94	0.56	0.03	0	0	0	1.53
	NE	1.45	0.30	0	0	0	0	1.76
	ENE	1.26	0.24	0	0	0	0	1.50
	E	1.33	0.30	0	0	0	0	1.63
	ESE	1.49	0.36	0	0	0	0	1.86
	SE	1.70	0.28	0	0	0	0	1.98
	SSE	2.43	0.24	0	0	0	0	2.67
	S	3.58	0.66	0	0	0	0	4.25
	SSW	3.23	1.07	0.05	0	0	0	4.35
	SW	3.17	1.41	0.05	0	0	0	4.63
	WSW	2.57	1.57	0.18	0.03	0	0	4.35
	W	1.94	0.74	0.11	0.08	0	0	2.87
	WNW	1.55	0.53	0.08	0	0	0	2.17
	NW	1.25	0.42	0.02	0	0	0	1.69
	NNW	1.27	0.64	0.09	0.02	0	0	2.02
	Total	30.02	9.93	0.86	0.15	0	0	40.96
B	N	0.14	0.29	0.24	0.05	0.03	0	0.75
	NNE	0.21	0.16	0.03	0	0	0	0.41
	NE	0.43	0.15	0	0	0	0	0.58
	ENE	0.58	0.18	0	0	0	0	0.77
	E	0.71	0.27	0.02	0	0	0	1.00
	ESE	0.92	0.49	0.02	0	0	0	1.43
	SE	0.68	0.40	0	0	0	0	1.08
	SSE	0.99	0.47	0.05	0	0	0	1.51
	S	1.83	0.75	0.09	0	0	0	2.67
	SSW	1.71	1.41	0.21	0	0	0	3.34
	SW	0.94	0.79	0.19	0.02	0	0	1.95
	WSW	0.60	0.71	0.16	0.01	0	0	1.48
	W	0.32	0.23	0.04	0	0	0	0.60
	WNW	0.19	0.22	0.02	0	0	0	0.43
	NW	0.22	0.23	0.06	0	0	0	0.51
	NNW	0.32	0.44	0.13	0.02	0	0	0.90
	Total	10.77	7.19	1.27	0.14	0.03	0	19.40

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2–4	4–6	6–8	8–10	>10	Total
C	N	0.08	0.06	0.04	0.02	0.03	0	0.24
	NNE	0.19	0.39	0.28	0.10	0	0	0.96
	NE	0.59	0.27	0	0	0	0	0.84
	ENE	0.47	0.20	0.02	0	0	0	0.69
	E	0.83	0.26	0.02	0	0	0	1.11
	ESE	0.78	0.39	0	0	0	0	1.18
	SE	0.42	0.13	0	0	0	0	0.56
	SSE	0.94	0.22	0.04	0.01	0	0	1.21
	S	2.15	0.85	0.18	0.02	0	0	3.20
	SSW	2.01	0.93	0.20	0	0	0	3.14
	SW	0.66	0.29	0.04	0	0	0	0.99
	WSW	0.50	0.59	0.47	0.09	0	0	1.65
	W	0.33	0.81	0.64	0.15	0	0	1.94
	WNW	0.30	1.00	0.22	0.02	0	0	1.54
	NW	0.23	0.66	0.20	0	0	0	1.08
	NNW	0.15	0.25	0.04	0.03	0	0	0.47
	Total	10.63	7.26	2.41	0.44	0.04	0	20.78
D	N	0.02	0	0	0	0	0	0.02
	NNE	0.21	0.27	0.08	0.02	0	0	0.57
	NE	0.40	0.53	0.21	0	0	0	1.14
	ENE	0.29	0.08	0	0	0	0	0.37
	E	0.44	0.08	0	0	0	0	0.52
	ESE	0.35	0.03	0	0	0	0	0.38
	SE	0.20	0	0	0	0	0	0.20
	SSE	0.79	0	0	0	0	0	0.79
	S	1.43	0.04	0.01	0	0	0	1.48
	SSW	0.86	0.03	0	0	0	0	0.90
	SW	0.23	0	0	0	0	0	0.23
	WSW	0.27	0.17	0.06	0.02	0	0	0.52
	W	0.23	0.27	0.10	0.01	0	0	0.60
	WNW	0.17	0.12	0	0	0	0	0.29
	NW	0.10	0.15	0.02	0	0	0	0.26
	NNW	0.02	0.01	0	0	0	0	0.03
	Total	5.99	1.78	0.49	0.05	0	0	8.30

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2–4	4–6	6–8	8–0	>10	Total
E	N	0	0	0	0	0	0	0
	NNE	0.02	0	0.02	0	0	0	0.04
	NE	0.04	0.03	0	0	0	0	0.07
	ENE	0.02	0	0	0	0	0	0.03
	E	0.08	0	0	0	0	0	0.08
	ESE	0.03	0	0	0	0	0	0.03
	SE	0.04	0	0	0	0	0	0.04
	SSE	0.18	0	0	0	0	0	0.18
	S	0.30	0	0	0	0	0	0.30
	SSW	0.17	0	0	0	0	0	0.17
	SW	0.02	0	0	0	0	0	0.02
	WSW	0.02	0	0	0	0	0	0.02
	W	0.01	0	0	0	0	0	0.02
	WNW	0.03	0	0	0	0	0	0.03
	NW	0	0	0	0	0	0	0
	NNW	0	0	0	0	0	0	0
	Total	0.95	0.05	0.02	0	0	0	1.02
F	N	4.79	0	0	0	0	0	4.79
	NNE	0.11	0	0	0	0	0	0.11
	NE	0.14	0	0	0	0	0	0.14
	ENE	0.21	0	0	0	0	0	0.21
	E	0.40	0	0	0	0	0	0.40
	ESE	0.32	0	0	0	0	0	0.32
	SE	0.47	0	0	0	0	0	0.47
	SSE	0.69	0	0	0	0	0	0.69
	S	0.82	0	0	0	0	0	0.82
	SSW	0.48	0	0	0	0	0	0.48
	SW	0.32	0	0	0	0	0	0.32
	WSW	0.20	0	0	0	0	0	0.20
	W	0.18	0	0	0	0	0	0.18
	WNW	0.16	0	0	0	0	0	0.16
	NW	0.11	0	0	0	0	0	0.11
	NNW	0.14	0	0	0	0	0	0.14
	Total	9.54	0	0	0	0	0	9.54

Table 2.3-2 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		<2	2–4	4–6	6–8	8–10	>10	Total
ALL	N	5.89	0.96	0.51	0.09	0.06	0	7.51
	NNE	1.67	1.38	0.44	0.12	0	0	3.62
	NE	3.04	1.26	0.22	0	0	0	4.52
	ENE	2.83	0.71	0.03	0	0	0	3.56
	E	3.78	0.90	0.05	0	0	0	4.73
	ESE	3.89	1.27	0.03	0	0	0	5.19
	SE	3.50	0.81	0	0	0	0	4.32
	SSE	6.01	0.93	0.09	0.02	0	0	7.06
	S	10.12	2.30	0.28	0.03	0	0	12.73
	SSW	8.46	3.44	0.46	0	0	0	12.37
	SW	5.33	2.49	0.28	0.03	0	0	8.13
	WSW	4.15	3.04	0.88	0.15	0	0	8.22
	W	3.01	2.05	0.90	0.24	0	0	6.20
	WNW	2.41	1.88	0.32	0.03	0	0	4.62
	NW	1.90	1.46	0.30	0	0	0	3.66
	NNW	1.90	1.34	0.25	0.06	0	0	3.56
	Total	67.89	26.21	5.05	0.77	0.08	0	100.00

Table 2.3-3. Joint frequency distribution, in %, of atmospheric stability, wind direction, and wind speed at 32 m above ground at PORTS for 1993

Stability category	Wind direction	Wind speed class (m/s)						
		0–2.1	2.1–3.6	3.6–5.7	5.7–8.7	8.7–10.8	>10.8	Total
A	N	0.83	0.64	0.21	0.10	0	0	1.79
	NNE	0.93	0.70	0.07	0	0	0	1.71
	NE	0.78	0.30	0	0	0	0	1.09
	ENE	0.69	0.25	0.02	0	0	0	0.96
	E	0.65	0.22	0	0	0	0	0.87
	ESE	0.65	0.16	0	0	0	0	0.80
	SE	0.84	0.14	0	0	0	0	0.99
	SSE	1.00	0.15	0	0	0	0	1.16
	S	1.25	0.18	0	0	0	0	1.46
	SSW	1.53	0.33	0.02	0	0	0	1.88
	SW	1.61	0.45	0.05	0	0	0	2.12
	WSW	1.36	0.39	0.07	0.03	.02	0	1.87
	W	1.05	0.37	0.12	0.08	.05	0	1.67
	WNW	0.85	0.30	0.13	0.02	0.	0	1.30
	NW	0.71	0.320	0.05	0	0	0	1.08
	NNW	0.71	0.51	0.11	0.01	0	0	1.35
	Total	15.43	5.42	0.88	0.27	.08	0	22.09
B	N	0.12	0.12	0.10	0.04	0	0	0.38
	NNE	0.16	0.13	0.03	0	0	0	0.31
	NE	0.17	0.13	0	0	0	0	0.31
	ENE	0.28	0.22	0.04	0	0	0	0.54
	E	0.26	0.25	0.03	0	0	0	0.54
	ESE	0.23	0.24	0.03	0	0	0	0.51
	SE	0.30	0.17	0.02	0	0	0	0.49
	SSE	0.36	0.14	0.02	0	0	0	0.51
	S	0.54	0.22	0.03	0	0	0	0.80
	SSW	0.60	0.40	0.09	0	0	0	1.09
	SW	0.63	0.45	0.17	0.02	0	0	1.28
	WSW	0.43	0.30	0.09	0.04	0	0	0.88
	W	0.36	0.21	0.07	0.02	0	0	0.66
	WNW	0.24	0.12	0.06	0.01	0	0	0.42
	NW	0.21	0.13	0.06	0.01	0	0	0.42
	NNW	0.12	0.23	0.11	0.04	.02	0.01	0.54
	Total	5.00	3.45	0.97	0.20	.04	0.02	9.68

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		0–2.1	2.1–3.6	3.6–5.7	5.7–8.7	8.7–10.8	>10.8	Total
C	N	0.09	0.17	0.13	0.11	0.03	0.04	0.56
	NNE	0.15	0.20	0.05	0	0	0	0.41
	NE	0.36	0.27	0.02	0	0	0	0.65
	ENE	0.31	0.41	0.09	0	0	0	0.81
	E	0.30	0.51	0.11	0	0	0	0.92
	ESE	0.26	0.56	0.17	0	0	0	1.00
	SE	0.36	0.49	0.22	0.01	0	0	1.09
	SSE	0.54	0.44	0.15	0.03	0	0	1.16
	S	0.79	0.65	0.41	0.09	0	0	1.94
	SSW	0.89	0.98	0.58	0.21	0	0	2.68
	SW	0.72	0.87	0.85	0.24	0.03	0	2.72
	WSW	0.50	0.55	0.43	0.18	0.04	0	1.71
	W	0.41	0.30	0.23	0.11	0.02	0	1.08
	WNW	0.30	0.29	0.22	0.07	0	0	0.89
	NW	0.14	0.34	0.22	0.06	0.02	0	0.78
	NNW	0.11	0.38	0.22	0.05	0.01	0	0.77
	Total	6.25	7.41	4.11	1.18	0.15	0.06	19.17
D	N	0.07	0.06	0.11	0.07	0.03	0.03	0.36
	NNE	0.29	0.42	0.28	0.09	0.02	0	1.11
	NE	0.38	0.70	0.16	0	0	0	1.25
	ENE	0.33	0.51	0.13	0	0	0	0.97
	E	0.27	0.78	0.16	0.01	0	0	1.22
	ESE	0.32	1.09	0.41	0.05	0	0	1.87
	SE	0.40	0.74	0.30	0.02	0	0	1.47
	SSE	0.84	0.53	0.48	0.18	0.03	0.01	2.08
	S	1.02	1.91	1.13	0.26	0.01	0	4.34
	SSW	0.79	1.70	1.32	0.51	0.08	0	4.42
	SW	0.84	1.27	0.88	0.38	0.06	0	3.43
	WSW	0.71	0.88	0.91	0.56	0.35	0.07	3.48
	W	0.57	0.77	0.83	0.62	0.19	0.08	3.05
	WNW	0.36	0.74	0.88	0.33	0.05	0	2.35
	NW	0.11	0.59	0.38	0.15	0.02	0	1.24
	NNW	0.03	0.27	0.03	0	0	0	0.32
	Total	7.33	12.96	8.38	3.23	.85	.22	32.97

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		0–2.1	2.1–3.6	3.6–5.7	5.7–8.7	8.7–10.8	>10.8	Total
E	N	0	0	0	0.01	0	0	0.05
	NNE	0.18	0.69	0.35	0.17	0.07	0	1.47
	NE	0.19	0.60	0.35	0.10	0	0	1.23
	ENE	0.13	0.34	0.04	0	0	0	0.50
	E	0.19	0.28	0	0	0	0	0.47
	ESE	0.11	0.34	0.04	0	0	0	0.50
	SE	0.22	0.16	0	0	0	0	0.38
	SSE	0.51	0.20	0.03	0.03	0	0	0.76
	S	0.58	0.69	0.10	0	0	0	1.37
	SSW	0.36	0.89	0.32	0	0	0	1.56
	SW	0.37	0.42	0.04	0	0	0	0.83
	WSW	0.54	0.31	0.11	0.03	0	0	0.99
	W	0.22	0.27	0.07	0.03	0	0	0.59
	WNW	0.19	0.45	0.14	0.05	0	0	0.84
	NW	0.05	0.19	0.08	0.02	0	0	0.34
	NNW	0	0.03	0	0	0	0	0.04
	Total	3.85	5.87	1.69	.42	.08	0	11.93
F	N	0.39	0	0	0	0	0	0.39
	NNE	0.12	0.12	0.06	.01	0	0	0.31
	NE	0.11	0.13	0.03	0	0	0	0.28
	ENE	0.11	0.02	0	0	0	0	0.13
	E	0.22	0.03	0	0	0	0	0.24
	ESE	0.12	0	0	0	0	0	0.12
	SE	0.19	0.02	0	0	0	0	0.21
	SSE	0.28	0.02	0	0	0	0	0.30
	S	0.30	0.10	0	0	0	0	0.41
	SSW	0.27	0.07	0	0	0	0	0.35
	SW	0.24	0.02	0	0	0	0	0.25
	WSW	0.43	0.03	0	0	0	0	0.46
	W	0.30	0	0	0	0	0	0.31
	WNW	0.17	0.02	0	0	0	0	0.19
	NW	0.12	0.02	0.01	0	0	0	0.15
	NNW	0.07	0	0	0	0	0	0.07
	Total	3.43	.60	.13	.01	0	0	4.17

Table 2.3-3 (continued)

Stability category	Wind direction	Wind speed class (m/s)						
		0–2.1	2.1–3.6	3.6–5.7	5.7–8.7	8.7–10.8	>10.8	Total
ALL	N	1.50	1.00	0.57	0.33	0.06	0.07	3.52
	NNE	1.83	2.26	0.85	0.28	0.09	0	5.32
	NE	1.99	2.15	0.57	0.10	0	0	4.81
	ENE	1.84	1.74	0.32	0.01	0	0	3.91
	E	1.89	2.05	0.31	0.01	0	0	4.27
	ESE	1.69	2.39	0.66	0.06	0	0	4.80
	SE	2.32	1.72	0.55	0.03	0	0	4.63
	SSE	3.52	1.49	0.68	0.23	0.03	0.02	5.98
	S	4.48	3.75	1.69	0.36	0.02	0	10.31
	SSW	4.44	4.37	2.34	0.73	0.09	0	11.97
	SW	4.40	3.48	1.98	0.66	0.09	0.01	10.62
	WSW	3.98	2.45	1.61	0.83	0.42	0.08	9.38
	W	2.90	1.93	1.32	0.85	0.27	0.09	7.36
	WNW	2.11	1.91	1.44	0.48	0.06	0	6.00
	NW	1.35	1.59	0.80	0.24	0.03	0	4.01
	NNW	1.06	1.42	0.47	0.10	0.04	0.02	3.10
	Total	41.29	35.72	16.16	5.32	1.21	.31	100.00

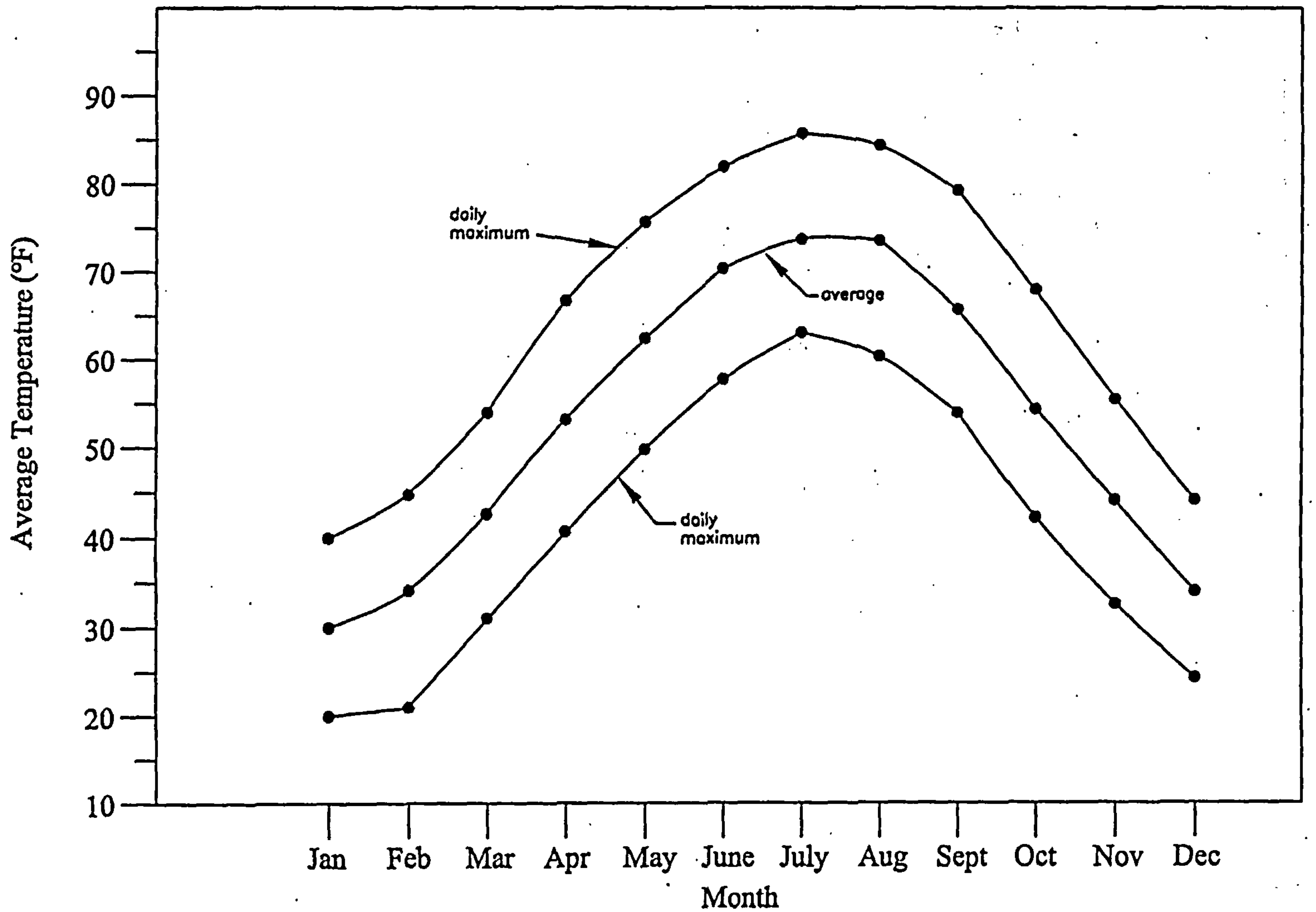

Figure 2.3-1 Monthly mean temperatures averaged over the period from 1951 to 1980 at Waverly, Ohio (Data Source: p. 863, Ruffner 1985)

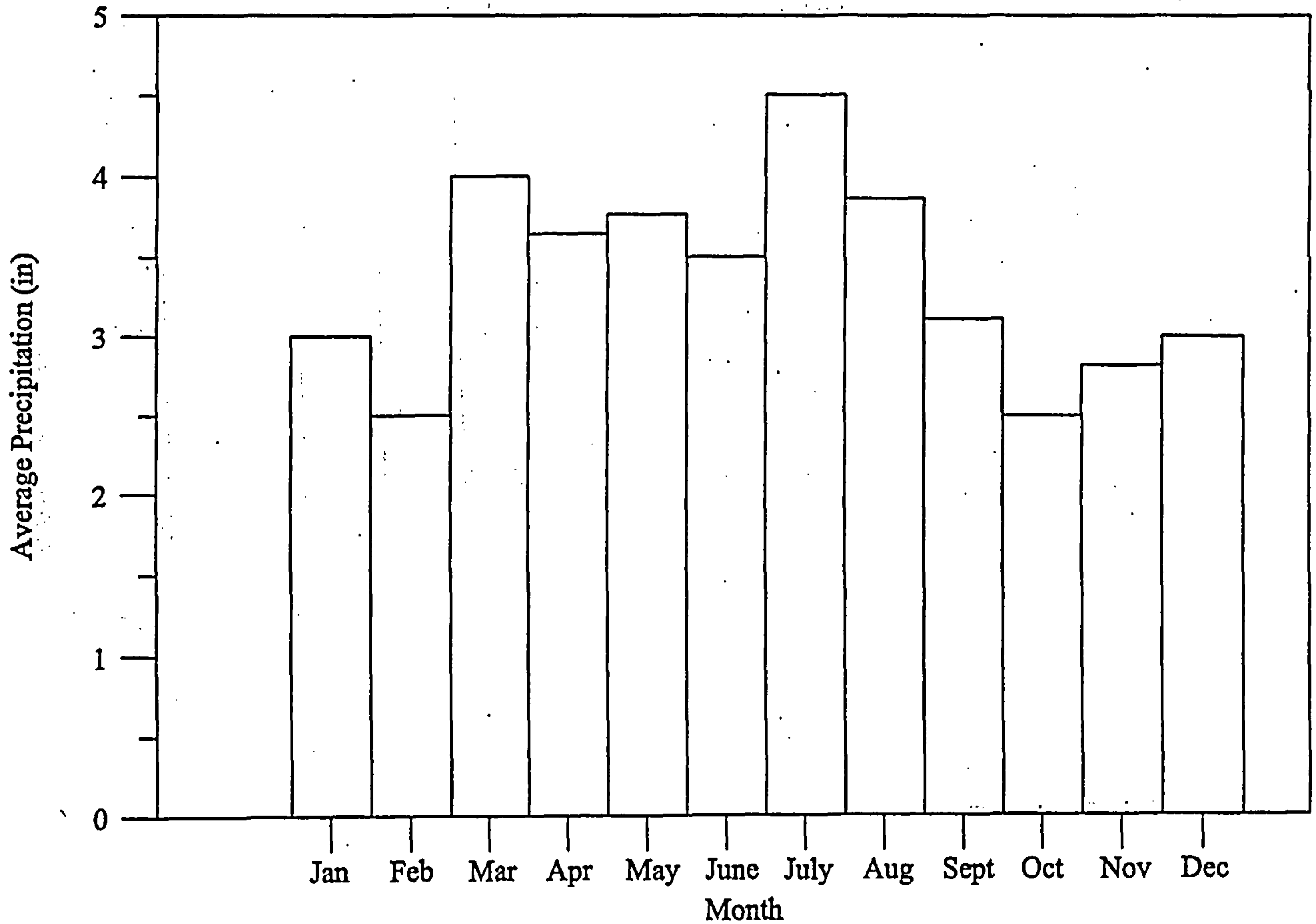

Figure 2.3-2 Monthly mean precipitation averaged over the period from 1951 to 1980 at Waverly, Ohio (Data Source: p. 863, Ruffner 1985)

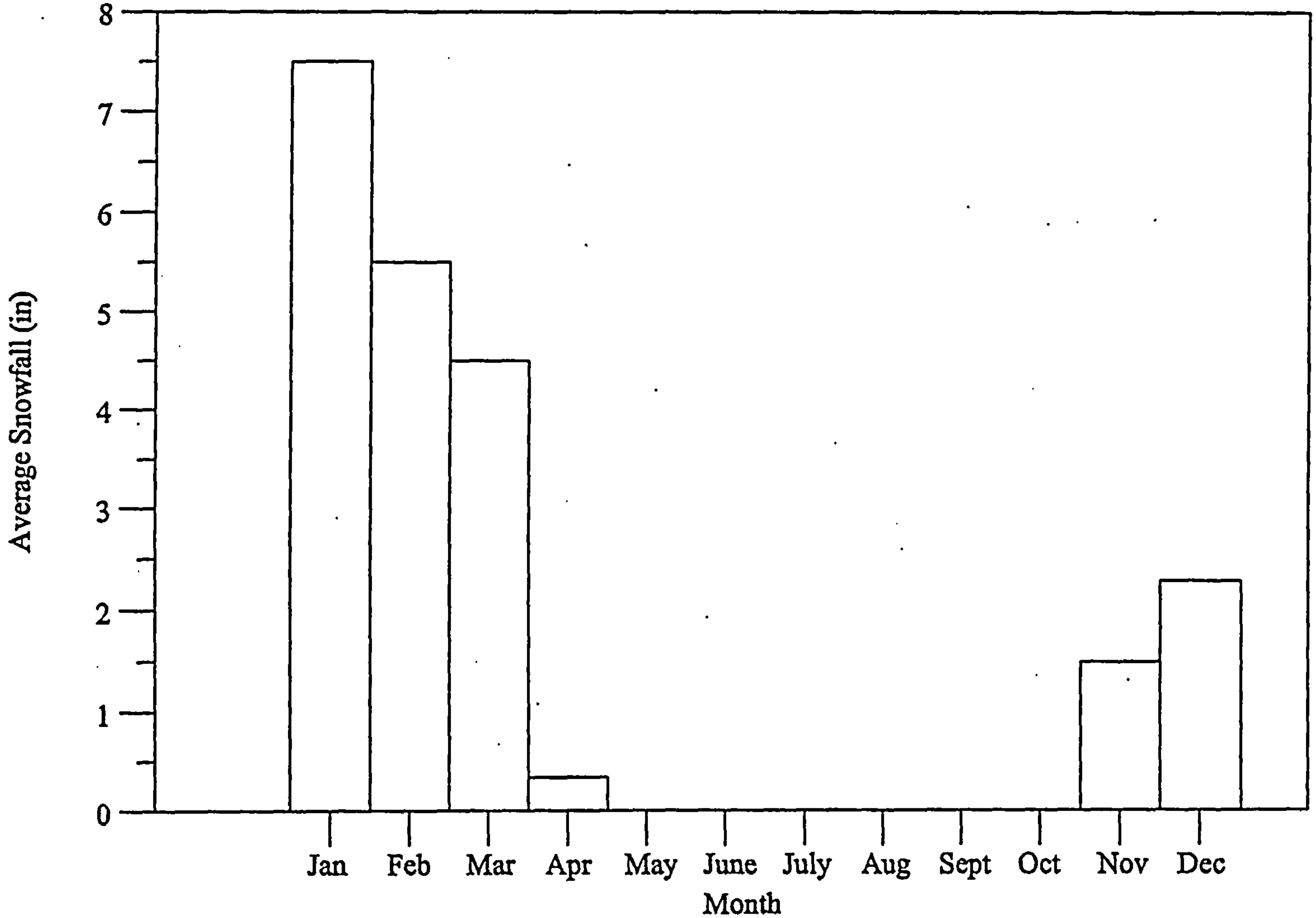

Figure 2.3-3 Monthly mean snowfall averaged over the period
from 1951 to 1980 at Waverly, Ohio
(Data Source: p. 863, Ruffner 1985)

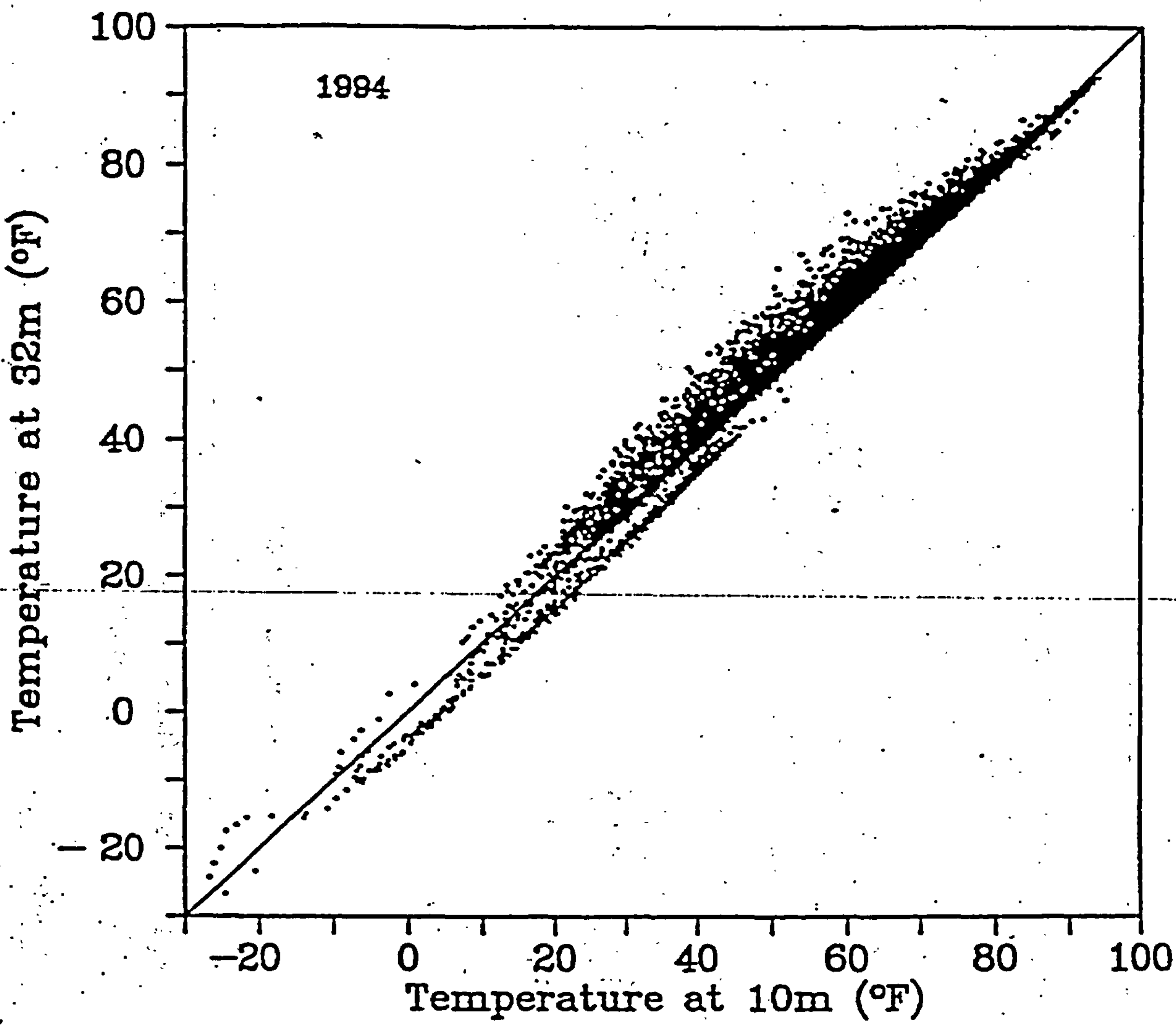

Figure 2.3-4. Hourly temperatures at 10-m and 32-m levels above ground at PORTS for 1994.

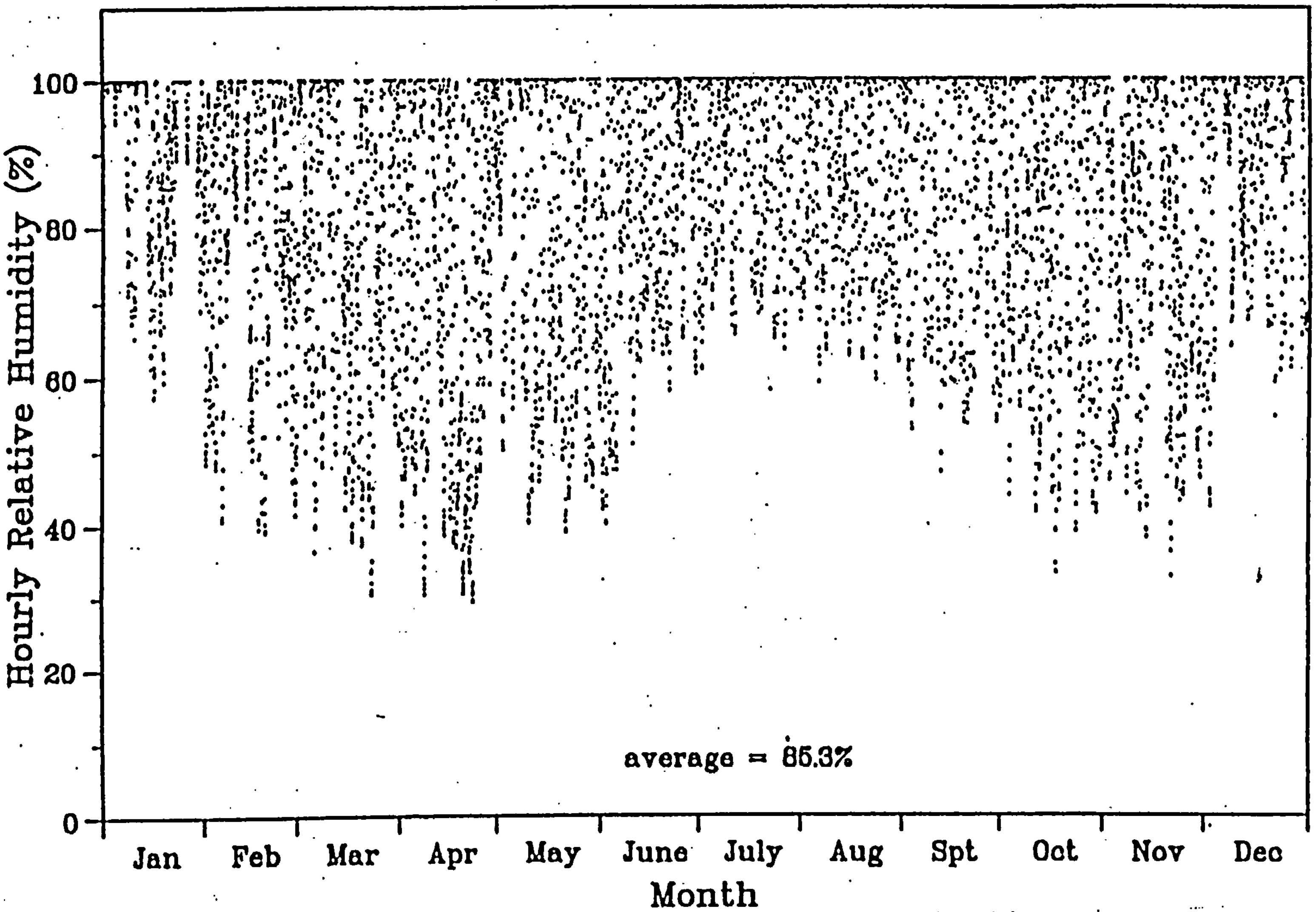

Figure 2.3-5. Hourly relative humidity data at PORTS for 1994.

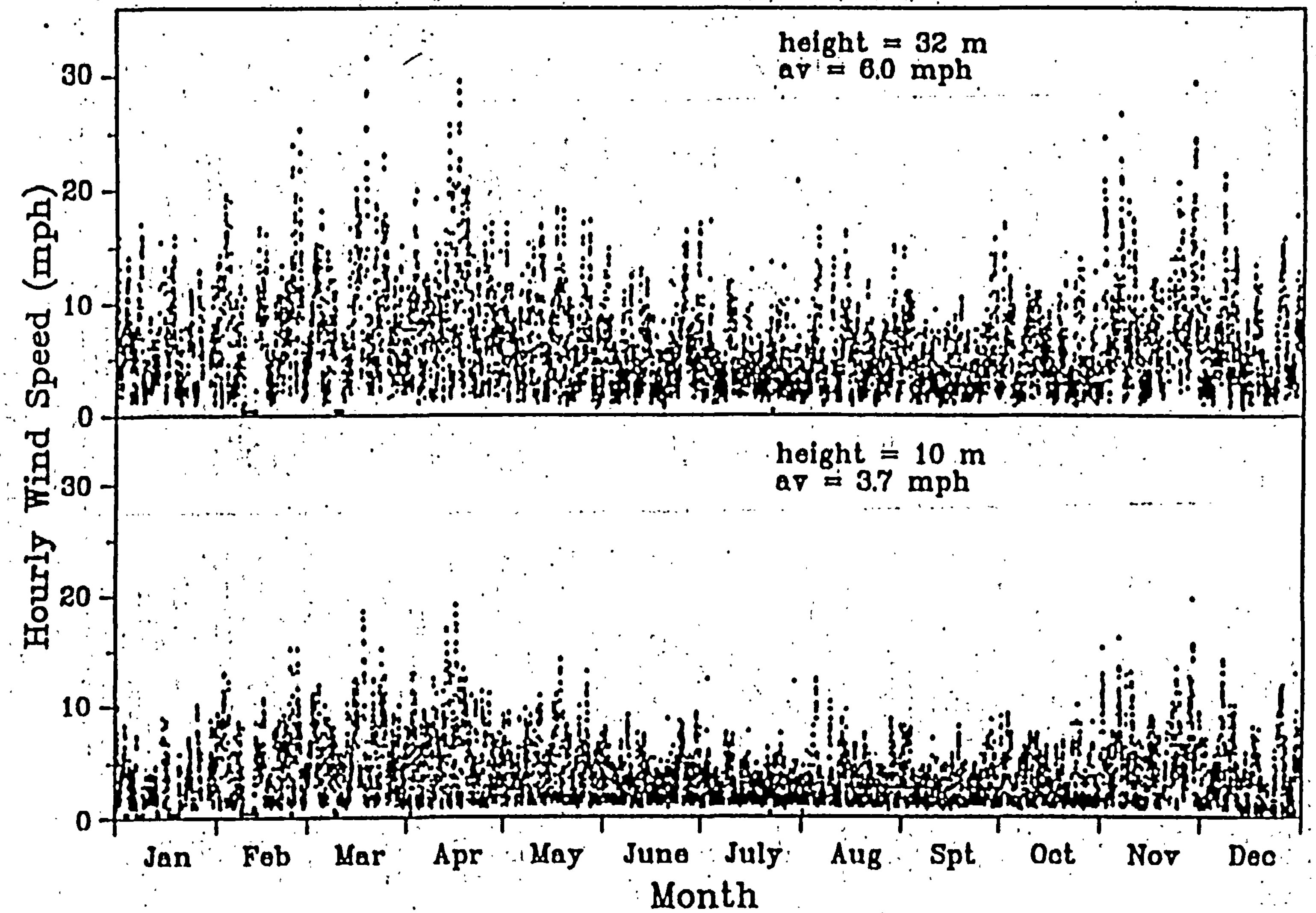

Figure 2.3-6. Hourly wind speeds at 10-m and 32-m levels above ground at PORTS for 1994.

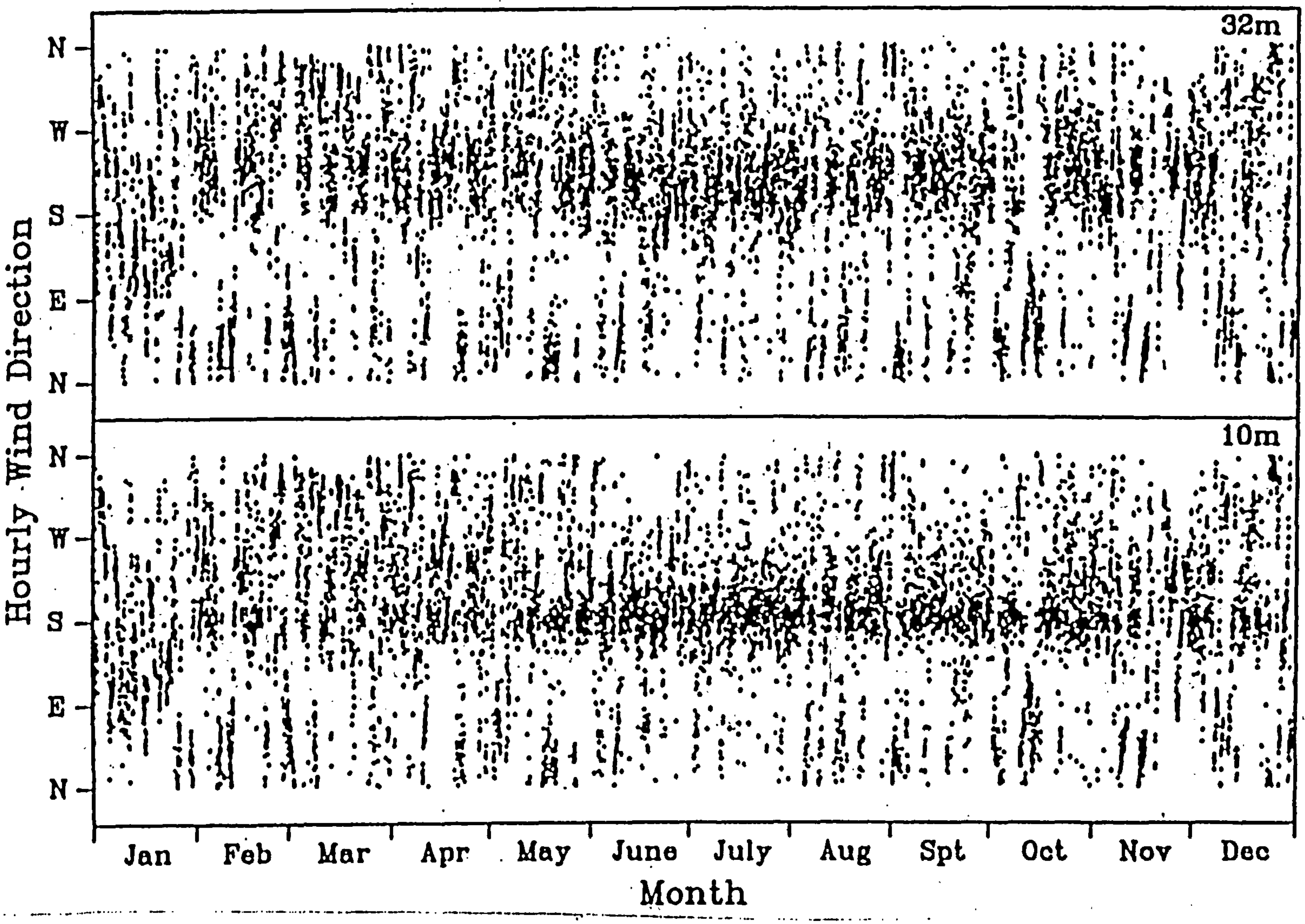

Figure 2.3-7. Hourly wind directions at 10-m and 32-m levels above ground at PORTS for 1994.

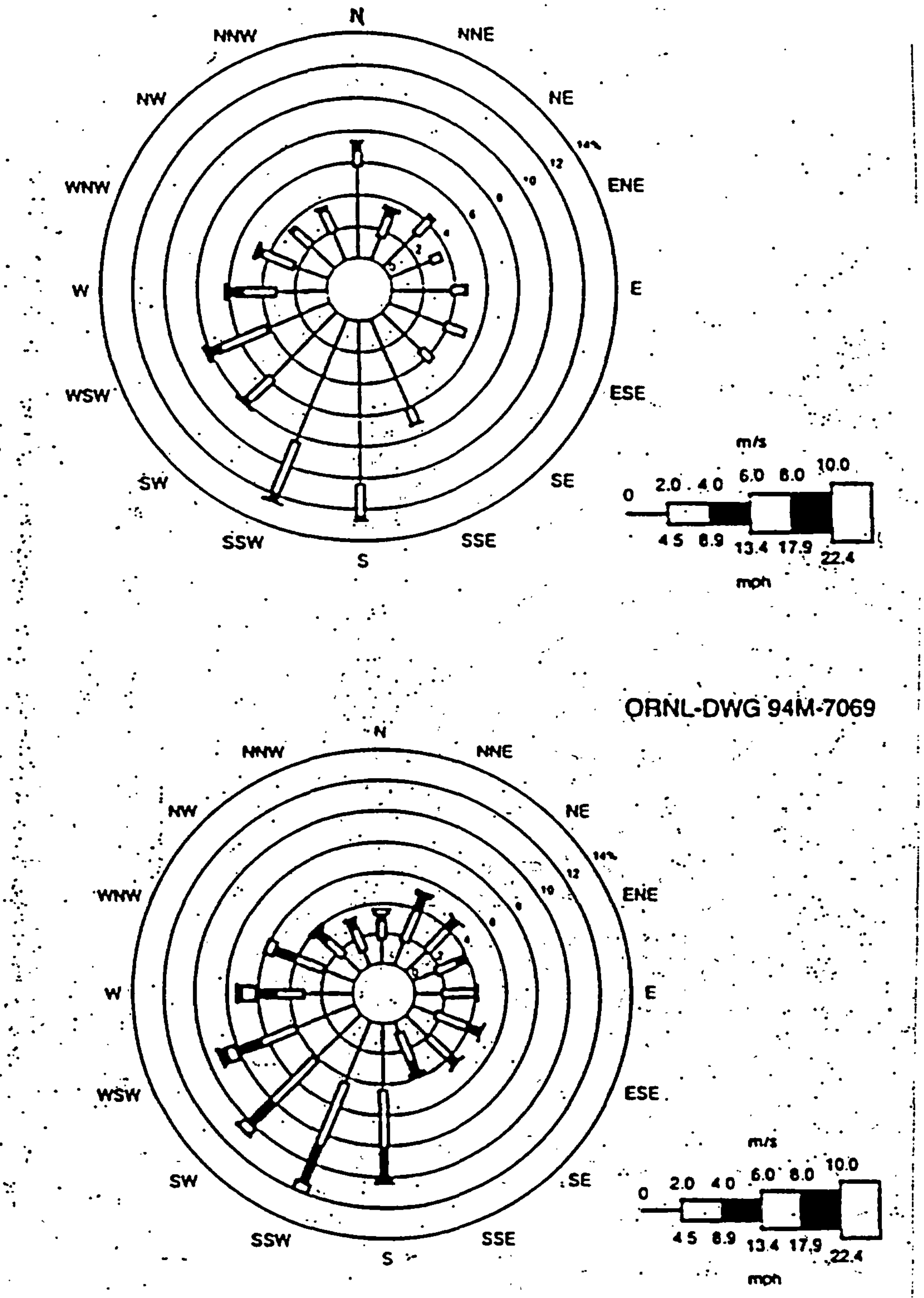

Fig. 2.3-8 Comparison of wind at 10-m (top) and 32-m (bottom) levels at PORTS for 1993. (Source: Kornegay et. al. 1994)

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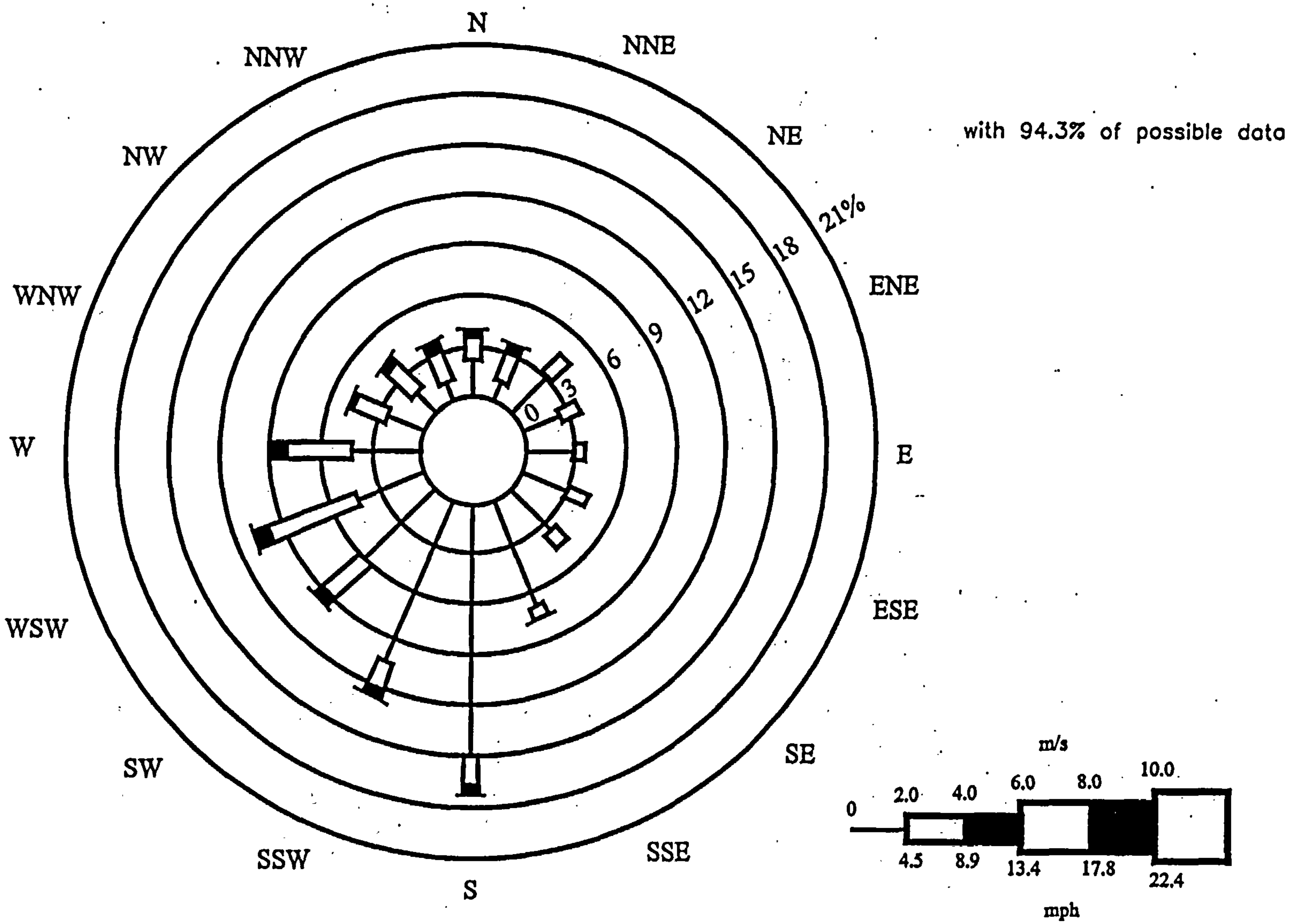

Figure 2.3-9 Average wind rose at 10-m level at PORTS 1992-94. (Source: Sharp 1995)

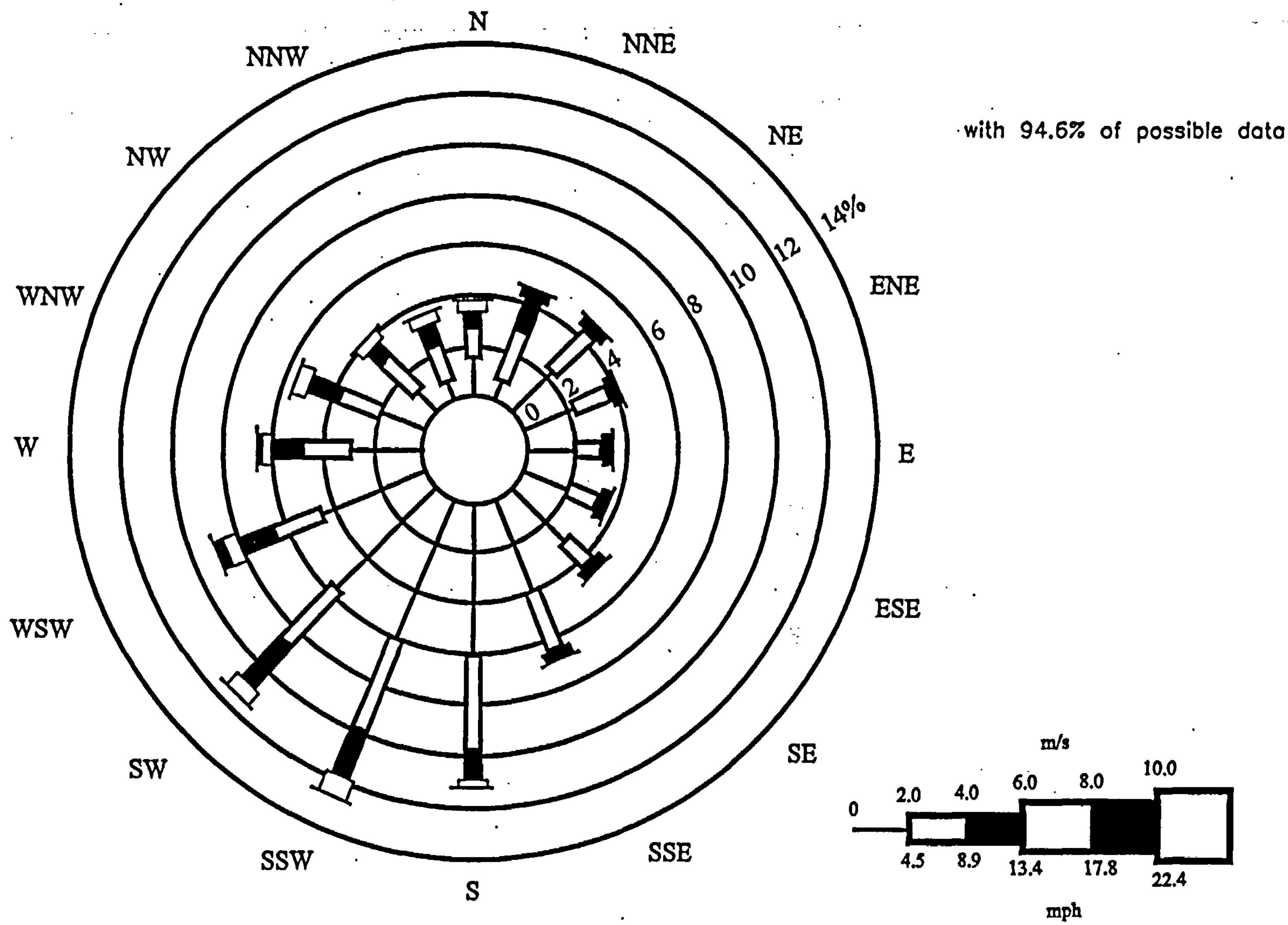

Figure 2.3-10 Average wind rose at 32-m level at PORTS 1992-94. (Source: Sharp 1995)

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2.4 SURFACE HYDROLOGY

2.4.1 Hydrologic Description

2.4.1.1 Scioto River Basin

PORTS is located near the southern end of the Scioto River basin (Figure 2.4-1), which has a drainage area of 6,517 square miles (COE 1991, p. 71). The headwaters of the Scioto River form in Auglaize County in north central Ohio. The river flows 235 miles through nine counties in Ohio, and through the cities of Columbus, Circleville, Chillicothe, and Portsmouth (ERDA 1977, p. 3-4; COE 1991, p. 71). At Portsmouth, in Scioto County, the river empties into the Ohio River at river mile (RM) 356.5 (ORSANCOM 1988, p. 7). The slope of the Scioto River channel averages about 1.7 ft/mile between Columbus and Portsmouth (OHDNR 1963, p. 2). Five of the river's tributaries have drainage areas of over 500 square miles each: Olentangy River, Big Walnut Creek, Darby Creek, Paint Creek, and Salt Creek.

Upstream retarding basins are located, or potentially can be built for flood control, on tributaries throughout the Scioto River basin (Figure 2.4.-1). The storage capacities of these reservoirs are limited. In units of 1000 acre-ft, some of the total storage capacities are as follows: Paint Creek, 145.0; Deer Creek, 102.5; Alum Creek, 124.0; Delaware, 132.0; Salt Creek, 100.3; Big Darby, 129.0; Upper Darby, 32.5; Mill Creek, 92.5; and Bellepoint, 88.2 (COE 1967, p. 11-88). Paint Creek, Deer Creek, Alum Creek, and Delaware Lakes, located about 55 to 105 miles above PORTS, are completed and in operation. Their full pool elevations are 845, 844, 901, and 947 ft, respectively. (COE 1991, pp. 72-74). Salt Creek Lake is in the inactive authorized category, and Big Darby and Mill Creek Lakes have been de-authorized (COE 1991, p. 72). Other existing reservoirs in the Scioto River basin are Lake White, Rocky Fork, Griggs, Hoover, and O'Shaughnessy, located about 6, 30, 88, 94, and 99 miles above PORTS, respectively (Figure 2.4-1) (OHDNR 1963, pp. 19-20).

The upstream retarding basin nearest PORTS forms Lake White along Pee Pee Creek, about 6 miles north of PORTS (Figure 2.4-2). The spillway of the reservoir is located at an elevation of 567 ft, while the roadway along the top of the dam is at an elevation of 577 ft (USGS 1979). Pee Pee Creek empties into the Scioto River south of Waverly at RM 40.

The U. S. Geological Survey (USGS) has collected stream-flow data for the Scioto River at Higby, Ohio, since 1930 (USGS 1992b, p. 144). The gauging station is located approximately 13 miles north of PORTS at RM 55.5. The drainage area of the Scioto River basin above Higby is 5130 square miles. The river flows measured at Higby from 1930 to 1991 range from 177,000 cubic feet per second (cfs) on January 23, 1937, to 244 cfs on October 23, 1930, and average 4,654 cfs (USGS 1992b, p. 144). The 1937 flood had a peak water elevation of 593.7 ft. The consecutive 7-day minimum discharge of record is 255 cfs, which occurred during October 19-25, 1930 (COE 1966, Table 9).

Water in the vicinity of PORTS is available from Lake White, the Scioto River, and groundwater supplies (ERDA 1977, p. 3-35). Most of the water used is taken from groundwater. Three municipal water supply facilities are located in the segment of the Scioto River between Higby and the confluence with the Ohio River (and all three use groundwater wells). Both Waverly and Piketon, located at RM 40 and 34, respectively, use groundwater wells. Their 1975 water use rates were 1.1 cfs and 0.54 cfs, respectively (OHDNR 1963, p. 7; ERDA 1977, p. 3-37). The city of Portsmouth has a population of 22,676 and uses water from the Ohio River through an intake at the Ohio River at RM 350.8, which is 5.7 miles upstream from the mouth of the Scioto River (ORSANCOM 1988, p.34). The pumping rate is about 11 cfs.

In 1975, the rural domestic groundwater use in the county was estimated to be 1.8 cfs (ERDA 1977, p.3-37); wells located in the vicinity of PORTS are shown in Figure 2.4-3.

Water used at PORTS normally comes from groundwater (Saylor et al. 1990, p. 5-29) (Figure 2.4-3). Of an average 19 cfs, 15 cfs is for cooling water makeup and 4 cfs for sanitary purposes (PMD and ECD 1989, app. 3). Currently, all water is supplied by wells in the Scioto River alluvium. These wells are located near the east bank of the Scioto River, downstream from Piketon. Four well fields (X-605G, X-608A, X-608B, and X-6609) have the capacity to supply reliably between 36.4 and 40.2 cfs.

2.4.1.2 The PORTS Area

PORTS is located about 2.5 miles east of the confluence of the Scioto River and Big Beaver Creek near RM 27.5 (Figure 2.4-2). The plant site occupies an upland area bounded on the east and west by ridges of low-lying hills that have been deeply dissected by present and past drainage features. The plant nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. Both groundwater and surface water at PORTS are drained from the plant site by a network of tributaries of the Scioto River.

Both Big Beaver and Little Beaver creeks receive runoff from the northeastern and northern portions of PORTS. Little Beaver Creek, the largest stream on the property, flows northwesterly just north of the main plant area (Figure 2.4-2). It drains the northern and northeastern parts of the main plant site (Figure 2.4-4) before discharging into Big Beaver. About 2 miles from the confluence of the two creeks, Big Beaver Creek empties into the Scioto River at RM 27.5 (Figure 2.4-2). Upstream from the plant, Little Beaver Creek has intermittent flow throughout the year.

In the southeast portion of the site, the southerly flowing Big Run Creek (Figure 2.4-2) is situated in a relatively broad, gently sloping valley where significant deposits of recent alluvium have been laid down by the stream (Rogers et al. 1989, p. 8). This intermittent stream receives overflow from the south holding pond (X-230K), which collects discharge of storm sewers on the south end of the plant site. Big Run Creek empties into the Scioto River about 5 miles downstream from the mouth of Big Beaver Creek (Figure 2.4-2).

Two unnamed intermittent streams drain the western portion of the plant site (Figures 2.4-2 and 2.4-4). The stream in the site's southwest portion flows southerly and westerly in a narrow, steep-walled valley with little recent alluvium. It drains the southwest corner of the facility via the southwest holding pond. The stream near the west central portion of the plant site flows northwesterly and receives runoff from the central and western part of the site via the west drainage ditch. Both unnamed streams flow directly to the Scioto River and carry only storm water runoff (Rogers et al. 1989, p. 8).

Little Beaver Creek receives 39 percent of the total PORTS effluents, Big Run Creek, 9 percent, and the two unnamed tributaries, 25 percent. The remaining 27 percent is discharged directly to the Scioto River through two pipelines (DOE 1987, p. 3-26). Treated effluents from a sanitary sewage plant are conveyed about 2 miles to the Scioto River via a 15-in. vitreous clay sewer line at Outfall 003; blowdown from the recirculating cooling water system enters the Scioto via Outfall 004 (DOE 1987, pp. 3-29, 3-33).

2.4.1.3 Site and Facilities

The PORTS nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. The top-of-slab floor elevations for the three process buildings were estimated from the roof elevations and the building heights and are all greater than 670 ft. (Johnson et al. 1993, pp. 4-41 to 4-48 and ERDA 1977, pp. 2-20 to 2-30). Elevations of surrounding areas and roadways (Johnson et al. 1993, p. 3-6; PORTS 1982) are shown in Figure 2.4-5. Their locations relative to Little Beaver and Big Run Creeks and to local drainage ways and storm sewer outfalls are shown in Figures 2.4-4 through 2.4-6.

Storm water that falls at PORTS is drained to local Scioto River tributaries by storm sewers that convey the runoff to a system of 14 outfalls as shown in Figure 2.4-6. The flow of storm water is further controlled by a series of holding ponds downstream from the storm sewer outfalls (see Figure 2.4-7).

The perimeter road, as shown in Figure 2.4-4, serves as a hydrologic boundary that prevents storm water runoff from backing up into the main process buildings, X-326, X-330, and X-333. Once storm water has been discharged onto the outer side of the perimeter road to the north, west, and south, the water flows downhill to local creeks and runs. To the east and southeast, the perimeter road acts as a diversion dam that directs storm water runoff to Big Run Creek. The northeastern corner of the perimeter road protects the main process buildings from flooding that could occur if the X-611B sludge lagoon dam failed. The relationship of storm water holding ponds, located along the outside of the perimeter road shown in Figure 2.4-7, to the topographic elevations, indicated in Figure 2.4-4, emphasizes the overall function of the PORTS surface water drainage system that has been described here (Johnson et al. 1993, p. 3-6).

Water used at PORTS is supplied by wells sunk into the Scioto River alluvium. The raw water is pumped through a 48-in. waterline (ERDA 1977, p. 3-9) to the water treatment plant, X-611, located near the northeastern corner of the site just outside the perimeter road (Figure 2.4-7). Pumphouse X-608, near the well fields, can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand (ERDA 1977, p. 2-113). The well fields and the X-608 pumphouse may expect flooding (ERDA 1977, p. 3-8), although all equipment in X-608 is located above the 571-ft level.

2.4.2 Flood History

The average annual discharge at the Higby station for the period of record (1930-1991) is 4,654 cfs, while the maximum discharge of record is 177,000 cfs observed on January 23, 1937 (USGS 1992b, p. 144). The stage of the 1937 flood was 593.7 ft above mean sea level (MSL). The historical flood stage of the Scioto River next to PORTS was estimated to be 556.7 ft by using the estimate that the

Scioto River drops approximately 37 ft between the Higby gauging station (RM 55.5) and the mouth of Big Beaver Creek (RM 27.5) (Wang et al. 1992, p. 8, Table 2.1). Elevations for floods (with three recurrence intervals) at the confluence of the Scioto River and Big Beaver Creek (RM 27.5), estimated by the U. S. Army Corps of Engineers (Wang et al. 1992, p. 8), are compared with the PORTS nominal grade elevation in Table 2.4-1.

Since PORTS has a nominal elevation of about 670 ft above MSL (Figure 2.4-5) and about 113 ft above the historical flood level for the Scioto River in the area, PORTS has not been affected by flooding of the Scioto River.

2.4.3 Probable Maximum Flood

The plant elevation is greater than the maximum historic levels recorded for the Scioto River in the area and the 500 year flood predicted by the U.S. Army Corps of Engineers. However, a calculation of the "probable maximum flood" (PMF) was also performed. The details of a method of calculating the PMF are discussed in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59, (NRC 1977, App. B). It is based on the drainage area and the location of the watershed involved. The drainage area of the Scioto River basin above Higby is 5131 square miles (USGS 1992b, p. 144) and that of the whole basin is 6517 square miles (COE 1991, p. 71). The drainage area of the Scioto River above PORTS (RM 27.5) is between those two values. A conservative estimate for the PMF discharge of the Scioto River at either Higby or PORTS is approximately 1,000,000 cfs. This value is used as the PMF discharge of the Scioto River at PORTS, which including the wind/wave activity contribution, would correspond to a flood level of 571 ft., well below the nominal 670 ft. elevation of PORTS.

Two widely accepted probabilistic methods, the log Pearson III distribution and the Gumbel method, have been considered. The 10,000-year flood discharges of the Scioto River at Higby determined with these two methods are 526,000 and 280,000 cfs, respectively. Both of these discharge rates are smaller than that of the PMF. The PMF is, therefore, the bounding event in determining the evaluation basis loads from flooding for PORTS.

Conservative estimates indicate that the failure of upstream dams would not threaten the safety at PORTS because of the high nominal plant grade elevation (Wang et al. 1992, App. A). In addition, the limited storage capacities of the reservoirs, the large stream distances of these dams from PORTS, and friction and form losses would make the actual wave heights even smaller than the estimated values. Discharges were considered of dam failures at full pool combined with that of either a 25-year flood or one-half of the PMF of the Scioto River. The result involving one-half of the PMF would result in a higher value, which is also somewhat greater than that of the PMF. However, this combined extreme flood would not threaten the safe operations of PORTS because of the high nominal plant grade elevation, similar to the case of the PMF.

2.4.3.1 Effects of Local Intense Precipitation

Storm Intensities and 10,000-Year Storms

The U.S. Weather Bureau 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 (Hershfield 1963). The results for the geographic locale including PORTS 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 total precipitation by the duration.

To determine whether the influx of rainwater from a 10,000-year storm can be conveyed away from plant structures, the intensity vs. duration relation for 10,000-year storms at PORTS needs to first be established. This was done by adopting an established empirical intensity vs. duration relation and using values listed in the last row of Table 2.4-2 and a nonlinear least-squares methodology (Johnson et al. 1993, p. 4-2). The resultant graph is shown in Figure 2.4-8. At small durations, although the intensities are high, the total precipitations are small. At large durations, the reverse is true.

Results for Creeks

Figure 2.4-9 shows the locations at PORTS where channel cross sections were evaluated and water levels were calculated in Big Beaver, Little Beaver, and Big Run Creeks and in two unnamed tributaries of the Scioto River. The stage-discharge relationships for the five streams were evaluated using the estimated cross sections and Manning's formula with $n = 0.15$, a value typical for flood plains and very poor natural channels (Johnson et al. 1993, p. 4-6). The peak runoffs of these streams can be calculated using the natural runoff model (Johnson et al. 1993, p. 2-3) and the intensity vs. duration relation shown in Figure 2.4-8. The maximum values of the peak runoffs, the corresponding durations, precipitations, and flood levels are listed in Table 2.4-3. Local floodings for different streams are caused by 10,000-year storms with differing duration values because each watershed drains a basin of a different size (Johnson et al. 1993, p. 4-8). The relatively large differences between nominal plant grade elevation and the calculated flood stage elevations for the five streams clearly indicate that the main process buildings would not be inundated by these streams during a 10,000-year storm.

Results for Storm Sewers

In addition to the Manning's formula and the natural runoff model, the urban runoff model and an inflow-outflow balance method (Johnson et al. 1993, pp. 2-4 and 2-9) were also used to assess the storm sewers. In each case, the duration that gives maximum peak discharge is determined and used as the critical 10,000-year storm.

Nearly one-fourth of the 3800-acre PORTS site is drained by the storm sewer system. In the storm sewer analysis, the drained area was subdivided into 14 drainage areas with sizes ranging from 17 to 163 acres (Johnson et al. 1993, p. 4-13, Table 4.7). Flow velocities and volumetric discharge rates were determined from the pipe diameter, material type, and a conservative minimum slope of 0.001 at the outlets (Johnson et al. 1993, p. 4-9). The results indicate that PORTS would experience local ponding during a 10,000-year storm because the storm sewer system has insufficient capacity to convey the rainwater to the outfalls. The average depth of water around the base of the buildings would range from 3.91 to 5.08 in. The existing storm sewer system would require from approximately 1.8 to 9.9 hours to drain the excess storm water to the outfalls (Johnson et al. 1993, p. 4-14).

The results presented above are conservative. For example, once each individual catchment is inundated, storm water tends to flow from catchments having higher water levels to ones having lower water levels. Pressurization of the storm sewer system after filling with water has been neglected. Runoff from streets and local topography, either natural or manmade, has also been neglected. These factors tend to reduce the calculated water levels.

The effect of a clogged storm sewer system on the ponding depth has been considered (Johnson et al. 1993, p. 4-15). The ponding levels computed with an inoperable sewer system are similar to the results obtained when the system is functional. The relative average water depths predicted by both analyses are similar in magnitude. Because the storm sewer flow is approximately one-fourth 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. Thus local ponding levels can be controlled by keeping natural surfaces within the security fence grassed, mowed, and free of high weeds, and by keeping debris from blocking urbanized surfaces. This would prevent water from backing up to higher levels than those presented above. Additionally, the tunnels could be potentially affected due to infiltration of water; however, tunnels are only used for cable runs and are otherwise abandoned. It is unlikely that significant safety problems would develop from tunnel flooding. Ponding on the site is not expected to impact safe operations.

Results for Ponds and Lagoons

To assess whether failures of the local dams could conceivably jeopardize the safety of critical systems, holding ponds, lagoons, and retention basins formed by these dams were considered in the local drainage analysis (Johnson et al. 1993, pp.3-36 to 4-39). They include the west drainage ditch; X-2230N west-central holding pond 2, X-2230M southwest holding pond 1, X-230K south holding pond, east drainage ditch, X-701B holding ponds (northwest, central, and southeast portions), storm sewer L, X-230L north holding pond, X-611B sludge lagoon, and X-611A lagoons (north, middle, and south lagoons) (Johnson et al. 1993, p. 4-37, Table 4.13). The only bodies of water that could affect the main process buldings are the X-611B sludge lagoon and the three portions of the X-701B holding ponds. The remaining water surface elevations are so far below the 670-ft minimum grade elevation of the main process buildings that further consideration is not warranted.

The X-701B holding ponds are located in the immediate vicinity of Outfalls D and E. After being remediated to the Ohio EPA's acceptance, the associated east and west containment ponds have been filled in, and only the central X-701B holding pond remains. Main process buildings are protected from this holding pond and the drainage ditch of the outfalls by a berm that rises to an elevation between 672 and 674 ft. This berm encompasses the X-701B holding pond and the Outfall D and E drainageway. The analysis demonstrates that this holding pond and outfall area would not overflow and inundate the main process buildings during an approximate 10,000-yr extreme storm (Johnson et al. 1993, p. 4-37).

The water level elevation of the X-611B sludge lagoon at 668.8 ft is close to the 670-ft minimum grade elevation at the main process buildings. The elevation of the top of the dam forming the lagoon is 676.3 ft and exceeds the 670-ft minimum. However, when the conservative estimate of flood wave height (4/9 of the dam height) is used, the flood elevation resulting from a break in the dam would be only 652.8 ft. The flood wave clearly poses no threat to the PORTS plant proper because it could not overtop Perimeter Road (Johnson et al. 1993, p. 4-37).

Results for Ditches and Culverts

The PORTS storm sewer system discharges through each of the outfalls shown in Figure 2.4-6 into a series of ditches, culverts, and holding ponds, with eventual discharge to nearby creeks or to the Scioto River directly.

Outfalls at PORTS have been analyzed to predict their response during a 10,000-year storm (Johnson et al. 1993, pp. 4-16 to 4-39). Outfalls A, B, J, N, and O (Figure 2.4-6) were treated as broad-crested weirs with no storm water flowing through culverts that pass beneath roads and railroad tracks. None of the calculated water surface elevations for these outfalls results in local flooding of the main process buildings located at a 670-ft grade elevation. Discharge from Outfalls C, K, L, and M occurs along the outer periphery of Perimeter Road where steep slopes promote the flow of rainwater away from the plant. Local flooding of the main process buildings attributable to these outfalls is not anticipated.

Outfalls D and E (Figure 2.4-6) discharge storm water to two culverts that pass beneath Perimeter Road to permit drainage to Little Beaver Creek. The calculated water surface behind these two culverts is below the grade elevation at the main process buildings. During an extreme storm, water surface will first rise above the inlets of the culverts, but pressurization and a concomitant increase in total discharge will then enable these culverts to pass the rainwater received. If clogging of the two culverts below Outfalls D and E occurs, the main process buildings could be flooded locally because Perimeter Road rises to an elevation of 674 ft at this location.

The remaining 3 of the 14 outfalls, Outfalls F, G, and H (Figure 2.4-6), associated with X-230K pond and Big Run Creek, were also analyzed (Johnson et al. 1993, pp. 4-29 to 4-36). Although some of the culverts would be incapable of carrying the influx of rainwater and some overbanking would happen during a 10,000-year storm, water surface elevations computed for flows in all of the related culverts are below grade elevation at the main process buildings and would not cause local flooding at these buildings during a 10,000-year storm.

Effects of Ice and Snow

PORTS has a generally moderate climate. Winters in the area are moderately cold. On the average, there are 112 days per year below 32 °F, but only 3 days per year at or below 0 °F (ERDA 1977, p. 3-17). The average annual snowfall is 22 in. To estimate the extreme snowfall at PORTS, values for three surrounding cities are used. The maximum monthly snowfalls of record for Columbus (Ohio), Charleston (West Virginia), and Louisville (Kentucky) are 34.4, 39.5, and 28.4 in., respectively, measured in January 1978 (Weather Almanac 1992, pp. 557, 697, and 821). If the largest value among the three is used for PORTS, and if an average density of 0.1 for freshly fallen snow is assumed (Linsley Jr. et al. 1982, p. 82), this snowfall corresponds to 3.95 in. of rainfall.

2.4.3.2 Probable Maximum Flood on Rivers

The maps and the procedure outlined in Sect. B.3.2.2 of NRC Regulatory Guide 1.59 were used to estimate the PMF discharge. The log-log plot of the data approximates a straight line. The drainage area of the Scioto River basin above Higby is 5131 square miles (USGS 1992b, p. 144), above Piketon is 5,824 square miles (OHDNR, 1963 Table 13), and above the mouth of the river is 6,517 square miles (COE 1991, p. 71). The drainage area of the Scioto River above PORTS (RM 27.5) is estimated from these values to be 6,000 square miles. PMF discharge of the Scioto River at PORTS as taken from the log-log plot is approximately 1,000,000 cfs. This value is adopted as the PMF discharge near PORTS (Wang et al. 1992, p. 8).

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 elevation at PORTS in accordance with Alternatives I and II in Appendix A of NRC Regulatory Guide 1.59. The fetch length near PORTS during the PMF of the Scioto River was estimated from USGS topographic quadrangle maps having a 1:24,000 scale to be 1 mile. The increase of flood elevations of the Scioto River near PORTS due to this wind wave activity was estimated to be 1.8 ft (Linsley and Franzini 1972, p. 181, Fig. 7-11). The PMF plus this coincident wind wave activity would have a flood stage of 571 ft.

Comparison of Flood Levels with PORTS Elevations

The nominal, top-of-grade elevation at PORTS is 670 ft, about 99 ft above the PMF plus wind wave activity flood stage of 571 ft. The top-of-slab floor elevations for the three critical, safety-related process buildings have values ranging from 670.4 to 671.4 ft. These buildings, therefore, would not be inundated by the Scioto River during a PMF superimposed with wind wave activity.

The PORTS water supply facility near RM 32.5 of the Scioto River, pumphouse X-608, and groundwater well fields, may expect flooding (ERDA 1977, p. 3-8). Using the estimate that the Scioto River drops approximately 31 ft between the Higby gauging station (RM 55.5) and the bridge at Highway 23 (RM 34) (Wang et al. 1992, p. 8, Table 2.1), the flood stages of the Scioto River near the supply facility were estimated to be 575 ft for the PMF. All equipment in the X-608 pumphouse is located above the 571-ft level (ERDA 1977, p. 3-8). Thus, under extreme conditions, the water supply to the enrichment process cooling system can be affected by flooding. However, such impacts on the cooling system would not result in a release of UF_6. The enrichment process can be sectionalized into an isolated cell configuration by closing strategic valves, and during severe conditions all or part of the cascade can be shut down.

2.4.4 Potential Seismically Induced Dam Failures

Several dam failures are considered in this section. The domino-type failure of the O'Shaughnessy and Griggs on the Scioto River, failures of individual dams on the tributaries of the Scioto River, and individual dam failures combined with either a 25-year flood or one-half of the PMF of the Scioto River may result in flood elevations that are comparable or even greater than that of the PMF 569 ft. However, even when a conservative wave height of 41.3 ft is used, the PORTS site clearly would not be threatened by this cascade of dam failures because the nominal plant grade elevation is 670 ft, which is 130 ft higher than the normal Scioto River level.

2.4.5 Channel Diversions and Ice Formation on the Scioto River

The ancient Newark River was a major channel for alluvium-bearing meltwater from the continental glaciations (LETC 1978, p. 5-13). This river system ended when its deep valley and those of other major south-draining streams were partially filled with silt, sand, and gravel outwash. The present Scioto River was developed on top of this glacial outwash during the final retreat of glaciers from the area (Lee 1991, p. 4; Norris and Fidler 1969, p. 8). The Scioto River apparently has a smaller flow and hence a more restricted channel. Therefore, channel diversions of the lower stem of the Scioto River out of the ancient Newark River Valley are unlikely.

Ice occurs on all streams in the Ohio River basin, and during the severe January of 1963 more than 18 in. of ice was formed on the Ohio River tributaries (COE 1966, p. 10). Winters near the PORTS area are moderately cold. On the average, there are 112 days per year below 32 °F, but only 3 days per year at or below 0 °F (ERDA 1977, p. 3-17). Ice on the Scioto River should not affect the water supply to PORTS because the plant uses groundwater taken from near the river. Additionally, ice formation would not pose a threat of flooding to PORTS, given the high elevation of the plant relative to the river.

2.4.6 Low Water Considerations

Water used at PORTS, an average of 19 cfs, can be supplied from wells in the Scioto River alluvium. The raw water is pumped through a 48-in water line (ERDA 1977, p. 3-9) to water treatment plant X-611 located near the northeastern corner of the site just outside the perimeter road. The pumphouse X-608 near the well fields can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand (ERDA 1977, p. 2-113).

At the Higby gauging station, which is approximately 13 miles north of PORTS, the minimum river flow measured from 1930 to 1991 was 244 cfs on October 23, 1930 (USGS 1992b, p. 144). The consecutive 7-day minimum discharge record of 255 cfs occurred during October 19-25, 1930 (COE 1966, Table 9). The volumetric river flow is much greater than the PORTS water use.

2.4.7 Dilution of Effluents

The average discharge of the Scioto River near PORTS is 4,654 cfs. Potentially, this discharge rate has a large capacity for reducing the concentration of received contaminants. For example, the uranium discharged from PORTS through the local drainage system to the Scioto River was estimated to be 45 kg during 1990 (Kornegay et al. 1991, p. 60). In 1990, the bulk of the uranium (76 percent) was discharged through Outfall 001 to Little Beaver Creek (Kornegay et al. 1991, p. 56). Assuming a full dilution, this would result in an average uranium concentration of 1.1×10^{-5} mg/L in the Scioto River.

Table 2.4-1. Comparison of flood elevations of the Scioto River near PORTS with the plant nominal grade elevation.

Recurrence interval	Elevation	
	Meters	Feet
50-year flood[a]	170.1	558.0
100-year flood[a]	170.8	560.3
500-year flood[a]	172.4	565.7
Historical record[b]	169.7	556.7
PORTS nominal grade	204.2	670.0

a. Estimates by U.S. Army Corps of Engineers (Rehme 1990; Wang et al. 1992, p. 8).
b. Estimated from records at Higby, 181.0 m (593.7) (USGS 1992b, p. 144), assuming the flood level at the mouth of Big Beaver Creek is 11.3 m (37 ft) lower.

Table 2.4-2. Precipitation as a function of recurrence interval and storm duration for PORTS (Johnson et al. 1993, p. 4-2).

Recurrence interval (year)	Storm duration (hour)						
	0.5	1	2	3	6	12	24
	Precipitation (in.[a])						
1	0.85	1.06	1.34	1.44	1.75	2.04	2.43
2	1.04	1.28	1.57	1.71	2.02	2.44	2.70
5	1.36	1.66	1.98	2.14	2.52	2.98	3.41
10	1.52	1.93	2.30	2.52	2.98	3.40	3.90
25	1.75	2.24	2.64	2.92	3.38	3.91	4.55
50	1.96	2.51	2.97	3.16	3.78	4.20	4.93
100	2.16	2.73	3.22	3.48	4.00	4.88	5.26
10,000[b]	3.46	4.45	5.15	5.57	6.42	7.49	8.32

a. 1 in. = 2.54 cm
b. Extrapolated values calculated using least-squares methodology.

Source: Hershfield 1963.

Table 2.4-3. The 10,000-year flood levels and related information for the five local streams at PORTS.

Stream	Basin size (mi)[a]	Slope (%)	Peak discharge (cfs)[b]	Duration (min)	Precipitation (in)[c]	Water level (ft)[d]
Big Beaver	70	0.265	222,605	201	5.73	591.1
Little Beaver	25	0.516	13,310	103	5.04	651.1
Big Run	4	0.8	4,944	59	4.42	644.2
Tributary (west-central)	4	4	4,944	59	4.42	646.3
Tributary (southwest)	3	4.6	4,188	55	4.33	625.1

a. 1 mi^2 = 2.59 km^2
b. 1 cfs = 0.0283 m^3/s
c. 1 in. = 2.54 cm
d. 1 ft = 0.305 m

Source: Johnson et al. 1993, pp. 4-9 and 4-10.

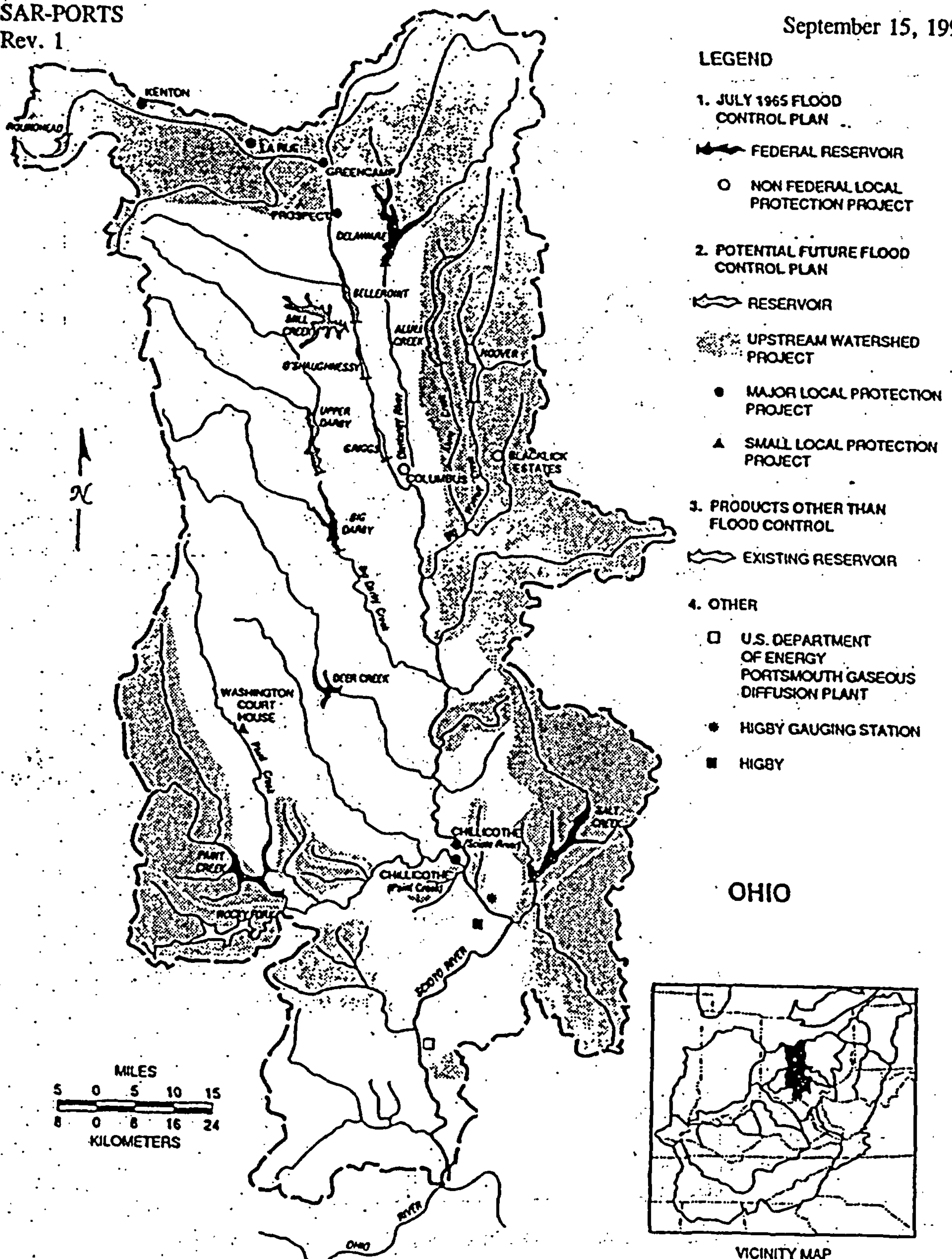

Figure 2.4-1. Scioto River watershed (COE 1967, p. 11-91).

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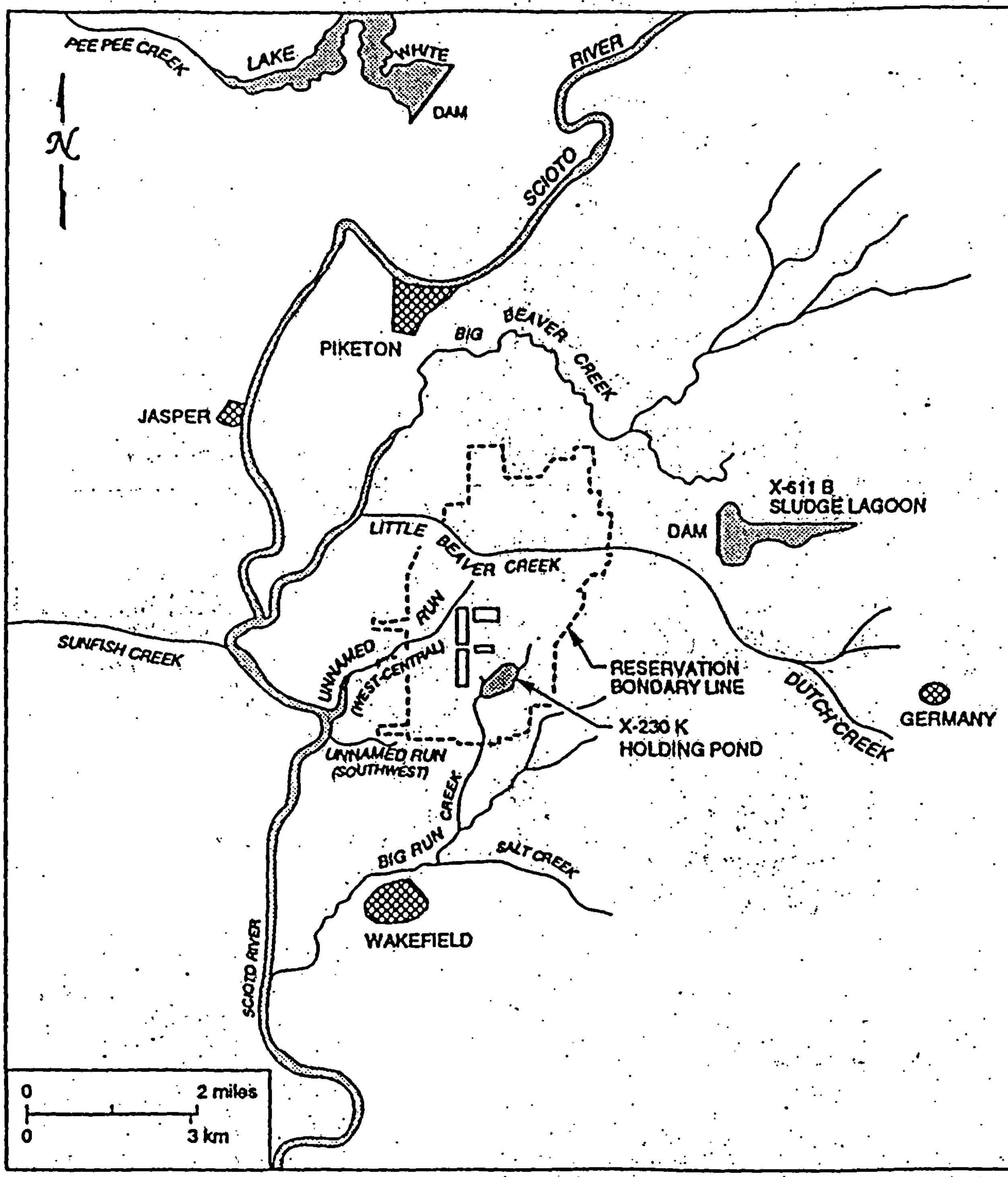

Figure 2.4-2. Location of rivers and creeks in the vicinity of PORTS (Johnson et al. 1993, p. 1-4).

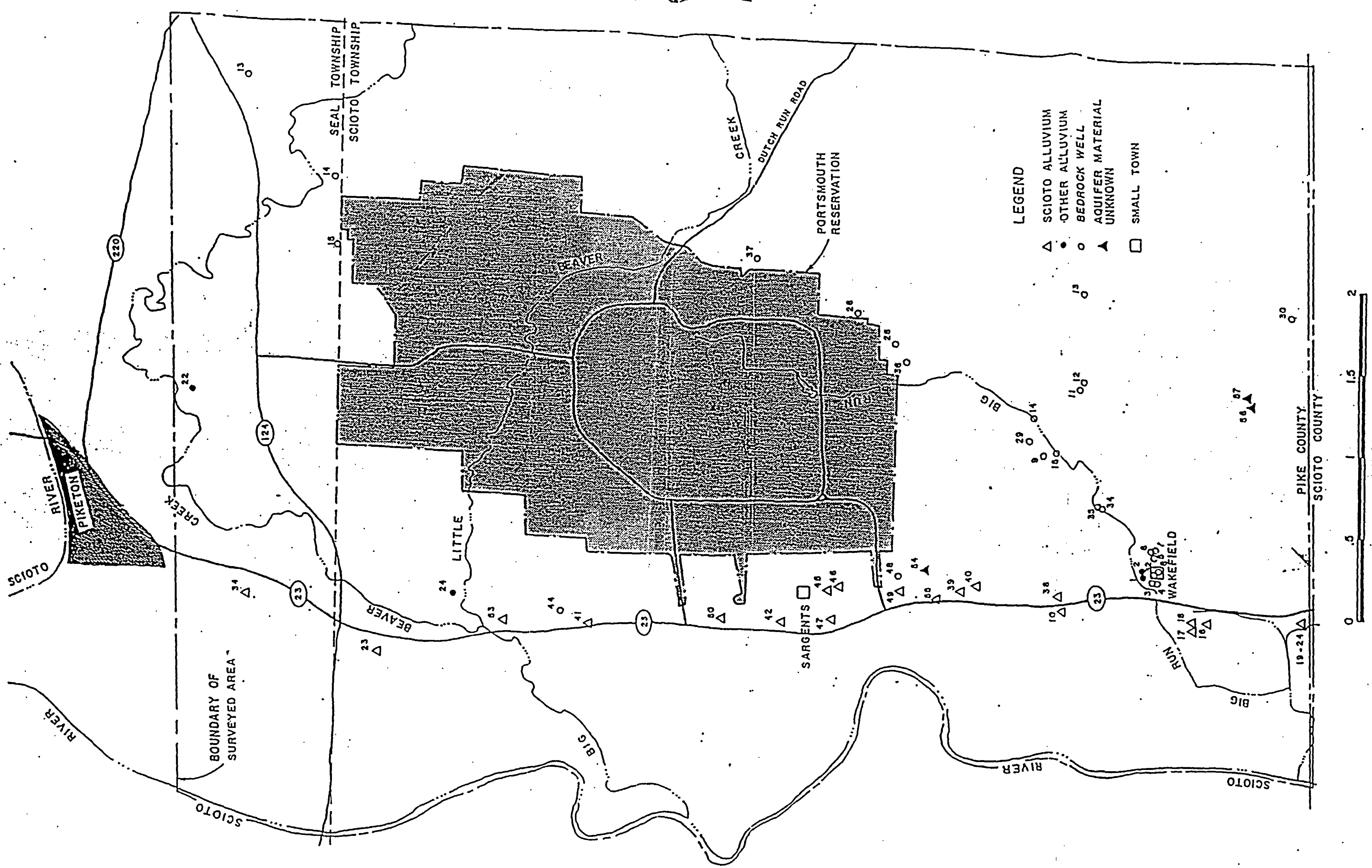

Figure 2.4-3. Located groundwater wells in the vicinity of PORTS (LETC 1982, Fig. 3.6; Saylor et al. 1990, p. 6-25).

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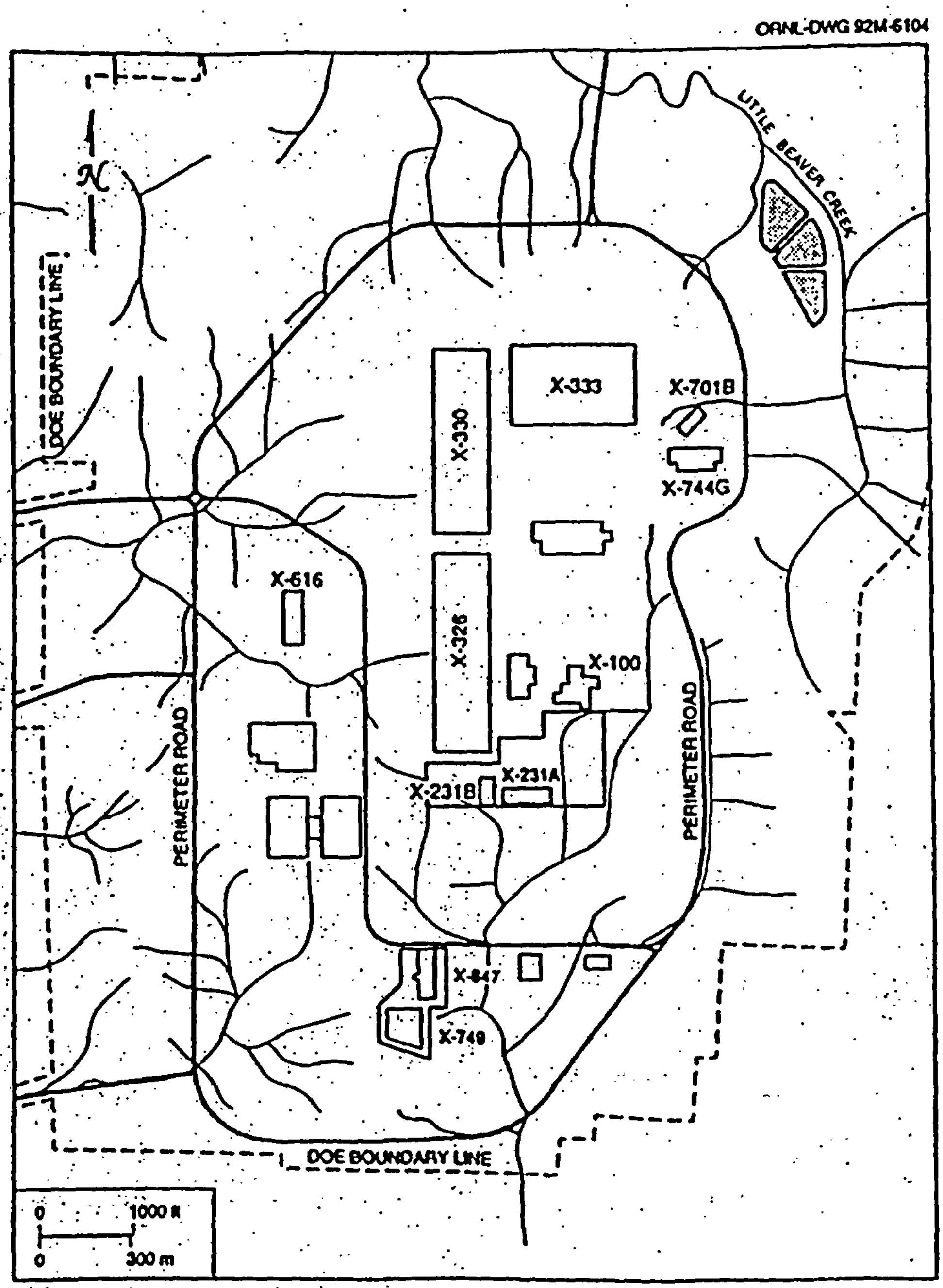

Figure 2.4-4. Local drainage at PORTS (Rogers et al., 1989, p.10; Johnson et al., 1993, p. 3-3).

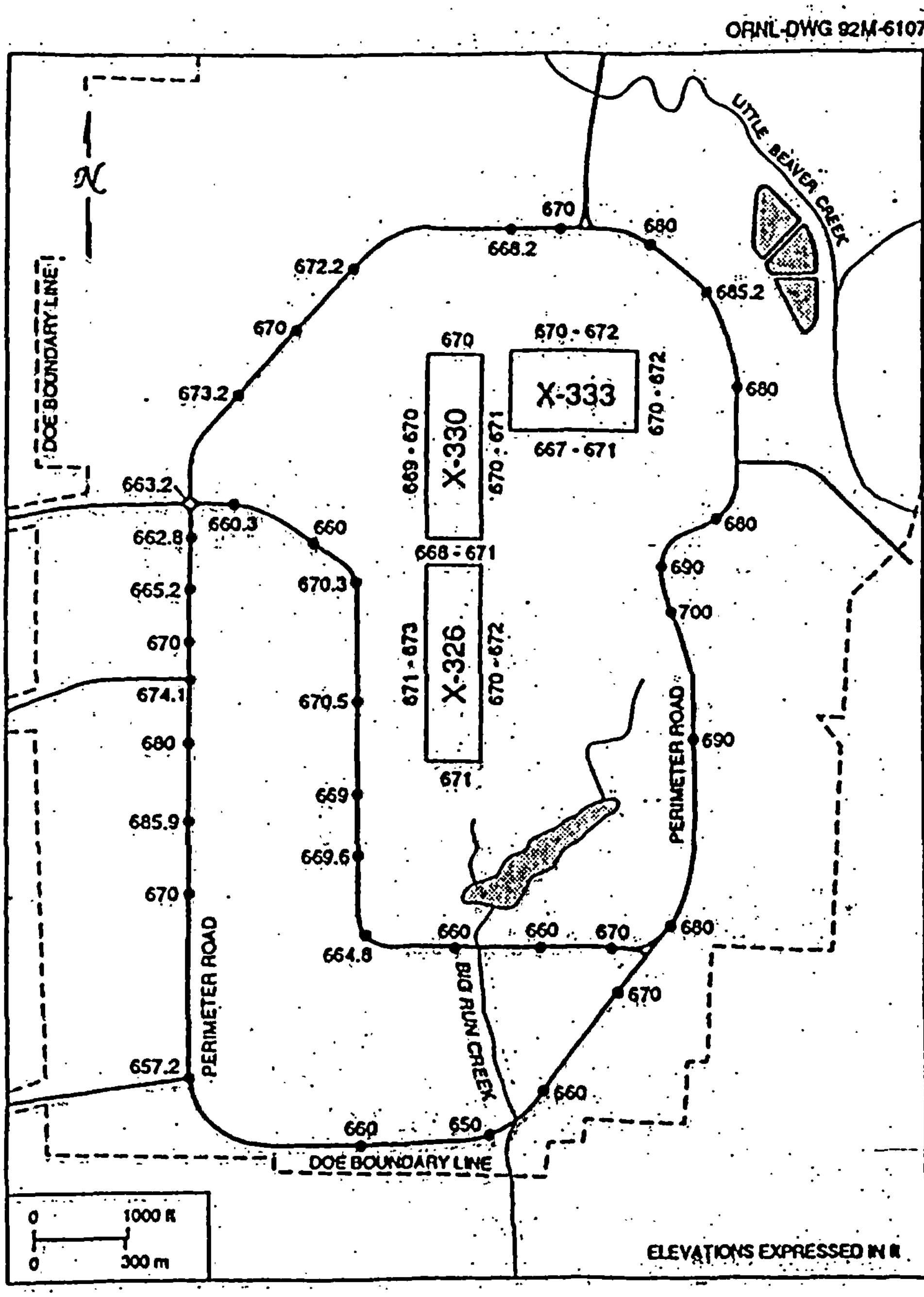

Figure 2.4-5. Elevations of roadways and of the surrounding areas of main process buildings (Johnson et al, 1993, p. 3-7).

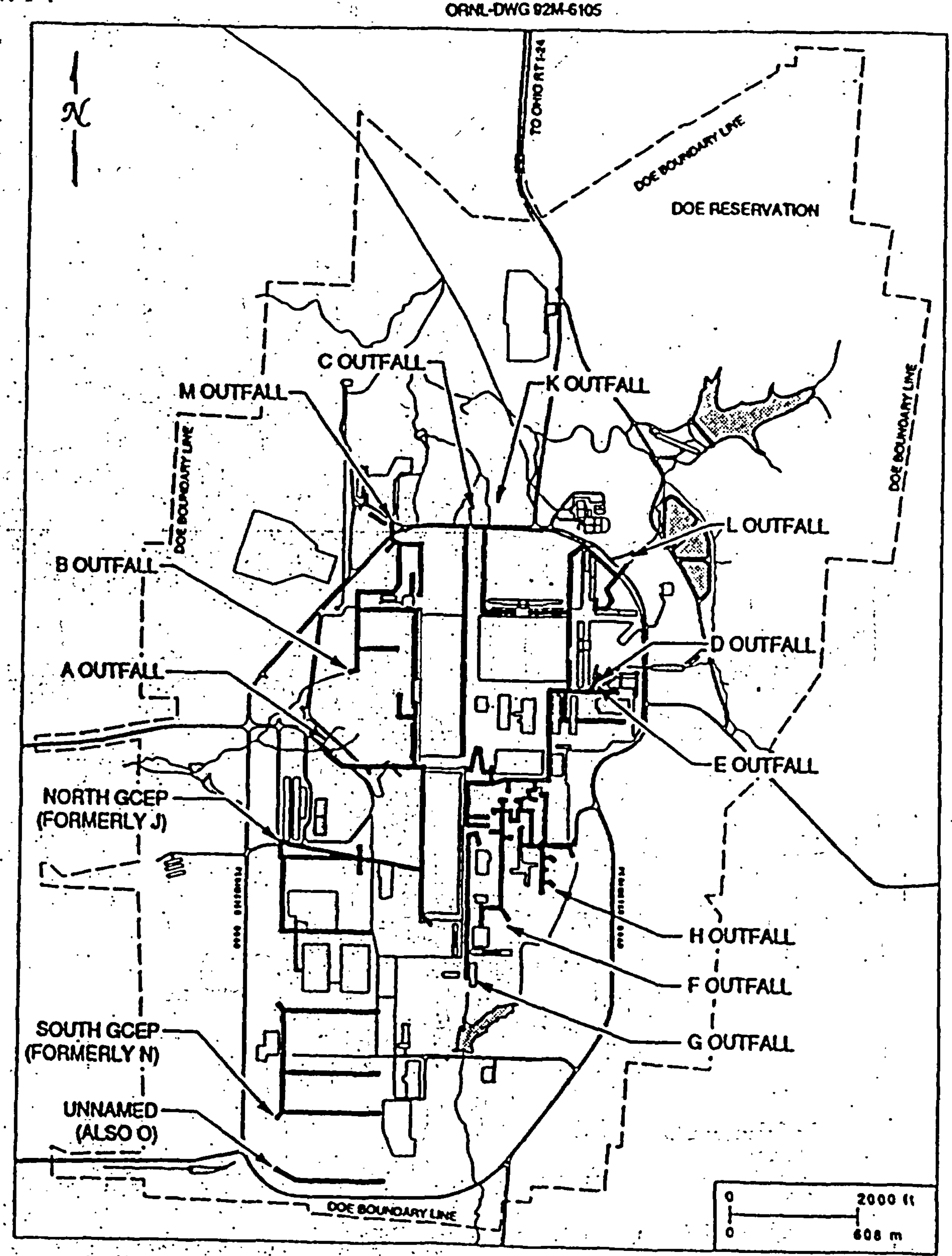

Figure 2.4-6. Storm sewer outfalls at PORTS (Johnson et al. 1993, p. 3-4).

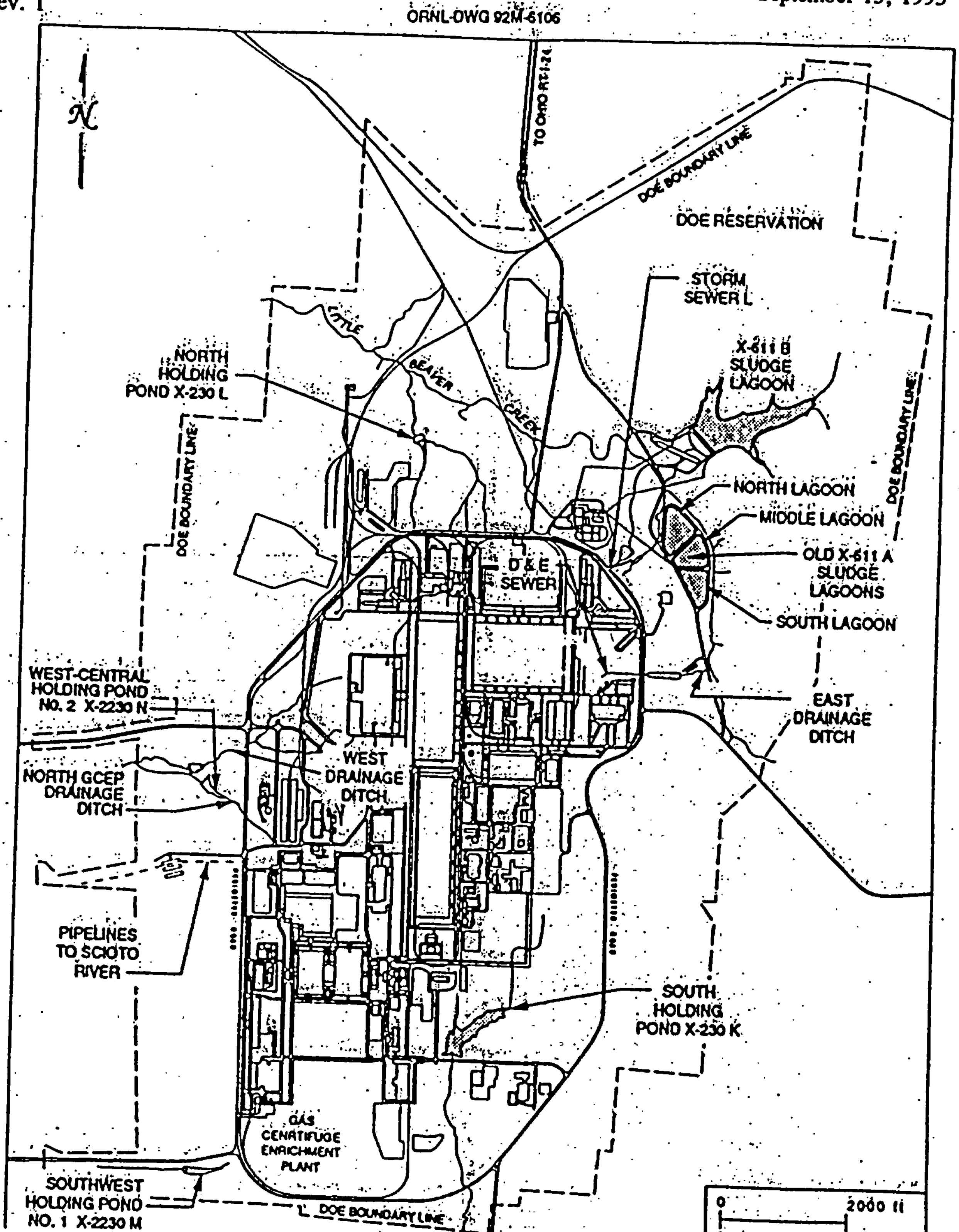

Figure 2.4-7. Ponds and lagoons at PORTS (Johnson et al. 1993, p. 3-5).

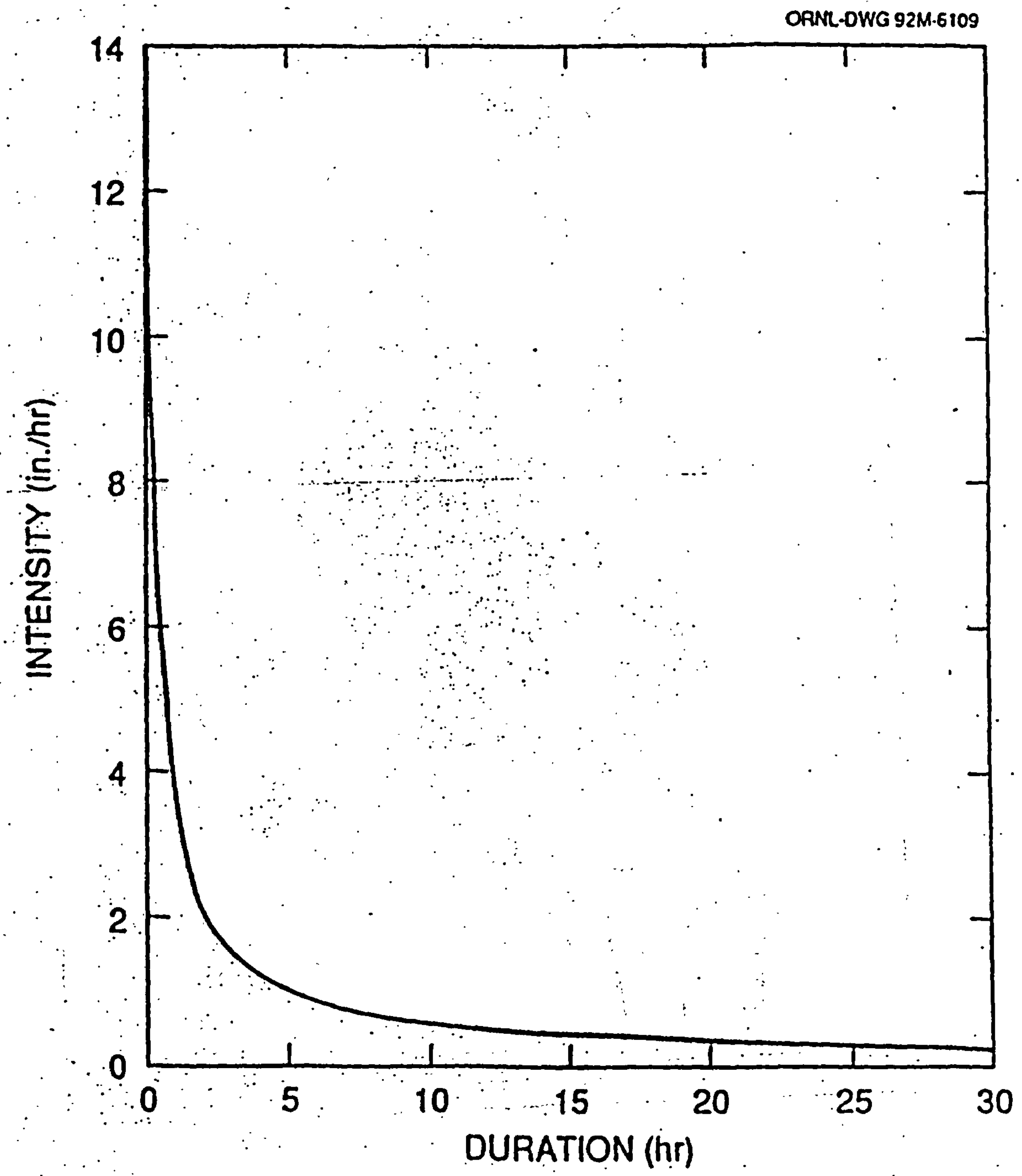

Figure 2.4-8. The 10,000-year intensity versus duration graph for PORTS (Johnson et al. 1993, p. 4-4).

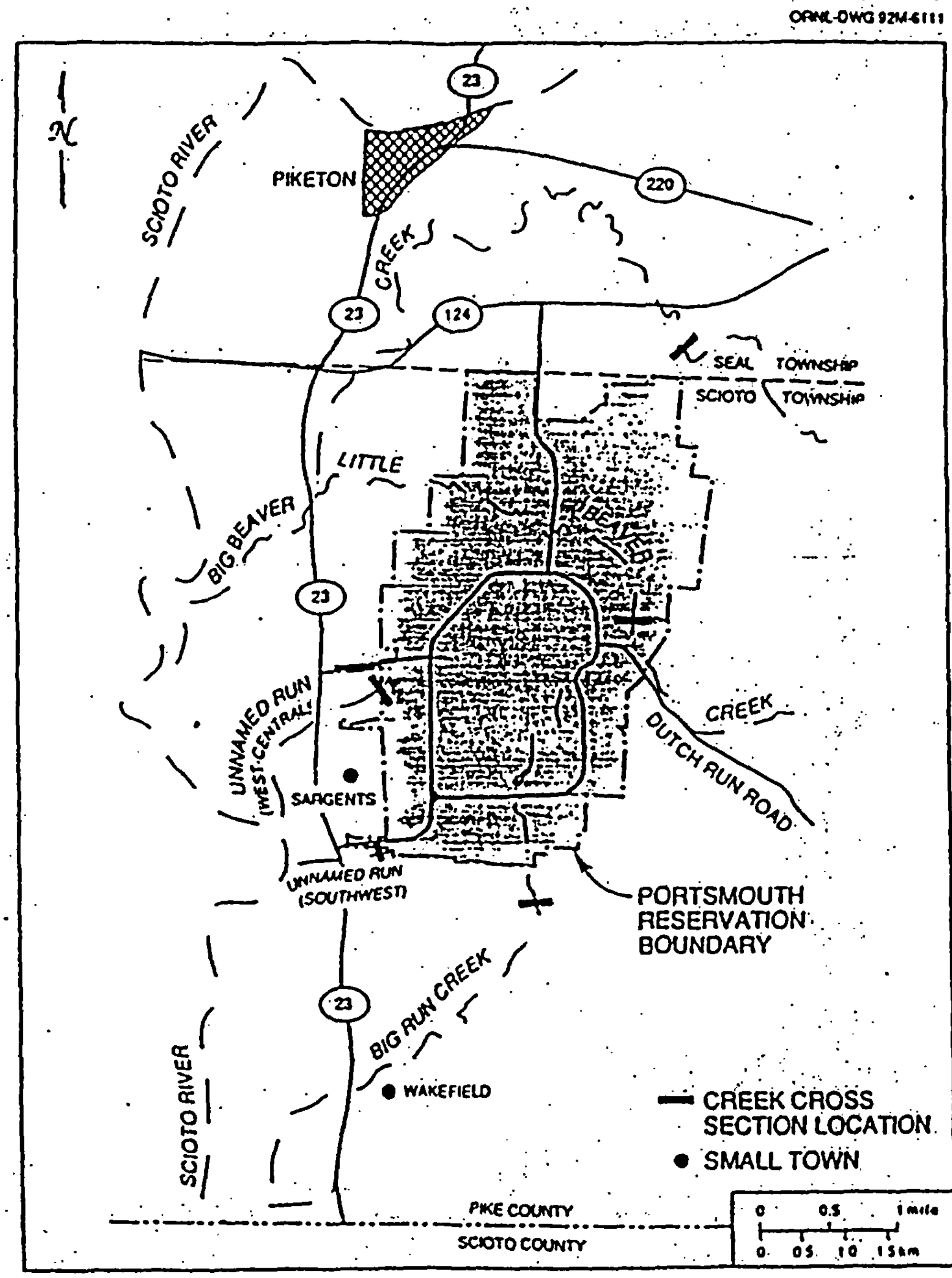

Figure 2.4-9. Locations of creek cross sections where the stage-discharge relations were evaluated (Johnson et al. 1993, p. 4-7).

2.5 SUBSURFACE HYDROLOGY

This section describes the subsurface hydrogeologic system in the Interior Low Plateaus region of southern Ohio in the vicinity of PORTS.

2.5.1 Regional and Area Characteristics

In the region surrounding PORTS in southeastern Ohio, groundwater is used for domestic and municipal drinking water supplies, irrigation, and industrial purposes. Larger demands are usually met by a combination of groundwater and surface water. A system of reservoirs is used for flood control in the Scioto River Basin, which also maintains surface water supplies during periods of low flow.

Aquifers in near-surface sand and gravel deposits adjacent to ancient or present surface drainage courses provide abundant quantities of water. Reliable quantities of groundwater from shallow bedrock aquifers are localized. While abundant quantities of satisfactory groundwater are available from deeper bedrock aquifers, depths as great as 1,000 ft make exploitation of those aquifers impractical except in the western part of the region. The quality of water from sand and gravel aquifers in the Scioto River Basin is usually classified as fair-to-excellent, while bedrock aquifers are classified as fair because of elevated iron content.

2.5.1.1 Aquifers

The subsurface hydrologic system near PORTS is composed of unconsolidated Pleistocene clastic sediments of glacial and alluvial origin in river valleys and of underlying Paleozoic bedrock units. Figure 2.5-1 shows the general configuration of these valleys and bedrock units near PORTS.

The unconsolidated sediments aquifer consists of two distinct aquifers in the immediate vicinity of PORTS: the Scioto River glacial outwash aquifer and "other" alluvial aquifers, all of Quaternary Age. The Scioto River glacial outwash aquifer consists of permeable deposits of sand and gravel beneath the area adjacent to the river and occupies the ancient Newark River Valley (Figures 2.5-1 and 2.5-2). The other alluvial aquifers consist of deposits of clay and silt interbedded with lenses of sand and gravel, and they partially fill the pre-glacial drainage channels (Figure 2.5-1) and major tributaries of the Scioto River. These latter aquifers, referred to as the Gallia aquifer of the Teays Formation, are of relatively lesser importance. Because of compositional differences related to their geologic history, the Scioto and Gallia aquifers are treated separately. Table 2.5-1 relates the Scioto River outwash, Gallia hydrogeologic units, and bedrock units to the regional stratigraphic setting.

The bedrock aquifer consists of Silurian through Mississippian limestones, sandstones, and shales. The distribution and use of most of the Silurian and Devonian aquifers is limited to the western portions of the state. For example, groundwater in the Greenfield limestone is used in the area about 50 miles west of PORTS. The bedrock aquifer near PORTS consists of the Mississippian-age Bedford Shale, Berea Sandstone, Sunbury Shale, and Cuyahoga Shale in ascending order (LETC 1982, pp. 3-12).

Scioto River Glacial Outwash Aquifer

The Scioto River Valley is underlain by glacial outwash sediments and riverbed alluvium that were deposited during the Quaternary Period. It is one of the principal aquifers in Ohio. The unit extends from the confluence of the Scioto and Ohio rivers to the headwaters of the Scioto in north-central Ohio (LETC 1982, pp. 3-17).

The glacial outwash deposits consist primarily of fine gravel and coarse sand that sometimes is interbedded with fine sand and silt and locally may contain small bodies of clay. These deposits are thickest, 70 to 80 ft, in a comparatively narrow incised bedrock channel, which in the Piketon area, generally underlies the west side of the river valley. The highly porous and permeable glacial outwash deposits are overlain by about 10 to 20 ft of fine-grained, poorly permeable river alluvium laid down by the modern Scioto River. The water table ranges generally from 10 to 15 ft below the ground surface, and the saturated thickness of the unit is about 40 to 65 ft. For the most part, the aquifer is unconfined (Norris 1983a, p. 288).

The Scioto River outwash aquifer supplies municipal, commercial, and domestic water for the area west of PORTS (USGS 1990). Yields are reported to range from 21,600 to 864,000 gal/d (Raab 1989). Large sustained yields are developed from wells ranging from 65 to 78 ft deep that are recharged by stream infiltration. Smaller yields are developed from wells sunk in thick permeable deposits of sand and gravel that occur farther away from the stream channel and are beyond the recharge influence of the Scioto River.

The Scioto River outwash aquifer is probably responsive to the stage of the present Scioto River. Water table depths in an area northwest of PORTS ranged from 10 to 29 ft below ground surface (Norris and Fiddler 1969, p. 11). Water table contours suggest aquifer discharge to the Scioto River.

Gallia Alluvial Aquifer

The Gallia alluvial aquifer, although similar to the Scioto River outwash aquifer by being Quaternary in age, differs in its geologic history and composition. The Gallia, consisting of silty sand and gravel, is the lower member of the Teays Formation. The overlying Minford Member consists of silt and clay. Where the Sunbury Shale is absent, the Gallia Sand overlies the Berea Sandstone. Because the Gallia represents localized infilling of an ancient streambed, its areal distribution is limited.

The Gallia Sand is used locally as a source of water for municipal, commercial, and domestic purposes. It provides water only in those areas underlain by the ancient Teays River. OHDNR (1963, Plate 11) reports yields from the Gallia ranging from 7,200 to 144,000 gal/d. Similar yields, which range from 4,320 to nearly 130,000 gal/d, are reported by Raab (1989) from the eastern portion of Pike County. Yield from a municipal well for the town of Beaver, east of PORTS, is reported at 129,600 gal/d by the USGS (1990).

Bedrock Aquifer

Data describing the bedrock aquifer in the region surrounding PORTS are generally limited to published maps and hydrograph data from the OHDNR, Division of Water. Such maps for Pike County (Raab 1989) and Jackson and Vinton Counties (Walker 1985) indicate that the bedrock aquifer serves only domestic needs. Flow in the Mississippian bedrock is illustrated in Figure 2.5-3.

2.5.1.2 Regional Groundwater Use

In the Scioto River drainage basin, which surrounds PORTS, estimated surface and groundwater withdrawal for all uses in 1960 was 399 million gallons per day. Approximately 23 percent of that withdrawal (92 million gallons per day) was derived from groundwater resources (OHDNR 1963, p. 28). Of that amount, municipal withdrawal accounted for 14 million gallons per day, and domestic use accounted for 12.2 million gallons per day. In Pike and Jackson Counties, estimated industrial demand for the year 2000 can be satisfactorily met by groundwater resources in Pike County, but not in Jackson County. Existing groundwater supplies for those counties constitute less than 1 percent of existing surface water supplies (OHDNR 1963, Table 19).

The Scioto glacial outwash aquifer serves as the principal aquifer in the region. Water from this aquifer supplies domestic, agricultural, industrial, and municipal needs. Several municipalities use the aquifer for reserve capacity. Minor alluvial aquifers (including the Gallia) supply domestic needs locally. Average yield of the Scioto outwash aquifer near PORTS is 118,080 gal/d, and average yield for minor alluvial aquifers is 30,240 gal/d (LETC 1982, Table 2.2).

Groundwater from bedrock aquifers used in those locations is removed from near-surface sand and gravel aquifers or adequate sources of surface water. Wells penetrating undifferentiated sandstone and shale bedrock aquifers in the near vicinity of PORTS yield from 144 gal/d to slightly more than 21,000 gal/d (LETC 1982, Table 2. 1). With the exception of one bedrock well, which is used for industrial purposes, all bedrock wells in the vicinity of PORTS are used for domestic or agricultural purposes. The Silurian age Greenfield Limestone is used as a groundwater resource but only in the western portion of the state where it occurs at relatively shallow depths.

2.5.1.3 Flow in the Regional Aquifers

Many details of the subsurface hydrologic system have been described at PORTS in LETC 1982 and Geraghty and Miller 1989a, 1989b, and 1990. With respect to aquifer contamination, the two most important aquifers are the Berea Sandstone and the Gallia. The ability for environmental contaminants from PORTS facility operations and waste disposal activities to enter these aquifers and migrate off-site is the most important characteristic of the subsurface hydrologic system.

The potential for offsite contamination of regional aquifers is a function of the distribution of geologic units that might enhance cross formational flow. The vertical head profile between the Berea and the Gallia is determined by the distribution of the Sunbury Shale. Where the Sunbury is absent or very thin, an upward vertical-head profile exists from the Berea to the Gallia. Where the Sunbury is present, a vertically downward head profile exists from the Gallia to the Berea. Thus, the proximity of onsite environmental contaminants to locations exhibiting downward vertical-head profiles poses the greatest potential for offsite contamination of the Berea. This flow from the Sunbury to the Berea would occur through fractures or deeply weathered zones in the Sunbury.

Groundwater flow at PORTS is controlled by the complex interactions between the Gallia and Berea units. The flow patterns are also affected by the presence and elevation of storm sewer drainpipes and their bedding and by the reduction in recharge caused by building and paved areas. Three principal discharge areas exist for all groundwaters: (1) Little Beaver Creek to the north and east, (2) Big Run Creek to the south, and (3) two unnamed drainages to the west. Groundwater flow patterns in both the Berea and Gallia are characterized by an east-west trending groundwater divide that passes through PORTS. Other groundwater divides are also present, dividing the flow system of each unit into four sub-basins in the Gallia and three in the Berea. Figures 2.5-4 and 2.5-5 illustrate that groundwater flow directions in the Berea roughly parallel those in the Gallia (Geraghty and Miller 1989a, pp. 1-10 to 1-11).

While contamination of the Berea aquifer from onsite activities is possible, due to the downward vertical-head profile from the Gallia, offsite monitoring has not detected contaminant concentrations above background levels (Kornegay et al. 1990, p. 67). Additionally, dissolved solids exceeding 10,000 ppm within about 5 miles downgradient from PORTS make it unlikely that significant portions of the Berea drinking water resource would be adversely affected.

Precipitation is the primary source of recharge of these aquifers. Recharge at PORTS is estimated at between 2.3 and 11.7 in./year (Geraghty & Miller 1989b, pp. 2-17 and 2-19). Infiltration reaches the water table and moves laterally to areas of discharge or vertically to adjacent aquifers. The Gallia aquifer near or adjacent to surface drainage ways are likely in active communication with the surface water.

2.5.2 Site Characteristics

PORTS sits in a mile-wide former river valley (Portsmouth River Valley) surrounded by farmland and wooded hills with generally less than 100 ft of relief. The main plant area has a nominal elevation of 670 ft above mean sea level (AMSL) about 130 ft above the stage of the Scioto River, which lies about 2.5 miles to the west. The Scioto River and its tributaries receive essentially all of the surface water and groundwater discharge at PORTS.

Geologic units controlling groundwater flow beneath PORTS are, in descending order, the Minford and Gallia unconsolidated units of the Quaternary age, and the Sunbury, Berea, and Bedford bedrock units of the Mississippian age (Table 2.5-1). The Mississippian Cuyahoga shale, the youngest bedrock unit in the area, forms the hills east and west of the main plant site (Figure 2.5-1). Also present in some places is up to 20 ft of artificial fill, which is predominantly Minford silt and clay.

The main groundwater flow system beneath PORTS is the Gallia sand and the lower unit of the Minford, the Minford silt. The Gallia is composed of silty to clayey sand and gravel, with silt and clay content amounting to about 30 percent (LETC 1978, p. 7-6). It has an average thickness of 3.4 ft and is not laterally continuous beneath PORTS (Geraghty & Miller 1989a, p. 2-3). The Minford averages 23.9 ft in thickness at PORTS, grading from clay and silty clay near the surface to predominantly silt at the base. The lower silty unit averages 7.6 ft in thickness and constitutes about 33 percent of the Minford. The Gallia sand and the lower Minford silt form the uppermost, unconfined aquifer (the Gallia aquifer) with a combined thickness of about 11 ft (Figure 2.5-6). The bottom of the Gallia aquifer has an elevation ranging from 630 to 640 ft AMSL in the plant area.

The Gallia aquifer is partly surrounded by the Cuyahoga shale, which lies in the wooded hills around PORTS (Figure 2.5-1) and is in various stages of decomposition. The decomposed state of the Cuyahoga can be identified by its gray-green color, clayey texture, thin bedding, and the presence of small flat remnant sandstone pieces. The unweathered rock is a moderately hard, gray to gray-green, thinly laminated shale with laminated or very thin layers of sandstone (LETC 1978, p. 7-8).

Both the Gallia aquifer and the Cuyahoga shale are underlain by the Sunbury shale in unweathered and various decomposition stages. The Sunbury has a thickness ranging from 0 to 20 ft with an average of about 10 ft over much of the site (Geraghty & Miller 1989a, p. 2-3). Beneath the west and northwest side of PORTS, the Sunbury is thin or absent; beneath the southeast half of PORTS, the Sunbury is present and thickens toward the east (Geraghty & Miller 1992, p. 8). The unweathered Sunbury is hard to moderately hard black, fissile, and highly carbonaceous. It commonly contains pyrite and marcasite nodules and layers. In advanced stage of weathering, the Sunbury is a gray, laminated, highly plastic clay (LETC 1978, p. 7-8).

The Sunbury separates the Gallia aquifer from the underlying confined aquifer, the Berea sandstone. The Berea is largely unweathered and has an almost uniform thickness of about 30 ft except over a small portion of the site where a few feet may have been removed by the former Portsmouth River. It is hard to very hard, thick bedded, and fine grained. The Berea contains occasional shale laminations, swirls, or blebs in the top 20 ft and many shale laminations and interbeds in the lower 10 ft, with shale layers commonly weathered partially or completely to clay (LETC 1978, p. 7-9). Where the Sunbury is absent or thin, the Berea aquifer and the overlying Gallia aquifer act essentially as one unit.

About 100 ft of Bedford shale underlies the Berea aquifer over the entire PORTS site. The lower 10 ft of the Berea is very similar to the underlying Bedford shale (Geraghty & Miller 1989a, p. 2-4; Battelle 1981, p. 36). The Bedford is composed of thinly bedded shale with interbeds and laminations of hard gray fine-grained sandstone and siltstone. Sandstone is occasionally calcareous and evenly distributed through the shale and amounts to about one-third to one-half of the Bedford formation (LETC 1978, p. 7-9).

2.5.2.1 Aquifers Beneath the Site

The Gallia exhibits the highest hydraulic conductivity of all aquifers on the PORTS site. Hydraulic conductivity values range from 0.11 to 150 ft/d, with a mean of 3.4 ft/d (Geraghty & Miller 1989a, pp. 1-10). Groundwater flow directions in the Gallia are roughly from the center of the PORTS site toward the surrounding low-lying surface water drainage system. The ultimate discharge area for most groundwater is Little Beaver Creek to the north and east, Big Run Creek to the south, and two unnamed drainages to the west.

2.5.2.2 Aquifer Properties

At the PORTS site, the Berea Sandstone exhibits little spatial variation in hydraulic properties. The site-wide mean hydraulic conductivity for the Berea is 0.16 ft/d (Geraghty & Miller 1989a, pp. 1-10). The highest hydraulic conductivity in the Berea was measured as 0.35 ft/d at the X-616 area, where the unit has been slightly eroded and may be slightly weathered; the lowest hydraulic conductivity was measured as 0.1 ft/d at both X-231B and X-701B.

Groundwater elevations in the Berea Sandstone are determined by local geologic conditions. Measurements at PORTS between August 1988 and September 1989 indicate a mean water elevation of 646.15 ft MSL with a standard deviation of 0.92 ft (Geraghty & Miller 1990, Table 2.3). A generally downward vertical gradient occurs between the Berea and overlying aquifer when overlain by the Sunbury Shale, which acts as an effective confining unit. Where the Sunbury is absent or very thin, an upward vertical gradient exists between the Berea and overlying aquifer. Groundwater flow in the Berea is expected to be similar to those of the Gallia except in the eastern part of the site, where the directions are generally toward the east and southeast.

Hydraulic Conductivity

The most conductive units beneath PORTS are the Gallia sand and the Berea sandstone (Geraghty & Miller 1989a, p. 2-10). The Gallia sand has a mean hydraulic conductivity of 3.4 ft/d and a range of 0.11 to 150 ft/d. The Berea sandstone has a mean hydraulic conductivity of 0.16 ft/d and a range of 0.0045 to 15 ft/d. These estimated values from single-well tests, together with hydraulic conductivity values obtained by LETC (1978) using other methods for various formations, are listed in Table 2.5-2.

Table 2.5-3 summarizes the hydraulic conductivities used in the Geraghty & Miller PORTS groundwater model (Geraghty & Miller 1989a, Table 2.1). Four values were used for the Gallia aquifer and two for the Berea aquifer. The vertical hydraulic conductivity for the Sunbury shale is an average value estimated from the vertical leakance values for layers ranging from 2 ft to 20 ft thick. Table 2.5-4 summarizes the hydraulic parameters used in the Geraghty & Miller Quadrant II RFI groundwater model (Geraghty & Miller 1992, Table 5.4).

Storage Coefficient

The storage coefficient of the Gallia sand, which may be in underconfined or unconfined condition depending on the thickness of overlying Minford clay, was found to be highly variable with a mean value of 0.016 and a range of 0.00011 to 0.41 (Geraghty & Miller 1989a, p. 2-11 and App. B). No corresponding statistical values for the Minford or Berea were reported, even though some similar data are available in that same source. An effective porosity of 20 percent was assumed for the unconsolidated Gallia aquifer in some particle tracking calculations based on the Geraghty & Miller groundwater flow model (p. 5-3). An effective porosity of 1 percent was assumed for the Berea in a velocity estimation (Geraghty & Miller 1989b, p. 2-14).

Recharge

Recharge from precipitation has been estimated to be 8.9 in./year using the 1985 data and the Thornthwaite method (Geraghty & Miller 1989a, p. 2-12 and Table 2.2). This corresponds to about 25 percent of the total precipitation of 35.78 in. that year. In general, the estimated annual recharge rates vary from 3.3 to 11.7 in./year. In the calibrated groundwater flow model for PORTS by Geraghty & Miller (App. A), three recharge values were used: 6.0 in./year for Minford clay, 1.2 in./year for

Cuyahoga shale, and 0 in./year for paved area. Recharge values used in the Geraghty & Miller Quadrant II RFI groundwater model (Geraghty & Miller 1992, Table 5.4) are summarized in Table 2.5-5.

Little Beaver Creek to the north and east, Big Run Creek to the southeast, and the two unnamed tributaries to the west control groundwater flow in the Gallia and Berea aquifers by acting as local recharge or discharge areas. In some places, the large-diameter storm drain segments are partially below the elevation of the Gallia water table (Geraghty & Miller 1989a, p. 2-13). These drains and surrounding gravel beddings may act as groundwater interceptors in the Gallia flow system.

2.5.2.3 Groundwater Flow

The main groundwater flow unit beneath PORTS is the Gallia aquifer formed by the Gallia sand and the Minford silt, with a combined average thickness of about 11 ft (Figure 2.5-6). The hydraulic conductivity of this aquifer is not considered as high, but the surrounding Cuyahoga shale and underlying Sunbury shale and Berea sandstone have even lower conductivities and form less important groundwater flow units (Geraghty & Miller 1989a, p. 2-10 and 7-10). In general, the Gallia aquifer beneath the main plant area receives recharge through infiltration of rainfall and discharges water to surrounding low-lying areas through openings formed by missing Cuyahoga shale. Figure 2.5-7 shows the configuration of these openings around the main plant area. As shown from this figure and also the bedrock surface plot shown in Figure 2.5-8, one narrow opening is between the X-701B area (E10,400 ft, N10,700 ft) and Little Beaver Creek to the east. Two wide openings exist, one near the northern perimeter road toward Little Beaver Creek and the other near the southern perimeter road (Figure 2.5-7). Discharges, in the form of groundwater, are likely to occur from the main plant area through these openings. Other openings that are not easily seen from the bedrock surface plot are associated with Big Run Creek to the south and the two unnamed tributaries to the west. Discharges through these openings are likely first in the form of groundwater and then as surface water in the creeks. All these discharge routes can be potential pathways for PORTS contaminants to reach areas outside the plant and ultimately the Scioto River.

Regional flow in the Berea is generally to the southeast, in the direction of structural dip. Locally, the flow direction is affected by Big Run Creek, Little Beaver Creek, and the west and southwest drainages (Geraghty & Miller 1992, p. 9). For example, flow in the northern part of the site turns somewhat northward due to the influence of Little Beaver Creek. In areas where the Sunbury is absent, the Berea and the overlying Gallia become hydraulically connected.

Figures 2.5-4 and 2.5-5 illustrate the potentiometric surface in the Gallia aquifer and in the Berea aquifer, respectively (Geraghty & Miller 1989a, Figures 2.16 and 2.17). Groundwater flow directions in both aquifers are influenced by the presence of Little Beaver Creek, Big Run Creek, and the two unnamed tributaries. At many places, the two groundwater flow systems are roughly parallel, but at some places, for example near the northern perimeter road, they are quite different. As indicated in Figure 2.5-4, groundwater divides separate the Gallia flow system into several flow cells. These flow cells have been used as the basis for the separation of the PORTS site into four RFI quadrants (Geraghty & Miller 1992, p. 8).

In general, large head differences exist between the Gallia and the Berea because the Sunbury shale presents an effective barrier that restricts the vertical communication between the two aquifers (Geraghty & Miller 1989b, Executive Summary). The Sunbury is approximately 5 ft thick over much of the X-749 Mixed Waste Landfill area, and the observed heads in the Gallia are approximately 10 to 15 ft higher than those in the Berea. Near the X-231B Oil Biodegradation Plots, the Sunbury is 10 to 12 ft thick and there is a 8 to 10 ft head difference. The Sunbury Shale is absent under the X-616 Chromium Sludge Surface Impoundments area. Beneath X-616, the Gallia and the Berea essentially act as one unit.

In 1988, a groundwater quality assessment (GWQA) investigation was implemented at four RCRA regulated facilities at PORTS: the X-701B Holding Pond, X-749 Mixed Waste Landfill, X-231B Land Treatment Area, and X-616 Chromium Sludge Surface Impoundments (Geraghty & Miller 1989b, p. ix). The results of this investigation indicate that the Gallia exhibits significant contamination with trichloroethylene (TCE) and other compounds at X-231B, X-749, and X-701B. In the underlying Berea sandstone, only very small concentrations of contaminants at or near the analytical detection limits were detected. No plume was found beneath the X-616 RCRA unit. In general, only small concentrations of radioactive contaminants were found.

Offsite monitoring of the sanitary water systems of local residents near PORTS began in 1979, and analysis for the presence of organic compounds was added in 1986 (Kornegay et al. 1991, p. 83). The monitoring is conducted semiannually on springs and private wells near PORTS including parameters such as uranium, technetium, total alpha, and total beta. To date, the monitored parameters have not been detected above background levels in any of the sampling locations.

Table 2.5-1. Regional stratigraphic and hydrogeologic subdivisions (Lee, 1991, p. 10).

ERA	System	Series	Formation or unit	Hydrogeologic Unit
Cenozoic	Quaternary	Pleistocene	Teays Scioto River Outwash Minford Member Gallia Member	Scioto River
	Mississippian		Cuyahoga Sunbury Shale Berea Sandstone Bedford Shale	Gallia
Paleozoic	Devonian	Upper	Ohio Shale	Bedrock

Source: Lee 1991, p. 10.

Table 2.5-2. Summary of mean hydraulic conductivity data for various formations

Formation	Minimum (ft/d)	Maximum (ft/d)	Mean (ft/d)	Source
Minford clay	0.000030	0.0019	0.00049	(a)
Minford silt	0.00072	0.016	0.0055	(b)
	0.0050	0.017	0.010	(c)
			0.62	(d)
Gallia	0.11	150.	3.4	(e)
	0.12	0.39	0.24	(f)
Berea	0.0045	15.	0.16	(e)
Bedford	0.020	0.17	0.062	(g)

a. Based on 18 triaxial tests (LETC 1978, Table 7-1).
b. Based on 20 triaxial tests (LETC 1978, Table 7-1).
c. Based on five constant head tests (LETC 1978, Table 7-1).
d. Single-well slug test (Geraghty & Miller 1989a, p. 2-11 and App. B)
e. Single-well test analytical results (Geraghty & Miller 1989a, p. 2-10 and App. B)
f. Based on three constant head tests (LETC 1978, Table 7-1).
g. Based on 13 packer injection tests (LETC 1978, Table 7-2).

Table 2.5-3. Summary of hydraulic conductivities used in the Geraghty & Miller PORTS groundwater flow model.

Formation	Conductivity (horizontal) (ft/d)	Conductivity (vertical) (ft/d)
Cuyahoga	0.46	-
Gallia/Minford	0.17	-
	2.0	-
	5.8	-
	14.0	-
Sunbury (average)	-	0.000554
Berea	30.	-
	170.	-
Bedford	33.	-

Source: Geraghty & Miller 1989a, Table 2.1.

Table 2.5-4. Hydraulic conductivity values used in the calibrated Quadrant II RFI groundwater model.

Geologic Zone	Zone No.	Horizontal (ft/d)	Vertical (ft/d)
Minford	1	0.5	5.0E-5
	2	0.5	5.0E-5
	3	0.5	0.1
	8	0.5	0.2
Gallia Sand	4	100.	7.5
	5	11.7	1.5
	6	48.7	5.0
Sunbury shale	7	3.0E-4	3.0E-5
Berea	9	3.3	0.3

Source: Geraghty & Miller 1992, Table 5.4.

Table 2.5-5. Recharge values used in the Geraghty & Miller Quadrant II RFI groundwater model.

Geologic Unit	Zone No.	Recharge (in./yr)
Minford	1	3.38
	2	0.25
	3	0.0
Gallia sand	4	26.28
	5	15.33

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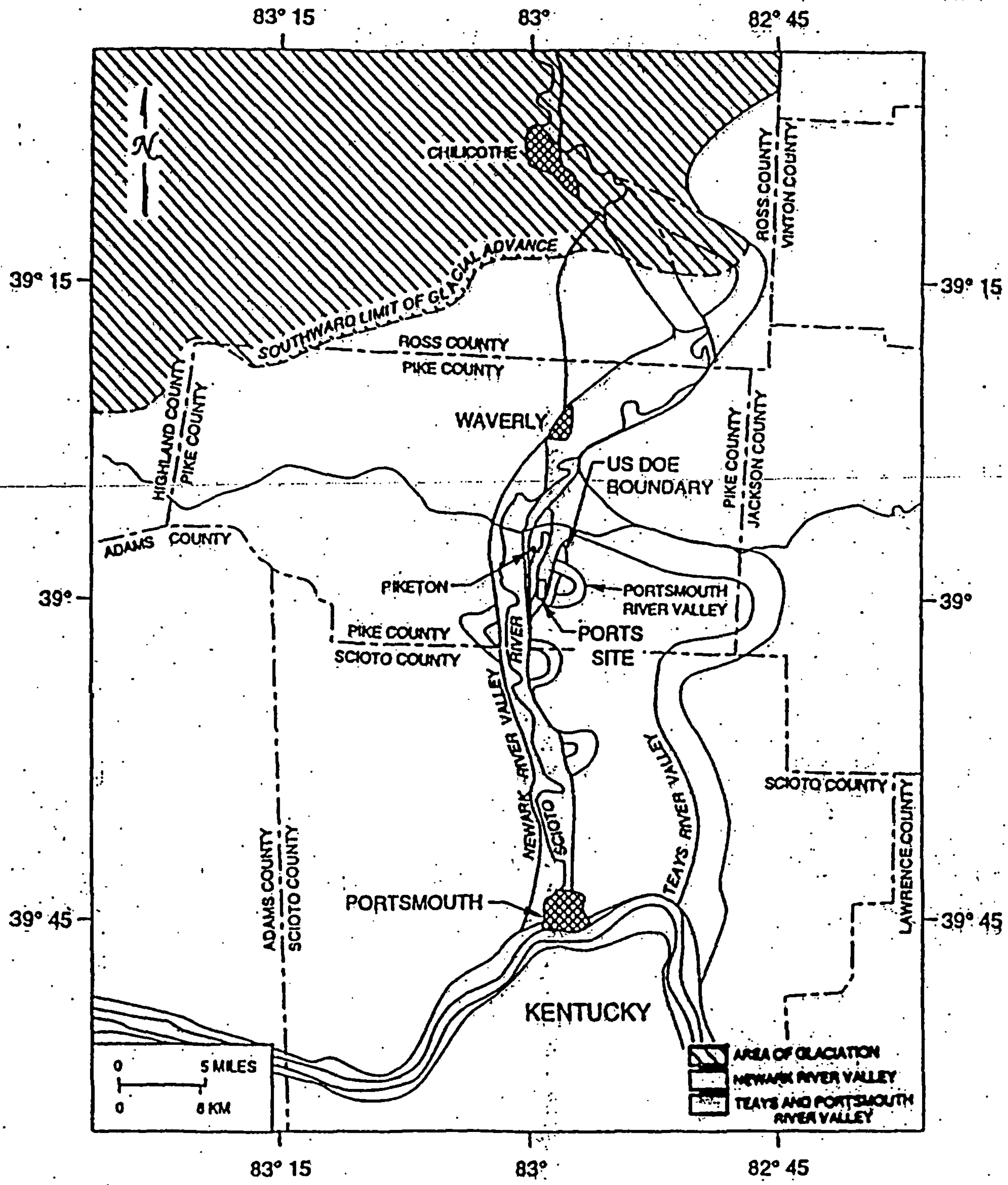

Figure 2.5-1. Location of the ancient Newark (modern Scioto) and Teays River valleys in the PORTS vicinity (Lee 1991, p. 12).

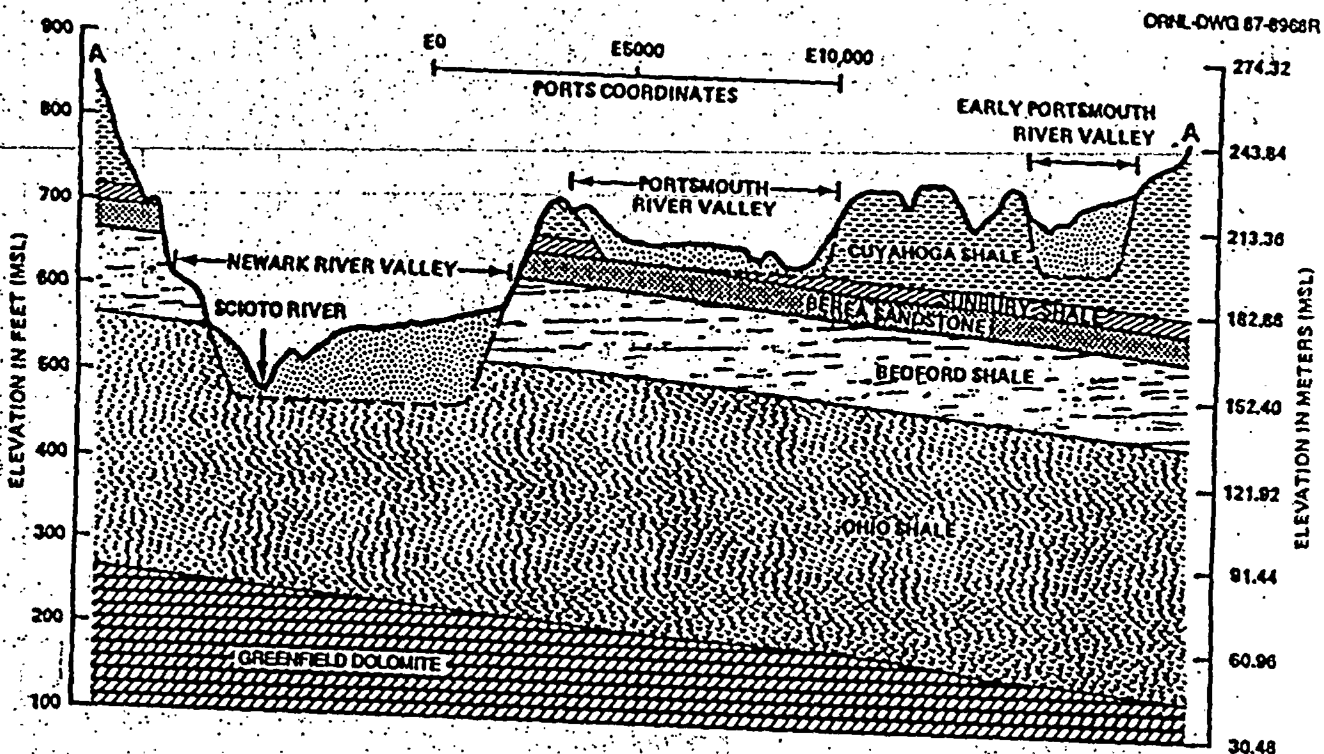

Figure 2.5-2. Geologic cross section in the PORTS vicinity (Lee 1991, p. 9).

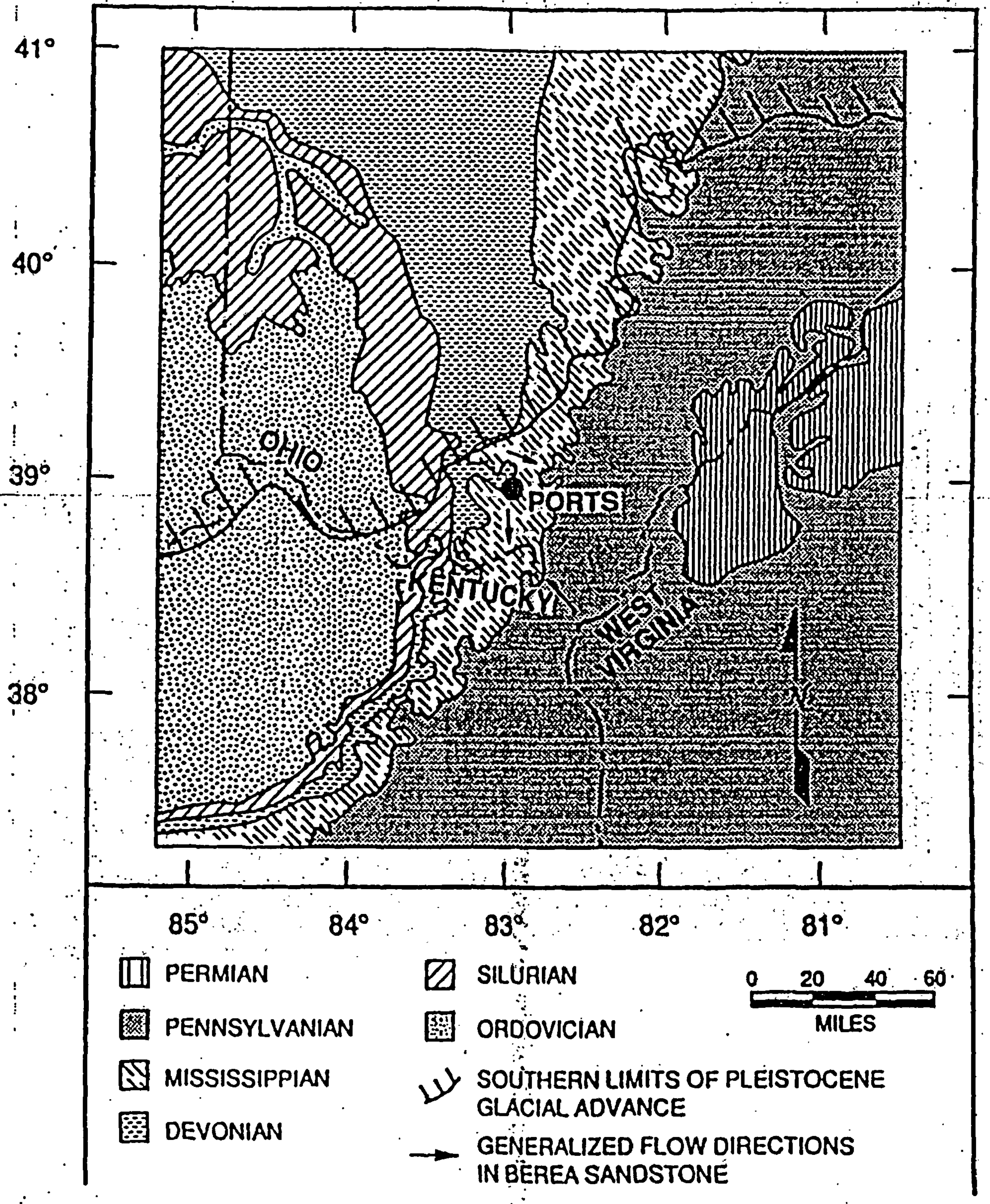

Figure 2.5-3. Geologic map of the PORTS region and generalized groundwater flow directions in Mississippian bedrock near PORTS (Lee 1991, p. 11).

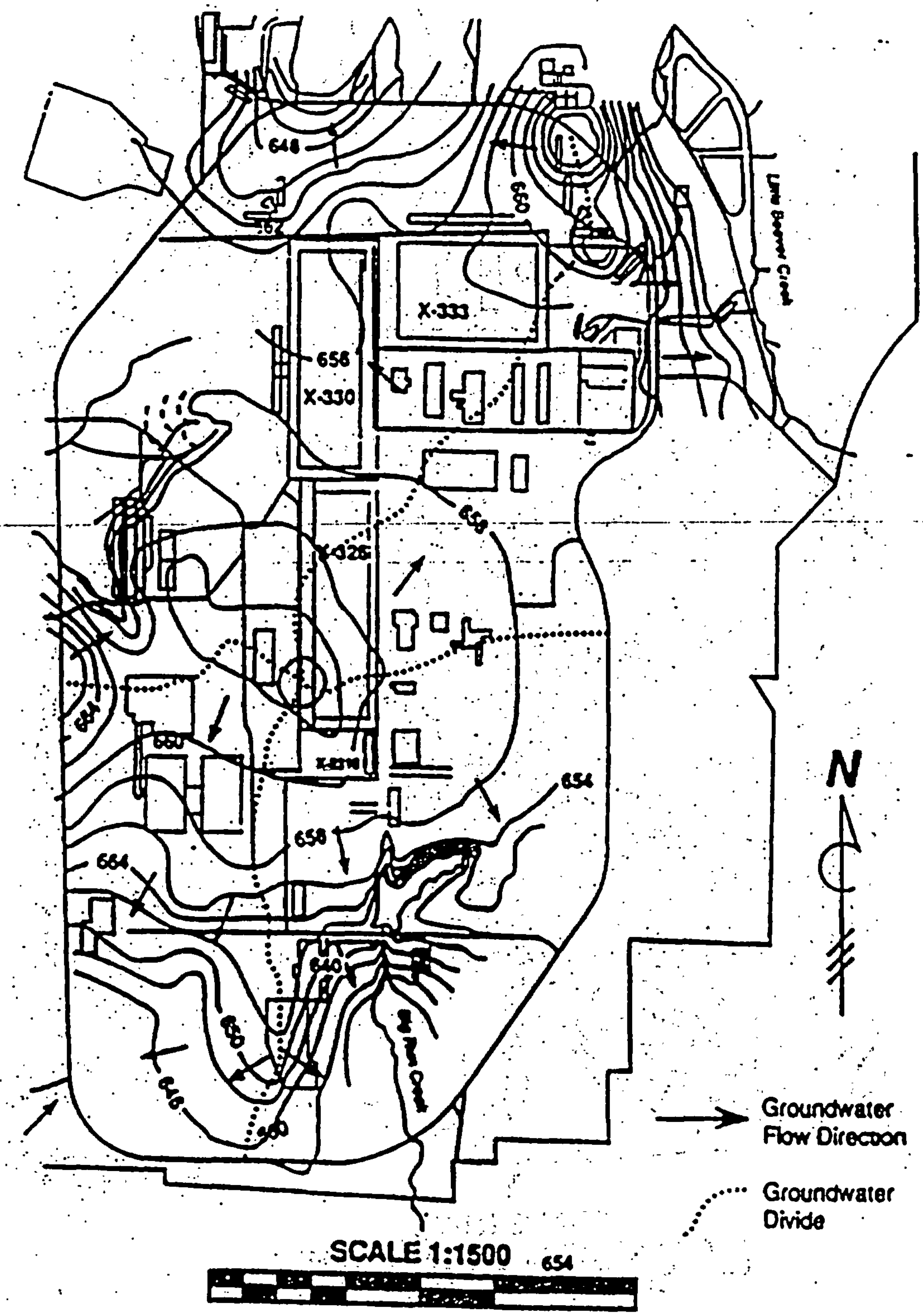

Figure 2.5-4. Potentiometric surface of the Gallia aquifer for December 12, 1988.

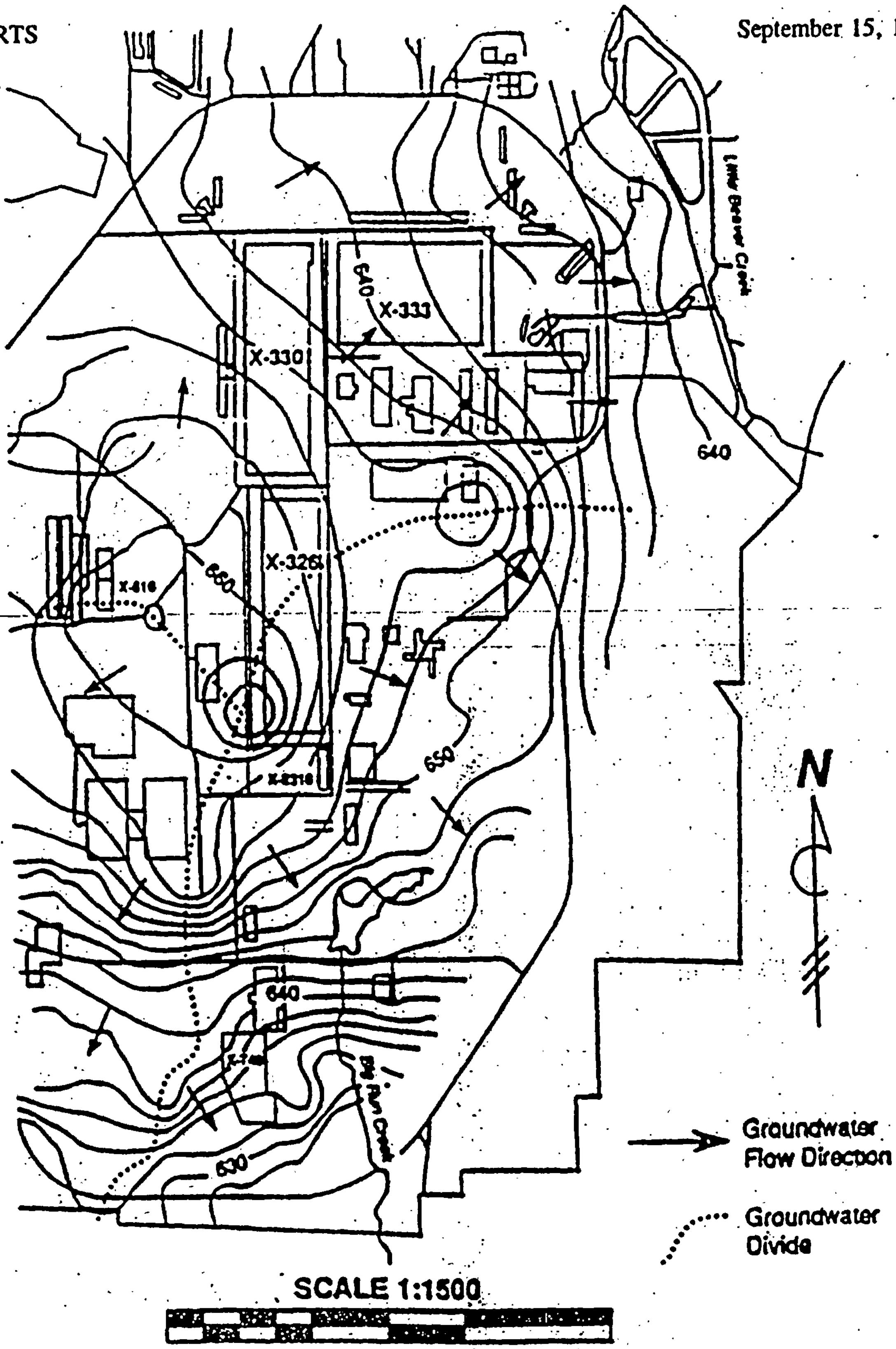

Figure 2.5-5. Potentiometric surface of the Berea aquifer for December 12, 1988.

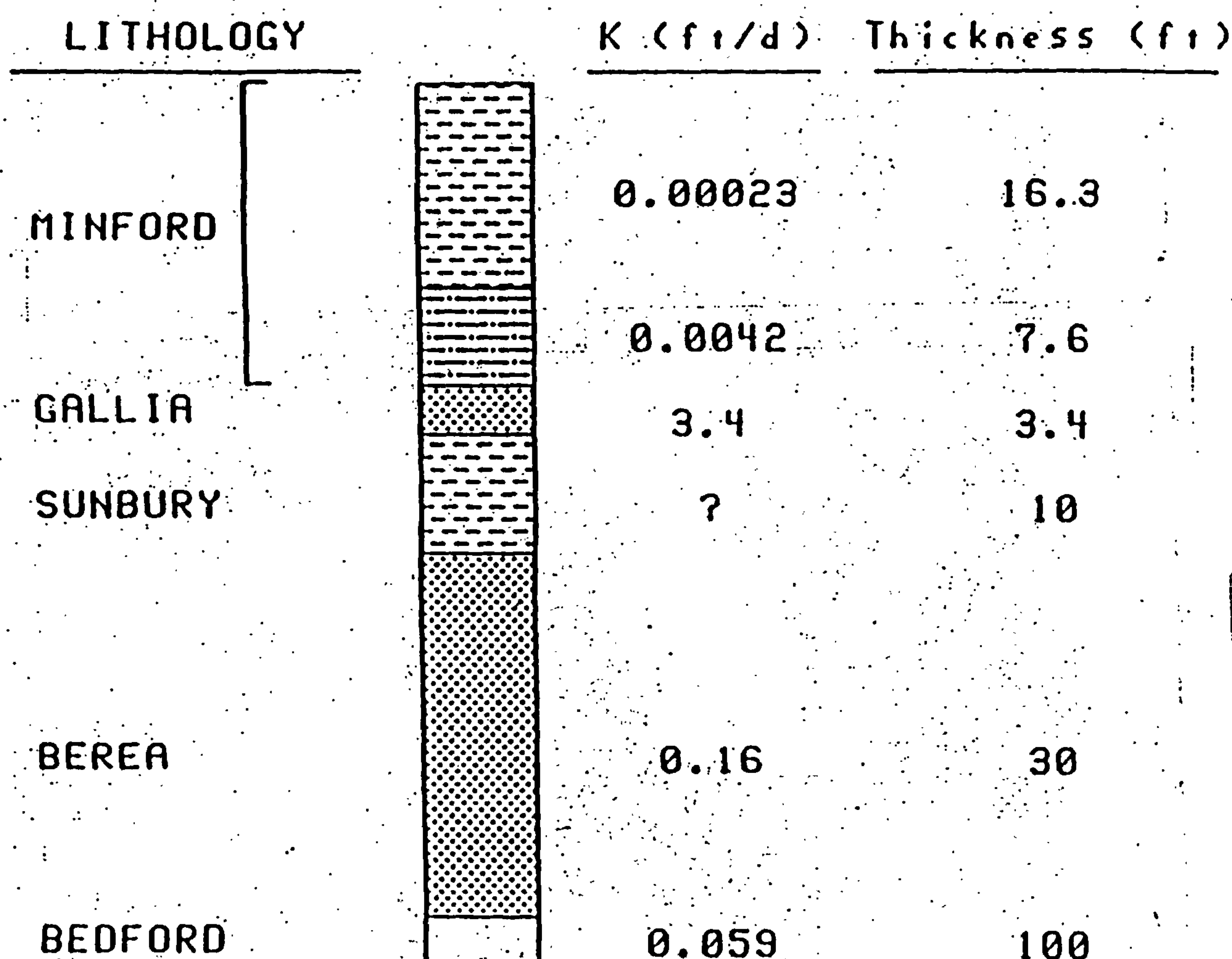

Figure 2.5-6. Geologic column at PORTS (Geraghty & Miller, 1989a, Fig. 2.4).

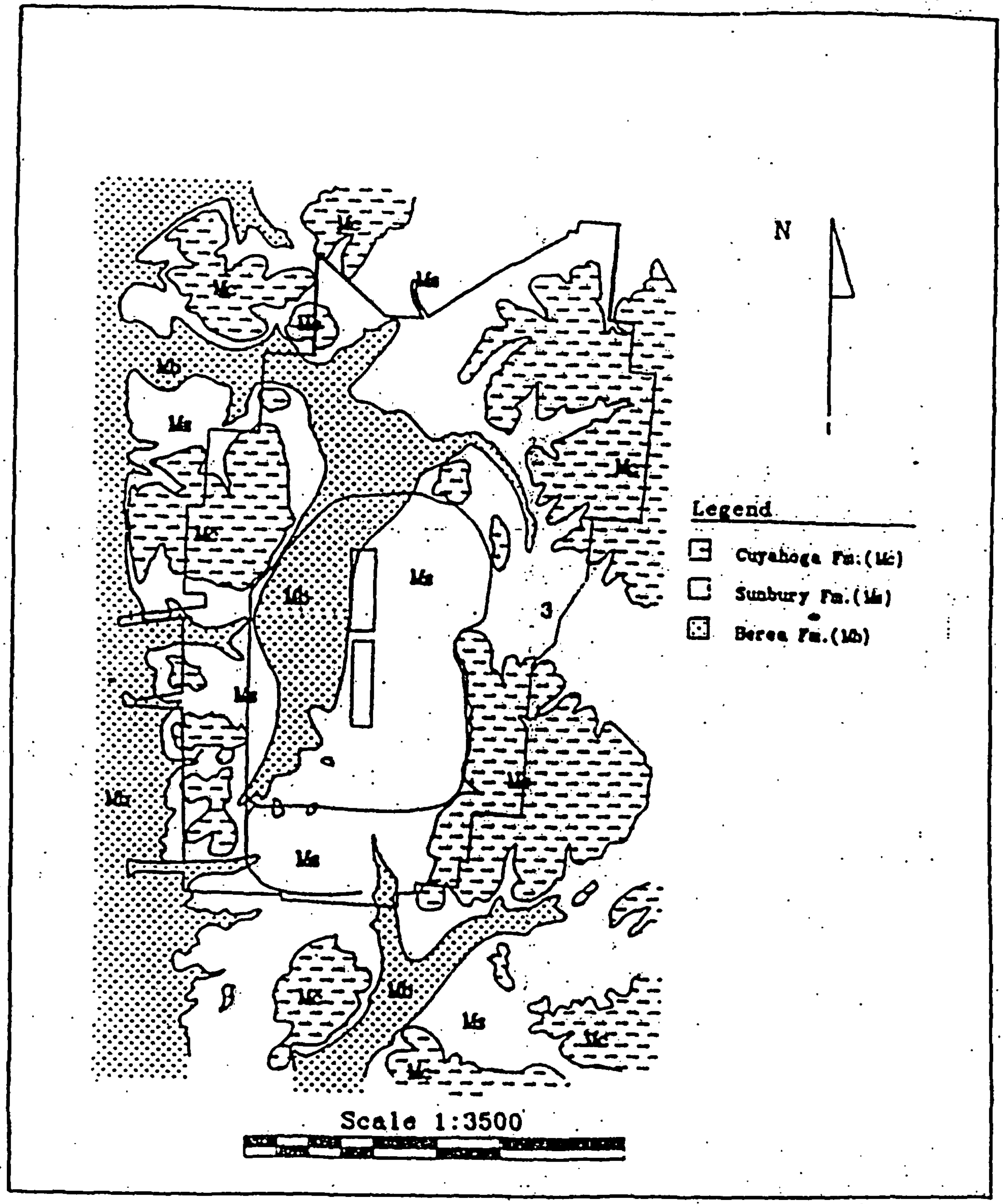

Figure 2.5-7. Hydrogeologic map of PORTS showing approximate outcrop/subcrop patterns of Mississippian bedrock (Geraghty & Miller 1989b, Fig. 1.1).

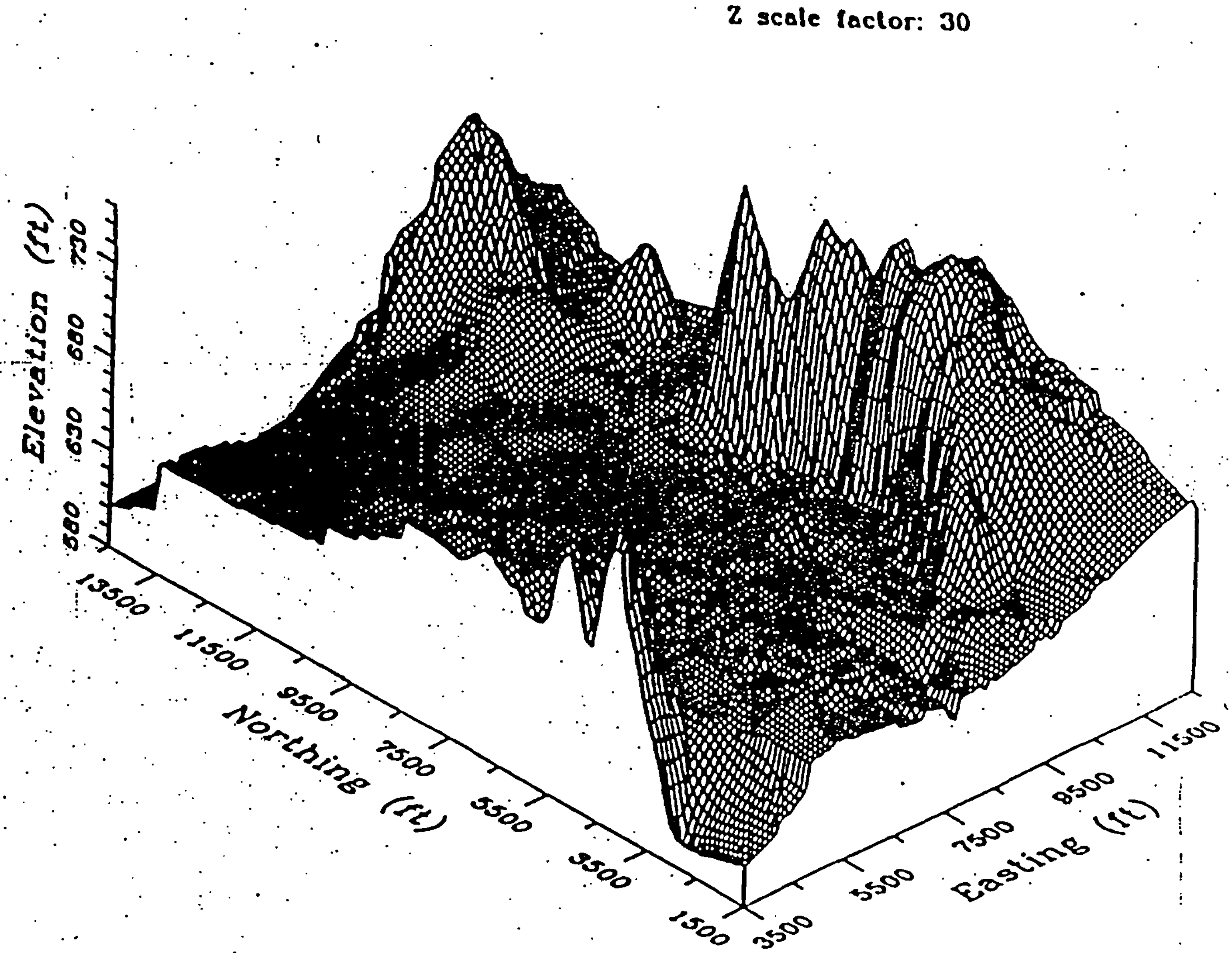

Figure 2.5-8. Bedrock surface beneath PORTS showing the narrow opening between the X-701B area and Little Beaver Creek to the east.

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2.6 GEOLOGY AND SEISMOLOGY

This section describes the geology and seismology, vibratory ground motion, surface faulting, and geologic structure at PORTS. 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

PORTS is located within the Interior Low Plateaus physiographic province, about 20 miles south of its northwestern edge. It is bordered on the north and west by the Central Lowlands province and on the south and east by the Appalachian Plateaus province. Figure 2.6-1 shows the relationship of the site to the physiographic provinces within a 200-mile radius of the site (Fenneman and Johnson 1946).

The Appalachian Plateaus province is composed of mature upland areas that have been dissected by erosion and now exhibit moderate to strong relief. This province is underlain by gently dipping Mississippian, Pennsylvanian, and Permian Age shale and sandstone. Both the adjacent Central Lowlands and the Interior Low Plateaus provinces are underlain by relatively flat-lying Paleozoic Age limestone and shale. The Interior Low Plateaus (Lexington Plain section) to the south and west is a mature to old plain of low relief, whereas the Central Lowlands (Till Plains section) to the north and west is a young feature of low relief. The Valley and Ridge (Tennessee section) is underlain by thrust-faulted Paleozoic limestone, dolostone, shale, and sandstone of moderate relief.

Portions of the Appalachian Plateaus, Central Lowlands, and Interior Low Plateaus provinces have been glaciated, but the site is south of the region covered by Pleistocene glaciation. However, alluvium and transported glacial sediments form a surface veneer in the mile-wide, broad valley where PORTS is located. The surrounding hills have been maturely dissected by erosion, exposing the underlying, nearly flat-lying shale and sandstone of Mississippian and Pennsylvanian Age. Ground elevations within the plant generally range from about 660 ft MSL to 680 ft MSL, although the ground rises to about 700 ft MSL at the base of hills that border the Perimeter Road; the surrounding hills extend up to about 1,200 ft MSL.

2.6.1.2 Regional Geologic History and Geology

The site is located near the western edge of the Appalachian Basin, a generally circular basin in which a thick column of Paleozoic sediments accumulated (Figure 2.6-2). The thickness of these Paleozoic Age rocks increases markedly south and east of the site (where several tens of thousands of feet of relatively undeformed Early Paleozoic sediments occur), but the nearest basement well (Ohio Permit No. 212—about 30 miles southeast of the site) encountered only about 5,600 ft of Paleozoic sediments overlying Precambrian bedrock. The Appalachian Basin is separated from the Illinois Basin to the west by the Cincinnati Arch and the Kankakee Arch and from the Michigan Basin by the Indiana-Ohio Platform and the Findlay Arch. Both the Michigan Basin and the Illinois Basin are semicircular basins that contain thousands of feet of relatively undeformed Early to Late Paleozoic clastic sediments. The Cincinnati and Kankakee Arches are composed of Early Paleozoic limestone and shale overlying a topographic high of Precambrian bedrock. Figure 2.6-3 depicts the regional geology. A northwest to southeast trending regional geologic profile is presented in Figure 2.6-4.

Ancient rift zones are significant in eastern North America because they are potential sites for reactivation in the contemporary stress field (Zoback 1992). The Rome trough is the nearest known ancient rift zone to the Portsmouth site. This structure was active as a rift zone in late Precambrian and Cambrian times. The Rome trough trends east-west through east central Kentucky. It terminates on the west against the Lexington fault in central Kentucky and is bounded on the north and south by the Kentucky River fault system and the Rock Castle fault system, respectively. The Rome trough turns toward the northeast in western West Virginia and continues on into western Pennsylvania and New York. More than 10,000 ft of Cambrian strata were deposited in most of the Rome trough during active rifting. Younger Paleozoic strata are much thinner in the Rome trough, which suggests that the most active rifting had run its course by the end of Cambrian time.

Continental glaciation covered about two-thirds of Ohio, with the glacier scouring rock and soil from the land surface to the north and depositing materials under it and at its southern edge. The last ice sheet receded from Ohio about 15,000 years ago, but it and its predecessors never advanced to cover the area of the site.

The presence of continental glaciation to the immediate north during the Quaternary Epoch interrupted and blocked drainage of pre-Pleistocene northward and westward flowing rivers and formed glacial lakes south of the glaciers. Consequently, sediment from the inflowing ancient Teays River and tributaries such as the Portsmouth River and sediment carried by glacial meltwater from the north were deposited in the river valleys. In the Portsmouth Valley, these sediments were deposited up to about 860 ft MSL. Since the retreat of the last glacier, the area has eroded and most of the glacial sediments have been removed. The remaining glacial sediments consist of about 3 ft of Portsmouth River alluvium overlain by about 23 ft of proglacial lakebed sediments (lacustrine deposits of the Teays Formation) consisting of silt and clay.

2.6.1.3 Regional Stratigraphy and Lithology

Much of the region consists of undeformed or only slightly deformed bedrock contained in the Appalachian, Illinois, and Michigan Basins. The Paleozoic rocks of the Appalachian Plateaus and the bordering Interior Low Plateau and Central Lowlands within 50 miles of the site are relatively undeformed and dip to the southeast at about 30 ft/mile. A broad arch of early Paleozoic Age (i.e., the Waverly Arch) may have been formed by Cambrian and Ordovician rocks beneath the site. Calvert (1968) questions the existence of the Waverly arch because Ordovician mountain building (orogenic movements) activity is unknown, but a postulated Paleozoic fault trending north-south in central Ohio may explain such an arch (ERCE 1990).

The nearest mapped surface tectonic features are high-angle, normal faults of the Kentucky River fault system, located about 60 miles to the south, and the Lexington fault system, about 50 miles to the southwest. These two fault systems form the north and west boundaries of the Rome trough, respectively. Both fault systems offset Ordovician to Pennsylvanian strata, which suggests sporadic activity in the Rome trough throughout Paleozoic time. Based on documents that preceded the work of Vanarsdale (1986), no Quaternary strata have been offset, indicating that these faults have not been active in the past 1.6 million years.

More recently, Vanarsdale (1986) mapped subtle Pliocene/Pleistocene displacements (1 to 2 ft) and possible Holocene warping along branches of the Kentucky River fault system. These displacements are both strike slip and reverse slip and are compatible with the contemporary stress field of Zoback (1992).

To the south and west, a few normal, high-angle faults in Indiana have been dated to be at least Pliocene (i.e., greater than 1.6 million years old) age (Ault et al. 1985).

Further to the southeast (i.e., about 150 miles, Paleozoic rocks at the margin of the Appalachian Plateaus and within the Appalachian Valley and Ridge province are broken by numerous thrust faults. This faulting is generally accepted as having occurred during the late Paleozoic or early Mesozoic. Because these are low-angle thrust faults, they do not penetrate deep into the earth's crust and probably react passively to the contemporary stress field.

Clastic rocks (i.e., sandstone and shale) underlie the soil at the site and these rock types extend downward to a depth of about 500 ft. Soluble bedrock (i.e., limestone and dolostone) is not present within 500 ft of the ground surface, although it crops out several miles to the north and west.

There are areas of surface karst development and caverns in the adjacent physiographic provinces, but none occur in the Appalachian Plateaus province near the site. Soluble bedrock is not present within 500 ft of the ground surface at the site, and there is a very low probability of solution of the bedrock producing caverns or karst terrain at the site.

The plant is situated in the middle of a relatively flat, broad, river valley, and almost all slopes that exist within the plant have inclinations of less than 3 horizontal to 1 vertical (3H:1V). Landslides occur only in areas of more steeply sloping ground such as the adjacent hills; because of the relatively flat slopes, there is only a very remote possibility of slope failures in the plant area due to heavy precipitation and/or ground shaking. However, there is a higher possibility of surficial (i.e., topsoil) slope failures in steeper cut and fill slopes outside the perimeter road and in the adjacent hills during periods of intense rainfall and/or ground shaking.

Coal is present only in the Pennsylvanian rocks of the region to the east at higher elevations. Further, there are no known underground mines developed for extracting aggregate or other mineral resources in the area that would affect the performance of the facility.

A modest, spotty production of natural gas from the underlying Ohio shale occurs within a 5-mile radius of the plant. The nearest known producing well is about 3,000 ft northeast of the site; it is currently producing about 50,000 ft^3 of gas per day (50 MD). Four other natural gas wells are located 3 to 5 miles to the southeast; production from them ranges from 5 MD to 40 MD. There are no reports of subsidence due to hydrocarbon extraction in southern Ohio.

The area is not known to be undergoing regional warping, but a very modest amount of rebound due to glacial unloading may still be occurring.

2.6.2 Site Physiography and Geology

2.6.2.1 Site Physiography

The plant is located within a broad, flat valley that was (1) primarily developed by long-term erosion of the shale and sandstone that underlies the Interior Low Plateaus physiographic province, (2) subsequently modified by partial filling by glacial and alluvial sediments, and (3) later subjected to erosion. The prolonged erosion since the end of the Permian Period (since 245 Ma) has produced the dominant topography. Ground elevations within the site range from about 620 ft MSL to 700 ft MSL; the highest elevations occur along the eastern and northwestern sides of the plant site where the Perimeter Road skirts the base of low hills. The nearby Scioto River (at about elevation 510 ft MSL) is the lowest elevation within 5 miles. The highest elevations (1,200 ft MSL) occur in a few of the surrounding maturely dissected hills.

Prior to construction of the plant, the area was farmland that formed a portion of the watershed for the nearby Scioto River. A drainage divide (about elevation 675 ft MSL) was at about plant coordinate N 9000, which separated gullies and streams flowing to the north from those flowing west and south. Generally, site preparation and grading involved only minor surface modification. With the exception of a few drainage features (swales) that required as much as 20 ft of fill, most of the area developed was cut less than 10 ft and filled less than 12 ft. Elevations within the Perimeter Road now range from 620 ft MSL to 702 ft MSL, with most of the plant area at about 670 ft MSL. Within the Perimeter Road is one slope about 10 ft high that has a slope of 2H:1V; other slopes have inclinations of 3H:1V or less.

2.6.2.2 Site Geologic History

Erosion of the region between the Triassic and Neogene Periods has produced the general shape of the region and the site. The regional drainage established during this period was the Teays River System, which originated in North Carolina and flowed generally west and north through Ohio, Indiana, and Illinois.

The glaciation, beginning about 1.6 Ma and extending to about 10,000 years ago, has had a marked effect on the geology of the site. Obstruction of the Teays River system (including the Portsmouth River and other drainage ways) by the advancing glacier created a series of finger lakes in the area (glacial Lake Tight). Sediments were deposited in these finger lakes from the inflowing rivers and from glacial meltwater, creating lacustrine (lake) deposits (Gallia sand and Minford clay) of the Teays Formation discussed earlier. The age of the Teays Formation is thought to range from 0.7 Ma to 1.5 Ma. As Lake Tight continued to be filled with glacial meltwater containing sediment, a new drainage path was finally established. The new drainage path was via the ancient Newark River; this river joined the ancestral Ohio River by flowing south along the approximate route of the existing Scioto River Valley. During the drainage to the south, significant erosion of glacial sediments occurred in valleys such as the one carved by the ancient Portsmouth River; an estimated 200 ft of sediment (i.e., from elevation 860 ft MSL to 660 ft MSL) was eroded. During the past 10,000 years, the site has been mostly undergoing erosion, with local streams depositing alluvium in response to flooding.

2.6.2.3 Site Geology and Stratigraphy

Aside from roadways and other ancillary structures outside the Perimeter Road, the plant is located within the valley eroded into the bedrock by the ancient Portsmouth River and later filled by glacial Lake Tight sediments. Except for a few low hills that extend into the plant site between N 5800 and N 10000, the Perimeter Road on the west and east generally follows the lateral limits of the ancient Portsmouth River Valley. The valley is bounded on the west by a series of low hills extending up to elevation 840 ft MSL that have been maturely dissected; these hills expose nearly flat-lying Mississippian Age shales of the Sunbury and Cuyahoga Formations. The Sunbury and Cuyahoga Formations are also exposed in the maturely dissected low hills east of the plant site. These consolidated Mississippian Formations dip downward to the east about 27 ft/mile (i.e., less than 1/2 a degree).

Drainage that developed at the site prior to glaciation consisted of a northward and westward flowing master stream (the ancient Teays River) and tributaries such as the ancient Portsmouth River. The Portsmouth River deposited a thin discontinuous veneer of alluvium in the site valley that has subsequently been covered by lacustrine deposits of glacial origin. Only the small streams that flow through the site contain recent alluvium.

Unconsolidated deposits at the site consist of Quaternary stream alluvium (Holocene and Pleistocene), Pleistocene lacustrine deposits of glacial origin, and older alluvium of the ancient Portsmouth River. Consolidated deposits within 500 ft of the ground surface consist of Devonian, Mississippian, and Pennsylvania shale and sandstone. Those formations in and near the site that are present within about 500 ft of the ground surface are described in the following subsections.

Unconsolidated material

1. Fill—Fill was placed during the 1950's to develop the site. Most of the fill ranges from 1 ft to 3 ft in thickness, but up to 20 ft of fill was placed in former stream valleys or draws to develop a plateau for building construction. The fill is composed mostly of clean, silty clay (USCS = CL); some organic material (USCS = OL) is evident at the boundary between the original ground and the fill in the area southwest of the plant. The fill is quite variable in density and strength in this area. Verification data regarding fill density and its moisture content indicate that the fill under the plant buildings was compacted to at least 95 percent of its maximum dry density according to ASTM D 698 (standard Proctor).

2. Lacustrine deposits—Lacustrine deposits averaging 23 ft in thickness are exposed at the ground surface over much of the site and underlie fill at the remainder of the site; these deposits have been termed the Minford clays, Minford silts, or the Minford Clay Member of the Teays Formation. The general soil profile is composed of about 16 ft of clay underlain by about 7 ft of silt. Both these soil types are firm to very stiff, overconsolidated, and classified as silty clay and silt (USCS = CL and ML, respectively), but some highly plastic clay (USCS = CH) occurs near the ground surface. The clays are mainly illite with some chlorite, minor vermiculite, and montmorillonite; the silts are mainly quartz and feldspar with illite and kaolinite.

3. Older alluvium—The lacustrine deposits are underlain by a discontinuous interval of clayey sand and gravel (Gallia sand) (USCS = SC and GM) deposited by the ancient Portsmouth River. The alluvium is commonly referred to as the Gallia Sand Member of the Teays Foundation in the nearby Teays Valley. The average thickness is about 3 ft; the maximum thickness of the alluvium is 12 ft. It is firm to dense. The sand is mostly quartz with chert and goethite; the clay fraction is composed of illite, kaolinite, and montmorillonite.

Consolidated material

1. Cuyahoga Formation—This Mississippian formation crops out in hills adjacent to the site, with the base of the formation at elevation 639 ft MSL (coordinates N 8400, E 10597). Because of the 27 ft/mile regional dip, its base (as well as the other formational contacts) is at a lower elevation toward the east. When unweathered, the Cuyahoga consists of about 339 ft of hard grey to grey-green shale

with lenses of sandstone. In the hillsides above the plant, the upper portion is reported to be conglomeratic.

2. **Sunbury Formation**—Underlying the Cuyahoga is a 19- to 20-ft thick interval of hard, black, carbonaceous shale containing pyrite and marcasite nodules. The top of this formation is at 640 ft MSL and the base is at 620 ft MSL in Boring 848DC; it underlies the unconsolidated sediments beneath most of the plant site.

3. **Berea Formation**—At Boring 848 DC, the Berea Formation underlies the Sunbury shale and extends downward to elevation 590 ft MSL. It is composed of about 30 to 35 ft of grey thick-bedded, fine-grained sandstone with shale laminations.

4. **Bedford Formation**—The Bedford is composed of about 98 ft of varicolored shale with interbeds of sandstone and siltstone. The sandstone may be calcareous, and some sandstone beds within it contain crude oil. The base of the Bedford in Boring 848DC is at 492 ft MSL.

5. **Ohio Formation**—The Ohio Shale is the uppermost Devonian Formation (>360 Ma) under the plant site. It is composed of 300 to 600 ft of dark brown, dark grey, and black fissile shale. This formation extends downward to at least 192 ft MSL.

2.6.2.4 Site Structural Setting

Essentially all of the site bedrock is covered by lacustrine deposits; some stream beds contain recent alluvium. Little bedrock is exposed at the site except in the hills surrounding the plant. Neither the U. S. Army Corps of Engineers studies nor the Law Engineering Study in 1978 discovered evidence of bedrock faulting. The available data indicates that the underlying bedrock is not faulted; it has a strike of N28°E and a homoclinical dip to the southeast of about 1/2 a degree. Mapping of joints in bedrock exposures in the adjacent hills and photo lineament analysis (Geraghty and Miller 189b) show two approximately orthogonal joint sets at N55°E to 65°E and at N25°W to 40°W, respectively. The relative cluster of joint measurements around these two orientations suggests that the rock is not structurally deformed. Figure 2.6-5 shows a site plan, the locations of borings, and the limits of geologic profiles.

2.6.2.5 Engineering Geology

The available evidence indicates the favorable performance of the facility since its construction in the 1950's with respect to bearing capacity, settlement, and modest seismic events.

No shears, folds, or other structural weaknesses are known to be in the bedrock. Measurements of joint sets in bedrock exposed around the plant site exhibit jointing typical of undeformed bedrock. These joints have no effect on the performance of foundations since they are covered by an interval of lacustrine glacial deposits. No evidence from the borings indicates zones of deep weathering that might indicate faulting or shearing.

No published data exist on unrelieved stresses in the bedrock, but the geologic history suggests that the bedrock may still be undergoing a very slow isostatic rebound. This rebound is due to a combination of the past loading and subsequent unloading of the bedrock by the Pleistocene glaciers and/or stress relief from erosion of the unconsolidated lacustrine sediments.

The consolidated bedrock within 500 ft of the ground surface is predominately clastic in origin (shale and sandstone). Although the Berea sandstone underlying the site is not calcareous, portions of the Berea Formation are calcareous in other areas. A calcareous sandstone might be subject to a slight loss in volume due to solution. The likelihood of such volume loss at the site is very low.

Weathering of portions of the Sunbury shale containing marcasite and pyrite may produce some net expansion, but these formations are not exposed at the ground surface at the site and such weathering should have no effect on the facility.

Most of the unconsolidated soils are cohesive and overconsolidated (i.e., they are not thixotropic) and relatively uniform in thickness and extent. The soils exhibit a low potential for liquefaction and differential settlement. Cohesive soils exposed at the surface may exhibit minor shrinkage cracks resulting from moisture loss.

The geologic literature and records of mineral production in the site area indicate no mineral extraction has been done beneath the site. The potential exists for minor oil and gas accumulations in the underlying consolidated strata, but there are no records of significant gas or oil production within 5 miles of the site.

The soil at the site is primarily low plasticity clay and silty clay (USCS = CL and ML). The bedrock is composed of hard shale and sandstone.

No limestone, dolomite gypsum, salt, or marble strata are contained within the uppermost 500 ft of the bedrock underlying the plant. Although thin-bedded strata of the Berea sandstone are reported to be calcareous in southern Ohio, none of the literature indicates it is calcareous at the plant site. Bedrock solution, caves, and karst development are not a consideration at the site.

The regional geologic history and extensive amount of exploratory data indicate no evidence of tectonic depressions, shears, faults, or folds.

The plant uses process water from the aquifer below the Scioto River, and no groundwater is withdrawn from the subsurface at the plant site. There is no shallow or deep well injection of water or other liquids or waste at the plant site, and there has been none in the past.

The exploratory and laboratory test data indicate that the glacial and alluvial soils are over-consolidated and have moisture contents well below their liquid limit (i.e., they are not thixotropic). Engineering studies have shown the soils are only moderately compressible under applied foundation loads, and the satisfactory performance of the various foundations attests to that. The potential is low for surface fissuring of soils resulting from a period of extreme drought (desiccation).

The 1952 Site Clearing and Grading plan shows that building areas that required fill received Class C fill. Class C fill consisted of soil with crushed limestone that was compacted to at least 95 percent of ASTM D 698. Other documents indicate that the compaction requirement for engineered fill was at least 95 percent of the soil's maximum dry density according to ASTM D 698. The criterion for compaction of fill placed outside buildings is not known, but one document indicates that the fill where Building X-344 was constructed was densified to an average of 94 percent of ASTM D 698.

Foundations for the major structures (Buildings X-330, X-333, X-326, X-700, X-710, and X-720) bear upon the soil at shallow depths (<5 ft) using conventional foundations proportioned for allowable bearing capacities up to 4.0 kips/ft^2. A tunnel in Building X-705 bears on soil at a depth of about 25 ft (i.e., elevation 648 ft amsl). Construction records document that where fat clays (i.e., highly plastic clays wherein physical properties are very sensitive to changes in moisture content) or soft alluvial soil were encountered at foundation locations, they were excavated and replaced with stone or low plasticity clay compacted to 95% of its maximum dry density according to ASTM D 698.

The studies by the U. S. Army Corps of Engineers and Law Engineering in the 1970's in the area south-southeast and southwest of the plant found groundwater between 650 ft MSL and 665 ft MSL. The basal older alluvium exhibits no evidence of artesian conditions. Limited data on groundwater fluctuations indicate variations of between 3 ft to 5 ft over a period of 6 months. The groundwater level responds to annual precipitation.

Except in rare instances, no significant problems were encountered with groundwater during construction of the facility. Most foundations bear upon the stiff lacustrine soils at depths of 5 ft or less below the finished floor elevation of the buildings. In instances where deep excavations were required to install features such as tunnels (i.e., the tunnel in Building X-705), unstable soil was encountered below the groundwater level.

No slopes within the Perimeter Road have inclination of 3H:1V or greater except for one slope; this slope is not adjacent to any structures (ERCE 1990). Low inclination slopes less than 20 ft in height that have soil parameters of $\phi = 10°$, c = 1000 will have a static safety factor of at least 2.0 and a dynamic safety factor of at least 1.5 under a peak ground acceleration of 0.21 g. The natural ground and engineered fill upon which the structures are founded have been analyzed for shear failure and settlement. Design documents show the factor of safety against shear failure under static conditions is more than 2.0, and predicted total settlements of foundations are less than 2 in. Because of the stiff nature of the foundation soils, negligible settlement will occur as a result of the evaluation basis earthquake (EBE).

2.6.2.6 Geologic Hazards

This subsection summarizes potential regional and sitewide geologic hazards at PORTS. The following sections provide supporting details. Conclusions are based on a report by ERCE (1990) and on-site drilling data provided by COE and by LETC (1978).

2.6.2.6.1 Subsidence Hazard

There is very little potential for natural or man-induced subsidence at PORTS. No carbonate or evaporite rocks are found within 500 ft of the surface. Significant solution cavities are unlikely to form at greater depths, without which karst topography cannot develop at the surface. The youngest strata beneath the site are Mississippian age; the oldest coal seams are in still younger nearby Pennsylvanian age rocks but are not present beneath the site. No other mines of any type are within 5 miles of the site. There are five natural gas wells within 5 miles of PORTS; the nearest well is located about 3000 ft northeast of the site. These wells produce small quantities of gas from the Ohio shale, which lies about 500 ft beneath the site. Subsidence related to this production is likely to be small and relatively uniform at the surface. No other hydrocarbons are produced within 5 miles of the site, and any future hydrocarbon or groundwater production from fully consolidated Paleozoic rocks beneath the site would be unlikely to cause significant subsidence. There is little or no potential for groundwater production from the lacustrine (lakebed) silts and clays beneath the site. The Pleistocene alluvial aquifer beneath the on-site lakebed sediments is too limited in extent to support significant groundwater production. Off-site groundwater production is currently limited; there is no on-site production of groundwater. Differential settlement of construction fill and lakebed sediments ran its course within the first few years of construction at PORTS.

2.6.2.6.2 Landslide Hazard

There is very little potential for landslides at PORTS. Slopes are generally gentler than 3H:1V. Static and dynamic factors of safety for low inclination slopes of less than 20 ft in height generally exceed 2 and 1.5, respectively, for cohesive clays with friction angles less than 10° and cohesive strengths exceeding 1000 psi. The dynamic factor of safety is based on an earthquake ground motion of 0.21 g. Slopes are unlikely to fail unless erosion during a flood oversteepens the slope's toe.

2.6.3 Analysis of Geologic Stability

2.6.3.1 Earthquake History

Between 1776 and August 17, 1990, 264 earthquakes have occurred within 200 miles of the site.

The location of the epicenters of the largest recorded earthquakes within 200 miles of the plant are shown in Figure 2.6-6. The record extends from 1776 through August 17, 1990, and includes all tremors shown on the figure with Richter magnitudes of 4.0 or greater, as well as all earthquakes where a magnitude has not been assigned. Events with a magnitude of up to 3.9 are not shown. The tremors shown on the figure with no assigned magnitude are of low energy. Two earthquakes of Richter magnitude 5.0 or greater (5.80 FA, 1897; 5.1 mb, 1980) have occurred within this 200-mile radius in the 204-year period. The 1980 event had an epicenter in the central stable portion (Interior Low Plateaus physiographic province) and the 1897 event occurred in the deformed Appalachian Highlands (Valley and Ridge physiographic province). The Richter 5.1 mb event in northern Kentucky at 38.2°N, 83.9°W occurred at depth in the basement where geologic strucucture is poorly understood. The focal mechanism for the Kentucky earthquake is consistent with the contemporary stress field (Mauk et al, 1982). The 5.80 FA May 31, 1897, event at 37.3°N, 80.7°W on the Virginia-West Virginia border is believed to have been located in the basement, based on observations of recent seismic activity by Bollinger and Wheeler (1988). A basement structure has been tentatively identified by Bollinger and Wheeler that has a more northernly orientation than surficial Appalachian highland structures. Observations of Mauk, Bollinger, and their coworkers raise doubts that surficial structures bear any relation to contemporary seismicity in this region. PORTS operating personnel indicate that the facility has performed without seismic damage or interruption of operations during its existence, and there have been no observed ground ruptures, sand boils, or subsidence at the site.

2.6.3.2 Identification and Description of Capable Faults

Including multiple fault systems and groups of related faults, 376 faults are mapped within a 200 mile radius of the site. These have been compiled from existing published and unpublished geologic literature. Fault studies by the Tennessee Valley Authority (TVA), which contained information on 375 of these faults, show that only the ``White Mountain Fault Zone'' may be capable, i.e. exhibited movement at or near the surface in the past 35,000 years or movement of a recurring nature in the past 500,000 years. This fault is 20.5 miles in length and is located in Bell and Knox Counties, Kentucky, about 155 miles south-southwest of the site.

More recent studies suggest the possibility that some faults have been active more recently than earlier believed. Such faults are located in Illinois, Indiana, and Kentucky.

A few low-displacement thrust faults to the west in Indiana have been described by Ault et al. (1985) and Ault and Sullivan (1982), and similar faults in southern Illinois have also been described (ERCE 1990). In each case, faults are described as (1) being post-Pennsylvanian and pre-Pleistocene in age, (2) thrust faults that are contained entirely within Pennsylvanian coal seams, and (3) aligned with the contemporary stress field.

The Kentucky River and Rock Castle fault systems form the northern and southern boundaries, respectively, of the Rome trough in eastern Kentucky (Harris and Drahovzal 1996). The Rome trough extends eastward from central Kentucky. Then it bends northeasterly through western West Virginia and western Pennsylvania to western New York. The Rome trough is a late Precambrian to lower Paleozoic graben (rift zone) that contains 10,000 ft or more of Cambrian sediments. The Paint Creek fault system lies within the Rome trough. The Lexington fault system and the Precambrian Grenville Front form the western boundary of the Rome trough.

At least one fault system (Kentucky River) within the Rome trough has reactivated in the contemporary stress field. Vanarsdale (1986) mapped subtle Pliocene/Pleistocene displacements in alluvium along the Kentucky River fault system and possible Holocene warping along branches of this system. Senses of displacement (i.e., strike-slip and reverse faulting) along these structures are compatible with the contemporary stress field of Zoback (1992). However, there is no evidence that the Kentucky River fault system is capable in the regulatory sense.

The Rough Creek fault system (almost 200 miles to the southwest in Kentucky) is shown on numerous geologic quadrangles across Kentucky as being post-Pennsylvanian, pre-Pleistocene (loess) in age.

Thrust faulting, generally associated with strata in the Valley and Ridge province, is found within the southeastern portion of the 200-mile radius of the site. The nearest example of this is the Pine Mountain fault. Further to the southeast in Virginia and Tennessee, numerous faults and portions of faults are shown as being of post-Pennsylvanian age. The general consensus of opinion is that the hundreds of thrust faults within the Valley and Ridge (including the Pine Mountain fault) and within the Blue Ridge occurred as a result of the Appalachian orogeny. These low-angle, non-basement-penetrating thrust faults are not believed to be active in the contemporary stress field.

Most historical seismicity in the region is believed to be associated with reactivation of deep-seated Paleozoic and Precambrian rift zones in the contemporary stress field. Many of these rift zones have not been well documented and have no surface expression. One exception is the Rome trough, a Precambrian/lower Paleozoic rift zone that is oriented in an east-west direction through east central Kentucky and West Virginia. The Rome trough is bounded on the north and south by the Kentucky River and Castle Rock fault systems, respectively. Another fault system (Irvine-Paint Creek) lies within the Rome trough. All of these fault systems are easily traced on the surface. Deep wells drilled between the Kentucky River and Castle Rock fault systems encounter abnormally thick sections of Cambrian sediments. Vanarsdale (1986) shows that the Kentucky River fault system was reactivated as recently as Pliocene-Pleistocene time. Total displacement over the last several million years is on the order of 1 or 2 ft.

Branches of the Kentucky River fault system are not believed to be capable of surface rupture in the regulatory sense because only one displacement of limited magnitude (1 to 2 ft) has been identified on any one fault in the last 1.6 million years. One of the strongest twentieth century earthquakes in the eastern United States occurred in this general region: the Maysville, Kentucky, earthquake of July 1980 (Mauk et al. 1982). The relationship between this earthquake and the Rome trough is uncertain.

2.6.3.3 Surface Faulting

The published map of Ohio [1920, revised 1947 and subsequently reprinted 1981 (Bownocker 1981)] shows no faults within 50 miles of the site. The state map of Kentucky shows faults about 50 miles southwest of the site and 60 miles south of the site.

The geologic setting of the site suggests there is a low probability of faulting within 5 miles of the site. No data from the three extensive geotechnical studies at the site (rock shearing, sharp changes in strata dip, and flexures) are characteristic of faulted rocks. The available data indicates the site bedrock is not faulted.

Although 7½-minute geologic maps are not available, Ohio Geological Survey representatives do not believe there are any capable faults in the area nor within 5 miles of the PORTS facility. The available seismic and geologic data and geologic history suggest that capable faults are not likely in the area.

The USGS National Earthquake Information Center Earthquake Database System shows no record of earthquakes within 5 miles of the site from 1776 through August 17, 1990. The nearest reported earthquake hypocenter was about 22 miles north of the site (39.3°N, 83.0°W) on November 22, 1899; its epicenter is unknown. That earthquake had a reported Modified Mercalli Intensity of IV.

The focal depths of the 264 earthquakes of record within 200 miles of the site have ranged from 0.62 to 20 miles . Nearly all earthquakes with accurate focal depth determinations occurred within the geologic basement at depths of 6.2 miles or more.

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Figure 2.6-1 Regional physiographic map (after Fenneman and Johnson 1946)

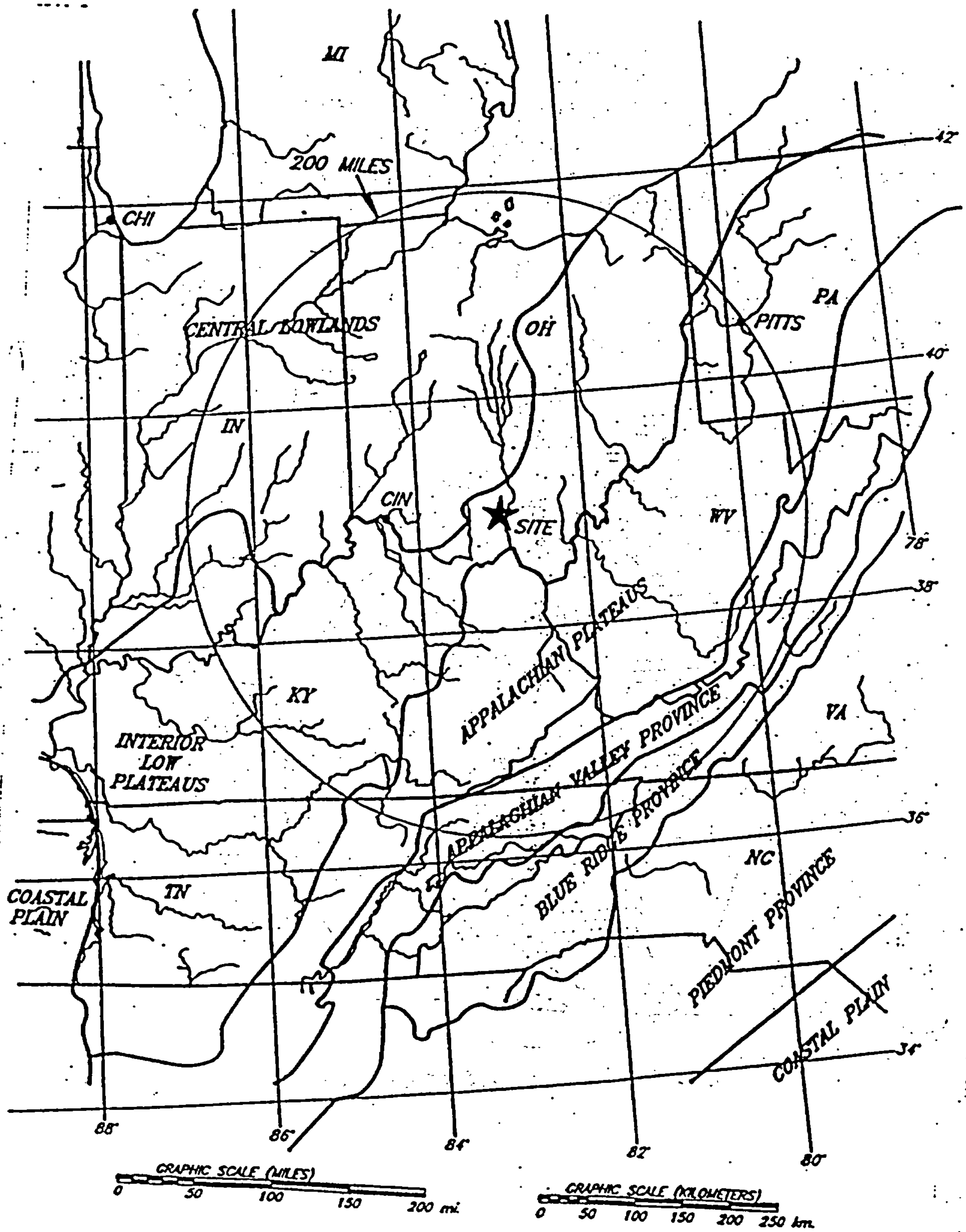


Figure 2.6-2. Regional geologic setting (modified from Rudman et al.).

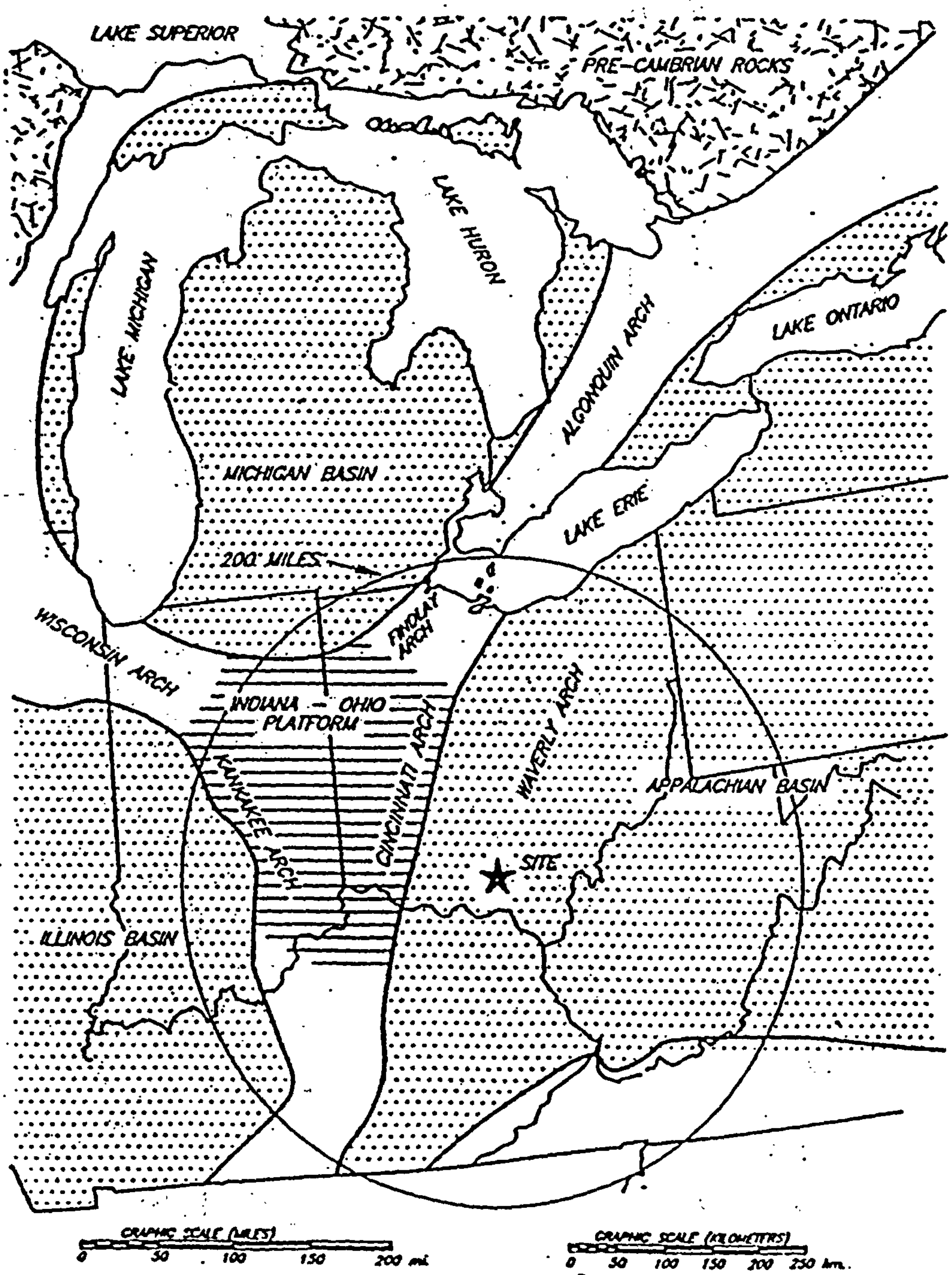
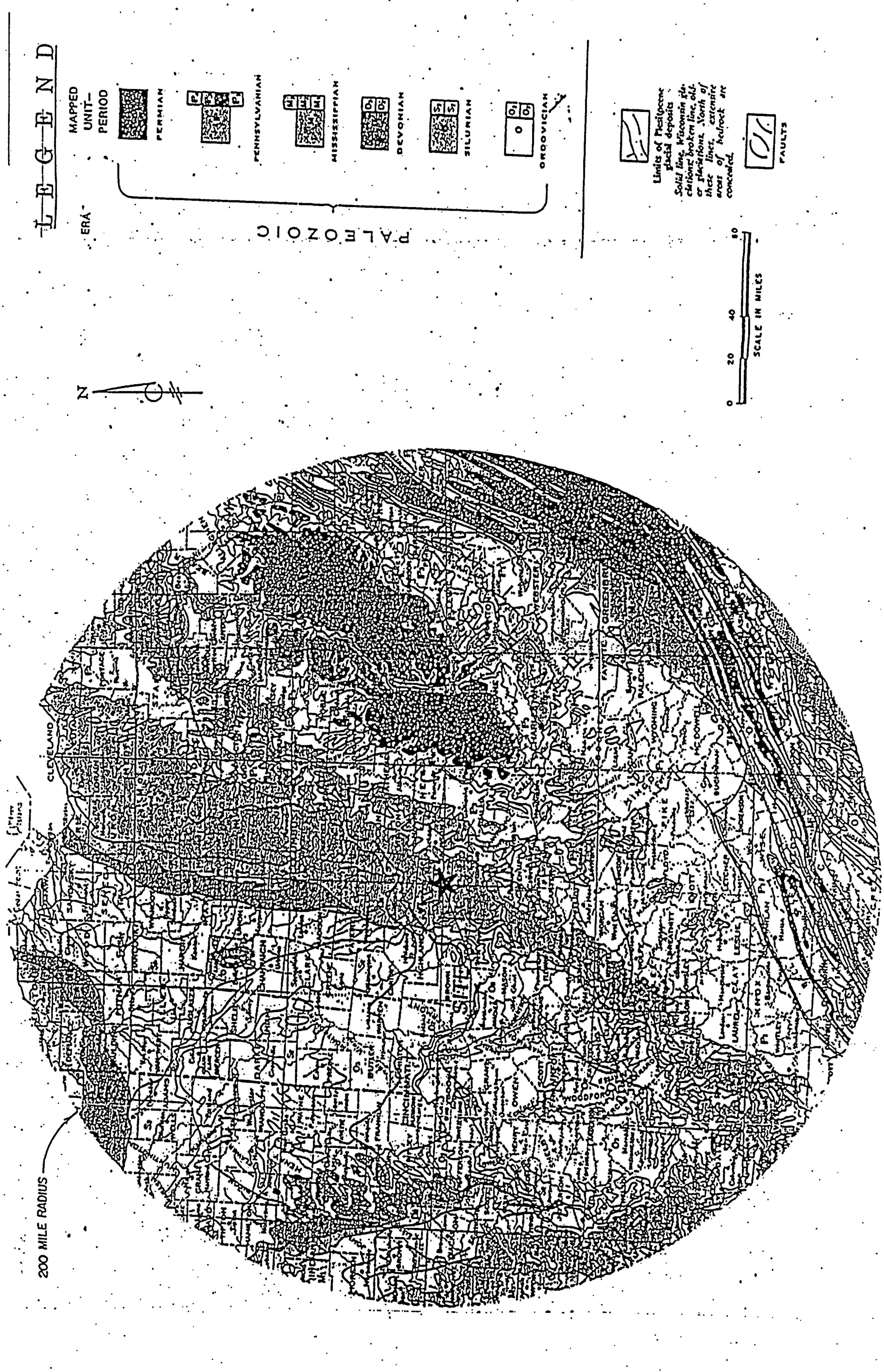


Figure 2.6-3 Regional Geologic Map. (From King, 1974, the U.S.G.S. Geologic Map of the United States, 1974)



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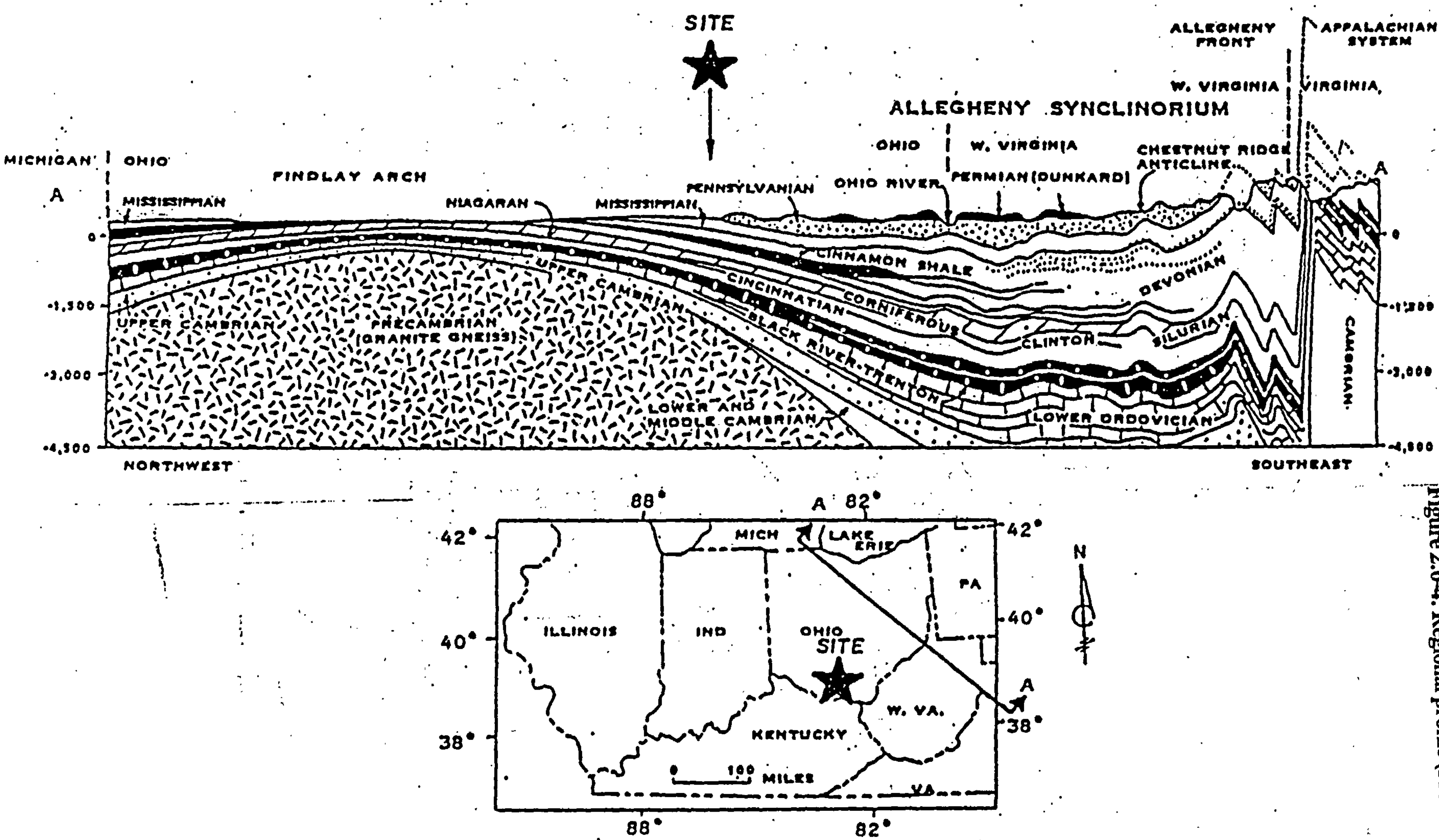


Figure 2.6-4. Regional profile (From King 1974).

September 15, 1995

Figure 2.6-5. Site plan, locations of summary borings, and geologic profile limits. (1 in. = 2,000 ft.)

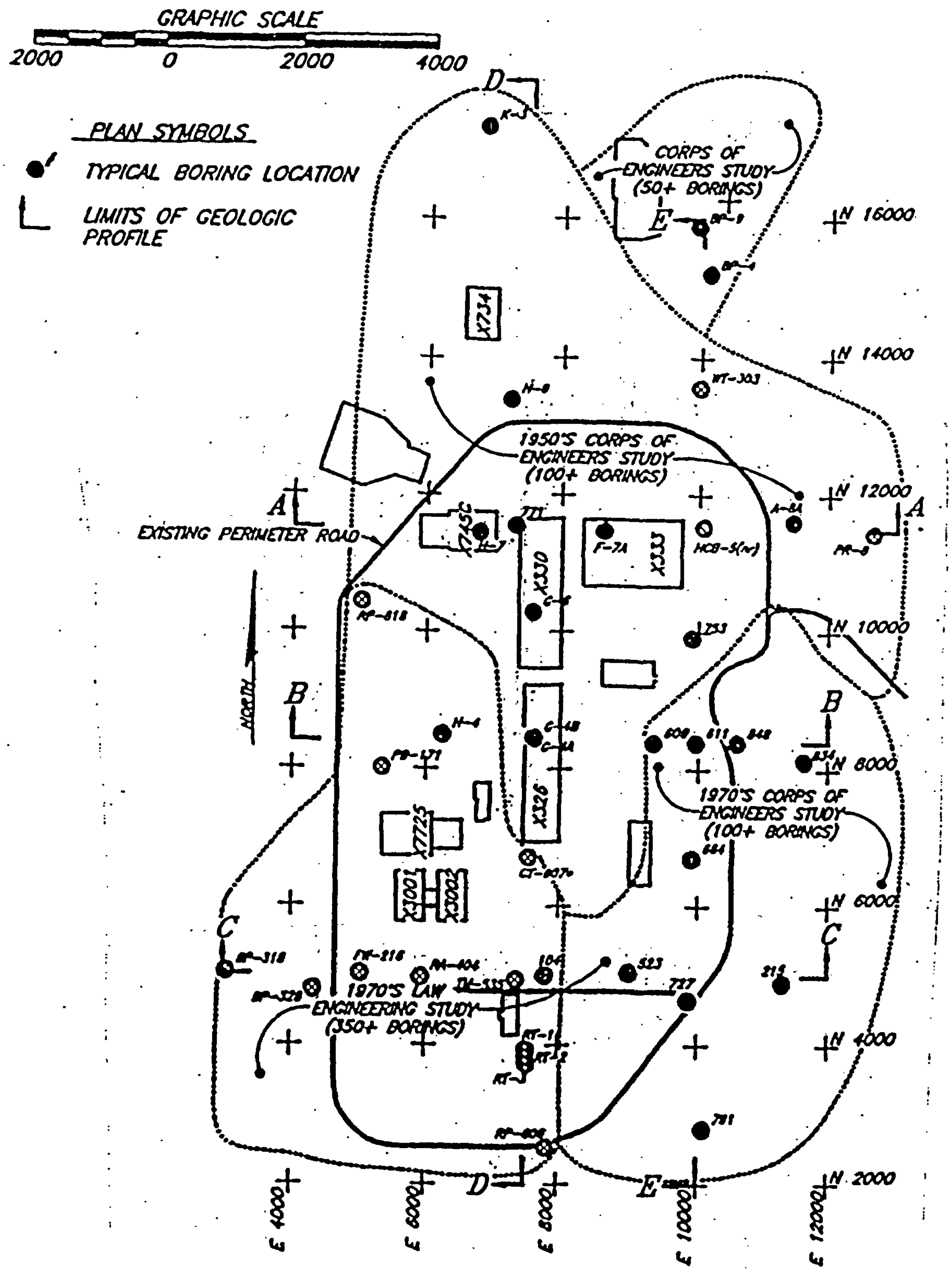
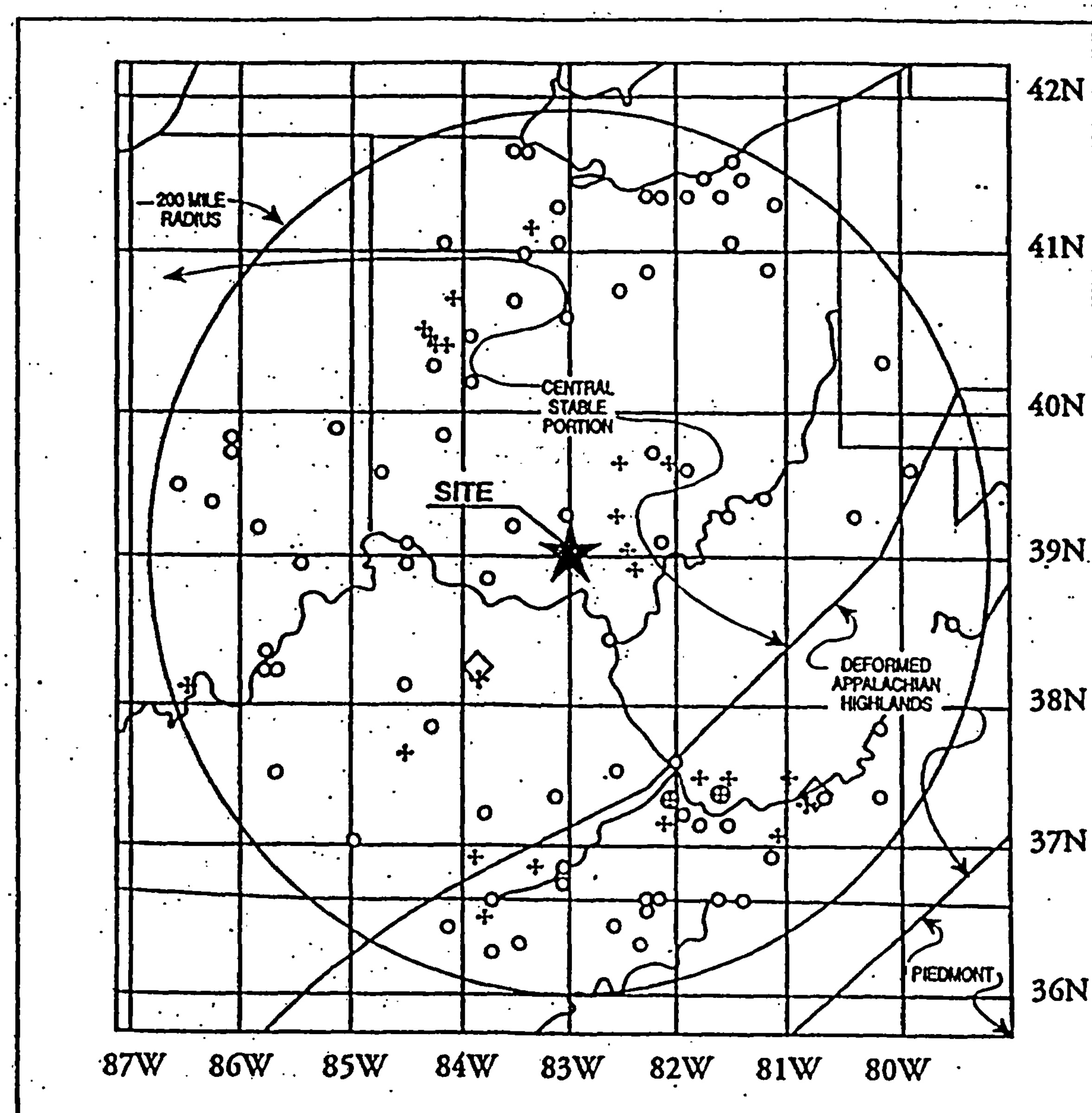


Figure 2.6-6. Seismotectonic provinces and epicenters of historical earthquakes, 1776-1990.



SCALE: 0 50 100 MILES

Computer graphics by Roger N. Hunter, Geophysicist

RICHTER MAGNITUDES (ONLY UNKNOWN AND 4 OR GREATER MAGNITUDES ARE SHOWN)

o UNKNOWN MAGNITUDE 4 + 5 ◇

U. S. Geological Survey, National Earthquake Information Center
Data taken from the Earthquake Data Base System

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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

The earthquake hazard 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 EBE ground surface motions.

The seismic hazard analyses are described and documented in *Seismic Hazard Evaluation for the Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio* (Risk Engineering, Inc. 1992). The probabilistic seismic hazard analyses were performed using the Lawrence Livermore National Laboratory (LLNL) and Electric Power Research Institute (EPRI) seismic hazard methodologies. The LLNL and EPRI seismic hazard methodologies represent major efforts to characterize the seismic hazard for nuclear power plants in the central and eastern United States and use the most recent, up-to-date understandings of seismicity and ground motion relations for the region. The results of these studies and the two methodologies were used to develop the seismic hazard for PORTS. Both the LLNL and EPRI studies utilize a point-source representation of earthquakes, thereby ignoring the nonzero dimensions of earthquake ruptures. This simplification is appropriate for this site because earthquakes with large ruptures are highly unlikely to occur near the site (because of low values of maximum magnitude).

The probabilistic seismic hazard results from the LLNL and the EPRI methodologies were used in accordance with the *Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites* (DOE 1992) to develop site-specific uniform hazard rock response spectra. The DOE guidelines (DOE 1992) provide a methodology for combining the seismic hazard results from LLNL and EPRI to obtain a mean uniform hazard response spectra. Additional evaluations were made to address the uncertainty in the low frequency range (2.5 Hz and less) of the response spectra and are documented in a letter report from the Center for Natural Phenomena Engineering (Hunt 1993) and in *Seismic Hazard for the Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio, Department of Energy Reservations* (CPNE 1995).

The deterministic seismic hazard analyses was performed by obtaining actual earthquake records with magnitudes and site characteristics similar to the Portsmouth seismic environment. The response spectra obtained from the earthquake recordings were compared with the probabilistic site-specific uniform hazard response spectra to illustrate that the uniform hazard response spectra were appropriate for the PORTS site.

Independent calculations and a review of the seismic hazard analyses for the site were performed by USGS. The results of the USGS review are documented in *Review of Earthquake Hazard Assessments of Plant Sites at Paducah, Kentucky, and Portsmouth, Ohio* (USGS 1992a). The independent review of the seismic hazard results by USGS indicated that the seismic sources, recurrence rates, maximum magnitudes, and attenuation functions used in these analyses were representative of a wide range of professional opinion and were 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} resulted in about 0.08 G, which compares favorably with the 0.06 G derived from combining the EPRI and LLNL results according to the DOE guidelines (DOE 1992). The USGS uniform hazard response spectra are also in reasonable agreement with the site-specific spectra, particularly in the frequency range 2.5 Hz and less, which is the range of the predominant frequencies of the structures at this site. The differences in the uniform hazard response spectra can be attributed mainly to the magnitudes of the earthquakes used in the attenuation functions, resulting in the USGS results being more representative of stiff soil accelerations than rock accelerations.

Based on the rock outcrop motions defined in the seismic hazard analyses, soil amplification and liquefaction evaluations were performed. The soil amplification evaluation is documented in a COE report, *Site-Specific Earthquake Response Analysis for Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio* (Sykora and Davis 1993). The soil amplification analyses 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: 500-, 1000-, and a 5000-yr events. From the geotechnical and geophysical investigations, 15 individual soil columns were derived for use in the amplification analyses. Also an average soil column was created to conduct sensitivity studies. The average soil column is used to represent the overall site. The geotechnical information from past site studies defining the variation of shear modulus and damping ratio with shear strain was used along with standard relationships developed by others. These standard relationships typically represent a best-estimate fit of numerous compiled data from investigations conducted throughout the United States.

The computer program SHAKE (Sykora and Davis 1993) was used to perform the soil amplification analyses and to calculate the free-field ground motions for each of the 15 soil columns and the average soil column. The predominate site period is about 0.1 sec. Other site periods were also calculated corresponding to sites with a thicker soil deposit or higher shear wave velocity. The motions calculated at the ground surface of free-field (soil over rock) were amplified over rock outcrop motions for all cases at almost all periods. Sensitivity studies were also conducted using the average soil column. The effects of bedrock impedance ratio, depth to bedrock, shear modulus relationship used, damping ratio relationship used, and the maximum shear modulus were investigated. The results of the sensitivity studies suggest that the depth to bedrock and maximum shear modulus are the two most important factors for the site response calculations. The bedrock impedance ratio is also important but to a lesser degree. The assignment of shear modulus and damping ratio relationships was found to have a small effect on the analyses, primarily because the site-specific relationships do not vary considerably and are very similar to the standardized curves. It was determined that the range of response using the 15 individual soil columns is comparable to, or even wider than, the results of the sensitivity studies considering all possible combinations of variability and uncertainty using guidelines such as those established by NRC (NRC 1989). Therefore, the individual responses from the 15 soil columns were used to determine the free-field ground surface motions. The soil liquefaction evaluation is documented in a report prepared by ERCE, *Portsmouth Gaseous Diffusion Plant, Final Safety Analysis Report, Section 3.6, Geology and Seismicity* (ERCE 1990). The liquefaction evaluation demonstrated that liquefaction was not a concern for the EBE 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 seismic hazard curve for peak horizontal ground surface acceleration is shown in Figure 2.7-1. The EBE return period to be used for the site is to be 250 yr. The justification for continued use of an approximate 250-year return period for the evaluation basis earthquake was developed by DOE (DOE 1995). The justification 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 and low in comparison to normal societal risks. In addition, the plants are not expected to operate for a large number of additional years. Given the low risk from a major release, previous estimates of building capacities, and short life of the facilities, the facilities were not believed modifiable within the remaining life in such a time frame that benefit would be achieved.

Based on a return period of 250 yr, the EBE horizontal ground response spectra for 5% damping is shown in Figure 2.7-2. The EBE response spectra was determined by scaling the 500-yr return period response spectra by the ratio of PGA of the 250-yr return period earthquake divided by PGA of the 500-yr return period earthquake. The vertical earthquake ground motion is two thirds of the horizontal ground motion. Earthquake time histories representative of the EBE ground response spectra were also developed for use in structural and equipment evaluations. The development of these earthquake time histories is documented in a report by Risk Engineering, Inc., *Development of Artificial Earthquake Ground Motions for the Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio,* (Risk Engineering, Inc. 1993).

2.7.2 Flood Hazard

The flood hazard was evaluated by performing site-specific river flooding analyses from extreme river flooding and flooding due to local intense site precipitation. These flood hazard studies are documented in *Extreme Flood Estimates Along the Scioto River Adjacent to the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio* (Wang et al. 1992) and *Local Drainage Analysis of the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio, During an Extreme Storm* (Johnson et al. 1993).

The Scioto River, which flows in a north-to-south direction and empties into the Ohio River at Portsmouth, is located 1.9 miles west of the plant site. The plant site is situated about 141 ft above the banks of the Scioto River. The river flood study evaluated the potential for inundation of the plant site during a flood having a recurrence interval of 10,000 yr on the Scioto River. This was accomplished by applying statistical methods to extrapolate flood data recorded at the Higby, Ohio, gauging station to the 10,000-yr interval. Two different statistical methods, as well as a least-squares methodology, are utilized to calculate the flood stage. The calculated flood stage is about 97 ft below nominal plant grade; therefore, river flooding does not constitute a hazard.

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 yr 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 the local intense precipitation does not pose a flood hazard to structures except where roof ponding can occur. The effects of roof ponding were considered in the structural evaluations, which are described in Chapter 4.

2.7.3 Wind Hazard

The wind hazard was evaluated by performing a site-specific analysis. The site-specific study is documented in *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites* (Coats and Murray, 1985). LLNL utilized recognized experts in the field of wind hazards for the generation of this study which establishes the wind/tornado hazard curves for the Portsmouth site.

The wind hazard curve is shown in Figure 2.7-3 (Coats and Murray, 1985). The evaluation basis wind (EBW) return period to be used for the site was specified by DOE to be 250 yr (Jackson 1995). Another Wind hazard analysis was prepared by the Center for Natural Phenomena Engineering (LMES, Oak Ridge, TN) in 1998. The study concluded that although the straight wind hazard decreased some, the current curve was retrained. The 250 year return period EBW was determined to be a 90-mph, 3-second, peak gust with the comparable fastest straight wind speed of 75 mph. The reports concluded that there was no change required to evaluation of PORTS facilities for high winds. Based on a return period of 250 yr, EBW has a wind speed of 75 mph.

The justification for use of an approximate 250-year return period for wind was based on the rationale for 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 down wind. 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 PORTS. As noted above, the extreme wind value is used in this study and tornado wind loadings are not considered. Tornados do occur in Southern Ohio; however, specific analyses of the frequency of tornados in the region show that they are rare. Recent analyses covering a 32-year period for the United States show an estimated strike frequency within the fenced area of the plant of approximately 1 event per 30,000 years at PORTS. 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 tornados is believed justified.

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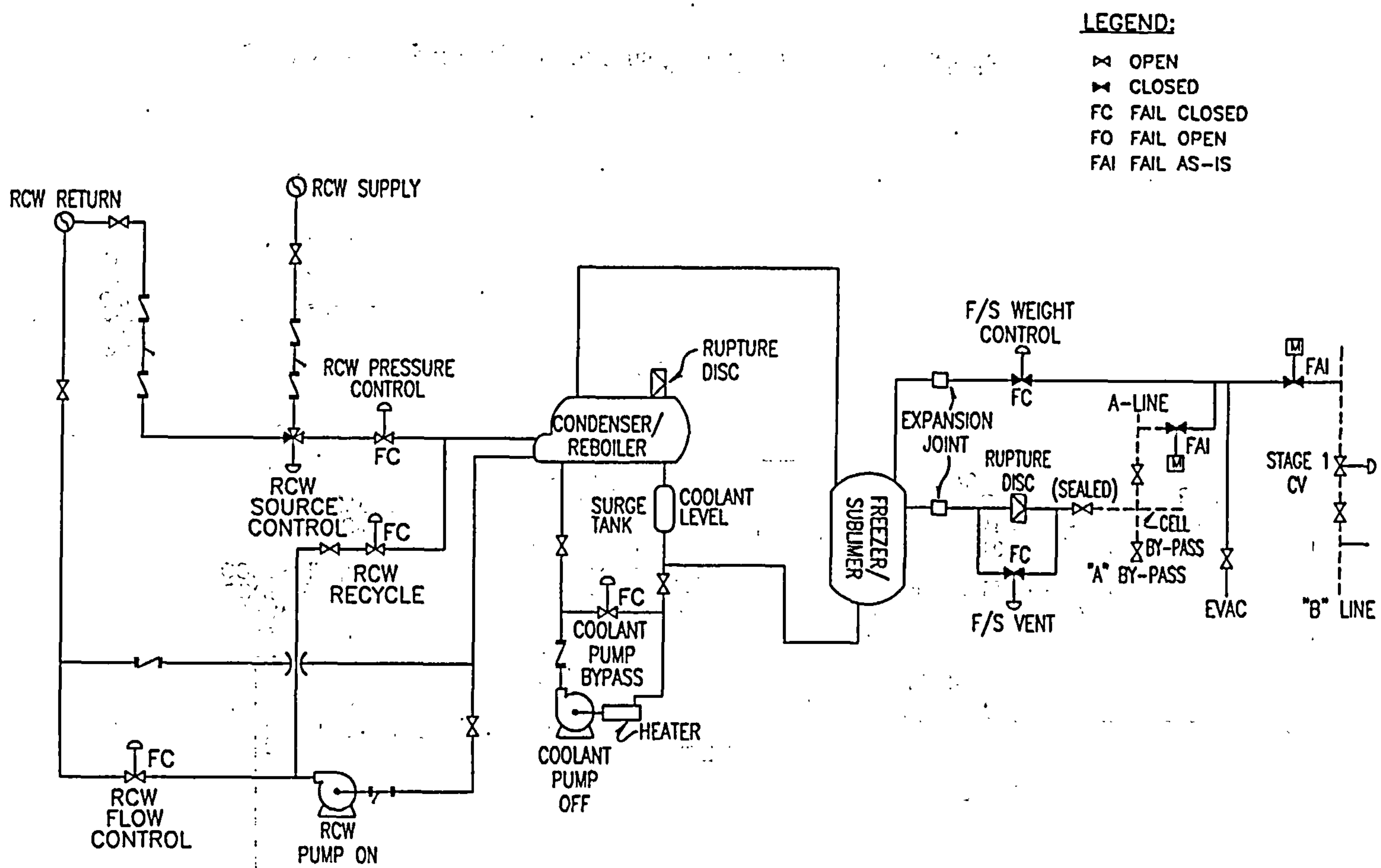

Figure 3.1-29 Operating Conditions for UF_6 Cold Standby Mode

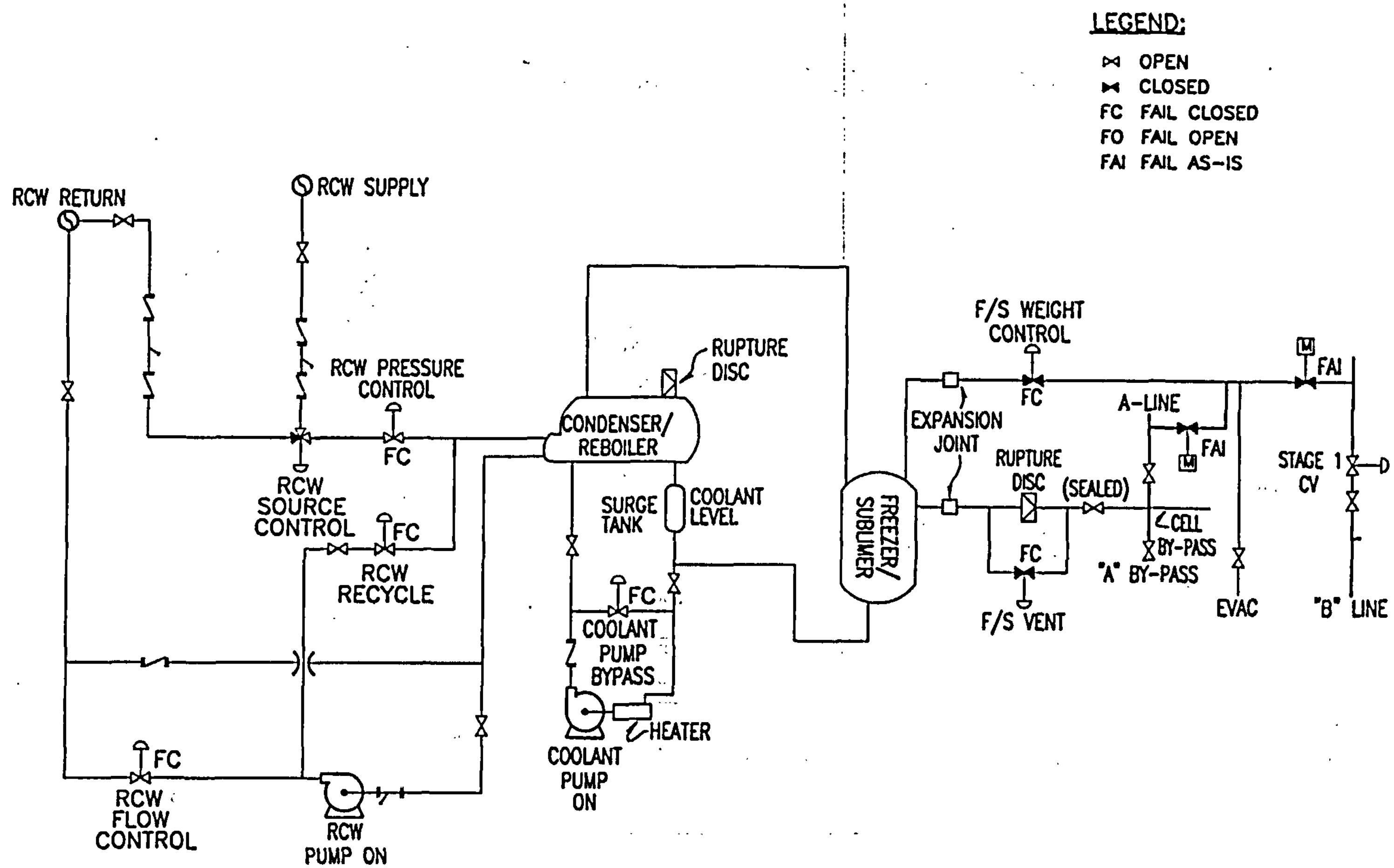

Figure 3.1-30 Operating Conditions for UF_6 Hot Standby Mode

A neutron irradiator is also located in this facility. The source is positioned pneumatically with mechanical or gravity-based fail-safe storage mechanisms. Neutron dose rates are below 5 mRem/hr at 1 ft. (30 cm) from shield surfaces when these devices are deactivated. Dose rates from the largest gamma irradiator will produce maximum radiation fields of less than 500 Rad/hr at 1 meter. Maximum dose rates for neutrons occur with unmoderated ^{252}Cf. This area can also be used for irradiations with low intensity gamma ray standards such as ^{226}Ra and ^{241}Am.

Distance and shielding are employed to assure that external exposures to personnel outside of the beam room are kept below plant limits. For all irradiators, their position is fixed either by size and weight constraints or by their physical installation. Both computer analysis and actual field results verify gamma exposure rates outside of the beam room are less than 0.1 mRad/hr at 1 ft. (30 cm) for measurements in the direct path of the radiation. Scattered radiation levels on the roof will be less than 4 mRad/hr at 1 ft. (30 cm) from either gamma irradiator. Scattered and penetrating neutron radiation fields on the roof will be less than 100 mRem/hr. Therefore, access to this area is physically restricted and is governed by radiological work limits. Appropriate radiological posting and boundary markers are in place should personnel require access to this area. Sky-shine effects in uncontrolled laboratory and outside areas are less than those that would require controlled access to these areas due to radiation levels.

The source storage room is located inside X-700 in the northeast corner of the RADCAL Facility. This area is used both for storage of tertiary and working level alpha and beta particle emission sources as well as a box-type irradiator and other small gamma or neutron sources used in the bench-top calibration or response checks of radiological survey instruments. All radioactive materials stored in this area are kept in special containers provided by the source manufacturer or are kept in lockable storage cabinets. Access to this room is controlled and all activities are controlled by active radiological work controls or direct surveillance.

The radiation protection development laboratory area, which is an integral part of the RADCAL Facility, is located in the southwest corner of this facility outside of the X-700 high-bay area. This laboratory can contain additional alpha and beta particle emission reference standards and miscellaneous low level standard reference materials provided by the National Institute of Standards and Technology. All radioactive materials stored in this area will be kept in special containers provided by the source manufacturer or are kept in lockable storage cabinets. Access to this room is controlled.

3.5.1.1.1.2 Monitoring and Protection Systems in the RADCAL Facility

The design of the facility, the safety devices, and the procedures meet the applicable ANSI and PORTS requirements. The RADCAL Facility is equipped with a number of operational alarms and interlocks that provide protection from the radiation hazard that exists. These include the following features that are part of the RADCAL Facility interlocks, which are important to safety as discussed in Section 3.8:

- Closure switches on the entrance doors and the beam room sliding radiation shielding doors. These composite lead, steel, and concrete doors are normally opened by key access. All irradiators must be de-energized for a door to open without generating a source scram alarm and an immediate return of the source to its storage position.
- Interior motion detectors. No source can be energized if motion is detected in the beam room.
- Neutron and gamma detectors. Separate detectors are interlocked so that no source can be energized if an area monitor is in a high alarm state. All sources will retract if a high alarm

state is actuated after a source is energized. Alert alarm states do not control source operations.

- Manual scram pushbuttons. Scram pushbuttons are located in the control room, beam room, and other convenient locations. Exposure will immediately terminate when the pushbuttons are actuated.
- Source rod assembly. The assembly requires electrical power to position the source during exposure.
- Control relays and solenoid valves for the above listed components.

A horn alarm is located on the control room operator's console that sounds if a scram pushbutton or a detector alarm is actuated.

Electrical power is supplied to the switches, control relays, solenoid valves, and control circuits for the above listed components. The electrical control components are configured such that any open circuit, switch failure, or interruption of power deenergizes the source rod assembly. The source rod assembly is a spring-loaded component that retracts the radiation source if power is interrupted. Therefore, the RADCAL Facility interlocks are fail-safe upon a loss of electrical power.

In addition to the above, the beam room walls and sliding radiation shielding doors are also important to safety as described in Section 3.8. The beam room north, east, and west walls are made of reinforced concrete. The south wall is made of reinforced concrete and contains two equivalent composite shield doors. Each shield door contains steel, boron loaded polyethylene, and lead in equivalent proportions to equal the concrete walls on the south side. No support systems are applicable to the beam room walls and sliding radiation shielding doors.

Although not classified as important to safety, the floor in the beam room has a special covering of concrete mixed with boron frits. Part of the floor in the beam room is below the main floor level.

Fire protection for the RADCAL Facility is provided by an extension of the sprinkler system used in the X-700 Building. The system was installed in accordance with the National Fire Protection Association Standard 13 (NFPA-13).

3.5.1.2 X-720 Maintenance and Stores Building

X-720 contains several types of maintenance shops. The south side of the building contains the Main Stores Area, and a Toxic Materials Storage Area. The building and its facilities are necessary to provide services for maintenance of the plant.

Hazardous materials and spills in the building are handled in accordance with the requirements of Section 5.6.

Specially constructed storage lockers to house toxic materials are located at the east end of the Stores Area. These lockers are equipped with diked doorways and are locked to minimize access to the material.

The work activities involved within this facility have the potential of dealing with radioactive contaminated materials and process related equipment. The requirements for working with radioactive

2.8 EXTERNAL MAN-MADE THREATS

A number of man-made threats external to the PORTS facilities were 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 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 (Dagenhart 1995). 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 (Buildings X-330 and X-326) each have an annual frequency of 2.1×10^{-7} per year of being struck by an aircraft. This frequency is below the risk of concern when compared with other risks associated with operation of PORTS.

2.8.2 Highway Accidents Near the Facility

Traffic accidents on public highways near the plant were considered to have the potential to affect plant structures because of overpressures that could reach the site as the result of an explosion. A calculation was performed using the contents of an 18-wheel tanker truck carrying gasoline as the worst case source of an overpressure event. This calculation was performed using accepted principles of overpressure calculation 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 (i.e., U. S. Highway 23, which is nominally 1 mile away from the plant) such that explosions being initiated from an accident of this type would not affect the site.

2.8.3 Barge Traffic Accidents on Nearby Waterways

Barge traffic does not flow on the Scioto River, which lies about 1 mile from the PORTS facility. The Ohio River does accommodate barge traffic; however, it is situated outside of the 5-mile evaluation zone.

2.8.4 Natural Gas Transmission Pipelines

Due to the USEC decision to discontinue uranium enrichment at PORTS, it is necessary to provide an alternative heat source for DOE facilities that had been heated by the Recirculating Heating Water

(RHW) System. The DOE alternative heating system (RHW Boiler System) consists of two hot work boilers, pumps, controls, and associated equipment in the northeast corner of the X-3002 GCEP Process Building. A natural gas pipeline will be installed from the Pike National Gas Company pipeline near the East Access road and buried about four feet underground to supply fuel for the boilers. The pipeline is installed approximately parallel to the East Access Road on its north side to the east of Perimeter Road, crosses Perimeter Road and runs parallel to the security fence on its south side until it reaches Brebe Avenue, and finally enter the northeast corner of the X-3002 building. The natural gas pipeline will be reduced in pressure to 100 psig when entering the PORTS site and is reduced east of X-622 to 30-40 psig for supply to the boilers in the X-3002 building.

DOE has performed analyses (ASA-SM-3002-0001) for the natural gas pipeline, the fuel oil storage, and the X-3002 RHW Boiler System operation. These analyses show that there would be no impact from accidents involving explosions or fire at the natural gas pipeline on USEC facilities containing or processing NRC regulated materials. While there could be some minor structural damage and injury to personnel, a fire or explosion would not affect the function of any USEC facilities (with the exception of the X-1107BV vehicle portal which could suffer damage and possible irreversible health consequences to personnel in the portal in the event of an explosion). The analyses show that a fire at the fuel oil storage would not impact any USEC facilities containing or processing NRC regulated materials; a large fire could require evacuation of the USEC X-7721 facility, however, it is unlikely that the facility would be damaged.

DOE has installed emergency shutoff valves at the site boundary to stop gas flow on detection of low pressure/high flow rate condition due to a pipeline rupture (these valves also have overpressure protection). The gas pipeline route is clearly identified to minimize the potential for excavation initiated accidents. The pressure reducing valve (100 psig to 30-40 psig) with a second emergency shutoff valve is installed at least 125 feet east of the X-622 facility.

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3.0 FACILITY AND PROCESS DESCRIPTION

The uranium element appears in nature in three isotopes having atomic weights of 238, 235, and 234. All three isotopes are fissionable, but only ^{235}U is capable of sustaining a critical reaction in most practical applications. Natural uranium contains approximately 0.7% ^{235}U isotope. Isotopic separation processes separate uranium (e.g., its compounds) into two fractions, one enriched in the ^{235}U isotope, the other depleted.

In the gaseous diffusion process, isotopic separation is accomplished by diffusing uranium, which has been combined with fluorine to form uranium hexafluoride gas (UF_6), through a porous membrane (barrier). The process utilizes the different velocities of the uranium isotopes to achieve separation. The separation of the lighter ^{235}U isotope from the natural isotopic mixture is small, so the process is repeated many times in various cascade stages to obtain the desired degree of ^{235}U enrichment.

As built, the Portsmouth Gaseous Diffusion Plant comprised 4080 separative stages. UF_6 of any enrichment (i.e., assay) may be fed into the system with current product enrichment limited to less than 10% ^{235}U.

UF_6 is fed from cylinders into the plant in the gaseous state and is withdrawn into cylinders in either the gaseous or liquid state. The withdrawals consist of both the tails (depleted) stream and the enriched stream. The amount of feed and withdrawal depends on the plant power consumption.

The plant has a maximum consumption of 2260 megawatts power. The plant power load is distributed throughout the isotopic and purge stages in operation according to stage size, which is based on the ^{235}U assay and flow of the UF_6 in the stage. Cascade pressures and equipment sizes are tapered from feed to withdrawal points. Natural assay uranium is fed into the largest stage equipment located near the middle part of the cascade, and the high assay is withdrawn from the smaller equipment located at one end of the cascade. The large equipment runs at higher pressures than the small equipment. Compressors are used to move the UF_6 gas streams through the process equipment. The energy introduced into the cascade is removed by heat transfer systems capable of removing the waste energy produced during cascade operations.

Gases lighter in molecular weight than UF_6 that enter the gaseous diffusion cascade are separated from the gaseous UF_6 and discharged through the purge cascades (Top and Side Purges).

The major utility systems and support facilities required to support the uranium enrichment process are identified in the following paragraphs.

A Plant Air System supplies dry air to the cascade for use as instrument air, purge air, and compressor seal air. This air system also serves the plant support and auxiliary systems. A steam plant supplies steam for heating to the cascade and auxiliary and support facilities. A nitrogen system supplies nitrogen to the cascade for use as a purge gas, for compressor seals and cell purging, and to support and auxiliary facilities for specialized operations. The cascade has lube and hydraulic oil systems that maintain a continuous supply of oil to compressor bearings, motors bearings, and hydraulic oil control valves. The cascade also has coolant systems that remove the heat of compression from the process gas and control its temperature. Water systems provide water for use in the cascade recirculating cooling water system, the sanitary water system, and the fire water system.

The plant is supplied electrical power through an extensive electrical supply and distribution system. This electrical power is distributed from the plants electrical switchyards to substations that in turn supply the facilities (e.g., feed facilities, decontamination facility, administrative and support facilities) and processes (e.g., process power systems, process auxiliary power system) on site.

UF_6 feed facilities provide a controlled rate of feed. Facilities are provided to withdraw the depleted gas stream and the product streams. Special equipment is used to move cylinders containing UF_6. The cylinders are stored, shipped, and received with special care to avoid either a criticality or the release of UF_6 to the atmosphere.

Facilities are provided to clean equipment and reclaim uranium. Maintenance facilities are provided for the repair and rebuild of cascade equipment such as converters, compressors, valves and instrumentation. Laboratories provide daily analytical support to cascade operations and develop improved methods and materials.

The plant maintains a fully equipped fire department. Most buildings on plantsite are equipped with automatic water sprinkler systems as required.

Gaseous diffusion plant operations, as well as cascade conditions, are monitored and controlled from Area Control Rooms located in the process buildings and X-300, Plant Control Facility. X-300 has sufficient communications equipment, instrumentation, and control capability to allow personnel to effectively monitor cascade conditions and provide supervision, direction and coordination of overall plant operations during normal and emergency operating conditions.

The PORTS enrichment operations were shutdown by USEC in 2001. Enrichment sufficient to allow for a stand alone enrichment capacity of 3 million SWU per year was placed in a "cold standby" condition. This equipment is currently maintained in cold standby with some chemical treatment for removal of residual deposits and some equipment removal and decontamination is in progress. The remaining cascade equipment is being maintained in a "cold shutdown" condition with some chemical treatment for deposit removal. Decontamination and decommissioning of this equipment is in progress under DOE control. A description of the condition of the enrichment equipment and the activities associated with it is provided in SAR Section 3.1.1.1.5. The remainder of the SAR Section 3.1 provides a description of the enrichment operations certified at the time of the shutdown of the uranium enrichment operations at PORTS.

3.1 CASCADE SYSTEMS

The principal Portsmouth Gaseous Diffusion Plant (PORTS) cascade systems are the enrichment cascade, the purge cascades, the Freezer/Sublimer (F/S) System, and the Cold Recovery System. The enrichment cascade produces enriched uranium via the gaseous diffusion process. The purge cascades remove contaminants from the process gas (PG) stream and allow for venting light waste gases. The F/S System may be used to temporarily store UF_6 from the cascade and to later reintroduce it back into the cascade in order to help maintain cascade efficiency. The Cold Recovery System provides the capability to treat gases removed from the cascade during maintenance activities by separating cascade contaminants from UF_6. The UF_6 can then be recovered for reintroduction into the cascade. The Cold Recovery System can also vent light waste gases from the cascade. These cascade systems, the facilities that house them, and their auxiliary and support systems are described in the following sections.

3.1.1 Uranium Enrichment Cascade

Three basic requirements must be met in order to apply the gaseous diffusion process—a stable process gas (uranium hexafluoride [UF_6]), a porous membrane, and a driving force to cause the process gas molecules to diffuse through the porous membrane. This section describes the enrichment cascade and how these requirements are met.

As a process gas, UF_6 has many advantages for use in the separation of uranium isotopes. It is one of a very few stable uranium compounds with an appreciable vapor pressure at moderate temperature. Furthermore, the fluorine atoms in the molecule have only one natural isotopic weight and the difference in mass between the $^{235}UF_6$ and $^{238}UF_6$ molecules is due entirely to the uranium isotopes. Thus, fractionation by molecular weight separates only the uranium isotopes. The properties of UF_6 are listed in Table 3.1-1. The UF_6 phase diagram is shown in Figure 3.1-1.

The disadvantage of UF_6 is its chemical reactivity. Its use necessitates special materials of construction and special operating techniques. The use of UF_6 also places limitations on the operating temperatures and pressures that may be used.

In the PORTS gaseous diffusion process, the porous membrane is arranged in the shape of a tube called the barrier tube. In consideration of the small amount of material that can be processed in a single barrier tube in a given time, large numbers of tubes are arranged in parallel in equipment called converters. By this means, the total amount of gas processed is increased.

The maximum isotope separation that can be achieved across a barrier tube pore is equal to the square root of the ratio of the weights of the gas molecules. Since the square root of that ratio for the isotopes of UF_6 is 1.0043, the separation of the lighter gas from the natural isotopic mixture is small, but the process is repeated many times to obtain the desired degree of enrichment.

The driving force that causes the gas molecules to diffuse through the barrier pores in one direction is provided by compressors that develop a high pressure ratio and operate efficiently at low suction pressures. Like the barrier tubes, this equipment must operate in an atmosphere of hot corrosive gas.

To ensure diffusive flow through the barrier tubes, a uniform pore size of less than two-millionths of an inch diameter must be maintained (Figure 3.1-2). The amount of barrier surface in each stage, or the number of barrier tubes, depends on the desired production capacity.

3.1.1.1 Functional Description

3.1.1.1.1 Stage

The basic functional unit in the cascade is the stage. A stage consists of a motor, a compressor, and a converter (Figure 3.1-3). The converter contains the barrier tubes and, in some cases, a cooler. The UF_6 in a single stage is introduced as a gas and made to flow, by the compressor, along the inside of the barrier tubes. About one-half of the gas diffuses through the barrier, the A-stream, and is fed to the next higher stage. The remaining, undiffused portion, the B-stream, is recycled to the next lower stage. The A-stream is slightly enriched with respect to ^{235}U, and the B-stream is similarly depleted.

Figure 3.1-3 also shows how stages can be connected in series, or cascaded, to accomplish significant enrichment. Control valves in the depleted, or B-stream, piping are used to control the interstage pressures.

In a theoretical cascade, the size of the equipment in each stage would be slightly different from the stages immediately above or below. The converters that contain the largest barrier area would be located at the normal assay (approximately 0.7% ^{235}U) feed point. The stages above the feed point, known as the enriching section, would be progressively smaller. The stages below the feed location, known as the stripping section, would also be progressively smaller.

In the PORTS cascade, economics dictates the use of groups of process equipment that have components of the same size and operating characteristics, thus limiting the number of different basic sizes. In addition to economics, nuclear criticality safety considerations require progressively smaller equipment and piping sizes as the ^{235}U assay increases through the cascade. As a result, five basic separative equipment sizes (compressors and converters) are used in the stages. The sizes, from largest to smallest, are as follows:

- 000 or X-33 size (largest),
- 00 or X-31 size,
- 0 or X-29 size,
- X-27 size, and
- X-25 size (smallest).

The number of stages required in each section of the cascade is determined by projected operating parameters and by the total level of enrichment and depletion planned.

3.1.1.1.2 Cells, Units, and Bypass Systems

To facilitate maintenance activities and to minimize resulting productivity losses, stages are grouped together to form cells. A cell has bypass, inlet, and outlet block valves that allow it to be taken off-stream, bypassed, and shut down. A cell is the smallest unit of equipment that can be isolated from the cascade for maintenance service. Figure 3.1-4 illustrates the principal components and configuration of a cell. The figure shows a "000"-size cell. Cells of the other equipment sizes are similar, differing primarily in the number of stages per cell and the location of the control valve within the cell.

For practical operation, cells are grouped together to form units. Each unit consists of a number of cells containing the same equipment type and, usually, operating under the same conditions. This grouping also allows additional flexibility in providing auxiliary services (e.g., lube oil and hydraulic oil).

The process equipment is housed in three buildings (X-326, X-330, and X-333). X-333, Process Building, contains 640 stages (80 cells, 8 units) of X-33 (or "000")-size equipment. X-330, Process Building, houses 500 stages (50 cells, 5 units) of X-31 (or "00")-size equipment, and 600 stages (60 cells, 6 units) of X-29 (or "0")-size equipment. X-326, Process Building, houses 720 stages (60 cells, 3 units) of X-27-size equipment, 1440 stages (120 cells, 6 units) of X-25-size equipment, and the purge cascades, which contain 120 isotopic stages (10 cells) and 60 specially designed stages (10 cells) of purge cascade equipment. Specifying the equipment type, unit, cell and stage makes it possible to identify the location of any particular stage. For example, the converter in stage one, cell five, unit three in X-33-size equipment would be specified by the identifier X-33-3-5.1.

References in the cascade description to "uprated" cells or equipment refer to a major PORTS upgrade that was undertaken in the mid-1970s to enable portions of the cascade to be operated above atmospheric pressure. Known as the Cascade Improvement Program/Cascade Uprating Program, this program resulted in modifications to various plant systems and equipment.

3.1.1.1.3 Cascade Shape, Flow and Taper

The term "cascade shape" typically refers to the PG flow configuration among the various cells and units. Several factors influence the cascade shape, including the production rate, the number of cells on-stream, and the availability of electrical power. A cascade producing at a high product rate must have higher mass flow rates between stages than one producing at a lower product rate. To use power efficiently, the stages in the middle of the cascade (or near the feed point) must have higher flow rates than those at the ends. Thus, the cascade shape is usually represented as a diamond—wider near the center, and tapering toward the ends. Figure 3.1-5 provides an example of a hypothetical PORTS cascade shape, given the number of on-stream units, the feed assays, the feed and withdrawal points, the product assay, and the power level. Changes in any of these variables can change the cascade shape. Each block shown in the figure represents a cascade unit. The diamond represents the tapered flow of an ideal cascade of this type.

Figure 3.1-6 presents a graphic representation of the cascade layout, and provides an example of a simplified process flow path to aid in understanding the operation of the cascade. Two feed points are used in this illustration. Normal assay feed is shown entering X-333 at Cell X-33-3-1. Feed product from the Paducah Gaseous Diffusion Plant (PGDP) with a higher assay is shown entering at Cell X-33-8-1. Note that feed points can vary depending upon the assay and cascade conditions. The figure shows a process flow path with all units through X-27-2 on-stream. Units X-27-3 through X-25-6 are shown bypassed (off-stream). Product withdrawal is shown at the Extended Range Product (ERP) Withdrawal Facility in X-326 from Unit X-27-1. Actual product withdrawal points can vary. This figure, though representative, reflects only one of many possible flow configurations. Figure 3.1-7 provides a schematic of the cascade interplant flow.

The PORTS cascade is tapered by appropriate sequencing of the five different equipment sizes and by reducing the pressures across each size equipment, which affects mass flow rate. In units of the same equipment size, tapering is achieved by gradually decreasing the pressure from cell to cell and unit to unit. At the point where the equipment size is reduced, the pressure is raised to compensate for the smaller equipment. Pressure tapering is then resumed. As the equipment size is further reduced, pressures are again tapered down toward the cascade ends in order to achieve efficient flow distribution.

3.1.1.1.4 Cascade Operation

PORTS has the operational capability to produce up to 10% ^{235}U product. The stripping section of the cascade can strip the ^{235}U isotope from normal feed material to reduce the concentration of ^{235}U in the depleted material, or tails, to the desired level. Stages designed to enrich or strip ^{235}U are known as "isotopic" stages. The PORTS cascade also contains purge stages that separate and purge contaminants from the system.

The cascade feed may be made up of two (sometimes more) streams of different assays. The lower feed stream is usually normal assay material (approximately 0.7% ^{235}U); the higher feed usually consists of slightly enriched product from the PGDP. The major cascade feed streams are supplied through feed headers connected to the feed autoclaves in X-342A, Feed Vaporization & Fluorine Generation Building, and X-343, Feed Vaporization & Sampling Building. Normal feed material is fed in X-333. For normal feed, Units X-33-3 and above are usually in the enriching section. The A-stream flows up the cascade (in the direction of higher enrichment), through the X-33 units, to the X-31 units in X-330.

Unit X-31-3 is normally the first unit above the X-33-size equipment. From the X-31 units, flow proceeds up the cascade to Units X-29-2 through -6. The A-stream flow can be sent to Unit X-27-1 in building X-326 from the top operating cell in X-330. Conversely, the B-stream flow can be sent from Unit X-27-1 to the top operating cell in X-330.

Units X-29-1, X-31-1, and X-31-2 are normally in the stripping section of the cascade and are below the X-33 units in the cascade flow arrangement. This accounts for the placement of the X-31 units between X-29-1 and X-29-2. Although the bottom of the cascade can be changed to any cell between X-31-1-1 and X-29-1-10, as economics dictate, X-29-1-10 is typically the bottom cell in the cascade, and the depleted B-stream from this cell becomes the "tails." This material is usually withdrawn at the Tails Withdrawal Facility.

The stages in X-330 and X-333 employ the "Badger" design in which both the A- and B-streams are compressed at each stage by a single compressor. Within a given cell, the B-stream flow from each converter is recycled back to the compressor of the previous stage. The B-stream from the bottom stage in the cell normally flows to the next cell down the cascade (in the direction of lower enrichment), while the A-stream normally flows from the top of the cell to the bottom of the next cell up the cascade. Control valves in the B-stream piping to each compressor are used to control the interstage pressure. In X-326, where the flow rate is lower and the equipment is smaller, stage control valves are installed at every third stage. This arrangement, called the "Badger Cluster," has two A-stream compressors and one A-B stream compressor in each cluster. Block valves are provided to isolate the lines extending into the units. Block valves are also provided on the building lines at each unit to separate units.

Bypass piping is provided around cells and units to allow flexibility in plant operations and maintenance. During normal operation, portions of the cell and unit bypass piping are used for flow up and down the cascade of the A-streams and B-streams, respectively. When a cell or unit is taken off-stream, the A-streams and B-streams are routed around that equipment by the use of the bypass piping. Evacuation lines and other auxiliary headers may also be used as bypass piping when the normal bypass piping cannot be used. PG flow between the process buildings is via tie-lines that provide a direct link between X-330 and X-333 and between X-330 and X-326.

Product withdrawals are typically made at the X-326 ERP Facility and the X-333 Low Assay Withdrawal (LAW) Facility. The Tails Withdrawal Facility, located in X-330, is where the tails stream is normally condensed and withdrawn. The Tails Withdrawal Facility can also be configured as a product withdrawal station. The feed and withdrawal facilities are described in Section 3.2.

Contaminant gases that enter the cascade through leaks or through operations and maintenance activities are removed in the purge cascades. The purge cascades are described in Section 3.1.2.

The cascade is equipped with multiple surge and power control systems that may be used to handle inventory shifts and facilitate efficient operation, including the Intermediate Surge System, the Bottom Surge System, and the F/S Systems.

Process equipment, piping, and instrument lines that contain PG are enclosed in housings to prevent condensation, or freeze-out, of UF_6. The housings retain the heat generated in the enrichment process, or they are provided with supplementary heating to ensure that the UF_6 remains a gas. The housings are described in Section 3.1.1.3.

Auxiliary systems that support the cascade include cascade coolant systems, lube oil systems, buffer systems, and UF_6 leak detection, as well as typical utilities, such as electrical power, compressed air, nitrogen (N_2), and various plant water systems. Fire protection is provided in each process building.

3.1.1.1.5 Process Buildings

This section contains general descriptions of the principal facilities and systems located in the three process buildings. The building structures are important to safety as described in Section 3.8.

The buildings are constructed of structural steel framing with reinforced concrete floors. The overall size varies among the three buildings; however, each includes an operating floor at grade, a cell floor above grade, and valve platforms at various levels above the cell floor. The buildings are composed of structural modules that are separated by construction joints (gaps) at the cell floor and the roof. In general, two support columns exist at each column line—one for each adjoining module—though shared columns exist at some column lines. Where separate columns are used for adjacent modules, the columns are not linked structurally, but they share a common foundation. Where shared columns are used, module separation is augmented by slotted connections at the beam-to-column joints. These connections transmit vertical loads, but the slots limit the transmission of lateral loads. The wide-flange columns extend through the grade slab where they are connected to baseplates that are anchored to foundation piers or footers. The ground floor slab is soil-supported and is not tied to the building column footings.

Siding is corrugated cementitious board attached to building girders. The buildings' roofs are composition roofing supported by steel trusses and purlins. The roofs are sloped to facilitate draining. Curbs (parapets) equipped with scuppers surround the roofs.

All three buildings are above the maximum flood elevation for the site, and no damage would be experienced from a flood. Accumulation of rainwater could occur on the roof as a result of heavy rainfall. However, no loss of UF_6 primary system integrity is expected to result from heavy rainfall. The buildings are expected to maintain their structural integrity in the most severe evaluation-basis earthquake event. High winds could cause siding failures at X-326, X-330 and X-333; however, no structural failures are expected to occur.

The separative, or PG, equipment and associated valves and piping are located on the second, or cell, floor of each building. In general, the ground, or operating, floor is the location for the control facilities, electrical switchgear, ventilation fans, unit auxiliary equipment, cell servicing facilities, and maintenance facilities.

3.1.1.1.5.1 X-333 Process Building

X-333 is approximately 1,456 ft long, 970 ft wide, and 82 ft high. It houses the largest of the process equipment (X-33 size) and the LAW Facility. The functional layout of the process cells in X-333 is shown in Figure 3.1-6. Although all of the enrichment cascade equipment in X-333 is X-33-size equipment, the horsepower-ratings on the compressor motors vary. For cascade optimization, the higher horsepower compressor motors are in the middle units on the east end of the building and the lower horsepower motors are in the end units at the west end of the building.

An Evacuation Booster Station (EBS), located on the cell floor approximately in the center of the building, is used in the preparation of cells and piping for maintenance (Section 3.1.1.4.1). The LAW Facility is located in the west end of X-333. The LAW Facility is described in Section 3.2.2. Two interbuilding booster stations (A-booster and B-booster) are located in X-333. They are used to maintain the flow continuity between the terminal stages in this building and the initial stages in X-330. The booster stations are described in Section 3.1.1.4.2.

A PG mover station, which may be used for cell servicing, is located on the cell floor between Units 4 and 5. The configuration of the PG mover station is similar to that of the EBS. However, unlike the EBS, light gases cannot be pumped by the PG mover station. The X-333 F/S Systems, located in Units X-33-2 through X-33-7 are described Section 3.1.3.

Area Control Room (ACR) 1, located on the operating floor near the center of the building, is the main control facility for X-333. This section of the cascade is referred to as Area 1. In addition to cell controls and instruments, the ACR is equipped with controls and instrumentation for the EBS, the LAW Stations, the PG mover station, and for auxiliary equipment, such as the diesel-powered backup generators. See Section 3.1.1.10.2 for a description of the instrumentation in the ACR.

Administrative offices, a kitchen, and restroom facilities are located in rooms adjacent to the control room. The basement below the ACR provides access to instrument cable tunnels that lead to X-300, Plant Control Facility (PCF), via the X-330 tunnel and to X-533B, Switch House.

Communications systems in the ACR are described in Section 3.1.1.10.2.10.

Local Control Centers (LCCs) for each enrichment cascade cell are located on the operating floor just below the equipment on the cell floor (Section 3.1.1.10.1).

The X-333 Cold Recovery System, which includes the surge drum room, a holding drum room, a refrigeration system, and a cold trap room, is located on the operating floor between Units X-33-3 and X-33-6 (Section 3.1.4). The X-333 Seal-Exhaust Station is located adjacent to ACR 1 (Section 3.1.1.6.1). A Coolant Drain, Recovery, and Transfer Station, which serves the cell cooling systems, is located on the ground floor just south of the ACR (Section 3.1.1.6.7).

The building also houses multiple electrical substations and distribution panels on the operating floor that supply power to the building's compressor motors and auxiliary systems (Section 3.1.1.8). Other major equipment on the operating floor includes the air compressors located in the southwest corner of the operating floor that are part of the Plant Air System (Section 3.1.1.6.6) and the building ventilation supply fans (Section 3.1.1.7).

A truck alley and a railroad spur track extend along the east and west sides of X-333 for delivery and pickup of process equipment. The cell floor extends over the truck alley and has hatches located under each crane bay. Heavy process equipment and motors are lifted to the cell floor for installation or storage of spares.

The X-333 Building enrichment equipment is currently either in a shutdown or in a "cold standby" condition. The equipment may be restarted for treatment and removal of deposits and/or to begin enrichment operations again. Cells have been evacuated of UF_6, a UF_6 negative obtained, and a dry gas buffer applied at slightly above atmospheric pressure. The shutdown cells are isolated from the RCW system; the cold standby cells are either isolated from the RCW system (condensers drained) or have a flow of RCW through the condensers (R-114 is present in cell coolant system in this case). The R-114 coolant is either stored in the cell coolant system, in the coolant storage tanks or is stored in railcars. The seal exhaust system remains operational to the extent required to support standby requirements and cell treatment operations. The X-333 Cold Recovery facility remains operational to support cell treatment for recovery of deposits and to support processing of vent gases from the X-340 complex. Lube oil is drained and isolated from cells in shutdown or cold standby. The unit lube oil system for standby systems remain operable.

Cell maintenance is performed to maintain the cells in a shutdown or "cold standby" condition, to prepare cells for chemical treatment for deposit removal, and to remove equipment for decontamination. Cell treatments, including inverse recycle treatments, are performed to recover deposits. The cell treatment gases are routed to one of the Cold Recovery facilities for recovery of UF_6, or are routed to the X-326 Building for processing in the isotopic/purge cascade cells. Any UF_6 recovered will be withdrawn at ERP or PW. The building is equipped with electric heaters, described in SAR Section 3.1.1.7, to assure that the High Pressure Fire Water System (HPFWS) remains above freezing and in service. The TSRs governing the X-333 Building cascade operations do not require the HPFWS to be operable when cells are shutdown and with the lube oil drained to the storage tanks. The CAAS remains operable and the TSRs remain in effect. The TSRs for the building enrichment equipment operation remain in effect for the applicable operating mode. Any cells with deposits are controlled as required by the TSRs and NCSAs.

3.1.1.1.5.2 X-330 Process Building

X-330 is approximately 2176 ft long, 640 ft wide, and 66 ft high. It houses X-29 and X-31-size equipment and the Tails Withdrawal Facility. The functional layout of the process cells in X-330 is shown in Figure 3.1-6. As indicated in the figure, the X-31 units are located between Unit X-29-1 and the remaining X-29 units. This arrangement facilitates cascade operations as described previously in Section 3.1.1.1.4.

An EBS similar to the one in the X-333 Building is located on the east side of the building in front of X-31-5-2 (Section 3.1.1.4.1). The Tails Withdrawal Facility is located in the northeast corner of X-330. The Tails Withdrawal Facility is described in Section 3.2.2. Two interbuilding booster stations are located on the cell floor. The A-booster to X-333 is on the east side of the building east of X-31-2. Its function is to overcome the pressure drop in the tie-line between the top cell of Unit X-31-2 (normally Cell 2) and the bottom cell of X-33-1 (normally Cell 1). A second booster station, located in the southeast corner of X-330 in front of Cell X-29-6-2, is used to boost the A-stream to X-326 (Section 3.1.1.4.2).

An Intermediate Surge Booster compressor, located on the east side near cell X-29-1-2, may be used when needed to pump PG from the B-stream of Unit X-33-1 to the intermediate surge drums (located on the operating floor) for PG inventory control and to minimize the effects of downsurges from the larger X-33 equipment (Section 3.1.1.5).

Two ACRs are provided on the operating floor of X-330 because of the large number of process stages in the building. ACR 2 is located between Units X-31-2 and X-31-3, and ACR 3 is located between Units X-29-3 and X-29-4. ACR 2 has instrumentation for Unit X-29-1 and Units X-31-1 through X-31-5. The area controlled by ACR 2 is referred to as Area 2. The Tails Withdrawal Facility control panels are also located in ACR 2. ACR 3 has the instrumentation for Units X-29-2 through X-29-6. The equipment associated with this control room is referred to as Area 3. See Section 3.1.1.10.2 for a description of the instrumentation in the ACRs.

As in X-333, administrative offices, a kitchen, and restroom facilities are located in rooms adjacent to the ACRs. The basement below the ACRs provides access to instrument cable tunnels that connect X-300 and X-530B, Switch House. Security barriers control ingress in certain tunnels. Communications systems in the ACRs are described in Section 3.1.1.10.2.10.

As in the other process buildings, LCCs for each enrichment cascade cell are located on the operating floor below the associated equipment on the cell floor (Section 3.1.1.10.1).

The X-330 Cold Recovery System is located at the east side of the building between Units X-31-5 and X-29-2 on the operating floor (Section 3.1.4). The surge-drum room for the bottom surge and the intermediate surge is located on the operating floor at the east end of Cell X-29-1-2 (Section 3.1.1.5.1).

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Two coolant drain stations are available—one located at Unit X-31-2, and the other at Unit X-29-3 (Section 3.1.1.6.7). The Interim Purge Facility is located on the ground floor at the east end of Unit X-29-5 (Section 3.1.4.2).

The building also houses multiple electrical substations and distribution panels on the operating floor that supply power to the building's compressor motors and auxiliary systems (Section 3.1.1.8). Other major equipment on the operating floor includes the air compressors, which are a part of the Plant Air System, and a nitrogen plant, which is part of the Plant Nitrogen System, located on the ground floor in the southeast corner of the building (Sections 3.1.1.6.6 and 3.1.1.6.5). The building maintenance shop area is located approximately in the center of the building on the operating floor.

A ventilation system provides the building with effective protection of equipment and with suitable ambient conditions for working personnel. Process heat from the cell floor is used to heat the operating floor during cold weather (Section 3.1.1.7).

A truck alley and a railroad spur track extend along the west side of X-330 for delivery and pickup of process equipment. The cell floor extends over the truck alley and has hatches located under each crane bay. Heavy process equipment and motors are lifted to the cell floor for installation or storage of spares.

The X-330 Building enrichment equipment is currently either in a shutdown or in a "cold standby" condition. The equipment may be restarted for treatment and removal of deposits and/or to begin enrichment operations again. Cells have been evacuated of UF_6, a UF_6 negative obtained, and a dry gas buffer applied at slightly above atmospheric pressure. The shutdown cells are isolated from the RCW system; the cold standby cells are either isolated from the RCW system (condensers drained) or have a flow of RCW through the condensers (R-114 is present in cell coolant system in this case). The R-114 coolant is either stored in the cell coolant system, in the coolant storage tanks or is stored in railcars. The seal exhaust system remains operational to the extent required to support standby requirements and cell treatment operations. The X-330 Cold Recovery facility remains operational to support cell treatment for recovery of deposits and to support processing of vent gases from the X-340 complex. Cells in shutdown or cold standby are isolated from the unit lube oil system and the oil is drained from the cell. The unit lube oil system remains operable.

Cell maintenance is performed to maintain the cells in a shutdown or "cold standby" condition, to prepare cells for chemical treatment for deposit removal, and to remove equipment for decontamination. Cell treatments, including inverse recycle treatments, are performed to recover deposits. The cell treatment gases are routed to one of the Cold Recovery facilities for recovery of UF_6, or are routed to the X-326 Building for processing in the isotopic/purge cascade cells. Any UF_6 recovered will be withdrawn at ERP or PW. The building is equipped with electric heaters, described in SAR Section 3.1.1.7, to assure that the High Pressure Fire Water System (HPFWS) remains above freezing and in service. The TSRs governing the X-330 Building cascade operations do not require the HPFWS to be operable when cells are shutdown and with the lube oil drained to the storage tanks. The CAAS remains operable and the TSRs remain in effect. The TSRs for the building enrichment equipment operation remain in effect for the applicable operating mode. Any cells with deposits are controlled as required by the TSRs and NCSAs.

3.1.1.1.5.3 X-326 Process Building

X-326 is approximately 2,230 ft long, 552 ft wide, and 62 ft high. It houses the X-27 and X-25-size equipment, the purge cascades and equipment, and the ERP Facility. The functional layout of the process cells in X-326 is shown in Figure 3.1-6. Cascade flow from X-330 enters X-326 at the northeast corner of the building and is directed into the first cell in Unit X-27-1.

The same basic auxiliary-service designs are used in X-326 as are used in the other buildings. The ERP Facility is located at the northeast corner of the building (Section 3.2.2).

Three ACRs (4, 5, and 6) are located in X-326. Two of the three, ACR 4 and ACR 6, are used directly for the control of operating equipment. ACR 4 is located between Units X-27-2 and X-27-3 on the operating floor. It has the cell monitoring and control instruments and auxiliary system instrumentation for Units X-27-1, X-27-2, X-27-3, and X-25-1. This section of the cascade is referred to as Area 4. Instrumentation for monitoring the ERP Station, the building evacuation valves in Area 4, and two diesel-operated backup generators is also located in this ACR. ACR 5 is no longer used to control operating cells due to the suspension of highly enriched uranium (HEU) production activities. It is located between X-25-3 and X-25-4, and it has the cell and auxiliary system controls and instrumentation for unused Units X-25-2, X-25-3, X-25-4, and X-25-5. Controls that were in ACR 5 that are needed for plant operation have been relocated to ACR 4 or ACR 6.

ACR 6 is located between Units X-25-6 and X-25-7. It has instrumentation and controls for X-25-6 and X-25-7, including the purge cells, the auxiliary systems for both units, line recorders for Units X-25-6 and X-25-7, and a slave recorder from the X-27-1B (even cells) recorder that monitors light contaminants' upflow to the side purge. Instrumentation is also included for controlling and monitoring the purge cascades (Section 3.1.2), the Freon degrader (Section 3.1.2), and the two diesel-operated generators that supply backup power to Area 6 and emergency power loads in X-300 (Section 3.4.1).

See Section 3.1.1.10.2 for a description of the instrumentation in the ACRs.

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Administrative offices, a kitchen, and restroom facilities are located in rooms adjacent to the control room. The basement below the ACR provides access to an instrument cable tunnel that leads to X-300. Security barriers control ingress in certain tunnels. Communications systems in the ACRs are described in Section 3.1.1.10.2.10.

LCCs for each enrichment cascade cell are located on the operating floor just below the equipment on the cell floor (Section 3.1.1.10.1).

A surge-drum room is located on the east side of the building at the end of Unit X-25-3 (Section 3.1.1.5). Two coolant drain and recovery stations serve the cell Coolant Systems. See Section 3.1.1.6.7 for a description of the Coolant Storage and Transfer Systems.

The Freon degrader, which is used to facilitate purging of Freon coolant contaminants from the light-contaminant upflow, is located near Cell X-25-7-16 (Section 3.1.2). The Product Withdrawal facility is located at the southwest corner of the building (Section 3.2.3). The alumina traps and air jets for the purge cascades are located at the south end of the building (Section 3.1.2). The maintenance shop is located in the center of the building between Units X-25-2 and X-25-3 on the operating floor. This process building also houses multiple electrical substations and distribution panels on the operating floor that supply power to the building's compressor motors and auxiliary systems. Other major equipment on the operating floor includes a diesel-powered backup air compressor, part of the Plant Air System, located in the northeast corner of the building (Section 3.1.1.6.6), and the building ventilation supply fans (Section 3.1.1.7).

A truck alley and a railroad spur track extend along the west side of X-326 for delivery and pickup of process equipment. The cell floor extends over the truck alley and has hatches located under each crane bay. Heavy process equipment and motors are lifted to the cell floor for installation or storage of spares.

The X-326 cascade equipment in Unit X-25-7 and selected cells in Units 27-1 and/or 27-2 are operated as needed to support the deposit recovery operations and the venting operations from the X-340 complex. The remaining X-326 Building enrichment equipment is currently in either a "shutdown" or "cold standby" condition. The equipment may be restarted for treatment and removal of deposits and/or to begin enrichment operations again. Shutdown and cold standby cells have been evacuated of UF_6, a UF_6 negative obtained, and a dry gas buffer applied at slightly above atmospheric pressure. The shutdown cells are isolated from the RCW system and the lube oil has been drained from the system to the storage tanks (or has been removed) and the R-114 coolant has been removed. The cold standby cells are isolated from the RCW system and the R-114 coolant is either stored in the cell coolant system, in the coolant storage tanks or is stored in railcars. The cold standby cells are isolated from the unit lube oil system and the lube oil is drained from the cells. The unit lube oil system is operable. The seal exhaust system remains operational to support standby requirements and cell treatment operations. The ERP and PW withdrawal facilities remain operational to support cell treatment for recovery of deposits and to support processing of vent gases from the X-340 complex.

Cell maintenance is performed to maintain the cells in a shutdown or "cold standby" condition, to prepare cells for chemical treatment for deposit removal, and to remove equipment for decontamination. Cell treatments, including inverse recycle treatments, are performed to recover deposits. The cell treatment gases are routed to one of the Cold Recovery facilities for recovery of UF_6, or are processed in the isotopic/purge cascade cells. Any UF_6 recovered will be withdrawn at ERP or PW. The building is equipped with electric heaters, described in SAR Section 3.1.1.7, to assure that the High

Pressure Fire Water System (HPFWS) remains above freezing and in service. The TSRs governing the X-326 Building cascade operations do not require the HPFWS to be operable when cells are shutdown and with the lube oil drained to the storage tanks. The CAAS remains operable and the TSRs remain in effect. Any cells with deposits are controlled as required by the TSRs and NCSAs. The TSRs for the building enrichment equipment operation remain in effect for the applicable operating mode.

3.1.1.2 Major Cascade Equipment

The containment function of the UF_6 primary system, including PG piping ≥2 inches in diameter, expansion joints, PG coolers, and associated valves and equipment containing UF_6, is important to safety as described in Section 3.8. The process system consists of an assembly of piping, vessels, compressors, valves, and auxiliary systems designed to circulate PG (primarily UF_6) for separating the uranium isotopes. The motor-driven compressors represent the only major dynamic equipment in the cascade. The compressor drive motors are outside the insulated enclosures. The maximum operating pressures for the cascade system are 25 psia (for uprated cells) and 14.45 psia (for non-uprated cells). Piping and equipment are designed to criteria that assure they meet or exceed the operating conditions they are expected to encounter.

Welds in the UF_6 primary system (converters, compressors, expansion joints, piping, and valves) have been pressure tested. All systems have been vacuum leak tested, and they meet the leakrate criteria specified in plant procedures.

3.1.1.2.1 Materials of Construction

The cascade materials of construction have good resistance to attack by the three fluorinating agents used in cascade operations—UF_6, fluorine (F_2), and chlorine trifluoride (ClF_3). Nickel plated steel, Monel, and some other alloys with a high nickel content have proven to be the most satisfactory materials,

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especially for high temperature operation. The corrosion rate for nickel and certain high-nickel alloys can be reduced by a protective coating of nickel fluoride.

Copper is acceptable for some process uses, and copper tubing is widely used for instrument lines. Some aluminum alloys also have good resistance to fluorinating agents and may be used for cooler components, converter transition pieces, compressor blades, compressor stator assemblies, and gasket material. Phosphor bronze finds various applications including bellows and Bourdon tube assemblies; while the uses of aluminum bronze include some converter fasteners. Inconel and certain stainless steels can also be used in specific applications.

Teflon and other plastics with suitable physical and chemical properties may be used as valve seats and packings. Viton and Fluorel elastomers have been successfully used as O-rings and gaskets.

3.1.1.2.2 Converters

The containment function of the UF_6 primary system, including the converters, is important to safety as described in Section 3.8. The main parts of the converter are the shell, the barrier tube bundle, and, in the larger size converters, the cooler. Five sizes of converters are used in the PORTS cascade. These are designated as "000" (or X-33), "00" (or X-31), "0" (or X-29), "X-27", and "X-25". The five sizes are similar in construction, except that the coolers are internal to the "000"-, "00"-, and "0"-size converters, while they are installed outside of the smaller X-27- and X-25-size converters. Figures 3.1-8 and -9 show examples of a large converter, with its internal cooler, and a smaller converter without an internal cooler.

The converters provide a gas-tight container for the barrier, and also supply the flow channels for the A- and B-streams. In each converter, PG enters a common inlet and is separated by diffusion into an A-stream and a B-stream, each of which leaves the converter through a separate outlet nozzle. The shells of all converters, which comprise part of the UF_6 containment, are fabricated of nickel-plated steel.

Barrier tube failure, such as the rupture of a small number of tubes would be of small consequence, resulting only in the loss of separative work efficiency. However, the rupture of a large number of barrier tubes could result in overload of the upstream compressor. The most common problem associated with the converters is plugging caused by the introduction of wet air. For plugging to take place, other failures must occur in the system, such as compressor shaft seal failures, expansion joint ruptures, or instrument line leakage. The term "barrier plugging" usually refers to a film of uranyl fluoride (UO_2F_2) collected on the barrier tube walls, rather than complete filling of the tubes. Even a thin film on the barrier tube walls will cause a change in converter operating characteristics. In most cases, barrier plugging will occur over a long period of time, and it is usually caused by small leaks in welds or instrument lines.

3.1.1.2.3 Compressors

The motive force that is required to overcome the gas stream pressure drop across the converters and move the gas through the cascade is provided by the compressors. Various designs of axial and centrifugal compressors are used in the cascade, depending upon the operating requirements, which vary at different points in the cascade. The containment function of the UF_6 primary system, including the compressors, is important to safety as described in Section 3.8.

A pressure drop occurs in the PG flow across each stage converter. In order to maintain the flowrate through the cascade, both the A- and B-streams must be recompressed at each stage of a Badger arrangement. This requirement is met by the use of compressors that can handle the compression of both streams and introduce the resulting gas stream as feed to a single converter. The discharge stream from the compressor is a mixture of the A-stream from a stage lower in the cascade and the B-stream from a stage higher in the cascade.

In the large-size stages (in X-330 and X-333), axial compressors are used because high efficiency is important where the largest quantities of power are consumed. In these buildings the stages are of the Badger design, where both the A- and B-streams are compressed at each stage by a single axial flow compressor, and the pressure is controlled by a control valve at each stage.

In X-326, where pressures are lower, interstage flows are small, and peak stage efficiency is less important. In this part of the cascade, the Badger Cluster arrangement uses the smaller two-stage centrifugal compressors. The Badger Cluster is described in Section 3.1.1.1.4.

Single-stage centrifugal compressors, axial compressors, or a combination of the two, are used in the building booster stations and the EBSs. These compressors are described in Section 3.1.1.4.

3.1.1.2.3.1 Centrifugal Compressors

Each centrifugal process compressor has two compression stages. In a type-A compressor, the gas streams enter the suction of the compressor and are routed into the first-stage impeller where they are compressed and routed into the suction of the second-stage impeller. The second-stage discharge enters a cooler where the gas is cooled prior to entering the converter. In the type-B compressor, the depleted stream returning from the stage above enters the compressor at the suction to the second-stage impeller. There, it mixes with the discharge of the first-stage impeller. As in the type-A compressors, flow from the second-stage impeller discharges into a cooler where the gas is cooled prior to entering the converter.

The two impeller stages are mounted on a common shaft, and gas flow is routed by the use of vanes and dividers inside the compressor. The shaft is supported by a load bearing on the drive end and a combination load-and-thrust bearing on the outboard end. The shaft is equipped with seals to prevent the inleakage of atmospheric air into the process system. The shaft may also be equipped with blowout preventers to allow the seals to be isolated from the process system for seal maintenance. Lubrication is supplied to the compressor bearings by a recirculating Lube Oil System, which is described in Section 3.1.1.6.3.

3.1.1.2.3.2 Axial-Flow Compressors

Axial-flow compressors are used to move large volumes of gas in the cascade. These machines, which are larger than the centrifugal compressors, are designated as "0", "00" or "000"-size. Figure 3.1-10 shows an example of an axial-flow compressor. This figure illustrates the principal compressor components, which are similar for all sizes of axial flow compressors. The "0" and "00" compressors are used in X-330, and the "000" compressors are used in X-333.

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 contains rows of stationary blades called the stator. Each set of blades (rotor-stators) constitutes a compression stage, and many stages can be combined efficiently to achieve high pressure ratios and high gas flow rates. As with the centrifugal compressors, the axial compressor shafts are equipped with seals to prevent inleakage of atmospheric air into the process system. The shafts may also be equipped with blowout preventers to allow the seals to be isolated from the process system for seal maintenance. Lubrication is supplied to the compressor bearings by a recirculating Lube Oil System, which is described in Section 3.1.1.6.3.

3.1.1.2.3.3 Compressor Shaft Seals

The containment function of the UF_6 primary system, including the compressor shaft seals, is important to safety as described in Section 3.8. The seals are designed to prevent the loss of UF_6 from the system and to minimize the inleakage of gases to the cascade. Each isotopic and purge cascade compressor requires two seal assemblies—an "A" seal at the suction end and a "B" seal at the high-pressure discharge end. The pressure conditions for seal operation are, therefore, different even for the seals on the same machine. Overhung-rotor centrifugal compressors, such as those used in the EBSs and the booster stations, require only one seal per machine.

Each seal system is equipped with a nitrogen feed line from the Plant Nitrogen System, a dry air feed line from the Plant Air System, and a seal exhaust line. The seal exhaust pressure is set above process pressure, the seal feed (nitrogen feed line) pressure is above the seal exhaust pressure, and the dry air pressure is set above the seal feed pressure. Thus, the seals are designed so that, in the event of seal failure, nitrogen and dry air are pulled into the process system rather than PG leaking out. See Section 3.1.1.6.5 for a description of the Plant Nitrogen System and Section 3.1.1.6.6 for a description of the Plant Air System. See Section 3.1.1.10.1.4 for a description of the Seal Feed Systems and Seal Exhaust Systems instrumentation and controls.

Isotopic compressors may also be equipped with "A" and "B" blowout preventers (BOPs), which correspond to the A and B compressor seals (Figure 3.1-10). These devices may be used to temporarily provide a seal between the PG and the shaft seal to permit a seal to be changed on a compressor. For "000"-size compressors, the lever-actuated BOP mechanism also lifts the compressor shaft to facilitate removal of the compressor bearings and seals. The "B" BOP actuators are buffered to prevent outleakage of PG. To provide operational flexibility, the actuator assemblies of failed BOPs on centrifugal compressors may, on a case-by-case basis, be replaced with cover plates.

3.1.1.2.4 Motors

Air-cooled, squirrel cage induction motors are used to drive the compressors. The motors are standard industrial equipment. A system of air supply and exhaust fans is used to generate air movement in the vicinity of each motor. In the X-33, X-31, X-29 and X-27 equipment, air is drawn through openings in the motor support bases by exhaust fans connected to exhaust ducts that lead to the outside and the operating floor.

The breakers and control circuit switches for the compressor motors are located on the operating floor level; whereas, the motors are on the cell floor level. The control circuits are such that the cell motors can be stopped from the ACRs, the PCF, and the switchyard, as well as the LCCs. They can only be started from the LCC.

3.1.1.2.4.1 Compressor Motor Manual Trip System

The Compressor Motor Manual Trip System enables operators to shut down the cell and booster compressor motors in the cascade from the ACR and to shutdown the cell and interbuilding booster compressors from the PCF. In the enrichment cascade, the trip circuit in each cell shuts down all of the compressors in the cell. In the EBS and the interbuilding boosters, trip circuits are provided for individual compressors. The Compressor Motor Manual Trip Systems for the cell compressor motors, and the DC Power Systems that support them, are important to safety as described in Section 3.8.

In X-326 and X-330, actuation of manual pushbuttons located in the ACR and the PCF initiates a signal to the trip coil of the cell motor circuit breaker. The trip coil then energizes, via the DC power supply, and initiates a breaker trip. The breaker trip disconnects motive power to the compressors in the cell. The cell circuit breakers for X-326 and X-330 are electric.

In X-333, actuation of manual pushbuttons located in the ACR and the PCF initiates a signal to the trip coil of an air circuit breaker (ACB) in the switchyard, which opens the 13.8 kV supply to the cell transformer. Tripping the ACB disconnects the motive power to the associated cell compressors.

The ACB is equipped with an air receiver that is designed to store air with sufficient pneumatic force to open the ACB in the event the normal air supply is not available. A check valve is provided on the air supply to the receiver so that pressure in the receiver is maintained in the event that the normal air supply is not available.

Power to the motor stop circuits in the ACR is from the 250 VDC systems. This DC power system is equipped with inter-ties that connect to alternate sources in the event the normal source is lost (Figures 3.4-5 through 3.4-7). The components of the cascade DC Power System that support the Compressor Motor Manual Trip System are important to safety as described in Section 3.8. Refer to Section 3.1.1.8 for a description of the cascade electrical systems.

Electrical power to the motor stop circuits in the PCF is from the 125 VDC system in the PCF. This system is equipped with an automatic transfer switch, which ensures that power to the trip circuit is available, even if the normal source is lost (Figures 3.4-6 and -7). The components of the PCF DC Power System that support the Compressor Motor Manual Trip System are important to safety as described in Section 3.8. Refer to Section 3.1.1.8 for a description of the cascade electrical systems.

3.1.1.2.4.2 Brakes

All cell and booster compressor motors are equipped with brakes. The brake is attached to the motor shaft on the end opposite the compressor. Normally, the brake systems are electrically operated. However, on loss of power, the brake is designed to engage to stop the motor.

3.1.1.2.4.3 Compressor and Motor Couplings

The couplings between the motor and compressor shafts are metal, non-lubricated, laminated disc type couplings or lubricated gear-tooth-type couplings.

3.1.1.2.5 Cell Coolant Systems

The Cell Coolant Systems remove the heat of compression from the PG and control its temperature at a specified value. Excessive PG temperature may cause accelerated equipment failure. Excessive cooling may cause condensation of PG on the coolers, which would lead to unstable operation.

The cell coolant systems rely on closed-loop, natural convection to achieve coolant circulation. Liquid coolant (R-114) is supplied to the gas cooler (evaporator) in each stage where it removes the excess heat of compression from the PG by vaporization (Figure 3.1-11). The coolant vapor leaving the cooler then enters the separator where entrained liquid is removed. The liquid removed by the separator flows back into the liquid line to the cooler inlet. The vapor leaving the separator continues to the condenser where it is cooled by the Recirculating Cooling Water (RCW) System. This heat transfer turns the coolant vapor back to a liquid, which drains by gravity back to the gas cooler. The hot RCW flows to cooling towers where the heat is transferred to the atmosphere, and the cooled water is pumped back to the condensers again.

The pressure in the coolant system is normally controlled by a pressure sensor that causes a control valve to modulate, depending upon the setpoint pressure. Over-pressure in the coolant system is normally controlled by a pressure blind switch (PBS) that trips the cell motors at a predetermined coolant pressure. Coolant system instrumentation is described in Section 3.1.1.10.1.3. When maintenance is performed on a running cell that requires the control or alarm power to be turned off, personnel monitor the cell cubicle for temperature and/or pressure variance from normal until the work is completed and the power restored.

All coolant systems have been pressure tested. Pressure tests are also conducted after maintenance work.

Because of the size of the equipment and the process layout, each X-33 cell has two coolant systems—one for the odd-numbered and one for the even-numbered stages. Each of these systems contains about 25,000–30,000 lb of coolant. Each X-29 and X-31 cell has one coolant system serving 10 stages. The coolant systems in the X-31 cells each contain about 21,000 lb of coolant, and the systems in the X-29 cells each contain approximately 14,000 lb of coolant. Coolant inventories in cells are monitored to detect leakage before it becomes potentially disruptive to cascade operation.

3.1.1.2.5.1 Process Gas Coolers

The PG coolers are heat exchangers that function by circulating a coolant medium through tubes over which the PG passes. The containment function of the UF_6 primary system, including the gas coolers, is important to safety as described in Section 3.8.

The PG coolers in X-330 and X-333, also known as stage coolers, can be located at the gas entrance end of the converter to cool the gas before it reaches the barrier; this arrangement is called A-B cooling. In A-line cooling, the gas cooler is located on the low-pressure side of the barrier where it cools the A-stream before it enters the next stage compressor. This has the advantage of allowing both the barrier and the compressor to operate at temperatures where they are most efficient.

A-line cooling is used in all of the X-33 and X-31 cells, X-29-1 even cells (except stage one of X-29-1-10), X-29-2 cells, X-29-3 cells, X-29-4 cells 1, 3, 5, 7, 8, 9, and 10, and X-27-1 cell 8.

The A-B-cooled cells are the X-29-1 odd cells (plus stage one of X-29-1-10), X-29-4 cells 2, 4, and 6, X-29-5 cells, X-29-6 cells, and all (except X-27-1-8) X-27 and X-25 equipment.

The gas coolers are fabricated from copper and/or aluminum. The "000"-size coolers are in the form of a large flat disk, with PG flowing through the disk (Figure 3.1-8). The "00"-size coolers are shaped like short cylinders, with PG flowing radially through the unit.

In X-326, the coolers are external to the converters. In these coolers, the tubes are "rolled" into steel tube sheets and then seal welded to eliminate coolant inleakage to the cascade. Surfaces of the cooler shell that are exposed to PG are nickel-plated to reduce corrosion. After maintenance, the coolers are pressure tested before being returned to service in the cascade.

3.1.1.2.5.2 Stage 1 Recycle Coolers

The containment function of the UF_6 primary system, including the recycle coolers, is important to safety as described in Section 3.8.

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. Thus, when an A-line-cooled cell is taken off-stream, additional cooling is achieved by a Stage 1 recycle cooler arrangement consisting of a 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 (Figure 3.1-4).

3.1.1.2.5.3 Condensers

The condensers are shell-and-tube heat exchangers that condense the coolant on the shell side by forced circulation of cooling water on the tube side.

3.1.1.2.5.4 Coolant High-Pressure Relief System

Each coolant condenser has a rupture disc to relieve the coolant system in the event that pressure limits are exceeded (Figure 3.1-11). The uprated cells are protected by a dual rupture disc assembly. A cavity between the two discs is vented to atmosphere. A diffuser is located downstream from the rupture disc assembly in the uprated cells. A manual block valve is located upstream of the rupture disc and must be opened and sealed before a system is placed into operation. The Coolant High-Pressure Relief System is important to safety as described in Section 3.8.

3.1.1.2.6 Valves, Flanges, Piping, and Expansion Joints

The containment function of the UF_6 primary system, including PG piping and flanges $\geq$2 inches in diameter, expansion joints, and associated valves containing UF_6, is important to safety as described in Section 3.8.

3.1.1.2.6.1 Piping

Process piping (cell, cell bypass, unit bypass, and auxiliary) is constructed of either Monel or heavy-gauge steel that is nickel-plated on the inside surface (the surface that is exposed to PG). Flanged joints are welded and must meet leak rates specified in plant procedures according to system size. For cells that operate above atmospheric pressure, flange joint welding has been uprated and clamps are used to reinforce selected flanges, as designated on engineering drawings.

3.1.1.2.6.2 Tie Lines

Tie-line piping extends between the process buildings to connect the cascade units. Tie-line piping consists of A-stream piping, B-stream piping, and auxiliary headers. The X-330 to X-333 tie-line housing contains two sets of A-stream and B-stream piping to accommodate the Cell X-33-1-1 and Cell X-33-8-2 ties. Some of the expansion joints in the X-330 to X-333 tie-line are 2-ply bellows type expansion joints.

3.1.1.2.6.3 Auxiliary Headers

The auxiliary headers include the evacuation headers, the evacuation return headers, the feed headers, the vent return headers, the product withdrawal headers, and the PG return headers. These headers are constructed of nickel-plated steel pipe or Monel. The function of auxiliary headers is to service the cells and to provide routes for transferring material to and from the cascade. The auxiliary headers contain valves to provide isolation capability and to facilitate routing of material by using different header combinations.

3.1.1.2.6.4 Welded Joints

In general, throughout the cascade, process piping and equipment are connected by welded flanged joints, with pairs of opposed flanges having nickel-plated mating faces, and modified butt welds. Exceptions include a small number of bolted flanges, small threaded lines, and some brazed or soldered (primarily instrument lines) pipe and tubing.

3.1.1.2.6.5 Expansion Joints

Monel bellows-type expansion joints are installed in the process piping throughout the cascade to allow for thermal expansion of the piping and for small differences in pipe alignment. For some piping operating at higher-than-atmospheric pressures, metal covers, known as omega covers due to the shape of their cross section, have been installed around the expansion joint bellows. The space between the cover and the Monel bellows is buffered so that a failure in the cover or the bellows will result in a leak of buffer gas to the atmosphere or to the process system.

In other piping operating at pressures above atmosphere, double, laminated bellows-type expansion joints (2-ply bellows) are used. The space between the two plies is buffered so that a leak in either ply will result in a leak of buffer gas to the atmosphere or to the process system.

3.1.1.2.6.6 Block Valves

The function of the block valves in the system is to isolate and bypass cells, allowing the cells to be taken off stream. The primary block valves in the system are equipped with motor operators, thus allowing them to be operated in unison from a single push-button when placing a cell on-stream or off-stream. Provisions to split the cascade (i.e., sectionalize the cascade) are provided at each cell. This operation is used to stop contaminant gas upflow in the cascade and to allow the contaminants to be removed to surge drums and to minimize or stop a cascade disturbance.

The block valves used throughout the cascade vary in size from 42 inches in the X-33-size equipment, to 4 inches in X-326 and in the auxiliary headers. Valves in this size-range are G-17-type valves. "S"-type manual valves are used on some feed and withdrawal lines; however, most are in the Seal Exhaust Systems and auxiliary service systems. The G-17 valve design has a wedge between the two discs so that, when closed, the discs are wedged against the valve seats. The closing time for a fully open 42-inch valve is approximately 3 minutes; smaller motor-operated valves (MOVs), down to 12-inch, require approximately 2-1/2 minutes to close.

The internal steel surfaces in contact with PG are nickel-lined to resist corrosion. The stem bellows in the cell block valves that have the potential to be above atmospheric pressure are buffered to prevent leaks to the environment. The G-17 valves are equipped with connections that allow gases to be purged from the valve body.

Block valves and bypass valves in X-31 and X-33-size equipment, excluding A-inlet and A-bypass valves, have also been modified by adding a purge connection to allow a buffer to be applied to the space between the valve's discs. Purge connections are also installed elsewhere in the cascade where the potential exists to handle UF_6 at pressures above atmospheric. The purge connection is used primarily in cases where a single valve provides isolation between PG streams of two different assays. The connection allows detection of seat leakage that could otherwise result in mixing of the two assays. In addition, it permits the connection of a gauge to check the valves for leaking seats and bellows.

"S"-type valves are typically smaller globe-type valves, with bellows seals on the valve stem, or diaphragm valves.

3.1.1.2.6.7 Stage Control Valves

The X-333 stage control valves are pneumatically loaded, hydraulically operated butterfly valves installed in the B-stream leaving each converter. These valves function to regulate the PG pressure for each stage. Instrumentation associated with the control valves allows them to be operated in manual or automatic mode. The valves are normally operated in automatic mode to maintain the pressure in the stage at a level determined by the setpoint of the instrumentation. Improper control valve operation can lead to such difficulties as motor overload, compressor deblading, barrier rupture, cascade splitting, and risk of outleakage from a ruptured instrument line or compressor seal.

The X-333 uprated control valves and most of the control valves in uprated X-31 stages have been modified by trimming part of the butterfly (vane) away to decrease the pressure drop across the valve.

The bearing housing flange covers, which open into the inside of the valve body, are gasketed and sealed. The seal around the linkage that transmits power to the valve vane is a rotary, moving-type seal assembly. Minimal inleakage occurs through this assembly and, with proper usage of the buffer zones, the assembly allows no wet-air leakage into the process system.

The entire valve body, including welding joints and seams, is leak tested to assure no wet air inleakage.

Due to the corrosive nature of the process gas, special materials and parts are used which require no oil, grease, or other applied lubrication for continued operation of the valve.

The hydraulic operator consists of a power cylinder enclosing a double-acting, hydraulic-operated piston which motivates the valve vane. A check valve prevents motion of the cylinder when the hydraulic oil pressure fails.

3.1.1.3 Housings and Enclosures

Process equipment, piping, and instrument lines that contain PG are enclosed in housings, that are heated if necessary, to prevent freeze-out of UF_6. Although these enclosures are not leak-tight, they provide some holdup of released gases before the gases enter the process building atmosphere. In addition, a portion of the solidified reaction products from a PG leak inside the housing will be deposited on surfaces inside the housing. The holdup and deposition of release products in the housings are addressed in Chapter

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4. The housings also aid in maintaining a suitable temperature for operational and maintenance work outside the housing.

3.1.1.3.1 Cell and Booster Station Housings

Housings over cells or interbuilding booster stations that are intended to be operated above atmospheric pressure are important to safety as described in Section 3.8. The cell housings are basically rectangular structures that enclose all of the cell equipment, except for the compressor motors. Although the sizes and configurations of the cell housings in X-330 and X-333 are different, the materials of construction are the same. The framework is steel with metal or cementitious board siding bolted in place. The tops of the housings are steel with removable hatches for ease of equipment removal. The housing panels on both ends of the compressor can be removed for compressor changeout. The X-326 housings are galvanized panels over steel frames. The panels consist of insulation sandwiched between sheet metal faces. Removable covers are provided to allow access to equipment for maintenance.

Where coolant lines extend through the concrete floor from the coolers, the small openings around the pipes are sealed. Sheet metal partitions separate the cell housings from the cell bypass housings around the A-stream and B-stream drops.

Although the siding panel seams are tightly closed, the cell housings are not designed to provide 100% secondary confinement in the event of a UF_6 release inside the housing. Outleakage detectors are installed in cell housings where above-atmospheric pressures may be encountered. See Section 3.1.1.11.2 for a description of the PG leak detection system.

Heat from PG compression is the only heat necessary for cell housings. In X-330 and X-333, cell housings are not insulated. In the X-326 housings, insulation is necessary to retain the heat.

The interbuilding booster station housings are constructed of the same materials as the X-330 and X-333 cell housings.

3.1.1.3.2 Bypass Housings

In X-333, PG bypass and service lines are enclosed in the cell and unit bypass housings. Cell bypass housings, located on the cell floor, extend north to south from the unit bypass housings through the center of each unit. The unit bypass housing extends from east to west through the center of the building. Most of the lines in these housings service all units by either direct connections or through special valving crossovers. The piping in these housings includes A-stream (enriched) and B-stream (depleted) lines, evacuation and evacuation return lines, and PG feed lines. In some cases, more than one line is provided for flexibility.

Cell bypass housings in X-330 and X-326 extend east to west from the unit bypass housing through the center of each unit. The unit bypass housing extends from north to south along the east side of the cell floor.

The framework for the bypass piping housing is heavy-gauge steel I-beams capable of supporting the bypass piping and valves. Except for the operators on the large MOVs (12 inch and above), valves are completely enclosed within the bypass housing. Manual valve operators (lazy rods) also extend through the housing.

The tops, bottoms, and sides of the bypass housings are galvanized sheet metal interlocking panels filled with fiberglass insulation. These panels are bolted to the frame and the "butt" ends are covered with sheet metal. This type of housing provides an excellent secondary-level containment, providing no panels are removed for maintenance access.

In X-330 and X-333, heat is supplied to bypass housings from the Plant Steam System. In X-326, the bypass housings (unit and cell) are electrically heated.

3.1.1.3.3 Building Tie-Line Housings

The building tie-lines, A-lines and B-lines, evacuation lines, evacuation return lines, and the smaller service lines, such as feed, PG return, product withdrawal, and vent return lines, are in elevated, heated housings. The tie-line housings are steam heated.

3.1.1.4 Booster Stations

3.1.1.4.1 Evacuation Booster Stations

3.1.1.4.1.1 Equipment

Each of the process buildings is equipped with an EBS. The X-330 and X-333 stations are nearly identical except that the X-333 EBS uses a slightly larger speed increaser between the motor and the compressor and there are minor differences in the lube oil systems. The X-326 EBS has not been used since the 1960s and has been physically isolated from all sources of inadvertent uranium incursion.

Both the X-330 and X-333 EBSs are located on the cell floor of their respective buildings. The EBS control center for X-333 is located in ACR 1; for X-330, the control center is in ACR 3. Each station contains three centrifugal compressors that can be operated singly or in series. These single-stage compressors use an "overhung" shaft/bearing arrangement. In this design, the shaft bearings are outside the compressor casing, and the shaft penetrates one side of the casing. Thus, only one shaft seal is required. Each compressor is individually cooled by a cooler and condenser, with the latter being cooled by the RCW System.

Evacuation headers provide a means of routing material to and from cells and auxiliary systems in the cascade. The headers can be used exclusively or in conjunction with other process or auxiliary headers to (1) transfer material from one location to another, (2) attain cell negatives, (3) evacuate wet air from cells, and (4) evacuate fluorine, F_2-ClF_3 mixtures, and their reaction products from cells undergoing unplugging and drying treatments. The EBS in each building can be connected to these headers to provide pumping capability when necessary.

The three high-speed centrifugal compressors in each station are driven by two-speed electric motors.

Gases discharged from each compressor are cooled by an evaporative-type gas cooler. The heat removed from each compressor discharge gas stream is transferred to the RCW System by means of the same coolant evaporation/condensation cycle used in process stage cooling. Each compressor is provided with a separate coolant system. The coolant systems are equipped with rupture discs for overpressure protection.

3.1.1.4.1.2 Evacuation Booster Station Instrumentation

Recycle Control

The operational features described below are typical for the EBSs in X-330 and X-333. Each compressor has a recycle valve that is instrumented to control the operating pressure. The valve is controlled by compressor suction pressure when the compressor is operating on low speed or by compressor discharge gas temperature when the compressor is operating on high speed. Operational experience has shown that it is generally desirable to operate the recycle valve within the 40–60% open range for maximum compressor efficiency.

Remotely Operated Purge Valve Control

An air-operated purge control valve is installed in the station suction header in X-333. This valve controls the connection to the Plant Nitrogen and the Plant Air System. Nitrogen or dry air may be used to purge the process systems to a UF_6 negative and to pressurize process equipment with air in preparation for maintenance or other cell activities. The pressure indicator—with external components—(PIX) for the control valve provides valve position indications and alarms in the ACR. The X-333 and the X-330 EBSs also have a motor-operated valve connected to the EBS station suction header that can be operated from the ACR to introduce either nitrogen or an air purge.

Suction Header Pressure Recorder

A dual range Pressure Recorder (PR) is used on the suction header to determine the evacuation rate and the system leak rate. This PR provides a recorded curve from which the operator can diagnose abnormalities during evacuation operations. The evacuation return (or discharge) also has the same type instrumentation.

Temperature Recorder

In the X-330 EBS, a Temperature Recorder (TR) indicates and records the internal compressor temperatures, provides audible and visual ACR alarms, and trips the affected compressor should the temperature rise to the setpoint. A separate TR records the seal exhaust temperatures. In X-333 EBS, a TR indicates and records (1) compressor internal temperature, (2) cooler discharge temperature (3) seal plate temperatures, and (4) seal exhaust line temperature. The TR has no automatic alarm or trip function. The three X-330 and the three X-333 EBS compressors each have a Temperature Blind Multiplier (TBM) located downstream of the compressor that indicates, in the ACR, the compressor gas discharge temperature. The TBMs have automatic alarms, but no trip functions.

Seal Feed and Seal Exhaust Controllers

Each EBS compressor uses a seal feed Differential Blind Multiplier (DBM) controller with a PIX to control the differential pressure between the seal feed and the compressor discharge. This ensures that the seal feed pressure remains higher than the compressor discharge pressure by a predetermined amount. The seal exhaust pressure is controlled at a fixed level below the seal feed pressure, but above process pressure. The seal exhaust actuates audible and visual alarms in the ACR when the position of the seal exhaust control valve is outside the established setpoints. Both situations can indicate bad seal conditions

Coolant System Controls

Each compressor is equipped with instrumentation to control the coolant pressure automatically to obtain the desired compressor temperature. This is only necessary during low-speed operation.

Audible and visual alarms in the ACR indicate low coolant pressure or high coolant temperature. Each Coolant System has two high-pressure switches, one for low-speed and one for high-speed motor windings. When actuated, the circuit breaker to that motor will automatically trip on high coolant pressure and cannot be restarted until it has been reset manually at the condenser platform. This same coolant instrumentation is used on cells.

Low Lube Oil Pressure Trip

Each station has a low lube oil pressure trip.

Recirculating Water Control

The EBS compressors are individually cooled by a coolant evaporator and a condenser that is cooled by the RCW System. Each EBS compressor has an electrical interlock system that automatically opens and closes the RCW bypass block valve when the compressor speeds are changed, thus permitting the compressors to be used in any combination (low or high speed).

Automatic Compressor Isolation

Each EBS compressor is equipped with inlet and outlet MOVs. The inlet valves have high-speed operators. A trip in one compressor will cause trips and automatic isolation of all three EBS compressors. Each valve is equipped with indicator lights that show the valve position status and the direction of travel or the cessation of movement.

3.1.1.4.1.3 Piping and Valves

The process piping connecting the compressors, gas coolers and recycle lines is nickel-lined steel. G-17 valves are provided for isolating each compressor. Hydraulically operated butterfly valves are associated with each station for pressure control.

3.1.1.4.1.4 Operation of Facilities

The EBSs are used to facilitate repair of equipment, such as compressors, valves, and expansion joints through a network of evacuation piping that is connected to every cascade system or component. When equipment containing UF_6 or other contaminants requires maintenance, a UF_6 negative must be obtained before that equipment can be opened for repair. (A UF_6 negative is not required for penetrating/cutting into instrument lines, connection of instrument lines to PG piping and associated instrument line valves.) Test results must show a UF_6 negative before work is allowed. A UF_6 negative condition is defined as one in which a reduction of the UF_6 concentration occurs for a given volume/system, by evacuation and/or dilution, to less than 20 parts per million (ppm) at a system pressure of 1.0 psia or less than an equivalent concentration, based on system pressure, as determined by the following equation:

$$20 \div \text{system pressure (psia)} = UF_6 \text{ negative concentration (ppm)}$$

Example:

20 ÷ system pressure of 2 psia = UF_6 negative concentration of 10 ppm

The two-speed motors, which allow separate compressor speed selection, enable this system to be versatile and effective in handling gaseous mixtures of 0–100 mole percent UF_6. The EBS may be used to pump various concentrations of UF_6 so long as the internal temperature of the compressors, on high speed, does not exceed the established setpoint.

The use of each evacuation system is limited by applicable nuclear criticality safety controls. A check for the buildup of solid uranium deposits in the coolers is performed quarterly using a radiation detection instrument.

When a compressor is taken out of service for repair, it can be isolated and bypassed to permit limited and somewhat restricted operation of the remaining two compressors. During maintenance of a compressor, safety regulations do not permit the high-speed operation of the remaining compressors while workers are in the immediate area unless the high-speed coupling shield is in place or a Lockout/Tagout permit is issued on the high-speed breakers of the operating compressors.

If the high-speed coupling shields are not in place, a safe distance must be maintained when the EBS is in operation since the compressors may be remotely switched from one speed to another. Located on the cell floors at the entrance of the EBS areas are warning lights that warn personnel when the EBSs are in operation. A small light burns when the stations are operating on low speed and larger flashing lights operate when they are on high speed.

The EBS is not used to pump gas containing ClF_3-F_2 mixtures with concentrations exceeding 8 mole percent because an explosive mixture may result if a simultaneous coolant leak in an EBS cooler were to occur. These concentration limits are maintained by sampling these mixtures before evacuation takes place.

When operated within normal parameters, the maximum discharge pressure of an EBS compressor handling material with a UF_6 concentration exceeding 8 mole percent does not exceed the allowable pressure as determined by the always safe coolant pressure curve (Figure 3.1-12). This serves to prevent freeze-out of UF_6 in the cooler.

The EBS is not used to perform more than one evacuation operation at a time.

3.1.1.4.2 Booster Stations

At those points in the PORTS cascade where a change in equipment size and a transition in pressure level occur, the PG pressure must be increased by passing it through a booster station consisting of one or more gas compressors and gas coolers. The gas compressors are axial or centrifugal, depending on the volumetric flow rates and pressure ratios required for the particular booster station. All stations are equipped with two compressor loops, one loop is normally in operation and the other remains on standby. The temperatures of both loops are monitored and maintained within limits specified in approved procedures.

Two process flows extend between X-330 and X-326—a B-stream flow from X-326 to X-330 and an A-stream flow from X-330 to X-326. The A-stream has a booster station in X-330 capable of raising the PG pressure sufficiently to provide adequate flow into the first stage of X-326. Downflow of the X-326 to X-330 B-stream is through a tie-line that is a continuation of the X-29-6 and X-27-1 unit bypass piping.

No booster is required for the B-stream flow at this point since the X-326 bottom stage pressures are normally higher than the X-330 top stage pressures.

Four process flows extend between X-330 and X-333—a B-stream flow from X-333 to X-330 en route to the Tails Withdrawal Facility, an A-stream flow from X-333 to X-330, an A-stream from the stripping section of the cascade in X-330 to X-333, and a B-stream flow from X-330 to X-333 (Figure 3.1-6). Booster stations are required for three of these streams: the X-333 to X-330 B-stream, the X-333 to X-330 A-stream, and the X-330 to X-333 A-stream. The pressure in the B-stream flow from X-330 to X-333 is sufficient so that no booster compressor is needed.

3.1.1.4.2.1 X-330 to X-326 A-Booster

The X-330 to X-326 A - booster station is located on the cell floor at the east side of X-330, near Cell X-29-6-2. PG flows from the top stage of X-330 to the suction nozzle of the booster station axial compressor. The axial compressor provides the first of two compression stages (Figure 3.1-13).

PG discharged from the axial compressor is cooled by a gas cooler and then passes into the inlet of a centrifugal compressor. This second stage of compression discharges PG directly into the X-330 to X-326 A-tie-line.

The gas flow is split as it enters the tie-line, a portion recycling through a control valve to the B-downflow line from X-326, and the remainder flowing into X-326 equipment. Splitting the flow is necessary because the interstage flowrate of the X-29 equipment exceeds the normal flow of the X-27 equipment. The recycled portion of the flow mixes with the X-326 downflow and proceeds through the B-line back to the B suction nozzle of the top X-29 stage.

A recycle line connects the discharge side of the gas cooler to the inlet of the axial compressor. This recycle line serves several functions. On reduced suction flow to the axial compressor, the recycle valve opens to prevent starving and surging the compressor. In addition, recycling the flow allows the compressor to warm up prior to being placed in service without disturbing normal interplant flow. The cooler is used to cool the axial discharge stream so that the high discharge temperature trip switch of the second-stage centrifugal compressor is not actuated.

The centrifugal compressors used in this station are single-stage compressors. The axial compressors are modified X-29 stage compressors with the B-inlet nozzle blanked off. The performance of the axial compressors is characterized by large flow and high efficiency compared with the centrifugal compressors. Two compressor loops are available. Normally, one loop is in operation with the other used as a backup.

Lube oil for the compressors is supplied from the X-29-6 or X-29-5 unit Lube Oil Systems. This dual supply is a precaution against failure of one system.

The Booster Station Coolant Systems are similar to those in the cascade cells, including the use of a Coolant High-Pressure Relief system that is important to safety as described in Section 3.8. See Section 3.1.1.2.5.4 for a description of the Coolant High-Pressure Relief System. The Booster Station Coolant Systems differ from cell systems primarily in their instrument settings and trip points. Control of station temperatures is accomplished with instrumentation similar to that used for cell coolant control. The booster stations are equipped with both a high coolant-pressure trip and a high compressor-temperature trip.

A station shutdown pushbutton is provided on the PCF panel for tripping the booster station compressor motors. Breaker position indicating lights are also provided on these panels. Overload-underload relays on an ACR EBS booster panel energize overload-underload alarm lights on the local booster panel, the ACR purge and evacuation booster panel, and PCF panel. When any of the booster breakers trip, the valve-closing circuits of the associated station block valves and the A-stream and B-stream building block valves actuate, as does the opening-circuit of the associated recycle valve. A selector switch for each pair of booster motors is provided on the local booster panel with contacts in series with the closing circuits of the A-stream and B-stream block valves which can be used to prevent automatic closing. The inlet pressure of the axial compressors is indicated on the local panel. A low-pressure condition actuates an alarm and opens the motor-operated recycle valves of the associated compressor. High internal temperature trips the motor control circuits for the axial compressors. Tripping the axial compressor automatically trips the centrifugal compressor.

The inlet and discharge pressures of centrifugal compressors 29AB-2 and 29AB-4 are indicated on the local control panel. High-temperature trips out the motor circuits for the centrifugal compressors. A PBS on the coolant system for each axial compressor is also connected to the associated breaker trip circuit.

The Booster Station Coolant System can be automatically controlled to maintain the desired PG temperature.

A control switch for manual operation of each motor-operated valve is provided at the local booster panel. Backup power from the diesel generators is supplied to the booster valves in the event of power failure.

3.1.1.4.2.2 X-330 to X-333 A-Booster

The X-330 to X-333 A-booster station is located on the cell floor of X-330 at the east side of Cell X-31-2-2. In a typical piping configuration, the PG A-stream flows from the top stage in Unit X-31-2 (normally Cell 2) to the suction of the booster station compressor. This compressor raises the pressure of the gas stream to that required for interplant flow in a single compression stage. It discharges PG into a line leading through the unit bypass pipe housing to the A-tie-line to X-333 (Figure 3.1-14). The tie-line connects with the A-inlet of the bottom stage compressor in X-333 (normally Cell X-33-1-1).

The flow to X-333 is not cooled at the booster station because precoolers are provided at Cells X-33-1-1 and X-33-1-3, which are normally the next cells up the cascade. However, when the compressors are operated on recycle, gas coolers located in the recycle lines are used to prevent excessive heat buildup.

The compressors used in this station are uprated X-31, axial-flow compressors with the B-inlet nozzle blanked off. Two compressor loops are available. Normally one loop is in operation, with the other used as a backup.

The lube oil supply for the compressors is provided either from the X-31-2 or X-31-3 unit Lube Oil Systems. The dual supply capability permits continued operation even if failure of one lube oil system occurs.

The Booster Station Coolant System is similar to those in the cascade cells, including the use of a Coolant High-Pressure Relief System that is important to safety as described in Section 3.8. See Section

3.1.1.2.5.4 for a description of the Coolant High-Pressure Relief System. The Booster Station Coolant System differs only slightly in size from those described in Section 3.1.1.4.2.1.

Trip circuits and automatic isolation features for this station are similar to those described previously for the A-booster to X-326.

Pressure and temperature instruments are similar to those previously described for the A-booster to X-326.

3.1.1.4.2.3 X-333 to X-330 B-Booster

The B-booster station is located on the cell floor of X-333 north of Cell X-33-1-1. PG flows from the bottom stage of Unit X-33-1 to the booster station compressor. This compressor raises the pressure level of the gas stream to that required for interbuilding flow. The X-333 to X-330 B-booster station is similar to the single-stage station shown in Figure 3.1-14. The gas stream is routed via the tie-line to the B-suction of the top stage compressor in X-31-2 (normally, Cell 2).

The PG is cooled by gas coolers that are similar to the booster station coolers previously described. The compressors are single-stage, centrifugal-flow compressors. Two compressor loops are provided. Normally, both loops are in operation. However, at low power levels, one compressor may be used. Lube oil for the compressors is supplied from the X-33-1 or X-33-8 unit Lube Oil System.

The Booster Station Coolant System is similar to those in the cascade cells, including the use of a Coolant High-Pressure Relief System that is important to safety as described in Section 3.8. See Section 3.1.1.2.5.4 for a description of the Coolant High-Pressure Relief System. The Booster Station Coolant Systems differ from Cell Coolant Systems primarily in instrument settings and trip points. The condenser is the same as those used in X-25 units 6 and 7.

Each booster station is supplied with the same type of monitoring and protection instrumentation and valve controls as described previously in the A-Booster to X-326 section.

To accommodate pressures to which the booster to X-330 would be subjected, several modifications were made to the booster station: double-walled, buffered expansion joints were added, the gas coolers were relocated from the discharge of the compressors to the suction, a second condenser was installed in parallel with the existing one to provide adequate cooling, and UF_6 detection devices were installed to monitor for leaks.

3.1.1.4.2.4 X-333 to X-330 A-Booster

The X-333 to X-330 A-booster station is located on the cell floor of X-333, south of Unit X-33-8. The inlet piping is arranged to draw PG from the top cell in operation in X-333. The discharge piping delivers the compressed PG stream into the building tie-line. A recycle line connects the booster station discharge line to the B-stream line from the bottom cell in X-31-3. This line recycles that portion of the A-stream handled by the X-333 A-Booster Station that is in excess of the interstage flow from X-330. The X-333 to X-330 A-booster station is similar to the single-stage station shown in Figure 3.1-14.

The axial compressors used in this station are modified X-33-size machines. Two compressor loops are provided. One loop is normally in operation, with the other used as backup. Lube oil is supplied to the compressors from the X-33-8 or X-33-1 unit Lube Oil System.

The Booster Station Coolant Systems are similar to those in the cascade cells, including the use of a Coolant High-Pressure Relief System that is important to safety as described in Section 3.8. See Section 3.1.1.2.5.4 for a description of the Coolant High-Pressure Relief System. The Booster Station Coolant Systems differ from cell systems primarily in instrument settings and trip points.

Electrical, monitoring and protection instrumentation is similar to that previously described for the other booster stations.

3.1.1.4.2.5 Instrumentation (Monitoring and Temperature Control)

Tie-line temperatures for X-330 and X-333 are monitored by a temperature recorder located in the X-330 to X-333 A-Booster Station. The X-326 to X-330 tie lines are monitored at the X-330 to X-326 A-Booster Station located in the southeast corner of X-330. The temperature recorders have low-temperature alarms which, when actuated, will energize both audible and visual alarms in their respective ACRs.

Flow between X-330 and X-333 is monitored and recorded on PRs located in ACR 2 and ACR 1. Low flow between the buildings will actuate both audible and visual alarms in the ACRs.

Temperatures in the X-330 and X-333 auxiliary pipe housings are thermostatically controlled to maintain the desired ambient conditions within the heated enclosures. A temperature sensing element located in the heated housing controls the air supply to an air-operated steam control valve. The control valve would fail open on loss of air. Should the control valve fail, manual bypasses are available. Steam can remain valved off for several hours (in winter months) without causing freeze-out of the UF_6 in the lines. The temperatures in the bypass housings are maintained at a temperature sufficient to keep the PG in a gaseous state.

3.1.1.5 Surge Systems and Power Load Control

Periodic shifts 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.

Two basic types of inventory shifts may occur: one, an excess flow condition (overload) known as a downsurge, and the other, a deficiency known as an underload. Overloads cause a transient pressure front to move down the cascade through the B-stream. Stage control valves located in the B-stream attempt to maintain a constant upstream pressure when in automatic mode. Therefore, when a control valve detects an increase in upstream pressure, it opens, allowing an increase in flow and resulting in a net downflow (downsurge) for the stage. The surge moves down the cascade from stage to stage in this manner until one of the surge-control systems is reached. There, the excess inventory can be stored.

When a decrease in pressure occurs, the stage control valve throttles the flow to restore the pressure. The underload moves down the cascade from the X-33 equipment until the surge system, which can supply the necessary inventory to compensate for the underload, is reached. Two such surge systems are available in X-330—the Intermediate and the Bottom Surge systems. Both systems are located on the operating floor in the northeast corner of X-330 in a heated room. The systems are maintained at an elevated temperature to ensure that the stored PG remains a gas.

The valving manifold on surge drum banks H, M, J, K, and L allows flexibility in the use of surge drum capacity between the Intermediate and Bottom Surge Control Systems. However, in a typical configuration, drum banks H and M are used for bottom surge control and banks J, K and L are used for intermediate surge control.

The surge drum pressure and room temperature instrumentation is important to safety as described in Section 3.8. The surge drum pressure monitoring instrumentation consists of pressure transmitters/transducers and pressure indicating instruments located at the drum room local panel. In addition, a PR, remote pressure indicating instrument, and alarm indicators are provided in ACR 2 and the PCF. This instrumentation allows operators to verify that surge drum pressures do not exceed the setpoint values and allows drum pressures to be monitored in the ACR and the PCF.

The room temperature instrumentation consists of multiple temperature elements in the surge drum room and the associated TI located on the outside wall of the room. These instruments allow operators to verify that temperatures do not fall below the established setpoint.

The containment function of the UF_6 primary system, including the surge drums, is also important to safety as described in Section 3.8.

The storage drums of the Intermediate and the Bottom Surge Systems are described in this section. The cell service surge drums are described in Section 3.1.1.5.2.

3.1.1.5.1 Intermediate and Bottom Surge Systems

3.1.1.5.1.1 Intermediate Surge Drums

Surge-drum banks J, K, and L (with a total nominal volume of 32,000 ft^3) are used in the Intermediate Surge Control System. These drum banks are located on the operating floor beneath Units X-29-1 and X-31-1. When a downsurge reaches the bottom of the X-333 cascade, the flow increases. This increase is detected by the intermediate surge instrumentation, which diverts the downsurge into the intermediate surge drums. An intermediate surge compressor may be used to boost the pressure and increase the flow rate into the intermediate surge drums when the plant electrical load is low. System controls are located on the Surge and Waste Panel in ACR 2.

When an underload reaches the bottom of the X-333 cascade, the flow decreases. This decrease is detected by the intermediate surge control system, and inventory from the surge drums may be supplied to the A-stream (A-Booster to X-333) to compensate.

Instrument failure could result in the UF_6 inventory in the intermediate drums being dumped on the cascade. However, this would be averted by closing the MOVs on the drums and isolating them from the cascade, or by switching the intermediate surge drums to manual control, depending on which instrument malfunctioned.

3.1.1.5.1.2 Bottom Surge Drums

Surge-drum banks M and H (with a total nominal volume of 22,000 ft^3) are used for the Bottom Surge Drum Control System. These drum banks are located on the X-330 operating floor adjacent to the intermediate surge drum banks. The B-stream flow at the bottom of the X-330 cascade is divided, with part being recycled to the A-stream and the remainder being routed to a compressor at the Tails

Withdrawal Facility. The tails stream is again split, with part going to a compressor and the remainder going to the A-stream at the bottom of the cascade (by automatic operation of the control valves). There, the excess material is stored in M and H surge drum banks. The controls for this system are similar to those described for the Intermediate Surge Control System.

When large downsurges cause overload conditions in X-31-2, X-31-1, or X-29-1, the overload can be reduced by raising the pressure level index (PLI) controller setpoints in those units. This will allow the units to hold the excess inventory until the material can be withdrawn at the Tails Withdrawal Facility.

3.1.1.5.2 Cell Service Surge Drums and Supplemental Surge Volumes

In addition to the Intermediate and the Bottom Surge Control Systems in the preceding sections, additional storage capacity is available for use in controlling cascade surges, including the Cold Recovery System surge drums, the Interim Purge surge drums, the Area 5 surge drums, and three banks of drums located in the X-330 Surge Drum Room.

The Cold Recovery System surge drums are primarily intended to store purge gases and reaction products resulting from cell drying and unplugging treatments until they can be cold trapped or returned to the cascade. However, the drums can also be used for inventory control in a major cascade disturbance. The Cold Recovery System surge drums are described in Section 3.1.4.

The surge drums associated with the Interim Purge located in X-330, the Area 5 surge drums (banks A, B, and C), and three additional banks of surge drums (banks X, Y, and Z) located in the Area 2 Surge Drum Room in X-330 may also be used to store PG and purge gases from the cascade until these gases can be returned to the cascade or transferred to other drums, then bled back to the cascade or cold trapped. The Interim Purge surge drum banks (banks N, P, and R) have a total nominal volume of 20,600 ft^3. Drum banks X, Y, and Z have a total nominal volume of 24,600 ft^3. Drum banks A, B, and C in Area 5 have a total nominal volume of 12,000 ft^3.

Off-stream cells in X-333 and X-330 can also be used as supplemental surge volumes. Conditions for this use, in addition to any criticality safety considerations, include the following: cell pressure must be maintained below atmospheric pressure, the contained UF_6 mass must be no more than 10,000 lb cell coolant must be removed, treatment gas or reaction product concentrations in the cell must be limited to cascade oxidant control bleed-back concentration levels, and potential ignition sources (e.g., compressor motor power supply) must be deenergized and isolated.

The cell volumes and the number of stages per cell are listed, by size of equipment, below.

- X-33 equipment (8 stages, 25,140 to 25,460 ft^3),
- X-31 equipment (10 stages, 11,780 to 11,960 ft^3),
- X-29 equipment (10 stages, 8,900 to 11,100 ft^3),
- X-27 equipment (12 stages, 2,200 to 2,320 ft^3). Note that Cell X-27-1-8 has been modified so that the volume is approximately 3,360 ft^3.
- X-25 equipment (6 or 12 stages, 940 to 1,650 ft^3).

3.1.1.5.3 Power Load Control

The plant process power load is monitored continually by means of a computer, which allows close control of the power load.

A pressure controller for Unit X-33-1, located in the PCF at the Cascade Controller/Coordinator's console, permits a limited degree of load control. This instrumentation is described in Section 3.1.1.10.1.1.

The plant power load is adjusted by raising and lowering the high side control pressure in Unit X-33-1, except Cell 1. In case of failure of the PCF controls, the system can be switched to manual control in ACR 1 or to local cell PLI control. This system can also be used to control downsurges to the X-330 cascade.

3.1.1.6 Auxiliary Systems and Equipment

3.1.1.6.1 Seal Exhaust Systems

The purpose of the Seal Exhaust Systems is to remove the nitrogen and dry air buffer gases from the compressor seal cavities. The Seal Exhaust Systems also provide emergency datum exhaust in case of datum pump failure. (See Section 3.1.1.6.2 for a description of the datum systems.)

The Seal Exhaust Systems consist of one or more pumping stations for each process building and a building header system that may be sectionalized to individual unit and cell branches. One seal exhaust station in X-333 services Area 1. The station is equipped with multiple vacuum pumps that can be used for either wet-air evacuation or seal exhaust. The seal exhaust header pressure can normally be maintained with two pumps; the remaining pumps are for backup. Each vacuum pump has an alumina trap to absorb traces of UF_6 that might get into the system in some types of seal failures. System design and operating methods provide a means for using the X-333 vacuum pumps for either seal exhaust or for cell wet air evacuation.

X-330 is equipped with two separate Seal Exhaust Systems and one Wet-Air Evacuation System. Typically, the vacuum pumps at the seal exhaust stations are used for seal exhaust and an air jet located in the cold recovery area is used for wet air evacuation. The system in Area 3 can be set up to service the entire building, but normally there are separate stations in operation in Area 2 and Area 3. The systems are separated by a block valve in the center of the building. This valve is normally closed and buffered with nitrogen. In case of failure of the Seal Exhaust System in Area 3, the Wet-Air Evacuation System can be used as a backup. Due to criticality considerations, the Area 3 Seal Exhaust System would never be pulled through the Area 2 seal exhaust station. The EBS can also be used to pull seal exhaust gases from Area 2 or Area 3.

X-326 has three separate seal exhaust stations—one each in Areas 4, 5, and 6. These systems are separated by block valves, and any one may be valved into the other for backup in case of a system failure. The seal-exhaust stations are equipped with vacuum pumps and alumina traps sized to meet nuclear criticality safety requirements. The stations are located on the operating floor just east of the ACRs. As in the other process buildings, the X-326 seal-exhaust gases pass through alumina traps before they are exhausted to the atmosphere from the roof vents.

Because the prevention of a nuclear criticality accident is a primary concern in the seal exhaust stations, they are operated in accordance with the nuclear criticality safety requirements described in Section 5.2 and Appendix A to Section 5.2.

The activated alumina used in the seal exhaust and wet-air traps in the process buildings is exposed to gases that contain UF_6. When this alumina becomes saturated and needs to be exchanged for fresh alumina, special precautions are required. The alumina is either vacuumed from the geometrically safe traps into a Nuclear Criticality Safety (NCS)-approved container or dumped from the trap into an NCS-approved container. The NCS-approved containers are handled in accordance with the nuclear criticality safety requirements described in Section 5.2, Appendix A.

Handling of the oil from the seal exhaust pumps is also described in Section 5.2, Appendix A.

3.1.1.6.2 Datum Systems

Because of the sensitivity of barrier and compressor performance to the cascade pressure level, it is desirable to maintain the operating pressures accurately. Pressures must therefore be sensed by instruments that have as their reference pressure either a full vacuum or a carefully controlled pressure. For low process pressures, the vacuum reference is adequate since the range of the instrument will not have to be so large as to make it insensitive to small pressure variations. For most cascade pressures, however, it is necessary to supply the pressure sensing instruments with a precise datum pressure that is fairly close to the pressure level being measured. Narrow-range differential pressure instruments that have the needed sensitivity are used.

Datum systems consist of a volume of dry air that can be fed and exhausted through pressure control instruments to maintain a preset pressure level. Prior to inventory, the datum instrumentation is calibrated to ensure accuracy. A given datum system usually services a plant unit or half unit in the isotopic cascade. Since all of the unit pressure transmitters and controllers are referenced to the same datum, 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.

Datum systems for each cascade unit are controlled from the ACRs. The High Datum Systems (also known as unit Datum Systems) and the Standby Datum Systems are used to control the datum for cascade units in X-330 and half units in X-326. The High Datum, Low Datum, and Standby Datum Systems are used for controlling the datum for cascade units in X-333. (The addition of a Low Datum System is required because of the greater operating pressure range of the cascade cells in X-333). As indicated by the system name, the Standby Datum Systems are used when the normal systems are not available. In addition to the unit Datum Systems, each cell is equipped with a Cell Datum System that may be operated locally from the cell's LCC.

Components of the unit, Standby, and Cell Datum Systems in each cascade unit 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 process are important to safety as described in Section 3.8.

Electrical power to the datum systems instruments and the alarm indicators in the ACR is required for the datum systems to accomplish their safety function as described in Section 3.8. The power source for these instruments in each cascade unit is the DC Power System. DC power is supplied to the datum systems from a distribution panel in the ACR. As shown in Figure 3.4-5, an automatic transfer switch in the supply to the cell, and the distribution panel, ensures that datum instruments receive power from an alternate source in the event the primary DC source is lost. See Section 3.1.1.8 for a description of the cascade power systems.

3.1.1.6.2.1 High Datum Systems

The High Datum Systems are the primary pressure reference for stage control in cascade operations. Each unit has one or more High Datum Systems (Figures 3.1-15 and -16).

A transmitter (a pressure blind multiplier [PBM] in X-326 or X-330; a differential blind multiplier [DBM] in X-333) senses the High Datum System pressure and converts it to a signal pressure. The signal pressure is transmitted to a pressure indicating controller (PIC). The PIC, in turn, controls a device called an inverting booster relay (IBR). The IBR receives filtered plant air that it balances with the datum exhaust (datum vacuum) to regulate the High Datum System pressure. To compensate for short-term fluctuations in pressure, a surge volume is installed in the system side of the IBR. From the surge volume, the system is connected to the unit (X-330 and X-333) or half unit (X-326) high datum headers through a pneumatic block valve (a control valve).

The control valves in the High Datum Systems are part of a system to protect the High Datum Systems in case of component failures. The control valves are spring-loaded to close and require air pressure to open. The valve is controlled by a three-way solenoid valve, which operates to vent the air from the control valve operator, allowing the spring to close the valve.

The solenoid valve is caused to operate by pressure switches that monitor system parameters. When the solenoid valve is operated, alarms are activated at the datum control panel and the ACR. The datum system high/low-pressure alarms in the ACR serve both the High and the Standby Datum Systems. The loss of plant air to the datum control instruments or high pressure in the Datum Exhaust Systems will cause the three-way solenoid to close the control valve, isolating the Unit Datum Systems in the area so that the datum pressures are "locked-in" until the pressure is returned to the normal range.

The alarms and lock-in circuits are checked in accordance with plant procedures. The High Datum Systems are calibrated (single point calibration) before each cascade inventory to ensure the accuracy of the data obtained.

3.1.1.6.2.2 Standby Datum Systems

The Standby Datum Systems are manually operated versions of the High Datum Systems (Figures 3.1-15 and -16). They are used as temporary replacements for the High Datum Systems, and they have no emergency features. There is no pneumatic block valve to isolate the system in the event of a failure, and the system must be manually valved into the high datum headers when used. Pressure regulation is functionally similar to the High Datum Systems, with a manually regulated pressure indicator with external components (PIX) taking the place of the PBM, PIC, and IBR. The pressure is sensed and recorded, and a PBS actuates alarms on abnormally high or low pressure. These alarms can monitor both High and Standby Datum Systems. No automatic regulation takes place; and, when in use, this system is checked by operators.

The Standby Datum Systems are calibrated (single point calibration) before each cascade inventory to ensure the accuracy of the data obtained.

3.1.1.6.2.3 Low Datum Systems

Low Datum Systems are used only in X-333 because of the greater pressure ranges that occur in the cascade cells in that building. The Low Datum Systems provide reference pressures for the A-suction pressures in X-333 (Figure 3.1-16).

The Low Datum Systems are functionally similar to the High Datum Systems. The principal difference is that the Low Datum Systems do not have the automatic lock-in circuits or the high/low-pressure alarms. There is no standby system for the low datum; and since it serves no control purpose, it is not considered critical to operations. Pressure is recorded similar to the Standby Datum System.

The Low Datum Systems are calibrated (single point calibration) before each cascade inventory to ensure the accuracy of the data obtained.

3.1.1.6.2.4 Cell Datum Systems

The Cell Datum Systems are located at the cell control panel in the LCC. They are used as backups for the unit High Datum Systems. The Cell Datum Systems may also be used when special control strategies call for datum control of individual cells. They are generally used during cell purging operations and when pressurizing cells to atmospheric pressure or above.

The Cell Datum Systems provide a reference pressure to the high side of the stage DBMs in the same manner as the High Datum Systems. The systems operate similar to the manual portion of the High Datum Systems. Each Cell Datum System consists of a PBM, a PIX, and the piping/tubing and valves that connect them to the unit high datum header, the seal exhaust header, and the nitrogen header (Figures 3.1-15 and 16).

3.1.1.6.2.5 Datum Exhaust System

The Datum Exhaust System consists of two vacuum pumps with a common exhaust header serving the datum systems in the area. The exhaust header has its own pressure transmitter and a recorder located in the ACR. In an emergency, it is possible to connect the datum exhaust to the building Seal Exhaust System. On high exhaust-header pressure, a switch in the header activates the high datum solenoid valves, sounds alarms in the ACR if the vacuum exceeds preset limits, and isolates the Unit Datum Systems connected to that system.

3.1.1.6.3 Lube and Hydraulic Oil Systems

3.1.1.6.3.1 Descriptions

Each cascade unit has its own system to maintain a continuous supply of oil to the compressor bearings and motor bearings for lubrication and cooling, and to cascade control valves for hydraulic actuation. There are 29 separate systems, which are basically of the same design. The nominal oil capacity of these systems is:

- X-333 — The capacity is 24,800 gal in each of eight systems,
- X-330 — The capacity is 18,150 gal in each of 11 systems, and

- X-326 — The capacity is 28,050 gal in each of ten systems.

Each unit oil system consists of supply tank(s), drain tank(s) (two drain tanks in X-333 and X-326), lube oil piping, two lube oil pumps, two hydraulic oil pumps, a lube oil cooler, bypass piping, a main duplex filter, and a duplex filter for each cell or half-cell system. The drain tanks, which are located in pits or diked areas on the operating floor, provide the oil supply for both the lube oil pumps and the hydraulic oil pumps.

The oil for the booster stations is supplied from adjacent units. The vacuum pumps in the seal exhaust, datum, and wet air evacuation stations use vacuum pump oil that is not supplied from the unit Lube Oil Systems.

All supply tanks are equipped with MOVs that can be operated from the PCF to either isolate the tanks or quickly drain them to the drain tanks. Annual visual inspections are made of the external surfaces of tanks and oil coolers in accordance with plant procedures.

Lube Oil

Each of the two lube oil pumps is capable of supplying the unit's oil needs. Thus, one pump is normally in operation, and the other is used as a spare. The pumps are electrically interlocked so that the spare pump will start automatically if the supply tank level drops to a preset level. The drain tanks provide the oil supply to the pumps. From the pumps, the oil flows through a strainer and a cooler, and then to the unit supply header and the vented supply tank (Figure 3.1-17). Supply lines branch off the header to each cell in X-330 and X-326 and each half-cell in X-333. The oil is filtered again in the cell before being supplied to the motor and compressor bearings. The oil then collects in a return header, which drains to the drain tank, completing the loop. The cells are normally supplied directly from the lube oil pumps. However, the roof-mounted supply tank can provide a temporary, gravity-fed oil supply to the unit should both pumps fail to operate.

When necessary, oil can be added to the unit systems through charging lines on the drain tanks. Oil is pumped from a portable tank into the drain tank.

The makeup oil is supplied from a storage tank located southwest of the Maintenance Shop in X-330. A dike surrounds the tank. The tank has a nominal capacity of 10,000 gal of oil. This oil is pumped from a tank car or tank truck (located in track alley) by a hose into the storage tank.

Hydraulic Oil

Oil from the drain tank is also the supply for the Hydraulic Oil System pumps (Figure 3.1-17). Oil for hydraulic-actuated control valves is pumped by one of two pumps in each unit system. One pump can normally supply oil for the entire unit, while the other is a spare. The pumps are electrically interlocked so that the spare pump will come on automatically if the discharge pressure drops to the setpoint. In X-333, over-pressure protection is provided by a relief valve that reroutes excess oil to the suction line of the pump. The oil is routed to each stage control valve to supply the motive force for valve operation. After passing through the hydraulic-oil control valve, the oil flows into the lube-oil return header and drains to the drain tank.

3.1.1.6.3.2 Instrumentation and Controls

The instrumentation and controls are, in general, the same in each unit throughout the cascade. Locally-mounted instrumentation and controls in each unit Lube Oil System consists of a high-low level alarm, that actuates an audible and visual alarm in the control room when the drain tank level changes by more than the setpoint amount. A high-pressure switch actuates an audible and visual alarm in the control room to indicate that the main lube oil strainer is plugging. When the supply tank level drops to a preset level, a PBS actuates an audible and visual alarm in the control room and automatically starts the spare lube oil pump.

One stage in each cell or half-cell throughout the cascade is equipped with a PBS on the lube oil supply to the stage motor. The cell motors trip automatically if the oil pressure drops below the setpoint. This switch provides protection for the cell if strainers plug. Temperature indicators are provided locally in each lube oil pit.

Pressure indicators are located at each cell lube oil supply line downstream from the duplex strainer and cell lube oil block valve from which the individual cell and half-cell pressures are manually controlled. The Hydraulic Oil System also has pressure indicators for each cell or half-cell supply header. These are located downstream of the valve that is used to block the cell hydraulic oil flow.

In the Hydraulic Oil Systems, a PBS on the discharge of the hydraulic oil pump actuates audible and visual alarms in the control room and starts the spare pump automatically if the system pressure drops below the setpoint.

3.1.1.6.3.3 Fire Potential

The large inventories of lube oil in the three process buildings represent the greatest potential for fire in the buildings. Low lube-oil pressure trips are provided for cell protection. In addition, MOVs allow the gravity-feed supply tanks to be isolated or quickly drained in the event of a leak. In a fire emergency in a lube oil pit, an automatically operated sump pump will prevent fire sprinkler water from causing the pit to overflow.

A drain pipe between the supply tank and the pit area will dump oil into the pit in case of a supply tank rupture. The normal valve alignment is to have the lube oil sump pump discharge into the storm drain for emergency operation.

3.1.1.6.4 Recirculating Water System (Within the Buildings)

The RCW is supplied from two pipe loops located on opposite sides of each process building. Branch headers equipped with block valves extend from these loops to the cascade units in each building. Each header supplies a specified number of cells, depending on the building in which the equipment is located. After cooling the process equipment, the RCW is circulated through the cooling towers and returned to the supply loops. An RCW loop can be removed from service with the building headers being supplied from the loop on the opposite side of the building.

The primary use of RCW in the process buildings is to remove excess heat from the various coolant systems. RCW supply and return valves are provided for each coolant condenser. When the condenser or the coolant system requires maintenance, the water must be drained from the system to prevent water from entering the coolant side of the system.

Corrosion of the recirculating water piping and equipment is inhibited by a chemical treatment program.

The plant RCW System is described in Section 3.4.2.

3.1.1.6.5 Plant Nitrogen System

The Plant Nitrogen System distribution piping in the process buildings supplies gaseous nitrogen at various pressures required for normal operation. Examples of nitrogen use include seal feed, cell datum, buffering critical areas, cell treatment, purging cells to the cascade, and servicing equipment when especially dry gas is required.

If the nitrogen pressure drops below the setpoint pressure in the building headers, emergency crossover air regulating valves will open and allow dry air to enter the system from the Plant Air System. The emergency crossover valves also have a manual bypass valve.

The Plant Nitrogen System is described in Section 3.4.3.

3.1.1.6.6 Plant Air System

Dry, compressed air is distributed throughout the process buildings by the Plant Air System. Typically, plant air is used at various reduced pressures for instruments; for ventilation control; as a backup for the Plant Nitrogen System; for seal air; for the datum systems; and for purging, buffering, maintenance services, and general utilities. Diesel-powered air compressors, located in X-330 and X-326, serve as backups in case the normal power supply to the compressors is not available and to augment air system capacity as needed.

The Plant Air System is described in Section 3.4.4.

3.1.1.6.7 Coolant Drain, Recovery, and Transfer Systems

The Coolant Drain, Recovery, and Transfer Systems are designed to recover coolant and to transport it within the plant or between tank cars and storage facilities in the plant. In addition, the systems serve to evacuate residual coolant from the Cell Coolant Systems prior to opening the coolant systems for repairs and to evacuate air from the coolant systems before they are placed on-stream.

The Drain, Recovery, and Transfer Systems are comprised of networks of coolant drain headers throughout the plant and systems of piping and equipment located in pit areas on the process building operating floors. The principal system components are a drain tank, liquid transfer pumps, vapor transfer pumps, exhaust pumps, condensers, piping and instrumentation. The primary function of the Coolant Drain System is to distribute coolant from the storage facility in the plant to the Cell Coolant Systems. Each Cell Coolant System is tied into the coolant drain header. The drain, recovery, and transfer systems are completely separate in operation and control with respect to the other plant systems. In each of the process buildings, the piping layout allows coolant to be transferred from any coolant pit area, to any designated cell.

The Area 1 Coolant Storage and Transfer System has two drain tanks, each having a capacity of 11,000 gal that serve X-333. X-330 has two Coolant Storage and Transfer Systems—one in Area 2 and one in Area 3—each having an 11,000 gal capacity drain tank. Either system can be used to service the

Cell Coolant Systems in the entire building. The X-326 Building has a Coolant Storage and Transfer System located in Unit X-27-3 (Area 4) and one located in Unit X-25-5 (Area 5). Either system can service the entire building. Each drain tank has a capacity of approximately 5,000 gal.

The groupings of system equipment located in the areas referenced above are referred to as "stations." Two liquid transfer pumps are provided for each station. They are located in the coolant pit on the operating floor. Although coolant vapors are not highly toxic, they could displace air in the pit area and cause suffocation. To prevent this, a positive air supply is furnished in each pit from a fan or air supply duct from the unit ventilation system. A manometer and oxygen sensor are supplied to indicate that the air draft is acceptable. Administrative control requires that Operations confirm that the ventilation is adequate before entering the pit area.

Each Coolant Storage and Transfer System, except the system located in Area 5 (Area 4 vapor pumps service all of X-326), has two vapor pumps to remove coolant vapors from Cell Coolant Systems. This is accomplished by pulling the vapors from the cell systems and discharging them through the coolant condenser into the drain tank.

The exhaust pumps are used to obtain coolant negatives and to evacuate wet air from the cell Coolant Systems following maintenance and repairs.

The Coolant Drain, Recovery, and Transfer System condensers are used for coolant recovery purposes by cooling and condensing the gas discharged by the vapor pumps. Rupture discs and relief valves are located on the discharge of the vapor pumps and on the drain tank.

The following tests and inspections are conducted on the Coolant Storage and Transfer Systems:

- Periodic internal inspection of the drain tanks,
- Drain tanks are analyzed for moisture content, and
- Before a tank car of coolant is unloaded, it is sampled and analyzed for moisture content.

When a Cell Coolant System requires maintenance, the cell (half-cell in X-333) liquid coolant is first drained to the coolant drain tank. After the liquid coolant has drained, the vapors are removed by the vapor pumps—to the setpoint value below atmospheric pressure for the X-27 and X-29-size equipment and to less than atmospheric pressure for the other equipment sizes —and discharged through the condenser into the drain tank. The exhaust pumps are then used to evacuate the system.

After the system is evacuated, the pressure is increased to atmospheric pressure with dry air and again evacuated by the exhaust pump. Finally, system pressure is once again increased to atmospheric pressure with dry air and turned over for maintenance.

A purging operation must be performed to reduce coolant vapors. This is necessary because when coolant vapors are exposed to an open flame, they are oxidized to highly toxic phosgene gas.

3.1.1.6.8 Conditioning-Gas Storage Facilities and Distribution Lines

Chlorine trifluoride (ClF_3) and fluorine (F_2) are mixed in storage drums to form a conditioning gas that is used in the cascade buildings. ClF_3 is supplied from compressed gas cylinders, and F_2 is supplied from the Fluorine Generation System. ClF_3 and F_2 are managed under the plant's chemical safety process.

ClF_3 storage and handling are addressed in this section. Refer to Section 3.4.7 for a description of the F_2 system. Figure 3.1-18 depicts the principal components of the Conditioning Gas Storage System.

PORTS has two Conditioning Gas Storage Systems—one in X-330 and one in X-333. Normally, the X-330 system supplies conditioning gas for X-330 and X-326, and the X-333 system supplies conditioning gas for that building. Either system can be aligned to supply gas to any of the process buildings. The two Conditioning Gas Storage Systems are of similar design and configuration. Each system consists of a storage drum, a loading manifold, instrumentation and alarms necessary for safe operation, and valves and piping that connect the storage drum to the use points. The ClF_3 and F_2 systems are nonradiological chemical systems that are important to safety as described in Section 3.8.

ClF_3 is delivered to the plant in cylinders that comply with Department of Transportation (DOT) specifications. The cylinders are stored primarily at X-742, Gas Cylinder Storage Facility. ClF_3 storage quantities that are subject to 29 CFR 1910.119 requirements, including ClF_3 stored in X-742 and in the storage drum rooms in X-330 and X-333, are addressed in Section 5.6.13.

Each system has a cylinder-loading manifold in which up to two ClF_3 cylinders are connected to the system using tested, certified pigtails. The loading manifold is housed in a metal cabinet with plastic windows. A mechanism attached to the cylinder valve allows it to be manually closed from outside the cabinet or outside of the storage drum room. The cylinders of liquid ClF_3 are connected to the charging manifold and secured by clamps that prevent the cylinders from turning when the cylinder valve is operated. The cylinders are isolated from the system when charging is complete. Spare cylinders are secured to storage racks that are bolted to the concrete block wall.

From the feed cylinder at the loading manifold, gaseous ClF_3 flows to the storage drum by natural evaporation. No external direct heat is applied to the cylinders. F_2 from the Fluorine Generation System is added to the ClF_3 in the storage drum to produce conditioning gas. The storage drum has a nominal volume of 2,000 ft^3. The maximum allowable working pressure (MAWP) for the drum is 20 psia. Drum operating pressure is maintained below atmospheric pressure. During charging operations, gas flow into the drum is controlled from the storage drum room using manual valves. However, ClF_3 flow is automatically isolated if the drum's setpoint pressure is reached. Drum pressure during charging is monitored locally and in the ACR.

Normally, each system contains 150–360 lb (at approximately 6–12 psia) of vaporized ClF_3 in the storage drums. Up to two cylinders of liquid ClF_3, containing up to 160 lb each, are connected to the charging manifold. The quantity of ClF_3 in cylinders that may be stored in these areas at a given time is administratively limited to less than 1,000 lb. Cylinders of compressed nitrogen are used to purge the loading manifolds because the use of the higher-pressure cylinders eliminates the potential for contaminating the building nitrogen header with ClF_3. Up to two nitrogen cylinders may be connected to the loading manifold.

The system is designed so that two block valves are available to isolate the storage drum and/or the ClF_3 feed cylinders from the distribution system and from interfacing plant systems, including the plant F_2 header, to ensure positive isolation during operational or maintenance activities.

The air supply to the PBMs that monitor system pressure is required for the Conditioning Gas Storage System to perform its safety functions. Compressed air from the Plant Air System provides the motive force for the PBMs to operate. From the Plant Air System header, the air flows through a filter and a pressure reducer before it reaches the PBMs. A valve at the header allows the PBM branch line to be isolated from the air system for maintenance. A relief valve is provided in the branch line to prevent over-pressurization. The air supply from the PBM back to the Plant Air System header is a support system that is important to safety, as described in Section 3.8. The air system is described in Section 3.1.1.6.6.

3.1.1.6.8.1 Instrumentation

- Locally-mounted instrumentation includes a pressure transmitter that allows the ACR to monitor the storage drum pressure.
- A PR in the respective ACR provides a continuous record of the storage drum pressure, feeding operations, and continuous leak-rate.
- A pressure switch actuates an audible and visible alarm in the ACR when the storage drum pressure reaches the high-pressure setpoint.
- At the high-high setpoint, a second pressure switch actuates another audible and visual alarm in the ACR, actuates an audible alarm outside the storage drum room, and de-energizes an alarm light over the storage drum room entrance door; at the high-high setpoint, a third pressure switch automatically closes the control valve to the loading manifold.
- A pressure indicator on the line leaving the storage drum room monitors cascade system pressure to aid in determining whether the valves are properly aligned.
- Each cylinder position is provided with a pressure indicator.
- The loading manifold is provided with a pressure indicator.
- PBMs tied into the cylinder pigtails sound an audible alarm and activate the alarm lights over the entrance doors if the setpoint pressure is exceeded.
- A test manifold in each storage drum room allows for simulating a pressure increase to check activation of alarms and proper operation of the PRs in the ACR.

3.1.1.6.8.2 Materials of Construction

Materials of construction are specified on the basis of the intended service. Copper, brass, and steel may be used for general ClF_3 service. Monel and nickel may be used where higher corrosion resistance is desired. Gasket and packing materials may include copper and lead.

3.1.1.6.8.3 Primary Confinement Systems

<u>Storage Drum and Piping</u>

In X-330 and X-333, ClF_3 and F_2 are contained within the storage drum and piping inside a heated room. The normal storage drum operating pressure is maintained at a setpoint lower than atmospheric pressure, so that any leak would result in ambient air being pulled into the system.

<u>Cylinders</u>

The ClF_3 and the nitrogen cylinders comply with DOT specifications and are visually inspected before being attached to the Conditioning Gas Storage System.

3.1.1.6.8.4 Secondary Confinement System

The drum storage rooms are constructed of noncombustible materials such as concrete block walls, concrete and sheet-metal ceilings. The storage drum rooms are well sealed to prevent any release within the rooms from entering the operating floors. The entrance doors are kept tightly closed, and cracks are sealed to prevent air exchange. Because of these design characteristics, the storage drum rooms are considered secondary confinement systems for the stored gases. The ClF_3 Storage Drum Rooms are heated to prevent liquefaction of the gas in the storage drums during cool weather. Each storage facility has an exhaust duct extending from the roof of the storage drum room through the roof of the process building. The exhaust system is intended primarily for use in case of an accidental release.

3.1.1.6.8.5 Special Gas Treatment

When new equipment is installed or cascade equipment has been opened to atmosphere, a special treatment of F_2 and/or ClF_3 may be used to condition surfaces exposed to wet air while open as well as to remove moisture before exposing the equipment to UF_6. Deposits of UO_2F_2 and other solid compounds may also be removed from equipment by exposure to these gases.

ClF_3 and F_2 are respiratory irritants even in low concentrations and can cause deep irritating burns on contact with the human skin.

Both gases react violently with organic and oxidizing materials and, at elevated temperatures, with most metals. Procedural controls are exercised over the introduction of these gases into the cascade to minimize the risk of an explosive reaction.

Following cell treatment, strict adherence to the administrative controls for the introduction of ClF_3 and F_2 into the cascade and the prohibiting of coolant in a cell during the gas treatment are necessary to protect the equipment.

3.1.1.6.9 Buffer Systems

Buffer systems are used in the process system to prevent PG outleakage or wet-air inleakage. Pressures in the buffer systems are kept higher than the PG pressure to assure that leakage will be inward; provisions are made to purge the PG from the process gas system with nitrogen or dry air.

There are two Buffer Systems in the cascade. One system supplies the compressor flanges, Blowout Preventers (BOPs), control valves, and expansion joints. The other supplies block valves only. The buffering medium, dry air, is supplied from the Plant Air System. Most of the supply tubing runs are outside of the cell housing and enter the housing near the buffered component.

Compressor casing flanges are designed using a double concentric gasket arrangement. When the compressors are in service, the annular spaces between the gaskets are buffered with dry air so that if a leak should develop, dry, rather than atmospheric, air will enter the cascade. Figure 3.1-10 shows a typical gasket arrangement and buffer system connection in an axial compressor. Buffer gas is also provided for the stage control valves and BOP bellows.

3.1.1.7 Heating and Ventilation Systems

3.1.1.7.1 Heating System

Steam, which is produced at X-600, Steam Plant Facility, is distributed to user facilities throughout the plant. In X-330 and X-333, steam is used to heat UF_6 enclosures and storage drums. These enclosures and drums include cell housings, cell by-pass housings, unit by-pass housings, interbuilding tie-line housings, cold recovery piping and holding drums, surge drums, LAW Station piping, freezer/sublimer piping, boosters and Tails Withdrawal Facility piping. In X-326, steam may be supplied to coils in the supply fan ducts for general building heating in case of low ambient temperatures. Cell and unit bypass housings are electrically heated in X-326.

The purpose of the heating system is to prevent freeze-out of UF_6 in the process piping or equipment. As a minimum, the X-326 steam heating system will be operated to maintain temperatures that will prevent the freezing of sprinkler systems as well as other water-containing systems, such as recirculating water lines, sanitary water lines, sewage/drain lines, and equipment that collects water and is not drained (e.g. air receivers, water traps, steam traps, condensate systems, etc.). Portable steam heaters, that are available for supplemental heating, have no automatic control mechanisms installed to control steam usage. Some facilities in X-330 and X-333 have electric heaters or electric and steam heaters combined. Such facilities include the booster systems, cold recovery area, and the LAW Station.

The steam lines are sectioned with manual valves so they can be easily isolated for repair. There is usually ample time for repairs without any danger of UF_6 freeze-out; however, portable electric heaters are available, if needed. The most probable locations for freeze-out are the A-line and B-line drop housings in X-333 that could freeze out in approximately 8 hours under normal conditions, if steam heat is cut off.

The X-330 Tails Withdrawal Facility operation is affected when steam is unavailable for 2 to 3 hours. Temperatures are regularly monitored by operators to reduce the chance of heat loss and freeze-out.

Due to the shutdown of the enrichment process, the process buildings are heated and winterized to provide for personnel needs during the winter months and to provide adequate heat to maintain the HPFWS in service during the winter months. The required heat is supplied by steam and electricity to support required cascade operations using the currently installed heating systems. Portable electric heaters are placed in the process buildings to provide general building area heat during the winter months. The process building areas will be maintained at 40 degrees F or greater at all times. This will assure the functionality of the HPFWS. Most of the building ventilation system, described in the next section, is shutdown to conserve heat during the winter months. Since the enrichment process is no longer operating, there is no need for building ventilation systems to remove process heat or to maintain any specified building differentials. Also, the ventilation zone purge systems in the X-330 or X-326 are not operable during cold standby.

3.1.1.7.2 Ventilation Systems

Ventilation systems are provided in the process buildings primarily for limited control of the operating temperatures for motors and transformers, although other functions may be served. These systems consist of outside air intake dampers, filter rooms, fans, fan discharge dampers, ducts, and supply air grilles. Outside air is drawn in by the fans and delivered to the cell floor through a network of ducts.

The process power system transformers, the major heat source located on the operating floor, are self-ventilated. However, the heated air from the transformers still must be removed from the immediate vicinity by the Process Ventilation System.

The exhaust air system equipment consists of an individual exhaust duct for each motor (except the smaller X-25-size motors), a network of exhaust ducts, dampers, fans, fan discharge/recirculation dampers, and roof-mounted exhaust vents. An automatic sprinkler system provides protection against a fire in the ventilation duct. Manipulation of the dampers permits routing any desired portion of the exhaust air to recycle, mixing it with the outside air being drawn through the intake dampers. Exhaust air is routed to the roof level where it is discharged.

The X-330 and X-333 ventilation systems are used to maintain the desired temperature as well as a pressure balance between the operating and cell floors. The system is designed so that, normally, the

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pressure on the operating floor is maintained negative with respect to the outside ambient, and the pressure on the cell floor is maintained positive with respect to outside ambient air.

The Process Ventilation Systems' design divides the buildings into operating zones. A zone usually consists of one-half of a process unit. The process ventilation control system is equipped with a key-operated purge valve that is located on the cell floor in the center of each ventilation zone. Manipulation of this valve causes the recirculating dampers to close and the roof vent, air exhaust, and intake air dampers to open fully; thus, the zone is effectively purged. This valve overrides the floor thermostats and is used only when it is desired to rapidly exhaust smoke, coolant vapors, or any other undesirable fumes from either the operating floor or cell floor of the zone.

The control circuit also contains a manual three-way valve that is located at the filter room door and is used to position dampers for filter cleaning. Manipulation of this valve will, through a relay, fully close the recirculating and intake dampers and open the air exhaust dampers. Three-way solenoid valves are wired through the vane-axial exhaust fan starter circuits and de-energize when the fan motors are shut down. This causes the closure of both the air exhaust and recirculating dampers to prevent possible backflow of air into the exhaust system when an exhaust fan is not operating. A damper, operable from the operating floor by a chain extension, is installed in each motor exhaust branch duct at the point where it connects to the main exhaust duct. These dampers permit rapid isolation at that branch from the remainder of the system in case of a motor fire.

There is no single shutdown point or control for the ventilation system. Shutdown requires that the operator(s) go to each supply fan and exhaust fan control switch and manually shut down each individual fan. The controls are located on the operating floor.

In the X-25-size equipment, a set of steam heating coils has been installed in the discharge ducts of the supply air fan to provide a method of adding supplementary heat to the ventilation system during winter operation.

In addition to the Process Ventilation Systems, additional ventilation has been provided in several areas. Each battery room has an exhaust fan to eliminate the buildup of hydrogen. Maintenance areas, rest rooms, and shower rooms have exhaust fans. The coolant drain pits have ventilation to remove coolant vapors in the pit. The ACRs have self-contained air conditioners to protect special instruments and equipment. Drum storage areas and the LAW Station have unit heaters and ventilation systems. The cold recovery areas use ventilators for containment of any release of hazardous materials.

Failure of the ventilation air control system in a process building may cause a reverse differential pressure relationship between the cell floor and operating floor. The cell floor pressure must be maintained higher than the operating floor pressure to ensure a hot air supply flow to local control panel instrument ducts; otherwise, the UF_6 in the instrument lines could freeze out with a resultant loss of cell pressure control. To help prevent this, the uprated X-333 and X-330 cells and all of the X-326 cells have electrical heaters installed in the instrument ducts.

To minimize instrument line freeze-out due to a ventilation failure, the following additional features are provided:

- The X-330 and X-333 ACRs have a low-pressure alarm for each Pressure Reducing Station (PRV) that will activate when the pressure falls to the established alarm setpoint.

- X-333 has an east and a west PRV, either of which can be used to supply the other in case of a station failure.
- X-330 has a PRV for each unit. A PRV failure in one unit would not significantly affect the building differential pressure.
- X-326 has two PRV's. However, because of the low pressures and electric duct heaters in X-326, freeze-out of instrument lines is not likely.
- The process buildings have gauges in the ACRs that show pressure differential between operating and cell floors.

All the process transformers have either high-temperature or fan-failure alarms in the ACRs.

3.1.1.8 Cascade Electrical Systems

The PORTS electrical system, which includes the Process Power System, the Process Auxiliary Power System, the Backup Diesel Generator System, and the DC Power System, is described in Section 3.4.1.

The 13.8 kV Process Power System feeders from the switchyards supply multiple transformers located on the operating floors in the process buildings. In X-333, there are two 13.8 kV to 2400 V process power transformers for each cell. In X-330, the feeder from the switchyard supplies two transformers. Each transformer supplies one cell, except in Units X-29-5 and X-29-6 where there are two transformers per feeder; each transformer supplying two cells. Power is supplied to the stage motors in these buildings at 2400 V. In X-326, which has smaller equipment, process power is supplied to the cells at 480 V.

Each EBS can be fed from three separate feeders in X-330 and two separate feeders in X-333 through the use of tie breakers. Emergency power from the backup diesel generators is supplied to the EBS valves for automatic isolation in case the normal power supply is not available.

The power supply for each of the interbuilding booster compressor motors is from a 2400-V bus served by a 13.8 kV/2400 V transformer. In addition, a tie breaker is located on the bus so that other similar transformers may be connected to serve the bus upon failure of the normal supply transformer. Upon loss of voltage, undervoltage relays automatically trip the motor feeder breakers.

Power to auxiliary systems, including utilities, control systems, lighting, and the building cranes, is from the Process Auxiliary Power System. Power is fed from the switchyards at 13.8 kV to the process auxiliary substations on the operating floors of the process buildings. There, the voltage is reduced to 480 VAC and the power is routed to various distribution panels. The Process Auxiliary Power System is described in Section 3.4.1.

Multiple backup diesel generators are provided to supply power in each process building for isolation of cascade equipment and necessary monitoring capabilities during power failures. The diesel generators provide backup power to selected valves, lights, and such other special auxiliary equipment as seal-exhaust pumps, datum pumps, and rectifiers. The diesel generators function automatically in case of failure of the Process Auxiliary Power System (either complete or partial plant failure). Each diesel generator has its own distribution system for supplying power to special equipment in two units. Provisions have been made to connect to other diesel systems in case a given diesel generator fails to start. The diesel generators are described in Section 3.4.1.

The DC Power System in the process buildings can provide up to 250 VDC. The system consists of storage battery banks, charging systems, and associated controls located on the operating floor in each unit. Rectifiers associated with each battery bank serve as battery chargers and are the normal source of DC power for the unit. Power to the rectifiers is supplied from the Process Auxiliary Power System. In the event the normal DC source is unavailable, the system automatically switches to the storage batteries. Inter-ties between the unit DC systems can also be used to provide additional backup sources of DC power. Uses of DC power in the process building include the Compressor Motor Manual Trip System, the datum systems, the Onsite Warning/Evacuation System air horns, and various controls and instruments. See Section 3.4.1 for a description of the plant DC Power System.

3.1.1.9 Cranes and Rigging

Several sizes of cranes and hoists are used for handling cascade equipment. In addition to the cranes, various slings and fixtures are used in the process buildings. The cell floor process building cranes, slings, and fixtures are described in this section. Cranes that handle UF_6 cylinders are described in Section 3.2.4.2.

3.1.1.9.1 Cell Floor Process Building Cranes

All of the cranes used to move equipment in the process buildings are bridge-type cranes. The cranes travel in runways that extend the full width of the building. The cranes travel on rails supported by runway girders located just below the building roof trusses. The runway girders are supported by the building columns near the ceiling of the cell floor. One crane is located in each runway. The cranes that are important to safety as described in Section 3.8 are 1) the crane in X-333 that is normally parked over the unit bypass piping, and 2) the cranes that are used to transport heavy equipment above or around cascade equipment that is intended to be operated above atmospheric pressure.

The numbers and capacities of the cranes used to move process equipment within the buildings are as follows:

Building	Quantity	Capacity	Primary Use
X-333	10	15-ton	Coolant condensers, tube bundles, water control valves and piping.
X-333	10	38-ton	Process converters, motors, compressor, block valves and process piping.
X-333	1	23-ton	Valves, piping, and various process equipment associated with the unit bypass piping.
X-330	22	15-ton	Process equipment, converters, compressors, motors, piping and control valves.
X-326	20	5-ton	Process equipment, converters, compressors, motors, piping and control valves.

In X-333, alternate crane bays have 38-ton capacity and 15-ton capacity cranes. The larger cranes are located over the process converters, motors, and compressors, while the smaller, 15-ton, cranes only travel over the cell coolant equipment. Consequently, there is no equipment under these smaller cranes that will exceed their rated capacity. The 23-ton crane in X-333 is located over the unit bypass piping and travels the entire length of the building. No equipment element is located beneath this crane that exceeds its rated capacity.

The principal components of the cranes are the bridge, the trolley, and the hoist. The bridge spans the building crane rails. The trolley, which supports the hoist mechanism, travels on the bridge, allowing the hoist to move in a direction transverse to the crane bay. The hoist is the lifting mechanism. The cranes are equipped with electric brakes on the trolley and the hoist. Loss of power to the electric brakes causes them to engage. The bridge is equipped with hydraulic brakes. The controls are located in the cab that is mounted on the bridge. Entrance to each cab is via a fixed ladder. The access ladders are equipped with safety cages. The ladders in X-326 and X-330 are located at one end of the crane runway. In X-333, ladders are located at each end of the runway. Access to the cranes in X-326 is also available from the unit bypass piping housing. The crane cabs may be air-conditioned because of the high temperatures encountered near the ceiling during summer operation. Personal protective equipment is provided for each crane operator in case of a UF_6 release during crane operation.

Operators of cab-controlled cranes are provided with emergency escape mechanisms to allow safe exit from the cab in the event of an emergency. With the exception of the 23-ton crane in X-333 that is parked over the unit bypass piping, the cranes are parked in standby locations and are not over operating equipment when not in use. Crane movement over operating cells with a heavy load is limited by administrative controls to minimize the potential for dropping a load on an operating cell. The cranes are periodically inspected to verify that upon operator release of the controls when loaded at rated capacity, the hoist will stop, limiting the load to small movements due to momentum. In addition, the cranes are functionally inspected according to procedure by the crane operator prior to first time crane use each shift to ensure proper operation and the absence of observable damage. Additional administrative controls are described in Chapter 4.

Electrical power to the cranes in the process buildings is from the Process Auxiliary Power System. The power system is described in Section 3.1.1.8.

3.1.1.9.2 Slings and Fixtures

The slings and fixtures used for handling process equipment vary in configuration, depending on the type and size of the equipment to be handled. Each sling and fixture is marked to indicate its rated lifting capacity. Slings that do not have a tag with a load-test date less than one year old are returned to the maintenance area for re-certification or disposal. Each sling and fixture is periodically inspected and load-tested in accordance with plant procedures. In addition, procedures require users to check for obvious damage prior to using the device on each shift.

3.1.1.10 Control Facilities

Control facilities at PORTS associated with the enrichment cascade consist of LCCs for each cell in the enrichment cascade, an ACR for each area in the process buildings, and the PCF.

3.1.1.10.1 Local Control Center Instrumentation and Controls

LCCs, which house the instruments and controls for a single cell, are located on the operating floor just below the equipment on the cell floor. They are arranged in a manner that facilitates operator movement from one LCC to another. At an LCC, an operator can read and adjust stage pressures, read stage temperatures, adjust cell coolant temperatures, check the condition of the compressor shaft seals, open or close the cell-block and bypass valves individually, and start and stop the stage motors. The Cell Datum Systems are also controlled from the LCCs.

PG from the cell is piped through an instrument line to a Pressure Blind Multiplier (PBM) or a Differential Blind Multiplier (DBM) located in the electrically heated portion of the LCC. These instrument lines, located inside heated, insulated ducts, travel from the equipment pressure taps, through the cell housing and the cell floor, to the top of the LCC. In uprated cells, the ducts are electrically heated and thermostatically controlled. Some non-uprated cells depend on the pressure differential between floors to force the hot air from inside the cell housing down through the instrument duct to keep the lines well above the freeze-out temperature. Units X-29-1 through X-29-6 are the only units that do not have electrically heated instrument line ducts.

Other instrument lines that do not connect directly to the process are secured in instrument racks outside the heated duct. These racks contain instrument output lines, buffer lines, and seal feed lines.

Parameters that may be monitored and/or controlled from the LCCs are:

- Pressure measurement and control,
- Cell Datum Indicator,
- Temperature instruments and controls,
- Seal feed and exhaust instrumentation,
- A-suction pressure indicator,
- Buffer System instrumentation,
- Automatic recycle control (X-333 and X-330 only),
- Coolant over-ride control (X-333 and A-line-cooled cells in X-330 only),
- Block valve control,
- Cell Datum System instrumentation (Section 3.1.1.6.2), and
- The Top and Side Purge (Section 3.1.2).

3.1.1.10.1.1 Pressure Measurement and Control

As described in Section 3.1.1.1.4, the process equipment in X-330 and X-333 is controlled at each stage, referred to as a Badger design; whereas that in X-326 is controlled in clusters of three stages referred to as Badger Clusters. Pressure control is accomplished using a control valve and pressure control instrumentation, which is the same for each control valve, whether it controls a stage or a cluster. In X-330 and X-333, each stage is equipped with a DBM, a PIC and a control valve. The PIC indicates the stage pressure and also has a pointer that indicates the control valve position. Pressure taps to the stage DBMs are located on the converter B-outlet line at every stage. In X-326, a control valve controls the pressure for each cluster. The cluster process pressure tap is located on the B-downflow from the converter three stages ahead.

Stage-control pressure indicating controllers (PICs) are normally operated in automatic mode. The manual mode is used when putting cells on-stream and off-stream when operating conditions require or warrant the use of the manual mode.

An indicator on the stage PIC shows process pressure and is actuated by the output of the DBM. The output pressure of the DBM is proportional to the differential between the datum pressure and process pressure. The process pressure can be calculated using the following equation:

$$\text{Process Pressure} = \text{Datum} - \text{DBM Range} + \left(\frac{\text{Pressure Indicator (PI) Reading} \times \text{DBM Range}}{100}\right)$$

The output of the DBM is also sent to the input chamber of the controller during automatic control. The instrumentation is the same for every stage or cluster control valve.

Another instrument common to the enrichment cascade stage PIC is the pressure level index (PLI). This instrument is merely a pressure reducing valve and indicator that is used to induce a pressure on the stage stacks enabling the process pressures in an entire cell to be raised or lowered simply by setting this instrument for the percent change desired. In X-333 and in Units X-31-1 and X-31-2 in X-330, a master PLI (located in the ACR) is used to raise and lower cell pressure to minimize pressure disturbances that travel to the bottom of the cascade. Most of the Unit X-33-1 pressures are controlled in the same manner from the PCF for the purpose of power load control. (Section 3.1.1.5.3).

3.1.1.10.1.2 Cell Datum Indicator

Each LCC has a datum pressure indicator—with external components— (PIX). This instrument can be set to monitor unit high datum (predetermined set pressure) or cell datum. Setting the instrument to monitor cell datum allows for local adjustment of the datum pressure. The range of the instrumentation on uprated cells permits the reading of pressures up to 25 psia on the PICs. On the remaining cells the range is up to 20 psia. Normally, the on-stream cells operate on unit high datum as described in Section 3.1.1.6.2.

Valving arrangements are such that any cell in a unit can be set up to be the datum-controlling cell in the event of an emergency, such as datum pump failure.

3.1.1.10.1.3 Temperature Instruments and Controls

A temperature indicator (TI) monitors the cell temperatures. Depending upon cell design, the monitoring points vary. In an uprated and A-line-cooled cell, the converter B-outlet and compressor A-suction temperatures are indicated on a TI. The last stage discharge temperature, coolant temperature, and instrument line duct (except in X-29 equipment) temperature are also monitored. In non-uprated, A-B-cooled cells, only the A-line temperatures, last stage discharge temperature, and coolant temperatures are monitored.

The cell TIs in X-330 and X-333 have no control feature. In X-326, an isotopic Stage-12 compressor discharge temperature that reaches the setpoint value will cause the Stage-12 recycle valve to open. This is to protect Stage-12 from compressor overheating when the cell is off-stream.

Cubicle temperatures are monitored on a simple dial TI. Failure of the cubicle or duct heaters may result in the freeze-out in process control instrument lines. In this event, control of the cell is lost because false pressures will be indicated on the stage PICs. To prevent equipment damage, the situation is investigated and corrective actions are taken immediately. Repairs to restore cell control receive high priority. The cell must remain on manual until the instrument lines are thawed.

Instrumentation provides alarms at the LCC and ACR for high coolant temperature and low coolant pressure. A pressure switch on the Coolant System also initiates cell shutdown if the pressure in the Coolant System reaches the high pressure setpoint.

The cell PG temperature is controlled by an RCW control valve on each coolant condenser that regulates the coolant vapor pressure at a value equivalent to the desired temperature. The coolant temperature is monitored on the cell TI.

3.1.1.10.1.4 Seal Feed and Exhaust Instrumentation

All the seals in a cell are supplied by a Seal Feed System that is usually divided into two separate systems, one for the A-seals and one for the B-seals. Each Seal Feed System contains a number of instruments for controlling the seal feed pressure above the PG pressure to prevent wet-air inleakage to the cascade and PG outleakage to atmosphere, or to the Seal Exhaust System. Also in conjunction with the normal seal feed control, is a low-limit control. The purpose of the low-limit control is to always keep a sufficient pressure in the feed chamber of the shaft seals. This limit is provided to assure that the seal feed pressure does not fall too low, during cell evacuations. Control air failure to the cell Seal Feed and Seal Exhaust Systems results in the seal exhaust control valve closing.

3.1.1.10.1.5 A-Suction Pressure Indicator

The A-suction pressures are monitored on the A-suction PI on each cell. A defective instrument, or break in an instrument line, would result in inleakage of wet air into the cascade. Atmospheric leaks or breaks in any of these lines would be indicated by higher than normal reading when compared with the other pressures. Normally the A-suction pressures are nearly equal, except in tapered cells or cells having two different types of converters or compressors. Accessible leaks can be repaired on these lines without taking the cell out of service.

3.1.1.10.1.6 Buffer System Instrumentation

In the uprated cells, each cell buffer panel is equipped with a flowmeter, and a high and low pressure alarm. Both the flow and pressure alarms are indicated on the cell panel in the ACR. The alarms will actuate the B-seal floodlight in the ACR. This is a separate light from the seal exhaust alarm light. To determine the location of the alarm, the LCC and local cell buffer cabinet must to be checked. Alarm indicators are provided at the LCC for each B-seal cavity pressure. The flow alarms at the buffer panels are normally checked periodically and corrective action initiated for any problems found. If there are any problems with the main buffer supply, a standby system is available at the buffer control panel.

3.1.1.10.1.7 Automatic Recycle Control (X-333 and X-330 only)

A recycle controller is provided at the LCCs in X-330 and X-333. These instruments protect the Stage 1 compressor by opening the recycle valve automatically (uprated cells only) during a cascade disturbance caused by shifting inventory or by the accidental "starving" of the Stage 1 compressor. When high-side pressure increases or A-suction pressure decreases by more than the limits specified in approved procedures, the recycle valve will open automatically to restore the differential and, thereby, keep the Stage

1 compressor out of the surge range. Loss of air flow through the instrument ducts that depend on the ventilation pressure differential between floors to produce the flow, or freeze-out of instrument lines due to cubicle heater failure, can cause the recycle to open.

3.1.1.10.1.8 Coolant Over-Ride Control (X-333 and X-330 only)

As an A-line cooled cell is taken off-stream, the pressure in the A-line between the top stage converter and the A outlet valve will increase to approximately the compressor's discharge pressure. Due to the phase relationship, UF_6 could freeze out in that portion of the A-line and on the cooler. Instrumentation and controls have been installed on A-line-cooled cells that will automatically adjust the RCW control valve position to ensure that the A-line temperature is high enough to prevent UF_6 condensation or freeze-out on the cooler.

Failure of the override instrumentation could cause freeze-out in the top stage cooler of an off-stream cell. This would result only in an operational problem. Its failure would not cause a malfunction or interfere with the operation of the RCW control valve control system while in the manual mode, but could affect automatic operation.

3.1.1.10.1.9 Block Valve Control

Beside each LCC is a Valve Control Center (VCC). The VCC houses a main electrical breaker and individual valve breakers for the MOVs associated with that cell. The control section of the VCC has a mimic of the cell and bypass piping with valve position indicating lights and controls for each individual valve. The indicating lights will show whether the valves are open or closed, if the valve is traveling and the direction of travel, or if the valve has stopped. Pushbuttons are provided to initiate group valve operations, including:

- Master Valve Stop (will stop all valves in motion, except cell recycle).
- Cell Off-Bypass Open (closes the A-inlet, A-outlet, B-inlet, B-outlet, and opens the A-bypass and B-bypass).
- Cell Off-Split or Cell Top Split (closes the A-outlet and B-inlet and, in some locations, the A-inlet and B-outlet will also close).

Uprated cells have a motor operated evacuation valve control, which facilitates rapid response when transferring inventory is required in above-atmospheric operations. Manual operation can be performed on any MOV that fails to operate.

The cell motor breaker controls are located adjacent to the VCC. Indicators are provided that show the breaker positions. A transformer potential indicator light is provided to show that the cell feeder is energized.

3.1.1.10.2 Area Control Room Instrumentation and Controls

Each process building has one or more ACRs. Their locations and areas of control are described in the respective building subsections of 3.1.1.1.5. The ACRs are the control and communication centers for their designated process areas. Instruments and controls in the ACRs permit operators to monitor process equipment, control operations, and take mitigative actions when required. The principal instruments and controls available in the ACRs are described in this section.

3.1.1.10.2.1 Motor Load Indicators

Motor load indicators (ammeters) are provided in the ACR for each cascade compressor motor and for the interbuilding booster compressor motors. In addition, motor load indicators are also provided in the PCF for each enrichment cascade cell. The motor load indicators in the ACR for the enrichment cascade compressor motors in X-330 and X-333 and the motor load indicators in the PCF for the enrichment cascade cells are important to safety as described in Section 3.8.

Each stage motor has its own motor load indicator identified by stage, cell, and unit. Operators use the motor load indicators as diagnostic tools in identifying abnormalities resulting from malfunctions of process equipment and in providing information for taking mitigative action. 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 onsite personnel.

Load alarms and indicator lights located in the ACR are also associated with each motor load indicator. A change beyond established limits in the amp load on any stage motor will actuate an audible and visual alarm for the respective cell. The amperage change that results in an alarm indication varies from a nominal 10% in the cells operating above atmospheric pressure, to a nominal 30–40% for cells operating below atmospheric pressure. The alarms consist of lamps located adjacent to each motor load indicator. In addition, when any one of the load indicators in a cell is tripped, a cell alarm lamp (located above the bank of motor load indicators) and a horn are actuated. The horn will continue to sound until an alarm reset button is pushed. This alarm is slaved to the PCF.

3.1.1.10.2.2 Remote Operation of Valves

Each cell has the following pushbuttons for remote operation from the ACR :

- Master Valve Stop,
- Cell-Off Bypass Open,
- Cell-Off Split (in X-326 and non-uprated cells in X-330),
- Cell Top Split (in X-333 and uprated cells in X-330),
- Recycle Open (X-326 Recycle Close),
- Motor Stop,
- Cell Evacuation Valve (uprated cells only), and
- AB2 Close (uprated cells only).

Auxiliary headers, such as feed lines, vent return lines, PG return lines, evacuation lines, product withdrawal piping, and plant air headers, have MOVs to provide isolation of the building tie lines. ACRs 1, 2, 3, and 4 have switches for remote operation of these valves.

Those cells having motor-operated cell evacuation valves are provided with a control switch and indicating lights on the PLI panel or respective cell panel in the ACR.

In X-333, and in the uprated units in X-330, jumper lines with MOVs have been installed on designated cells (Cells 3, 4, 8, and 7 in X-330 and Cells 4, 5, 8, and 9 in X-333) in each unit. The jumper lines connect the unit evacuation header to the "B" outlet line of these cells to provide a means of removing excess inventory from the cascade to surge drums quickly, with or without the use of the EBS. The MOV control switch is located in the middle of the cell panel.

3.1.1.10.2.3 Alarms (Cell)

Each cell panel includes the following audible and visual alarm indicators:

- Seal exhaust (high-low differential),
- Coolant (high temperature and low pressure),
- Load (high or low),
- Coolant override (A-line-cooled cells only),
- Seal flood/buffer/DBS (uprated cells only),
- High transformer temperature or fan power off,
- Fan failure,
- Cell high discharge temperature (X-326 only), and
- High PG temperature (Top and Side Purge only).

3.1.1.10.2.4 Unit Utilities Panel

All the unit utilities panels have similar instrumentation alarms and indicators. They are as follows:

- Lube oil gravity supply tank level indicator,
- Lube and hydraulic oil pump controls,
- High-low datum alarms,
- Datum lock-in alarm,
- High-low lube oil level in the drain tank,
- High lube oil pressure or filter high differential,
- Low hydraulic pressure,
- Sump pump alarms,
- Mimic of the unit auxiliary power supply with indicators showing the position of the transformer secondary breakers and tie breaker,
- G-17 bellows (uprated cells), and
- Cascade Automatic Data Processing (CADP) smokeheads (used during manual mode on uprated cells).

3.1.1.10.2.5 Utilities Panel

There are dial indicators and alarms on each plant utility system. Each ACR is equipped with such a panel. Both audible and visual alarms are actuated on low pressure, except as noted. They are as follows:

- RCW header pressure,
- Plant air pressure, (Indication Only)
- Plant nitrogen pressure,
- Sanitary water pressure,
- Fluorine distribution pressure,
- Ventilation system floor differential pressure,
- Ventilation system air supply pressure, and
- Pressure recorder with both seal exhaust and area datum pressure.
  (Alarms are actuated on high pressure)

3.1.1.10.2.6 Line Recorder Panels

A line recorder is a mass spectrometer that monitors the relative change in N_2, O_2 and coolant, or "lights," concentrations as these contaminants flow through the cascade. There is one line recorder for each unit in X-330 and X-333, and there are two line recorders per unit in X-326 (except for Unit 25-7 that has only one). They have switching arrangements that permit them to monitor the cells in their respective units, as well as the cells in adjacent units. Periodically, due to wet air inleakage, the instrument lines plug. This disables the ability to monitor the plugged cell. The instrument line may be isolated if the cell above it has the ability to detect inleakage. This feature allows monitoring to be continued during line recorder maintenance. The PCF has a slave recorder for each unit in the cascade.

3.1.1.10.2.7 Tails Assay Monitor Panel

In ACR 2, a remote recorder from the tails assay spectrometer is located on the ACR operator's desk. A printout of the tails assay is provided at approximately 5-minute intervals. In case of spectrometer failure, U-tube samples are pulled at intervals specified by procedures.

3.1.1.10.2.8 Top and Side Purge Monitors

ACR 6 contains the monitors and controls for both top and side purge operations. They are described in Section 3.1.2.

3.1.1.10.2.9 Valve Status Control

A number of cascade auxiliary valves that do not have electrical position indicators are controlled administratively by means of valve control tags and pin charts. This system is used to show valve status and minimize the possibility of mis-aligning manually operated valves in the cascade piping. Double checks help prevent costly inventory mixing losses and reduce the nuclear hazard potential associated with uranium material entering equipment of unsafe geometry. It is the responsibility of each first line manager to maintain coordination between the area and the PCF. It is the responsibility of the Cascade Controller/Coordinator to coordinate valving between buildings. Operating procedures outline the use of the tags and valve control boards.

3.1.1.10.2.10 Communications

The ACR operator has three methods of communication: radio, telephone, and a paging system. Two radio channels are available to contact operations, maintenance and security personnel, and others. There are three telephone systems: a conventional telephone, a Private Automatic Exchange (PAX) telephone, and a Red-phone System. The PAX System may be used to talk to the operators on the operating or cell floors and to persons at other onsite locations. The Red-phones are direct lines from the process areas to the X-300.

A dual paging system is used to communicate to all floors. One system, building air horns, sends out coded blasts to communicate with operators, sound a recall or initiate a personnel accountability action. A second, distinctive horn system is used for emergency evacuation in case of a radiation hazard.

3.1.1.10.2.11 Surge and Waste Panel 2

Surge and Waste panel number 2, which is located in ACR 2, includes pressure indicating instrumentation and associated alarm indicators for the intermediate and bottom surge drums that are important to safety as discussed in Section 3.8. These instruments are described in Section 3.1.1.5.

3.1.1.10.3 Plant Control Facility

X-300 is a dome-shaped, circular building located east of X-326. The exterior walls, roof, floor slabs, stairs, tunnels, vault, and other structural members are constructed of reinforced concrete. The structure of X-300 is important to safety as described in Section 3.8.

Supervisory control equipment, offices, and auxiliary rooms are located on the ground floor. Building power equipment, communication equipment, and air-conditioning and ventilating equipment are located in the basement. Control and instrumentation tunnels extend from the basement of the PCF to each of the process buildings. Communication, control and instrumentation cables from each of the six ACRs, the switch-houses and the telephone building enter the PCF through these tunnels. Communications to and from the PCF consist of a radio system, a PAX Telephone System, a conventional telephone system, a Red-phone System, a ring-down telephone, the Plant Public Address System, and the Evacuation Alarm System. The ring-down telephone is a direct line to the Department of Energy Emergency Operations Center in Oak Ridge, Tennessee. The other communication systems are described in Section 3.1.1.10.2.10.

The PCF contains, in one central location, the control instrumentation and communication equipment required for supervision, direction and coordination of overall plant operation. Sufficient equipment is available to monitor the operating conditions vital to the production cascade and power systems. From this location, action can be taken to sectionalize the process system, shut down the entire process system, or monitor the process system performance for an indefinite period of time after operating personnel have been evacuated from the rest of the site. The power load to the entire plant is also monitored here and adjustments are made by the use of an automatic load controller as described in Section 3.1.1.5.3. An automatic data processing unit monitors various process equipment (Section 3.1.1.11).

Monitoring and controlling are accomplished by means of instruments and controls mounted on a system of panels arranged in a circular manner. On each group of panels, the cascade equipment and associated utilities are represented by a simplified diagram representing process piping, cells, valves, booster stations, and associated auxiliary equipment. Valve and motor breaker position-indicating lights, alarm lights, motor load indicators for total cell load indications, and recording instruments are parts of the display. Interbuilding panels show the connecting piping involved. There is also a schematic display of radiation alarms and the Fire Protection Sprinkler System.

3.1.1.10.3.1 Utilities Monitors and Control Systems

The RCW pumps may be started and stopped by use of the controls located on the control panels. There are audible and visual alarms for most plant utilities as well as instruments and/or recorders that indicate the operating pressures of the air, nitrogen, RCW, and sanitary water systems.

3.1.1.10.3.2 Cascade Monitors and Control Systems

All of the line recorders used in the cascade are slaved to the PCF. Totalizing motor load indicators with load alarms, indicating the total load for each cell, are mounted on the cascade mimic panels. Surge drum, intermediate surge drum, and bottom surge drum pressures can also be monitored. These are hard-wired analog systems.

The following actions can be accomplished from the PCF:

- Any cell can be shut down.
- A top split (close A-outlet and B-inlet) at each unit in X-333 and X-330 can be accomplished.
- In X-326, the cascade can be split at the top (Cell 2) and middle (Cell 19) of each process unit (provided cell 2 is on-stream and valve power is on).
- The interbuilding booster stations can be shut down and automatically isolated.
- The interbuilding tie-line valves can be closed.
- The purge cascades can be shut down and isolated. (See Section 3.1.2.)
- The withdrawal stations can be shut down.

3.1.1.10.3.3 Electrical Monitoring and Control Systems

A portion of the ground floor of the PCF is devoted to activities associated with the power system, including power distribution and the monitoring and surveillance of transmission line loading, switchyard power equipment voltage, and power transformer loading.

The following items can be controlled from the power system control facilities:

- The 345-kV breakers (primary oil and/or gas circuit breakers),
- The power transformer (secondary breakers),
- The 13.8-kV reserve bus tie breakers,
- The synchronous condensers and breakers, and
- The power transformer tap changers.

Indication of process power distribution system breaker status is provided without control capability.

3.1.1.10.3.4 Radiation and Fire Alarms

An alarm will be indicated on a radiation alarm console, or criticality accident alarm console (Section 3.6.2), when a Criticality Accident Alarm System (CAAS) radiation detection cluster is actuated anywhere on site.

The High-Pressure Fire Water System sprinkler system has alarms and indications showing the system number which is translated by fire services personnel to a specific building and location. Fire pull boxes located throughout the plant will actuate an alarm and indicate the location of the fire pull box sending the signal.

For fire protection reasons, the lube oil gravity supply tanks can be isolated or quickly drained to the lube oil drain tank from controls on a panel in the PCF. These controls normally have safety clips that must be removed before the controls can be operated in order to prevent accidental operations.

3.1.1.11 Cascade Automatic Data Processing System

Automatic data processing units monitor various process equipment operating conditions such as cell temperature, out-leakage detector status, and freezer/sublimer parameters. The central processing unit (CPU) is located in X-300A, Process Monitoring Building. Terminals are located in ACRs 1, 2, 4 and 6 as well as the PCF and X-7721, Maintenance, Stores & Training Building .

The CADP System monitors process variables such as temperature, PG outleakage, and various instrument and electrical conditions in X-333 and X-330 uprated cells, and to a minor extent in X-326. Alarm capability is also provided.

3.1.1.11.1 Temperature Monitors

The following temperatures are monitored by the CADP Systems:

- Process Temperatures
- A-Suction
- B-Outlet
- Cell Coolant
- LCC Instrument Duct
- Top Stage Discharge
- Auxiliary Temperatures
- X-333 EBS
- X-333 A- and B-Booster Station
- X-330 Tails Station
- X-330 A- and B-Booster to X-333
- X-330 Holding Drums

3.1.1.11.2 UF_6 Release Detection Monitors

The UF_6 release detection systems in the cascade are monitored by the CADP System. These detector systems have detection and alarm functions only. The UF_6 release detection systems are important to safety as described in Section 3.8. The detector systems alert operators to take the appropriate mitigative action in the event of a UF_6 release from this process equipment.

In X-330 and X-333, "00" and "000" equipment designed for operation above atmospheric pressure is monitored by multiple detectors mounted inside cell housings, cell bypass housings, unit bypass housings, the tie line housing between X-330 and X-333, the feed tie-line housings between buildings X-343 and X-333 and buildings X-342 and X-330, and the A and B-Booster stations. The detectors, which are typically mounted near the top of the housing, 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. Figure 3.1-19 depicts a typical UF_6 release detection system.

3.1.1.11.2.1 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 reaction products with moisture 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 detector produces an output signal.

The UF_6 release quantity that would actuate the detectors is established as follows. On the basis of the blueprint of a typical "000"cell housing, the calculated net volume internal to the cell housing is 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 most of the detectors in the cell housing within 30 seconds (detectors that have just test-fired may take as long as 90 seconds). It should be noted that a release in cell housings with smaller volumes, "00" or withdrawal area housings, would actuate all the leak detectors at smaller release quantities. A 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 of UF_6 reacted. At 50% relative humidity, there would be enough moisture in the cell housing air to react with about 1,500 lb UF_6 and 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 an adiabatic reaction, the temperature of the gases in the cell housing would increase initially by about 120°F from a normal operating temperature of about 200°F. If there were only 10% relative humidity, the initial temperature increase would be about 25°F. 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 ft from the top of the cell housing, which is approximately 19 ft in height, it would only take a fraction of the amount discussed in the previous paragraph to cause the detectors to actuate. This is consistent with plant experience that demonstrates the ability of the UF_6 detectors to detect very small leaks that require considerable searching and leak testing to discover. This indicates, for the postulated accidents described in Chapter 4 associated with the cell over-pressurization scenarios, that a single operational detector in the cell housing would be adequate to detect the release. It also points out that a release of the magnitude described in the accident analysis 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 postulated releases is one per cell housing. However, due to the extreme sensitivity of the detectors, and their desired operational capability of detecting very small releases, it is desirable to have at least two detectors operational per cell housing since actuation of one detector is not necessarily an indication of a UF_6 release. So, the safety function of shutting down the cell is not 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 the detector to actuation causes other than a UF_6 release.

The UF_6 detectors installed in the LCCs are not treated as alarms for initiating the cell shutdown safety function since the source of these alarms cannot result in a large release and detectors in these locations are more susceptible to actuation from the temperature and dust associated with merely opening the sampling cabinet. They are, however, retained as operational alarms and responded to as with any UF_6 release under the Radiation Protection and Emergency Response programs.

Finally, it should be noted that the UF_6 and reaction products that are released from the cell housing will continue to react exothermically with the moisture encountered in the process building air primarily in hydrolyzing the UO_2F_2 and the hydrogen-fluoride (HF). The overall heat of reaction of a pound of UF_6 with excess water available is approximately 1050 BTU. Thus, the released UF_6 and reaction products will continue to produce a buoyant plume inside the process buildings, which will contribute to allowing safe evacuation of the cell floor. The evacuation of individuals working above the cell housings requires extra consideration for that reason. Even so, the release rate from the cell housing will be considerably slower than the release postulated from the process equipment. Tests conducted at PGDP indicated that a release rate from the cell housing of about 9 m^3/sec could be experienced at the pressures expected to develop. However, the initial release of UF_6 would displace about 910 m^3 (32,000 ft^3) of air that would require about 100 seconds before any release would occur. The release rate at that point would be generated by the volume increase associated with the reaction (due to both increase in molar volume and by temperature increase due to the exothermic reaction). As noted above, the reaction rate is dependant on the availability of water in the cell housing air. The reaction with the initial water available will provide the motive force (by means of the temperature differential created by the reaction) to release heated reaction products from the top of the cell housing and draw in more air from the cell floor at the bottom of the cell housing to continue to react with the UF_6.

The sensitivity of the detectors is maintained at adequate levels by 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. This bias voltage is applied automatically as a periodic ramp voltage by a computer system or manually as a fixed voltage. The firing removes the "history effect" from the detectors and verifies that the detectors will actuate at an acceptable firing voltage. While the computer system allows for "fine-tuning" of the firing voltage, improving the sensitivity of the detectors to below 200 mg/m^3, manual firing will maintain the sensitivity at acceptable levels. Detector nominal sensitivity is 2–3 orders of magnitude better than that required to detect a release of even a few hundred pounds of UF_6. As a result, the confirmation of the detectors ability to fire with the voltage nominally applied is the item of primary safety importance rather than the precise firing voltage. As such, either the computer controlled or manual firing mode provides the requisite surveillance function. Additionally, while the computer mode provides more frequent assurance of detector operability, the manual mode, with test firing once per shift, has proven effective for verifying that the detectors are operational. Furthermore, as shown in engineering studies, a single operational detector will provide an alarm for any significant release. Therefore, since multiple detectors are located in each area, the potential for operating for a number of hours with a detector that is inoperable is not a safety concern. Accordingly, while the computer-operated mode is more sensitive and provides greater assurance of individual detector operability, the manual mode is adequate for determining system operability.

3.1.1.11.2.2 Signal Conditioners

The signal conditioning units control the detector system operating mode as either normal or manual, energize relays that initiate alarm circuitry upon detector actuation, distribute power to the system components, and convert 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits. The signal conditioners also provide a means to manually test fire the detectors and to manually reset the alarm circuits. Lamps on the signal conditioners indicate the firing status of individual detectors. The detector system in a given cascade unit contains multiple signal conditioners, all of which are connected to the ACR and to the substation computer. In manual operating mode, an alarm signal from a detector energizes a relay in the signal conditioner that actuates designated alarm circuits. The relay latches in the "on" position until manually reset. In normal mode, an alarm signal from a detector is processed by the computer, which activates alarm indicators in the ACR and in X-300. Each detector is wired to an individual channel of the signal conditioners.

3.1.1.11.2.3 Operation

Detector actuation in manual mode results in an audible alarm in the ACR and the illumination of a general smoke alarm light on the affected ACR unit panel. The alarm light indicates the unit from which the alarm signal is received. In normal mode, detector actuation also illuminates a lamp on the mimic panel in the ACR that indicates the location of the detector. In normal mode, the computer system also causes the alarm printers in the ACR and in X-300 to record the detector actuation. In the manual mode, an operator must investigate the signal conditioner in the affected unit processor panel to determine which detector actuated.

3.1.1.11.2.4 Support Systems

The 120 VAC electric power supply to the UF_6 release detection systems in the cascade is from the plant Process Auxiliary Power System. For a given detector system, the 480 VAC-power from the Process Auxiliary Power System is fed from one of the auxiliary substations that serves the building through a circuit breaker in the substation to a VCC (and its circuit breakers) that, in turn supplies multiple local cell panels. The power then flows through a transformer that steps the voltage down to 120 VAC. The 120 VAC is fed through additional protective circuit breakers in the local cell panel to the detector system's signal conditioner. The 120 VAC power system is the power source for the detector circuits. The AC power supply, from the detector system signal conditioner back to the auxiliary substation breaker, is a support system that is important to safety as described in Section 3.8. The Process Auxiliary Power System is described in Section 3.4.1.

3.1.1.11.2.5 Alarm Indicators

"Mimic" panels in ACRs 1 and 2 display the status and the location of each detector in the respective process equipment. The mimic panels display a map of the cell floor or process area monitored by the detectors. The mimic processor displays information on the state of all detectors on the display map.

The alarm entries on the alarm typer indicate whether the detector is experiencing trouble or a valid alarm. The mimic panel is not operable when the detector system is in manual operating mode.

In normal operating mode, the CADP System will initiate a trouble alarm upon loss of power to the detectors.

In the manual operating mode, loss of power would be detected in the ACR by the loss of other monitored equipment, or at the local cell panel by the extinguished status lights on the signal conditioner, depending upon where the power failure occurred.

In both normal and manual operation, an individual detector alarm indicator light on the front of the signal conditioner is illuminated when a detector actuates.

In manual operating mode, a "smoke release" indicator lamp and an alarm horn located in the ACR actuate when an alarm condition occurs for any smoke detector in the unit.

3.1.1.11.3 Equipment Status Monitors (Uprated Cells Only)

Another parameter monitored by the CADP System is instrument and equipment status. This category is strictly an in-or-out-of-limit indication. It does not measure temperature or pressure. It is simply based on the parametrical setpoints established to indicate problems or failures of instrument, electrical, or process equipment in the process system. These points are coolant high temperature, outleakage signal condition status, and stage temperatures.

3.1.1.11.4 Operation

The signals emitted by the various CADP monitoring sensors described in this section are received by the unit processor associated with that unit.

It is at the unit processor that the signals for each sensor are received, checked against predetermined limits, and relayed to the CPU in X-300A. If the unit processor has generated an alarm request, the CPU prints the alarm on the terminals in the ACR and PCF.

The unit processor is located at the LCC on the operating floor. In X-333, the eight unit processors, one for each unit, are located at Cell 6. In X-330, the five unit processors, one for each unit of X-31-1 through X-31-5, are located at Cell 5 in each unit.

3.1.1.12 Cell Treatment and Cascade Oxidant Control

In order to prevent exothermic reactions/explosions, procedures control the following:

- The introduction of nitrogen and limiting the amount of F_2/ClF_3 introduced into a cell.
- Removing liquid coolant and evacuating the Coolant System to limit the amount of coolant available for a reaction if there were a coolant leak.
- Monitoring of the cell with an infrared analyzer or laboratory analysis of samples to detect any coolant or fluorocarbons, which would indicate a coolant leak or oil in the cell.
- Operator presence at the cell instrument panel and frequent monitoring of cell pressures and temperatures. The contents of cells in X-333 and X-330 are dumped to surge drums if

compressor discharge temperatures reach the established setpoint. Cell treatment dump temperatures for cells in X-326 differ from those in X-333 and X-330 because of equipment and equipment configuration differences. The contents of the isotopic cells (Units X-27-1, -2, and X-25-7 odd) in X-326 are dumped to surge drums if the A-suction temperature or the stage 12 discharge temperature reaches (or exceeds) its setpoint. The contents of the low-speed purge cells (X-25-7-2, -4, -18, and -20) are dumped if the A-suction temperature reaches (or exceeds) its setpoint value. The contents of the high-speed purge cells (X-25-7-6, -8, -10, -12, -14, and -16) are dumped if the A-suction temperature, the stage 1 discharge temperature, or the stage 6 discharge temperature reaches (or exceed) its setpoint.

- Sampling the cell to assure presence of free ClF_3 to avoid the formation of the more reactive compounds, such as ClO_2.

The probability of an exothermic reaction in a cell during ClF_3 treatment has been reduced to low levels because of these procedures.

As part of the HEU Suspension Project, a new method of treating cells was developed called inverse recycle. This method creates a relatively flat gradient concentration of treatment gases by routing the A-stream from the top of the cell to the bottom. (Inverse recycle can also be performed on the B-stream.) Since the gradient is flat throughout the cell, additional amounts of treatment gas can be utilized while still maintaining the concentration limits in a stage. As in normal cell treatments, the sources and existence of coolant in the cell is eliminated prior to the introduction of oxidants, while the disposal of these gases to the Cascade are administratively controlled through existing procedures.

To minimize the potential for a treatment gas exothermic reaction/explosion using inverse recycle, the following controls are used:

- Cells are treated individually and no more than four cells are treated at any one time. Adjacent cells cannot be treated at the same time.
- The increase in treatment gas during inverse recycle cell treatment is limited to 70% for the second and subsequent treatments.
- The ratio of ClF_3 to F_2 is maintained to that utilized for normal cell treatments.
- The treatment gas concentration at any point in the cell will be no more than currently experienced in normal cell treatments.

In order to control the introduction of oxidants into the cascade, the F_2 and/or ClF_3 concentrations are maintained below prescribed levels and the cascade is monitored by line recorders to detect coolant inleakage that could result in an explosive mixture. Experiments have shown that a mixture of coolant and F_2/ClF_3 at sufficient quantities in the presence of an ignition source will explode at cascade pressure. The maximum mole percent of oxidants is too low to be measured at any point in the cascade, except behind severe plugs and at the purge cascade vent.

Within the top purge cascade, oxidants are controlled by administratively controlling the addition of oxidants to the cascade. A safe bleed-back rate is calculated based on the cascade lights upflow and the contents of the surge drum being planned for bleed-back to the cascade.

3.1.1.13 Cascade Monitoring and Surveys

3.1.1.13.1 Data Checks

Cascade operations personnel are responsible for monitoring and operating cascade equipment. Operational data and monitoring information are recorded on a variety of data, utility, or round sheets. These data are collected and recorded on a shift-by-shift, daily, weekly or monthly basis, depending upon the equipment and operational requirement.

In addition to the exact bimonthly (every other month) inventory measurement, daily checks are made to estimate the uranium and U-235 cascade inventory based on power data, drum pressures, and building average assay. These daily checks provide a means of detecting possible freeze-out of UF_6 in the cascade. Whenever there is sufficient evidence of freeze-out, a procedure is implemented to locate the solid material.

3.1.1.13.2 Radiation Surveys

To monitor uranium accumulations in cascade equipment that could result in a critical reaction, radiation surveys are routinely conducted in X-326 and X-330. Because of low assays and corresponding lower criticality risk, radiation surveys are taken less frequently in X-333. Numerous points are surveyed in each unit. The survey points are located over unit and cell bypass expansion joints, near cell and bypass block valves, and near piping where leaks or freeze-out are most likely to occur. The surveys will locate significant new deposits and indicate whether known deposits are significantly increasing in size. In addition to the surveys described above, designated converters in X-326 are surveyed periodically. More extensive radiation surveys are performed in X-326 because of the higher assays present in the building.

In Areas 2 through 6 (not including Area 5, which is shutdown), radiation surveys are also taken on the alumina traps associated with the seal exhaust stations. However, these surveys are primarily for uranium accountability and determination of the operating efficiently of the traps rather than for nuclear criticality safety.

3.1.1.14 Radiation Detection Systems

The CAAS clusters are located throughout the process buildings to detect radiation. The system is described in Section 3.6.2. The CAAS is important to safety as described in Section 3.8.

3.1.1.15 Fire Protection Systems

The primary fire hazards in the process buildings are the Lube Oil System, which is described in Section 3.1.1.6.3.3, and building roofs, which are described in Section 3.1.1.1.5. Fire protection is provided in each process building by multiple wet-pipe sprinkler systems. These systems are part of the plant High Pressure Fire Water System, which, along with its associated testing programs, is described in Sections 3.6.1 and 5.4. The High Pressure Fire Water System is important to safety as described in Section 3.8.

3.1.2 Purge Cascade System

3.1.2.1 System Description

The purge cascades are used to separate and remove low and intermediate molecular weight gases ("lights") from the cascade. These "light" gases usually consist of oxygen, nitrogen, cascade coolants, fluorine, and ClF_3 which have either leaked into the enrichment cascade or were introduced into the cascade via operating activities related to cell maintenance. Since these "lights" possess molecular weights lower than that of the UF_6 portion of the PG, they tend to concentrate in the upper stages of the purge and enrichment cascades, until vented, displacing the UF_6 PG to a position downstream of its desired location in the cascade.

The purge cascade consists of isotopic cells, the Side Purge cells, the Top Purge cells, exhaust (booster) pumps, chemical traps, an atmospheric exhauster, and associated flow instrumentation and controls. The Side Purge is used to vent most of the "lights" introduced into the cascade. The Top Purge, including its associated isotopic cells, operates in conjunction with the Side Purge to separate and vent the heavier "lights" and other contaminants not removed by the Side Purge. Due to its lighter molecular weight with respect to UF_6, the coolant introduced into the PG stream rapidly diffuses to the top of the cascade. However, the molecular weight of the coolant is greater than that of other lower molecular weight gases ("lights") present in the cascade; therefore, the coolant tends to form a "bubble" in the purge and isotopic cells of the Top Purge Cascade. These heavier "lights" include cascade coolants and various fluorinated compounds of metals such as technetium and molybdenum.

The purge cascade, located at the south end of X-326, comprises the top end of the enrichment cascade. The Side Purge cells normally receive flow from the top cell in Unit X-27-1 and return the flow back to the bottom cell in Unit X-27-2. The Side Purge is intended to remove approximately 90% of the "lights" and return the UF_6 and heavier "lights". The Top Purge cells normally receive flow from the top of Unit X-27-2, via the purge cascade isotopic cells, and return the UF_6 to the top cell in Unit X-27-2. The Top Purge is intended to vent the heavier "lights" and any residual "lights" not removed by the Side Purge.

The specially designed Side and Top Purge Cascade cells are the even numbered cells in Unit X-25-7. Each of these purge cells consists of six stages configured as individual Badger stages (Figure 3.1-20), while the isotopic cells have 12 stages configured in Badger clusters. (See Section 3.1.1 for a description of Badger stages and clusters.) The control system and trip features of the lube oil, coolant, and individual stage process pressure systems are similar to those in the enrichment cascade cells (Section 3.1.1). Normally the gas stream is exhausted from the top cell of each purge cascade at less than one ppm UF_6. The Side Purge Cascade A-stream flow normally enters the middle of cell X-25-7-2 (or cell 4 if cell 2 is not on-stream) which creates the Side Purge stripper section, and proceeds through cells X-25-7-2, 4, 6, 8, and 10 (as available) and into the Side Purge Booster station. The Top Purge Cascade A-stream flow enters the odd-numbered isotopic cells of Unit X-25-7, then through purge cells X-25-7-20, 18, 16, 14, and 12 (as available), and into the Top Purge Booster station. Figure 3.1-21 shows the flows within the purge cascade.

The Booster stations are normally used to raise and control the pressure of the vent gas stream before entering a Metering station. The vent gas stream entering the Metering station is either processed through the chemical traps or recycled back to the purge cascade to stabilize the concentration gradient. This "Concentration Recycle" from the Metering station provides a means of maintaining a concentration of approximately 95% "lights" at the inlet to the first high-speed purge cascade cell. The flow that is not used as the Concentration Recycle is measured, and the purge rate to the atmosphere is controlled by other flow loops in the Metering station.

The chemical traps remove most of the residual UF_6 and other radionuclides remaining in the purge gas before it is vented to the atmosphere. The flow exiting the chemical traps is evacuated by the Atmospheric Exhauster station, which includes air ejectors. The combined flow of vent and air ejector gases is monitored by continuous samplers used to establish the environmental discharge values of these vents.

Additional components have been added to the Top Purge Cascade to handle larger accumulations of contaminants in the concentration gradients and the withdrawal of very highly enriched uranium product. These components are the magnesium fluoride (MgF_2) trapping manifold, Product Withdrawal Supply and Return headers, Side Withdrawal (SW) Supply and Return headers, Top Purge Air Bleed station, and the Freon Degrader. The Top Purge Air Bleed station compensates for the reduction of "lights" inleakage previously originating from the HEU cascade and decreases the concentration of oxidant in the Top Purge. The function of a Freon Degrader system (basically, a side-stream reactor) is to react, in a controlled manner, the coolant with fluorine to produce lighter molecular weight gases, which can be more readily purged from the cascade.

The purge cascades use the Nitrogen, Plant Air, Fluorine, and Fire Protection systems in X-326 (Sections 3.4.3, 3.4.4, 3.4.7, and 3.6.1, respectively, for descriptions of these cascade support systems). The power source for the purge cascade stage motors, auxiliary systems, and emergency power are the same as for the enrichment cascade (Section 3.1.1). To assure the operation of the purge cascade cells, power to the high-speed cells is supplied by separate feed lines.

Designated valves and expansion joints and converters in the purge cascades are monitored periodically to detect buildup of UO_2F_2 deposits, indicated by increased gamma/neutron radiation readings. Deposits within compressors are identified by changes in operating characteristics. Buildup of deposits can also be detected by non-destructive analysis methods, including Operational neutron probe readings.

Purge cascade systems, structures, and components identified in Section 3.8 as being important to safety are described in Section 3.1.2.2. General facility safety support systems that are important to safety for X-326 (i.e., the CAAS, the Fire Protection System, and the UF_6 Release Detection System) are described in Section 3.1.1.

3.1.2.2 Equipment

The enrichment cascade description (Section 3.1.1.2) is applicable to similar components in the purge cascade, including: converters, compressors, motors, coolers, valves, piping, and the X-326 process building. Section 3.1.1.6 describes auxiliary cascade systems that support the purge cascade, including: Plant Air, electrical power, nitrogen supply, RCW, and fire protection. The purge cascade equipment descriptions in the following subsections focus on the differences between the purge cascade and enrichment cascade components.

The function of the UF_6 primary system in the purge cascade, which is identified in Section 3.8 as important to safety, is UF_6 containment. (See Section 3.1.1 for a description of the UF_6 primary system.) This function is similar to that of the smaller stages in the enrichment cascade (i.e., converters, compressors, coolers, expansion joints, valves, and piping), and applies to the Booster and Metering Stations, chemical traps, air ejectors, and the Freon Degrader system as well. Since the X-326 cells are operated at sub-atmospheric pressures, minimizing the possibility of a UF_6 release if the purge cascade is breached, the equipment housing is not important to safety, per Section 3.8.

3.1.2.2.1 Stage Compressors

The compressors in the isotopic cascade cells are identical to those in Section 3.1.1 for the enrichment cascade in X-326. The compressors used in each stage of the purge cascade cells are two-stage centrifugal designs which combine the A-stream out of the stage below with the B-stream from the stage above to supply the stage converter via a single discharge nozzle. The compressors in the first two low-speed purge cascade cells are designed to normally handle high concentrations of UF_6 or heavier "lights". The other intermediate/high-speed purge cascade cells use specially designed centrifugal compressors, whose operating speeds vary with the gearing of the speed increasers, based on the average molecular weight of the gas being pumped.

3.1.2.2.2 Process Piping

The containment function of the UF_6 primary system, including expansion joints, and associated valves and piping containing UF_6, is important to safety as described in Section 3.8. The process piping directly related to flow within the purge cells and associated bypass piping are nickel-lined steel and sized based on original design flow and function of the equipment. Welds on the UF_6 primary system are pressure and vacuum leak tested to ensure that the leak-rate criteria specified in plant procedures are met.

The purge cascade contains two separate unit evacuation headers—one dedicated to the isotopic cells of the Top Purge and another used for the Top and Side Purge Cascade cells, Booster stations, and chemical traps.

The feed header connects alternating isotopic cells in the Top Purge Cascade (X-25-7-3, -7, -11, -15 & -19), and the Product Withdrawal's Side Withdrawal (SW) Supply header, to various headers in X-326's unit bypass system.

The Side Purge Supply header runs the entire length of X-326 and contains a normally isolated section of cell bypass piping, which can be used to connect the low-speed cells in the Top and Side Purges to enrichment cascade cells in Units X-27-1 or 27-2. The Side Purge Supply header normally connects the A-stream out of Unit X-27-1 with the A-stream entering the middle of cell X-25-7-2 or -4 in the Side Purge.

The Side Purge Return header runs the entire length of X-326 and routes the B-stream flow out of the Side Purge to the A-stream of the first cell in Unit X-27-2, to supplement the number of cells in the isotopic section of the Top Purge Cascade. This header may be used to return the B-stream flow to the bottom stage in the isotopic section of the Top Purge Cascade. With the installation of the Top Purge Stripper section, the Side Purge Return header can also be used to supply the Stripper section of the Top Purge Cascade. The Side Purge Supply and Return headers can also be configured in several different flow paths for operation or maintenance of the purge cascades (Figure 3.1-22).

Each purge cascade contains a Concentration Recycle header that connects the respective Metering station with various locations in the purge cascade. This recycled flow out of the Metering station is returned to the purge cascade before the high-speed cells. This flow is used by the Concentration Recycle control system to increase the interstage flow of "lights" going to the purge cascade vent and stabilize concentration gradients within the purge cascade itself.

3.1.2.2.3 Motors

The motors used to drive the compressors in the two purge cascades are three-phase, induction, squirrel cage, AC motors. The motors used in the isotopic cells of the Top Purge are similar to those used in the enrichment cascade cells.

The purge cascade cell compressor motor manual trip system, which is identified in Section 3.8 as important to safety, includes the purge cascade ACR cell trip switches, and is similar to that for the enrichment cascade (Section 3.1.1). DC power is required to trip the compressor motors from the ACR. The 250-VDC power distribution system in X-326, which is identified in Section 3.8 as important to safety, includes battery banks, ACR trip circuit 250-VDC power supplies, 250-VDC control and alarm power breakers, circuit breakers, wiring, relays, and trip coils (Section 3.4.1).

3.1.2.2.4 Speed Increasers

Speed increasers are used in the intermediate and high-speed purge cascade cells and the Booster stations to increase the speed of the compressors relative to the motor speed and thereby enable the compressors to maintain the desired interstage flow based on the average molecular weight of the gas being processed.

3.1.2.2.5 Stage Control Valves

The stage control valves in the purge cascade cells are pneumatically controlled, hydraulically operated valves used to control the cell pressures (similar to the enrichment cascade). Each stage of a purge cell is provided with a control valve in the B-stream discharge line, so that the pressure in each converter is controlled. This, in turn, controls the separation rate in the converter. In the isotopic cells, a control valve is positioned before each two-stage compressor to control the pressure profile in the Badger cluster.

3.1.2.2.6 Coolant System

As in the enrichment cascade, the coolant systems in the purge cascade cells and the Booster stations serve to remove the heat of compression from the gases being pumped and control its temperature within a specified range. The coolant systems in the purge cascade cells and the Booster stations are similar to those in the enrichment cascade, except for size, capacity, and external location (refer to Section 3.1.1.2.5). Larger capacity coolant systems are used in the low-speed cells of the purge cascades, which are designed to handle higher UF_6 concentrations (Cells 2 and 20). The coolant system contains a pressure relief system to assure that the coolant system pressure does not rupture the process equipment. The cell coolant high-pressure relief system, which is identified in Section 3.8 as important to safety, includes rupture discs, block valves, and piping on the coolant systems for each purge cascade cell. This system is similar to that for the enrichment cascade (Section 3.1.1 for a description of the coolant high-pressure relief system). In addition to this system, instrumentation continuously monitors coolant system pressure. This instrumentation is alarmed and interlocked with the power supply to the stage motor.

3.1.2.2.7 Converters

The purge cascade converters are similar in design to the triple-pass, X-25 size isotopic converters, except for their permeability and the mechanical alignment of the converter shell with the purge cascade compressors (Section 3.1.1). The converters in low-speed purge cells can be directly replaced with converters from an isotopic 25-size cell. However, the designed permeability of barrier for high-speed cells requires special converter tube bundles, since this barrier is designed to separate "lights" from UF_6.

3.1.2.2.8 Expansion Joints

Expansion joints are located throughout the Top and Side Purge Cascades. They consist of sections of pipe connected by flexible metal bellows assemblies. Some of the joints also contain an internal monel sleeve to provide smooth flow over the convolutions of the bellows. Expansion joints are located on the compressor discharge and B-stream flow lines on each stage, as well as at other locations where equipment alignment and/or potential pressure surges make the use of expansion joints necessary.

3.1.2.2.9 Stripper Sections

The low-speed cells in the Side Purge Cascade (and cell X-25-7-20 in the Top Purge Cascade) contain auxiliary A-stream lines to the internal stages of the cell used to create a Stripping section. The Stripper section is created by closing the normal A-inlet block valve and opening both the bottom recycle valve of the cell and the internal A-line block valve. Within the Stripper section, the UF_6 concentration in the B-stream flow increases, since the only "lights" entering those stages are those evolved within that section of the cell. The purified B-stream exiting the Side Purge bottom stripper cell is normally piped into Unit X-27-2 as the A-stream, containing less "lights" (approximately 10% compared to the concentration entering the Side Purge). The A-stream exits Unit X-27-2 and enters the Top Purge; the B stream leaves Top Purge and returns to Unit X-27-2, continuing to Unit X-27-1 and the rest of the enrichment cascade [Figure 3.1-22 (Configuration A)]. Another potential configuration for the purge cascade directs the flow from the Side Purge directly to the bottom cell of the Top Purge, whose down-flow (B stream) is returned to Unit X-27-1 [Figure 3.1-22 (Configuration B)]. Flow out of the Side Purge can also be returned to the top stage of the Top Purge Stripper section. The purified B-stream exiting the Top Purge bottom stripper cell can be piped to Unit X-27-1 [Figure 3.1-22 (Configuration C)].

3.1.2.2.10 Booster Stations

The Booster stations for each purge cascade are made up of two parallel stations; each composed of compressors, motors, speed increasers, coolers, control valves and instrumentation. The Booster station is used to raise and maintain the pressure of the vent gas stream entering the Metering station and to supply a controlled B-stream flow to the last purge cascade cell. A schematic of the piping and flow for the purge cascade Booster and Metering stations is shown in Figure 3.1-23.

The flow entering the Booster station is the A-stream from the last purge cell that has been combined with a recycled portion of the cooled Booster discharge flow and fed into the A-inlet of the compressor. This recycle flow is needed since the capacity of the Booster station compressor far exceeds the A-stream flow entering the Booster station and to maintain the desired Booster temperature. The portion of the compressor discharge flow that is not recycled, or used to maintain B-stream flow into the top of the purge cascade, enters the Metering station. The Booster Station common Stage 6 B-stream recycle control valve is used to control the downflow of gas to the B-suction of the Stage 6 compressor.

The Booster station contains a number of interlocks that will automatically trip and isolate the station on high motor load or loss of power. The purge cascade Booster station instruments used to control the temperature, flow, and power are described below.

3.1.2.2.10.1 Temperature Monitors

The operational thermocouples on each Booster compressor are monitored/displayed in the ACR on a continuous recorder. The compressor discharge and interior temperature loops are tied to actuators, which will open their respective Booster station recycle valves if the temperature setpoints are exceeded.

3.1.2.2.10.2 Pressure Monitors and Control Loops

The control of the discharge pressure of a Booster station is accomplished by the interaction of three control loops. Two of these control loops also serve to control the temperature, flow, and pressure operating parameters of the on-stream Booster. The third control loop controls the B-stream as it exits the Booster station en route to the top cell of the purge cascade. Adjustments to these controls are made in the ACR, where the actual pressures are monitored and recorded.

3.1.2.2.10.3 Motor High-Current Trip

The motor high-current trip is a power interlock on the Booster station motor that will isolate power to the motor when the current exceeds preset limits, to prevent motor failure.

3.1.2.2.10.4 Automatic Booster Isolation

Upon the loss of power to the Booster station motor, such as could result from high coolant system pressure, the Booster station MOVs will close, thus isolating the on-stream Booster station.

3.1.2.2.11 Metering Stations

A Metering station is provided for each purge cascade. The Metering stations consist of flow measuring orifices, isolation valves, control valves, and the instrumentation necessary to control the metered purging and recycling of Booster station discharge. The metering portion of each station is divided into two sections—one for Normal Purge and the other for Emergency Purge operations. (This is a normal operation but, in cascade terminology, it is referred to as "Emergency Purge".) Normally, the Booster station discharge enters the Normal Purge section and the flow is measured by the Total Flow orifice. The Total Flow controller monitors and controls the venting rate of the purge cascade by adjusting the Total Flow control valve (purge control valve) so that flow across the Total Flow orifice is held constant. This control valve maintains a steady total flow rate through the Metering station by modulating in response to the operation of the Concentration Recycle control valve. The flow through the Concentration Recycle control valve is used to maintain the "lights" concentration at a desired value within the purge cascade during normal operating conditions. Prior to passing through the Total Flow control valve, the discharge gases pass through two parallel, low-range control orifices. These orifices continually measure the amount of gases purged during normal operation. On the Side Purge, both Normal Purge orifices are used in parallel, while on the Top Purge, only the larger orifice is used.

During normal cascade operations, there is a small amount of inleakage of contaminants into the PG stream. If the inleakage is held to a small enough level, the Normal Purge flow orifices are adequate to remove the "lights" contaminants. Typical flow in the Top Purge exits at nominal concentrations of 1 ppm of UF_6 or less. On occasion, increased flow of "lights" due to returning of cell purge materials at some point lower in the cascade causes an increase in purge flow rates. Although purge material returned to the cascade is closely monitored and controlled, occasionally a large bubble of "lights" forms in the cascade that must be removed at the Side Purge in order to prevent excess spillover reaching the Top Purge. Due to cell offstream and onstream activity and other cascade disturbances, the Side Purge rate is rarely constant. However, during normal operations, instrumentation serves to automatically control the effects of these variations. Figure 3.1-23 shows the Purge Cascade Metering Stations.

Higher purge rates are sometimes needed when the Normal Purge orifice cannot maintain the "UF_6 front" at the desired location in the purge cascade. These higher rates are accomplished by using the Emergency Purge orifice to increase the venting rate. Flow through the Emergency Purge orifice bypasses the Normal Purge orifices and the Concentration Recycle control system. Each purge cascade includes an Emergency Purge section consisting of two parallel flow measuring orifices and associated control and isolation valves. The purpose of this equipment is to measure and control the amount of purge gases being vented during Emergency Purge orifice operations. In the Side Purge Metering station the High Flow Emergency Purge orifice run is isolated by a manual valve under locked control of the PCF, while on the Top Purge Metering station, the Emergency Purge section is not used.

The Side and Top Purge Cascade Metering stations are each equipped with two major control loops, Total Flow and Concentration Recycle, as well as a number of individual control loops for each orifice run to control the Emergency Purge flow and prevent Concentration Recycle reverse flow.

3.1.2.2.11.1 Total Flow Controller

As the Booster station flow enters the Metering station, it is monitored across the total flow orifice. The flow is then diverted either down the Concentration Recycle line, which is throttled by the Concentration Recycle valve, or down past the metering orifices to the purge control valve. Based on the signal generated by the total flow orifice, the purge control valve and/or the purge flow rate are adjusted such that flow into the Metering station remains constant. The target total flow rate for the Metering station (the purge flow rate plus the Concentration Recycle flow rate) is maintained by the Total Flow Controller. When the Concentration Recycle control valve closes, flow across the total flow orifice will reduce. To bring the total flow back to its targeted value, the purge control valve will open. Conversely, when the Concentration Recycle control valve opens, flow across the total flow orifice will increase and the purge control valve will close to bring the total flow back to its target value. In the event of an air failure, the purge control valve (Air-to-Open) will fail closed, thus isolating the cascade from the atmospheric vent.

3.1.2.2.11.2 Concentration Recycle Control Instrumentation

The concentration gradient of UF_6 within the purge cascade is controlled by an instrumentation loop on both purge cascades. The Concentration Recycle control system is used to maintain a steady concentration gradient in the flow stream entering the high-speed cells of the purge cascade. This is accomplished by controlling the operation of the Concentration Recycle valve in the Metering station, which permits vent gases that contain low concentrations of UF_6 to be returned to the purge cascade. This recycling of flow increases the concentration of "lights' in the high-speed cells, thereby repositioning the concentration gradient. The monitor on the Concentration Recycle flow control signal also contains both visual and audible alarms if the control signal falls below a preset value. This alarm indicates the need for the ACR operator to adjust the total flow set point and Concentration Recycle flow rate.

3.1.2.2.11.3 Emergency Purge Instrumentation

The Side Purge Emergency Purge instrumentation controls the amount of flow going through the low-flow Emergency Purge orifice. (The high-flow Emergency Purge orifice can be isolated by means of a manual block valve.) Under normal operation, the initiation of flow through the Emergency Purge is prevented by an interlock. This interlock monitors the Side Purge Concentration Recycle flow control signal and will not allow the Emergency Purge to be engaged until the control signal exceeds a preset value. At this point both a visual and an audible alarm are actuated in the ACR, whereupon an operator can initiate the use of the Emergency Purge, if needed. The ACR operator, based on information available, can set the Emergency Purge controller to a desired purge rate and initiate flow. The Emergency Purge will remain engaged until disengaged by the ACR operator or automatically disengaged by the Emergency Purge interlock. Upon loss of air supply, the Emergency Purge control valve will close, preventing the inadvertent venting of UF_6.

3.1.2.2.11.4 Concentration Recycle Reverse Flow Instrumentation

Concentration Recycle reverse flow instrumentation monitors the inlet pressure to the low-flow Normal Purge orifice, which is upstream of the Concentration Recycle control valve, and compares it to the valve's downstream pressure. When the differential pressure approaches nominal zero psi, an audible and visual alarm is actuated in the ACR and the Concentration Recycle and vent streams are isolated. The control system automatically closes their respective MOVs isolating chemical traps from the Atmospheric Exhauster station. If reverse flow were to occur, material from the recycle return point would be pulled directly to the vent stream, thus bypassing the intermediate-and high-speed purge cells and the Booster station. This could result in high UF_6 concentrations entering the chemical traps, saturating the traps, and UF_6 being vented to the atmosphere.

3.1.2.2.12 Chemical Traps

The chemical traps are located between the Metering stations and the Atmospheric Exhauster station on the operating floor south of ACR 6. These chemical traps contain activated alumina (Al_2O_3) and possibly soda lime, and are used to remove residual quantities of uranium and technetium from the vent gases exiting the Metering stations.

The chemical traps are configured in parallel banks of three traps per bank that can be isolated individually and tied into a common inlet and outlet manifold for each purge cascade flow. Normally, only three banks are used for each purge cascade flow at any given time. The dimensions of the chemical traps, along with their physical spacing, assures an always-safe design for the purpose of nuclear criticality safety (Section 5.2, Appendix A).

Both the inlet and outlet manifolds are normally monitored by space recorders to detect changes in the concentration of radionuclides in each purge flow. The common outlet manifold of the traps contains the final isolation location of the vent flow before the Atmospheric Exhauster station. The pressure within the Top and Side Purge traps can be maintained and controlled by back-pressure control valves on the outlet manifolds. The interlocks and monitoring devices on the inlet and outlet manifolds of the purge cascade chemical traps serve to control the purge cascade back-pressure.

3.1.2.2.12.1 Side Purge Back-Pressure Control System

The outlet manifold of the Side Purge chemical traps contains a valve used to control the operating pressure in the traps. The control valve is located downstream of the final isolation valve for the Side Purge Cascade and is operated from the ACR. This valve modulates the trap outlet manifold pressure in response to the Booster station discharge pressure.

3.1.2.2.12.2 Top Purge Back-Pressure Control System

The valving manifold and instrumentation of the Top Purge back-pressure control system is designed to maintain the pressure in the Top Purge chemical traps by operating a separate set of control valves and associated isolation valves. When the control system is operated, these valves raise or lower the operating pressure of the Top Purge traps to match the Booster station discharge pressure, thereby increasing or decreasing trap retention time.

3.1.2.2.13 Atmospheric Exhauster Station

The Atmospheric Exhauster Station is located downstream from the chemical traps. Its purpose is to exhaust the Top and Side Purge Cascade vent flow to atmosphere. The station consists of a manifold of MOVs, controlled from the ACR, that connects the three air ejectors. Two of the air ejectors are normally operated continuously; one is dedicated to the Top Purge vent flow and the other to the Side Purge vent flow. The third, or Emergency Purge air ejector, is operated periodically in combination with, or as a maintenance spare for, the Top and Side Purge air ejectors. Each air ejector is powered by Plant Air. The air supply can be isolated manually for the Top and Side Purge air ejectors and remotely for the Emergency Purge air ejector.

The discharge flow from each air ejector enters a 4-inch diameter pipe, where it is monitored by separate continuous samplers for environmental and accountability purposes. After monitoring and exiting X-326, the Side Purge and Emergency Purge air ejector vent flows are combined into three vent stacks. This vent stream, along with the stream from the Top Purge vent stack, is exhausted to the atmosphere. The Side Purge and Emergency Purge air ejectors each have discharge isolation valves so that the individual systems can be isolated.

The Atmospheric Exhauster station contains both monitors and interlocks to assure that atmospheric pressure will not flow back into the purge cascade chemical traps or purge cascade itself.

3.1.2.2.13.1 Air Ejector Suction Monitor

Should the air ejector exhaust fail due to low air pressure, or if an atmospheric leak occurs, instrumentation will automatically isolate the purge cascades by closing their respective isolation MOVs.

3.1.2.2.13.2 Air Ejector Interlock

An interlock system on the Emergency Purge air ejector will not permit the ejector inlet valve to be opened unless the ejector air supply has been fully valved in. The interlock is necessary to prevent a misvalving that would permit atmospheric air to back into the chemical traps should the suction valve be opened before the air supply block valve is fully open.

3.1.2.2.14 Magnesium Fluoride Traps

Magnesium fluoride (MgF_2) traps can be connected to the cascade isotopic cells X-25-7-19 and -17. The valving manifold is tied into the existing Product Withdrawal piping to permit the side stream trapping of technetium and molybdenum from various locations within cells X-25-7-19, -17 and -15. The MgF_2 trap system consists of an enclosed valving manifold with three traps filled with MgF_2 pellets that can be used to reduce the peak concentration of the contaminant bubble within the Top Purge Cascade isotopic cells.

3.1.2.2.15 Freon Degrader

The function of a Freon Degrader system (basically, a side-stream reactor) is to react, in a controlled manner, the coolant with fluorine to produce lighter molecular weight gases, which can be more readily purged from the cascade. Degradation and/or removal of coolant from the Top Purge Cascade are necessary to maintain proper ACR control of the UF_6/coolant front within the isotopic cells of the Top Purge Cascade.

The Freon Degrader system consists of the following major systems/components: instrumentation to control the fluorine feed stream, instrumentation to control the process side stream, a mixer, a heated reaction column within a buffered shell, instrumentation to control temperature within a heated reaction column, instrumentation to control the pressure within the reaction chamber, and sintered metal filters. The operation of the Freon Degrader system is summarized below (Figure 3.1-24).

The Freon Degrader system consists of two separate Freon Degraders: the Cell Floor Freon Degrader and the Operating Floor Freon Degrader, only one of which is permitted to operate at any one time, to limit the potential quantity of fluorine available to react with cascade coolant. The support systems for both the Cell Floor and Operating Floor Freon Degraders are instrument Plant air, fluorine and nitrogen supply, and electrical power. The loss of air or electrical power will automatically result in safe shutdown of the Freon Degrader system, closure of the fluorine and coolant supply flow control valves, and opening of the nitrogen flush valve.

A controlled side stream of PG containing coolant contamination is mixed with a controlled or limited quantity of fluorine (depending on which Freon Degrader system is operating) and nitrogen (acting as a carrier gas supporting the coolant/fluorine reaction) within a "mixer", which is an expanded section of the Degrader system piping. The combined gas flow enters the buffered shell that houses the reaction vessel and is heated within the reaction chamber to initiate the reaction between the coolant and fluorine. The heaters within the reaction chamber are controlled to maintain the required temperatures to initiate the reaction. Once started, the exothermic nature of the reaction supplies sufficient heat to maintain the reaction. The reacted gases flow through a cooling section within the buffered housing and through a sintered metal filter (to reduce the amount of particulates entering the process stream) before returning to the Top Purge Cascade via a control valve (to maintain back-pressure).

Administrative controls and passive barriers prevent a criticality from occurring in the Freon Degrader system (Section 5.2, Appendix A).

3.1.2.2.15.1 Cell Floor Freon Degrader

The Cell Floor Freon Degrader is installed on the cell floor of X-326 in an enclosure erected adjacent to Top Purge Cascade cells X-25-7-18 and X-25-7-20 A- and B-line drops. The unit is controlled and monitored within the ACR. The Cell Floor Freon Degrader components include: nitrogen, fluorine, and air supply lines; PG supply and return lines; mixer; Degrader vessel; buffered Degrader shell; two parallel outlet filters; instrumentation; controls; and an insulated enclosure. The Cell Floor Freon Degrader system simplified flow schematic and instrumentation diagram is shown in Figure 3.1-25.

Process gas inlet and outlet piping headers containing coolant contamination are not currently connected to the Cell Floor Freon Degrader. However, the supply header extends from the vicinity of the Degrader (at compressor outlet pressure) to any existing supply locations or new locations in cells X-25-7-18, 20, 19, or 17, and the A-line between cells X-25-7-19 and -20. The reacted flow can be returned (when piping is connected) to existing cells X-25-7-16 and -14 locations, new locations in the B-line between cells X-25-7-19 and -20, and new locations in cells X-25-7-19 and -17 (Figure 3.1-24).

Gas flows to the Cell Floor Freon Degrader system are controlled from a control panel in the ACR that includes a process graphic display, valve controls, instrumentation, a multiple-point temperature recorder, an annunciator panel, and alarms. The rates at which PG/coolant, fluorine, and nitrogen enter the Freon Degrader system are regulated by the operator to maintain the temperature within the reactor. The PG/coolant flow rate and the fluorine flow rate are controlled by separate control valves. The fluorine flow is further limited by four parallel capillary tubes, calibrated to maximum flow rates of 25, 50, 100 and 200 scfd (standard cubic feet per day), respectively, at the maximum fluorine supply pressure. The capillary tubes are important to safety as described in Section 3.8.

To limit the potential concentration of oxidant available to react with cascade coolant, if the fluorine flow rate exceeds 400 scfd, an alarm will actuate in the ACR alerting the operator to reduce the flow rate. If the fluorine header pressure at the inlet to the Cell Floor Freon Degrader reaches approximately 4.5 psig, a pressure switch will actuate an alarm light on the ACR panel and alert the operator. If the fluorine header pressure reaches approximately 5.0 psig, another pressure switch will actuate an alarm in the ACR and cause the fluorine supply valve to close.

Thermocouples monitor temperatures of the Freon Degrader system. A temperature controller (TC), based on input from one of the thermocouples, controls electrical power supply to the reaction chamber. If the temperature of the mixer reaches approximately 300°F (indicating possible combustion), the mixer thermocouples will activate a flush system, flushing the mixer with nitrogen to dilute the reactants and cool the mixer. Activation of the flush system will be accompanied by an audible alarm and a visual indication on the annunciator panel in the ACR. If the monitored temperature in any component of the Freon Degrader system reaches approximately 1150°F, an audible and visible alarm will actuate on the ACR panel. If the monitored temperature reaches approximately 1200°F, an automatic system shutdown closes the fluorine and PG/coolant valves, opens the nitrogen flush valve, and shuts down power to the electric heaters.

Failure of a thermocouple that provides input to the temperature recorder in the ACR will cause the recorder to indicate above approximately 1200°F and will trip a high temperature alarm on the annunciator panel. Should the monitored temperature in the Freon Degrader vessel heating zone drop below approximately 950°F, a low temperature alarm in the ACR will activate.

The atmosphere within the insulated enclosure is monitored by ionization detectors that are connected to the existing building alarm system. These particulate-sensing detectors provide an indication of the presence of fluorine, UF_6, smoke, and other particulates. A modification of the detectors, accomplished at Portsmouth GDP, has made the units sensitive to fluorine.

3.1.2.2.15.2 Operating Floor Freon Degrader

The Operating Floor Freon Degrader is located on the operating floor behind the Top Purge Cascade cell X-25-7-16 LCC in X-326. The PG supply and return lines are connected to the Top Purge Cascade cells, through the cell floor, to the Operating Floor Freon Degrader system. Process gas/coolant, fluorine, and nitrogen flow rate adjustments are performed at a local control panel to maintain proper operating temperature and to ensure proper breakdown of the coolant. There is a control panel in the ACR with audible and visible alarms, a reset button for the Freon Degrader vessel heaters, and a manual shutdown button.

The Operating Floor Freon Degrader system components include: nitrogen, fluorine, and air supply lines; PG supply and return lines; mixer; Degrader vessel; buffered Degrader shell; two parallel outlet filters; instrumentation; and controls. The Operating Floor Freon Degrader system simplified flow and instrumentation diagram is shown in Figure 3.1-26.

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Process gas inlet and outlet piping headers containing coolant contamination are connected to the Operating Floor Freon Degrader through designated supply lines from the Top Purge Cascade cells X-25-7-18 or -20. The reacted gases are returned to either of the Top Purge Cascade cells X-25-7-14 or -16 (Figure 3.1-24).

Gas flows to the Operating Floor Freon Degrader system are controlled from a local control panel. The rates at which PG/coolant and nitrogen enter the Freon Degrader system are regulated to maintain temperature within the reactor. The PG/coolant flow is regulated by a control valve through the use of a pressure-indicator-controller (PIC) on the local control panel. Within the Freon Degrader system, the fluorine flow rate is controlled by a pair of block valves that reduce the building supply header pressure. When the Degrader is operating, the fluorine flow rate is limited by a capillary tube calibrated to a maximum flow rate of 265 scfd, at the maximum fluorine header pressure. The capillary tube is important to safety as described in Section 3.8.

If the fluorine pressure reaches approximately 0 psig at the orifice just prior to entry into the capillary, an alarm actuates in the ACR and closes the fluorine supply valve. If the Degrader vessel pressure reaches approximately 5 psia, an automatic system shutdown closes the PG/coolant and fluorine supply valves, shuts down heater power, activates an alarm light at the local control panel, and activates an alarm light and horn in the ACR.

Thermocouples monitor temperatures of the Freon Degrader system. If the monitored temperature in any component of the Freon Degrader system reaches approximately 1150°F, an indicator light on the local control panel and an indicator light/audible alarm on the ACR panel will actuate. If the monitored temperature reaches approximately 1200°F, an automatic system shutdown closes the PG/coolant and fluorine supply valves and opens the breakers for the electric heaters.

If the mixer temperature exceeds approximately 300°F, operator action may be required to prevent possible combustion in the mixer by manually valving nitrogen through the mixer until it cools. The heaters can be shutdown and the PG/coolant and fluorine supply valves can be closed from the ACR.

3.1.2.2.16 Top Purge Air Bleed

The Top Purge Air Bleed System is designed to decrease the concentration of oxidants in the Top Purge Cascade and to supply the Top Purge with additional "lights", as required. This action is accomplished by introducing Plant Air into either side of the A-line bypass valve of cell X-25-7-19, based on cascade parameters. The Top Purge Air Bleed System consists of a local control panel and a manual controller in ACR 6. The air flow is metered and controlled (manually).

3.1.2.3 Instrumentation and Controls

Instrumentation and controls for the purge cascade cells are similar to those in the enrichment cascade cells. (A description of similar components in the enrichment cascade cell instrumentation can be found in Section 3.1.1.10.) Therefore, this section will only contain a listing of instrumentation and controls related to the operation of the purge cascade.

3.1.2.3.1 Line Recorders

A line recorder is a mass spectrometer that determines the relative changes in concentration of "lights" in a given cell as these contaminants flow through the cascade. Because of the increased concentration of "lights", the line recorder cannot directly measure the actual "lights" concentration within the 6-stage purge cells. However, the flow entering and exiting the Side Purge is monitored for relative changes. The ACR operator monitors the quantity of "lights" entering the Side Purge via a slave line recorder and the flow exiting the Side Purge by a line recorder monitoring an isotopic cell within the Top Purge. Small leaks within the 6-stage purge cells can only be detected by taking the suspect cell off-stream and determining the inleakage rate of "lights" over a given time period. Large leaks within a purge cascade cell can be detected immediately by an increase in purge rate along with little relative change in the "lights" up-flow as seen in the line recorder directly below the purge cascade. The purge cascade can be isolated and the exact location of the leak determined by taking all suspect cells off-stream and detecting the inleakage rate of "lights" over a given time period.

3.1.2.3.2 Space Recorders

A space recorder is a large flow-through ionization chamber used to monitor the vent gases both upstream and downstream from the Top and Side Purge Cascade chemical traps. Under normal operating conditions, continuous samples from the inlet and outlet trap manifold for each vent stream are passed through a space recorder. These recorder readings are recorded and displayed in the ACR. The space recorder readings can be converted into UF_6 concentrations in the vent stream by the ACR operator. The display device also contains an audible and visual alarm, which is set to indicate a large increase in radionuclides in the vent stream.

The space recorder display is monitored by the ACR operator and is used to initiate a predetermined set of actions (e.g., backing of the "lights" front down into the isotopic stage, or switching chemical traps) if the UF_6 concentrations at the trap inlet or vent exceed the preset limits, as confirmed by other operational indicators. This confirmation is needed because the accuracy and on-stream longevity of space recorder operations is affected by the plating of technetium on the wall of the ionization chamber, which reduces the chamber's sensitivity to low UF_6 concentrations in the vent streams. When the trap outlet recorder on the Top Purge or both space recorders on the Side Purge are out of service, laboratory samples are taken in accordance with plant procedures.

3.1.2.3.3 Continuous Samplers

A continuous sampler is an environmental and accountability monitoring device used to accurately determine the quantity of material vented by the Atmospheric Exhauster station. Proportional samples relative to the vent flow are drawn through traps that are analyzed for fluorine, technetium and uranium. The analytical results are then applied to the actual total vent flow in proportion with the sample flow. The final analysis of these vent samples is reported monthly to Plant environmental, accountability and operational personnel. Significant increases in vent emissions that are identified upon initial evaluation of these results are investigated.

3.1.2.3.4 Total Oxidant Monitor

Two specially modified laboratory Fourier Transform InfraRed analyzers, known as a Total Oxidant (TOX) monitors, are connected to the Top Purge Cascade, at locations prior to the Booster station. To monitor the concentration of oxidants and coolant in the Top Purge, the TOX monitor converts the sampled oxidants into a detectable compound prior to entering the sample chamber. The TOX monitor estimates the peak concentration of the oxidant bubble within the Top Purge based on the concentration of coolant and the detectable compound at the given monitoring location. The TOX monitor output supplements the operating information obtained from the purge cascade, but does not provide oxidant control.

3.1.2.3.5 Cell Instrumentation

The instrumentation of a purge cascade cell is located in an LCC on the operating floor, directly below the cell it monitors and controls. (A description of LCC instrumentation for the enrichment cascade is in Section 3.1.1.10.) Each stage is equipped with an automatic pressure controller. Each cell cubicle has stage-PICs that indicate and control the high-side pressure and an A-suction PBM to which each stage may be valved individually to read the A-suction pressure. A PIX and a control valve on the RCW supply to the condenser regulate the coolant vapor pressure, which in turn controls the cell temperature. Indicators and controllers are also provided for the seal feed and seal exhaust differential pressures. Each cell cubicle has a temperature-monitoring/control device that monitors, alarms, and trips cell motors based on individual temperatures. Details on the temperature-monitoring/control device are presented below in Section 3.1.2.3.5.1. Each cell cubicle is electrically heated, and the temperature is controlled with a temperature switch. The cubicle temperature is indicated on a TI located on top of the cell cubicle housing.

3.1.2.3.5.1 Temperature Monitoring Device

A temperature-monitoring/control device is provided on each purge cascade cell LCC to monitor, alarm, and trip the cell motors in the event of a high temperature. The Purge Cascade is equipped with stage high-temperature warning and stage high-temperature shutdown alarms.

The temperatures monitored in the Purge Cascade (Top and Side non-isotopic) cells include cell coolant, each stage A-suction, Stage 1 compressor internal, and selected compressor discharges. Cell Recycle valves automatically open and alarm in the ACR if a high temperature occurs within the Stage 1 compressor (low and high-speed cells) and/or Stage 6 (high-speed cells) compressor discharge temperatures. Opening the cell recycle valves will prevent Stage 1 or Stage 6 compressors from overheating.

The temperatures monitored in the isotopic Top Purge Cascade cells include each coverter B-outlet, Stage 12 compressor discharge, and Stage 11 compressor B-suction. The Stage 12 discharge temperature is monitored to initiate the opening of the cell's top recycle valve.

3.1.2.3.5.2 Power Monitors

The power drawn by individual stages of the purge cascade is monitored in the ACR on the cell panel. Load alarms and indicators are also associated with each stage motor. A significant increase or decrease in any stage motor load will actuate an audible and visual alarm on the respective stage/cell. The operating band varies from a nominal 30-40 percent of the ammeter scale for those cells operating in a steady state condition, up to a band width of 10% to 90% ammeter range. The 10% to 90% band width is used on cells near the UF_6 front location due to the frequent fluctuations seen in the cell UF_6 concentration. When any one of these load indicators is tripped, a horn will continue to sound until the cell alarm silence button is pushed. This alarm is slaved to the Plant Control Facility. The major interlocks associated with purge cell power operations are described below.

The total power drawn by designated high-speed purge cells is monitored by relays in the ACR. The signal from the total motor load relay can be tied into an interlock that isolates the vent flow downstream from the chemical traps. The interlock, which can be manually overridden in the ACR, is engaged when the total motor load of the high-speed cell exceeds the cell normal motor load by a preset limit.

The cell Time-Overcurrent relay is a power monitor that will trip the power to the cell when the cumulative normal cell power load is exceeded by a preset limit. In the case that this power increase is the result of sudden atmospheric inleakage into the purge cascade, the operation of the Time-Overcurrent relay to interrupt the power supply to the cell will prevent out-gassing from the cell.

3.1.2.3.6 Cell and Unit Bypass Temperature and Pressure

The cell bypass housing temperatures are monitored as part of the routine operations. The housings are electrically heated and thermostatically controlled. The heaters are fed from different circuits to eliminate the chance of total heater failure. Temperatures are maintained at a level sufficient to prevent UF_6 freezeout in the process lines. A control valve in the B-line of the Unit X-27-1 bypass line, before cell X-27-1-2, may be used to maintain the B-stream pressure in the Top Purge Stripper section.

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3.1.2.3.7 Criticality Alarms

Radiation detectors tied into the plant-wide CAAS are located throughout X-326. This system monitors various locations in the building, including the purge cascades, to detect the occurrence of a nuclear criticality. The CAAS is described in Section 3.6.2.

3.1.2.4 Operation During Offnormal Conditions

3.1.2.4.1 Alternate Configurations

When, for any reason, purge cascade cells go off-stream, isotopic cells can be used as replacements in an alternate purge configuration. Normally, the loss of one Side Purge or Top Purge cell can be compensated by repositioning the UF_6 concentration gradient. If two or more Top Purge cells are lost, purging can continue by directly substituting isotopic cells at the top of the cascade for the off-stream Top Purge cells. If two or more Side Purge cells are lost, the quantity of "lights" going to the Top Purge will increase. This increase can be handled by reducing the Top Purge air bleed and/or increasing the vent rate.

The Top and Side Purge Cascades are provided with separate electrical buses, plus an alternate bus, to power the high-speed purge cells only, in one or the other (not both) of the two purge cascades at any one time. If one of the two normal power sources for the purge cascades is unavailable, the motors in the associated high-speed cells can still be energized from an alternate bus. However, if both buses are out of service simultaneously, a decision must be made as to which high-speed cells, Top or Side Purge cascade, will be used since the alternate switching arrangement can only energize one set of high-speed cells at a time. If the Side Purge is inoperable or unavailable, all "lights" pass through the Top Purge Cascade prior to venting.

3.1.2.4.2 Indication and Isolation of Failures

The procedures for recognizing and isolating failures in purge cascade equipment are generally the same as for enrichment cascade equipment. However, because of the vent streams from the purge cascades to the atmosphere, additional precautions are required. For example, when a purge cell goes off-stream, the concentration of UF_6 in the vent stream must be continuously monitored. In a situation where the equipment failures or inleakages to the system require corrective actions, the purge vents can be closed, and the situation is evaluated prior to restarting purge operations.

The loads on the compressor motors, as indicated by motor current, may indicate pending problems or failures. If the motor loads in any purge cell increases rapidly, higher than desired concentration of UF_6 may be entering the cell. Since purge compressors, especially those in high-speed cells, are designed for light gases, the higher density of UF_6 in the cell would increase temperatures and motor loads, potentially causing the cell to fail. Also, UF_6 entering the high-speed purge cells may be indicative of failure in the automatic purge control instrumentation. However, the purge cascades can be operated manually once this problem has been determined. If the motor load of a single stage increases rapidly, the problem may have been initiated by compressor parts rubbing, deposits in the compressor, bearing failure, or some failure associated with the motor.

If leaks occur in the purge equipment, a change in the normal purge flow rate may be observed, depending on the amount of the inleakage. When leaks in the purge equipment are suspected, the purge cell is taken off-stream and leak rated. Leaks of this nature are usually atmospheric air from instrument line leaks, buffers, or nitrogen from the seal feed system. Since purge cascade operation is sub-atmospheric, detection of potential UF_6 releases is not required.

With few exceptions, operator action is required to isolate failures. For example, if the cell motors trip due to a cell motor overload, the cell UF_6 block valves remain in their initial position. Thus, if the cell was on-stream, the operator would have to initiate action to close the MOVs to isolate the cell from other on-stream cells.

Expansion joint failures can be identified by either immediate increases in cell pressure, changes in "lights" up-flow and/or build-up over time of UO_2F_2 deposits near the expansion joint. The quantity of "lights" vented from the purge cascades is monitored periodically. The cells containing the expansion joints are monitored periodically for deposits using gamma meters. If a failed expansion joint is suspected, the section of the cascade containing the expansion joint is isolated and leak rated. Following repairs, the expansion joint welds are pressure-tested and a sub-atmospheric leak rate test is performed on the isolated section of the purge cascade.

3.1.2.4.3 Accessibility to Area for Emergencies

In an emergency, the purge cascades are monitored and operated primarily from the ACR. In an emergency situation, the stage motors can be tripped and the vent streams can be isolated between the chemical traps and the Atmospheric Exhauster station by personnel in the PCF. Access to the purge area on the operating floor is available via a tunnel that runs the length of X-326. Entrances to this tunnel are located at the PCF and outside the X-326 ACRs.

3.1.2.5 Hazardous Materials

Hazardous materials in the Side Purge cascade during normal operation are UF_6, fluorine, HF, and small quantities of ClF_3, other metallic fluorides, and coolant. The hazards associated with these materials are addressed in Section 5.6. The A-stream from the isotopic cascade, with approximately 90 vol% UF_6, enters the first cell of the Side Purge. By the time the gas stream passes through two cells (12 stages), it is reduced to a 5 vol% UF_6 concentration. Since the cells are operated well below atmospheric pressure, any external leak that develops will result in ambient air entering the cell. When these systems are opened for maintenance, strict administrative controls are in effect (Section 3.1.1.4.1).

Chlorine trifluoride and fluorine, from the enrichment cascade, are processed in the purge cascades. Due to the design of the Side Purge Stripper section, the Top Purge Cascade contains a higher concentration of higher molecular weight hazardous materials than appear in the Side Purge. Materials may include UF_6, cascade coolant, CF_4, ClF_3, and traces of technetium, and other metallic fluorides. As the concentration of UF_6 decreases in the Top Purge Cascade, the concentrations of non-uranium fluorides and cascade coolant increase. This contaminant "bubble," may cause a control problem which could potentially result in an environmental and health and safety problem. The presence of both cascade coolant and oxidants (F_2, and ClF_3) can create an explosive mixture, requiring only an igniter.

The Freon Degrader system combustion products and unreacted gases flow through the filters and the return line back to the Top Purge Cascade. The filters trap out particulate matter (solid uranium compounds, technetium compounds, and other heavy metal fluoride compounds) that is dispersed throughout the Freon Degrader system. HF and UO_2F_2 may form in the Freon Degrader system during a postulated leak of ambient air into the system. A leak in the fluorine and nitrogen supply systems, which are at above-atmospheric pressure, could produce a hazardous condition in the enclosure of the Cell Floor Freon Degrader.

Through operational controls (e.g., surge drum bleedback, Freon Degrader operation, and Side Purge venting), there are not enough fluorinating agents in the Top Purge to cause a reaction, regardless of the quantity of cascade coolant present. The estimated maximum concentration of oxidants can also be monitored within the Top Purge using laboratory instrumentation. Before a system in the purge cascade is turned over to maintenance for equipment removal, it is purged until the concentrations of technetium and UF_6 are reduced to acceptable levels. (See Section 3.1.1 for discussion of cell purging and evacuation.)

3.1.2.5.1 Accumulation of Technetium

Technetium is a low-energy beta-emitter of high specific radioactivity, which originated from reactor returns formerly used as feed material at PORTS. Equipment contaminated with technetium represents a health hazard if inhaled or contacted with the skin. Treatments are performed on the purge cascade before major equipment removal to control exposure of personnel to technetium in the work areas of the plant. When major pieces of equipment must be removed from the purge cascade for maintenance, personnel will reduce, when operationally feasible, the concentration of technetium compounds on the internal surfaces of the cell involved to an acceptable level so that the equipment can be safely removed and repaired. (Section 5.3 addresses worker radiological protection controls.) Removed purge cascade equipment is taken to the X-705, Decontamination Building South Annex or any other approved high contamination work area for disassembly.

3.1.2.6 Waste Disposal

Normal wastes from the purge cascade facility may include alumina, soda lime, MgF_2 pellets, technetium, heavy metal fluorides, and fluorine. The alumina, soda lime, and MgF_2 pellets are handled in accordance with applicable nuclear criticality safety requirements. Similarly, other contaminated materials are placed in long term storage on the plantsite.

In normal operation, gaseous combustion products of the Freon degradation are returned to the Top Purge Cascade. Particulates resulting from the degradation process are trapped out in the filters. Spent filters are staged for Health Physics monitoring to determine required radiological controls for filter cleaning and/or disposal.

3.1.2.7 Confinement System

Process materials are confined within the Freon Degrader system mixer, Degrader vessel, filters, and piping. The fluorine and nitrogen supply lines have been fabricated from materials meeting operating specifications for the intended system service environment. All pipe and components have been cleaned prior to installation to assure the absence of hydrocarbons, moisture, and rust, and have been purged following installation. After assembly, the leak-tightness of both the Cell Floor and Operating Floor Freon Degraders is verified by pressure and vacuum leak testing.

The Freon Degrader outlet filters have flanged connections on the inlet and outlet lines, on isolation valves on both sides of each filter, and on fittings for nitrogen purge line connections. The removal of a plugged or full filter is a normal maintenance function that could release small amounts of the contained particulates (technetium compounds and heavy metal fluorides). In the Cell Floor Freon Degrader, these particulates could be retained within the Degrader enclosure. The Outleakage Detection system in X-326 (Section 3.1.1.11.2) will detect releases of UF_6 from the Cell Floor Freon Degrader.

3.1.3 Freezer/Sublimer Systems

3.1.3.1 General Description

There are twelve Freezer/Sublimer (F/S) Systems installed in six units in the X-333 Process Building. The twelve systems are located at Cells 5 and 6 of Units X-33-2 through X-33-7. The purpose of these systems is to withdraw UF_6 from the cascade, store the material in the F/S vessels, and re-introduce the material back into the cascade, thus establishing plant power loads to compensate for the availability of process power. Each of the twelve systems is capable of withdrawing a UF_6 inventory equivalent to a nominal 12.7 megawatts of power. The systems are capable of operating in five different modes to safely accomplish the purpose described above. Additionally, two F/S systems (X-33-4-6 and X-33-6-6) have been modified to allow cold trapping of UF_6 from UF_6-Coolant mixtures. These modes of operation are described in Section 3.1.3.3.

Each F/S System has three primary subsystems:

- The Process Gas System, which is comprised of a F/S heat exchange vessel, load weighing system, and associated piping and valves.
- The Coolant System, which is comprised of components in the F/S vessel, a condenser/reboiler (C/R) heat exchange vessel, a coolant pump, and associated coolant piping and valves.
- The Recirculating Cooling Water (RCW) System, which is comprised of components in the C/R vessel, a RCW pump, and associated RCW piping and valves.

Figures 3.1-27 and 3.1-28 show diagrams of a typical F/S System in the Freeze mode and in the Sublime mode, respectively. Figures 3.1-29 and 3.1-30 show diagrams at a typical F/S System in the Cold Standby mode and the Hot Standby mode, respectively.

3.1.3.2 F/S System Description

3.1.3.2.1 Process Gas System

The Process Gas System withdraws gaseous UF_6 from the cascade, stores it in the solid state, and returns it to the cascade in the gaseous state. The UF_6 is withdrawn by passing cold coolant through tubes within the F/S vessel, thereby causing gaseous UF_6 to be solidified onto the F/S tubes and fins. Noncondensible gases entering with the UF_6 flow are allowed to return to the cascade cell A-stream bypass through a flow control vent valve, which returns some of the flow to the cascade during freeze mode.

By passing hot coolant vapors that condense in the F/S vessel tubes, frozen UF_6 is sublimed and allowed to return to the cascade through the weight control valve and a motor-operated block valve to the A-suction line of the cell stage 1 compressor. Dual-bridge load cells measure the amount of UF_6 in the vessel and provide data on the rate of change of the weight of UF_6 in the F/S vessel (Section 3.1.3.2.1.2).

The F/S Process Gas primary system, consisting of the F/S vessel, and cooling fins, piping, expansion joints, and valves, is important to safety as described in Section 3.8.

3.1.3.2.1.1 F/S Vessel

The typical F/S vessel is a heat exchanger in which UF_6 is frozen ~~onto~~ and sublimed from finned tubes through which the coolant heat-transfer medium is circulated. The F/S vessel is designed and fabricated in accordance with Section VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The design pressure for the shell and tube side is 150 psig at 200°F. A 150 psid rupture disc is provided on the shell side with provisions for UF_6 flow through the rupture disc system to the cascade cell A-stream bypass line.

3.1.3.2.1.2 F/S Vessel Weighing System

The F/S vessel weight is measured by three dual-bridge electronic load cell systems. The dual-bridge design provides two independent weight-measuring systems, which are compared by the instrumentation, such that any individual component failure will be detected. The TSR establishes a safety limit of 11,900 lb of UF_6 in the F/S vessel and a Limiting Control Setting (LCS) of less than or equal to 9,000 lb UF_6. An allowable test tolerance is provided to cover instrument drift and uncertainties during normal operation. The solidification phase of operation is accomplished by cold liquid coolant flowing through tubes inside the vessel. The Limiting Condition for Operation of the coolant weight is controlled to be greater than or equal to 1,800 lb. This additional weight requires an instrument setpoint to account for the UF_6, and the channel uncertainty. Calibration checks are made at the LCS to verify that instrument accuracy is within specifications.

3.1.3.2.1.3 UF_6 Weight Control Valve

The UF_6 weight control valve is located in the piping connecting the F/S vessel with the UF_6 inlet and outlet block valves. During freeze and sublime operations, the weight control valve is normally operated fully open to obtain maximum UF_6 flow rates.

3.1.3.2.1.4 UF_6 Vent Valve

The UF_6 vent valve is a control valve located in the vent line piping connecting the F/S vessel with the cascade cell A-stream bypass. The line also contains a block valve which remains sealed open during all modes of operation (except shutdown). During freeze operations, noncondensibles entering with the UF_6 into the F/S vessel are returned to the cascade through the vent line.

3.1.3.2.1.5 UF_6 High Pressure Relief System

The F/S UF_6 high-pressure relief system, consisting of a rupture disc, block valve, and associated piping to the cascade A-stream, is important to safety Section 3.8. A 150 psid rupture disc has been installed in the vent line between the F/S vessel and the cascade piping to release pressure to the A-stream cell bypass line. The block valve between the F/S rupture disc and the cascade cell A-stream bypass (i.e., the same block valve associated with the UF_6 vent valve operation, above) remains sealed open during all modes of operation (except shutdown).

3.1.3.2.2 Coolant System

The coolant system pressure is maintained above the PG system pressure, which is limited to a nominal maximum of 20 psia. In the event of a tube rupture within the F/S vessel, coolant will leak into the PG system. Continued leakage of coolant into the F/S system will increase the pressure until the controls trip the F/S unit to Cold Standby and open the UF_6 vent valve (Section 3.1.3.4.2.2). In the event of a tube rupture within the C/R, coolant will leak into the recirculating water system; water will not flow towards the PG system as long as enough coolant remains in the system to exert a pressure greater than water pressure. Continued leakage of coolant into the recirculating water system will eventually decrease the differential pressure and the control system will trip the F/S unit to the Hot Standby mode (Section 3.1.3.4.2.1). This action may temporarily increase the pressure in the coolant system. The C/R coolant levels are checked periodically for decreases in the inventory that would be an indication of a leak to the atmosphere or to the cascade.

The major components in the coolant system are the tubing and fins in the F/S vessel, the C/R, the coolant pump bypass valve, and the coolant pump. The coolant system also includes an auxiliary heater and a surge tank, which indicates coolant system levels.

3.1.3.2.2.1 Condenser/Reboiler

The C/R is designed and fabricated in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, Division 1, and Tubular Exchange Manufacturers Association Standards for a class "B" exchanger. The design pressure for the shell and tube sides is 150 psig at 200°F and 180°F, respectively. A 150 psid, double-rupture disc assembly protects the C/R. The RCW flows through the U-tubes making two passes through the C/R. During Freeze and Cold Standby operations, cold water from the RCW supply line is passed through the C/R tubes, condensing the coolant vapor which, in turn, freezes the UF_6 on the F/S tube fins. During Sublime and Hot Standby operations, hot water from the RCW return line is pumped through the C/R tubes, vaporizing the coolant liquid which, in turn, sublimes the UF_6 in the F/S vessel.

3.1.3.2.2.2 Coolant Pump Bypass Valve

The coolant pump bypass valve allows coolant liquid to bypass the pump during all modes of operation except the Sublime mode and upon low RCW flow.

3.1.3.2.2.3 Coolant Pump

The coolant pump is a centrifugal pump that is used to circulate coolant liquid from the F/S vessel to the C/R during sublime operations. The coolant is charged or drained from the F/S systems by utilizing the coolant storage tanks on the operating floor.

3.1.3.2.3 Recirculating Cooling Water System

The F/S RCW system provides hot and cold water to be used in the operation of the F/S systems. The primary components in each F/S RCW system are: a source control valve, a pressure control valve, a pump and a flow control valve. The RCW source control valve allows either cold water from the cascade RCW supply line or hot water from the cascade RCW return line (depending on the F/S mode of operation) to enter the F/S RCW system, circulate through the C/R, and be returned to the cascade RCW return line.

Cold RCW supply water is used to condense the coolant in the C/R and enable the coolant to freeze UF_6 in the F/S vessel. Hot RCW return water heats the coolant and enables the coolant to sublime the frozen UF_6 in the F/S vessel. The rate at which RCW circulates is regulated by the flow control valve.

3.1.3.2.3.1 Recirculating Cooling Water Source Control Valve

The RCW source control valve is a three-way, on-off service, control valve. During Freeze and Cold Standby operations, the RCW source control valve allows cold water from the cascade RCW supply line to enter the F/S RCW system. During Sublime and Hot Standby operations, the RCW source control valve allows hot water from the cascade RCW return line to enter the F/S RCW system.

3.1.3.2.3.2 Recirculating Cooling Water Pressure Control Valve

The RCW pressure control valve is located between the RCW source control valve and the C/R. This valve regulates the RCW pressure to the C/R.

3.1.3.2.3.3 Recirculating Cooling Water Pump

The RCW pump is a centrifugal pump that is continuously operated to maintain the water circulation in the C/R.

3.1.3.2.3.4 Recirculating Cooling Water Flow Control Valve

The RCW flow control valve is located between the RCW return header and the RCW pump. A flow control system manipulates the flow control valve to maintain the RCW flow at pre-determined limits.

3.1.3.3 F/S System Modes of Operation

The F/S System is designed to operate in five different load control modes: (1) Freeze, (2) Sublime, (3) Cold Standby, (4) Hot Standby, and (5) Shutdown.

3.1.3.3.1 Freeze Mode

The Freeze mode is defined as the solidification of UF_6 from the cascade B-stream on the F/S vessel finned tubes by cold liquid coolant flowing through inside of the F/S vessel tubes. The cold water flows from the F/S RCW system through the C/R and begins removing heat energy from the coolant. The UF_6 is frozen on the finned tubes of the F/S vessel. The temperature and pressure of the RCW to the C/R is controlled. The pressure of the RCW supply is reduced by a pressure control valve to prevent inleakage of water into the coolant system. If the differential pressure transmitter measures a differential pressure of less than or equal to preset limit between the coolant (high) and RCW (low), an alarm is sounded at the LCC and in the ACR, and the system is tripped automatically to the Hot Standby mode. The resulting higher water temperature will cause an increase in the coolant temperature and pressure. The combination of a higher coolant pressure and the lower water pressure results in a greater pressure difference between the RCW and coolant in the C/R. The RCW recycle control valve controls the RCW pump discharge pressure into the combined RCW stream to the C/R. The RCW pump discharge pressure will depend on whether hot or cold water is being pumped.

The temperature of the RCW supply to the C/R is blended using the cold water supply and the heated water from the C/R. If the temperature of the RCW supply to the C/R falls below the desired level, an automatic valve opens and admits C/R outlet water back to the inlet via the RCW pump to raise the temperature of the incoming supply water.

3.1.3.3.2 Sublime Mode

The UF_6 inventory is returned to the cascade by setting the system to the Sublime mode. The Sublime mode is defined as removal of solid UF_6 from the F/S vessel tubes by flowing heated coolant through the inside of the F/S vessel tubes. The UF_6 converts directly from a solid to a gas and is returned to the cascade A-stream.

The water source is changed to hot water from the RCW return, which flows through the C/R and is pumped back to the RCW return system. The coolant pump starts and pumps liquid coolant to the C/R. The hot water in the C/R tubes heats the coolant, causing the coolant to vaporize and flow to the F/S. The energy from the heated coolant is transferred through the F/S tubes and fins to the solid UF_6 on the fins. The UF_6 sublimes and is transferred through the weight control valve and the motor-operated block valve to the cascade low-pressure A-stream. The hot, liquid coolant drains to the ground floor where the coolant pump returns the coolant back to the C/R to complete the cycle. The rate of increase in plant power load depends on the sublimation rate from the F/S Systems. Generally, the F/S will be used at maximum rates for the power increase.

The sublime mode includes heating the F/S vessel after the inventory reaches 9,000 lb, UF_6. This mode is actuated by the high-high weight trip (Section 3.1.3.4.2.4). The F/S vessel inventory is reduced by slowly subliming the UF_6 back to the cascade A-stream. During this operation, hot water is circulated through the C/R at a reduced water flow.

3.1.3.3.3 Cold Standby Mode

Cold Standby operations will maintain any UF_6 in the F/S vessel in the frozen state. The Cold Standby mode is defined as maintaining UF_6 as a solid in the F/S vessel by recirculating cold coolant through the F/S tubes while the F/S process lines are isolated from the cascade.

The F/S process lines are isolated from the cascade (A-stream and B-stream block valves are closed). The RCW supply is opened to the C/R, cooling the coolant. The cold coolant flows by gravity to the F/S vessel where it removes the normal cell heat and is vaporized back to the C/R in an essentially steady state operation. During this operation, the RCW pump delivers a reduced water flow to the C/R. The process supply and return lines are isolated, stopping the flow of UF_6 to the F/S vessel. With no energy exchange, the coolant, RCW, and UF_6 temperatures will equalize at the RCW control temperature.

3.1.3.3.4 Hot Standby Mode

The Hot Standby mode is defined as maintaining UF_6 in an equilibrium state as the coolant and UF_6 temperatures equalize. The F/S process lines are isolated from the cascade and there is no flow of coolant through the F/S vessel.

The Hot Standby mode consists of heating the coolant by the RCW return system while isolating the F/S UF_6 supply and return lines (A-stream and B-stream block valves are closed). During this operation, the RCW pump delivers a reduced water flow to the C/R. The coolant pump is off and the pump bypass valve is open, allowing the coolant and UF_6 temperatures to slowly equalize with the hot water temperatures and the contents of the F/S vessel to be maintained in an equilibrium state.

3.1.3.3.5 Shutdown Mode

The Shutdown mode is defined as isolating F/S UF_6 process lines from the cascade, placing the F/S in Hot Standby mode, and tagging the unit out of service. In the case where the containment of the F/S unit is to be breached, the F/S vessel would be emptied of UF_6 inventory. If maintenance is required, the F/S vessel will be purged of its UF_6 inventory and sampled to verify that it is empty (UF_6 negative) prior to opening the vessel to the atmosphere.

3.1.3.3.6 Cold Trapping of UF_6 from UF_6-Coolant Mixtures

Modifications have been made to the F/S systems at Cells X-33-4-6 and X-33-6-6 so that UF_6-Coolant mixtures can be pumped from the cold recovery surge drums, through the evacuation header to the F/S system, where UF_6 freeze-out will be accomplished. The remaining gases will be returned to the surge drums through a jumper line between the F/S pressure relief line and the evacuation return header. The operation will involve components of the F/S high-high weight system but will not interfere with operation of the system. The relief system vent valve will be closed during the cold-trapping operation and must be opened at the conclusion of the operation. (This valve will be open when the systems are not being used for cold trapping to prevent light gases from accumulating in the UF_6 vessel during normal use.)

3.1.3.4 Instrumentation and Controls

LCCs are provided for manual control of the F/S system. Monitoring of the system can be accomplished from the ACR using the existing plant Automatic Data Processing (ADP) system (Section 3.1.1.11).

3.1.3.4.1 F/S Weight Monitoring

Three dual bridge load cells measure the total UF_6/coolant weight in a F/S vessel, providing information that the ADP system uses to monitor the F/S System, allowing operators to manually control the freeze or sublime rate (Section 3.1.1.11). The summed output from each set of bridges is used to regulate the amount of UF_6 in the F/S vessel. Each load cell provides a signal to both of the duplicate summing boxes which, in turn, supply an output signal to duplicate current transmitters, which activate duplicate pairs of trip switches (Figure 3.1-31). The output from the summing boxes is compared to setpoints (high and high-high weight settings). Each pair of trip switches includes a high and high-high weight trip switch (Trip Nos. 5 and 4, respectively [Section 3.1.3.4.2]). The trip switches activate trip relays that are each capable of performing the required isolation of the F/S, as specified below. The F/S vessel weight instrumentation requires 120 VAC power to operate.

The hard-wired safety trip circuits (such as the high-high weight trip) automatically activate alarms locally at the LCC panels on the operating floor and in the ACR. This system has its own annunciator both locally and in the ACR. Activation of the hard-wired signals will prevent any further operation until the conditions that caused the alarms have been corrected. The system is hard-wired and will over-ride automated or operator action. No automatic isolation or associated cell shutdown actions follow alarm activation. Although the high-high weight trip switches are not fail-safe on loss of electrical power, the trip relays, which are energized from the same power source (Auxiliary Motor Control Center [MCC]), are designed to fail in the safe position upon loss of electrical power.

3.1.3.4.2 Trip Systems

To prevent the overload of the F/S vessels, high pressures in these vessels, introducing water into the coolant system, or the loss of the RCW supply to the F/S systems, certain trips are provided to change modes of operation.

3.1.3.4.2.1 Trip No. 1

Trip No. 1 is activated when the F/S RCW system pressure increases to within a preset limit of the system coolant pressure, or when the system coolant pressure decreases to within a preset limit of the F/S

RCW system pressure. This condition occurs only when the system is in either the Freeze mode or the Cold Standby mode of operation. Hot Standby will result in partially closing the RCW source control valve. This will decrease the water pressure to the C/R and increase the coolant pressure, thereby increasing the differential pressure between the water and the coolant. In case of a leaking C/R tube, the coolant will leak into the RCW. Hot Standby means the system is isolated from the cascade, i.e., the weight control, vent, and both block valves (to the A- and B-stream lines) are closed.

Trip No. 1 is also actuated if the coolant temperature is reduced below 50°F with the same results. Activation of Trip No. 1 by low coolant temperature is essentially precluded as a result of the normal temperature of RCW coming into the C/R being at least 80°F. However, a sufficiently low ambient temperature on the operating floor could expose the coolant temperature thermocouple to a temperature low enough to activate this trip.

3.1.3.4.2.2 Trip No. 2

Trip No. 2 is actuated when the pressure in the F/S vessel exceeds a nominal 20 psia. The trip will isolate the F/S vessel (except that the vent valve is open to the cell A bypass suction pressure) and introduce cold water to the C/R, thus reducing the coolant pressure and the UF_6 pressure in the F/S vessel.

3.1.3.4.2.3 Trip No. 3

Trip No. 3 is actuated when the F/S RCW flow decreases below a preset limit. This trip could occur as the result of instrument air failure, power failure, RCW pump failure, or instrument failure. Trip No. 3 configures the system to a safe Shutdown mode by isolating the F/S systems from the cascade, closing the coolant pump bypass and weight control valves, maintaining the block valves (to the Aand B-stream lines) in their last position, stopping the F/S RCW and coolant system pumps, and closing the F/S RCW recycle valve. The vent valve remains open to the cascade A-stream.

3.1.3.4.2.4 Trip No. 4

Trip No. 4 (High-High Weight trip) is actuated when the UF_6 weight in the F/S vessel reaches 9,000 lb (Section 3.1.3.2.1.2). In this case, the F/S vessel is not isolated, but is placed in the sublime mode with the F/S weight control valve and the block valve open to the cascade A-stream, thus reducing the UF_6 inventory in the F/S vessel. Also, the block valve to the B-stream is closed, isolating the F/S System from the cascade B-stream inflow. After the inventory is reduced, the F/S is placed in the Hot Standby mode.

The High-High Weight trip system (Figure 3.1-29) includes the following important to safety components, as identified in Section 3.8 and described in Section 3.1.3.4.1: B-line (inlet) block valves, weight control relays, weight control valves (Section 3.1.3.4.3) and their associated solenoid valves, weight sensing instrumentation (e.g., load cells) and their associated circuitry, and the electrical power supply (Section 3.4.1) from the Auxiliary MCC to the B-line block valve motor operators, including breakers and wiring.

3.1.3.4.2.5 Trip No. 5

Trip No. 5 is actuated when the vessel inventory reaches 8,200 lb of UF_6. The trip will isolate the F/S vessel (the vent valve is closed to the cell A bypass suction pressure) and introduce cold water to the C/R, thus reducing the coolant pressure and the UF_6 pressure in the vessel.

Trip No. 5 differs from Trip No. 2 in that the vent valve to the cell A bypass suction pressure is closed.

3.1.3.4.3 Control Valves

The F/S system uses air-operated control valves to isolate or control the amount of various F/S process materials during operation (Section 3.1.3.2 for F/S System description). The air-operated control valves are operated by pneumatic input signals from solenoid valves. The two-way control valves are spring-loaded and are designed to fail in the closed position upon loss of air or electrical power supplies. The air-operated two-way control valves in the F/S System include: RCW pressure control, RCW recycle, RCW flow control, coolant pump bypass, F/S weight control and F/S vent. The RCW source control valve is a three-way spring-loaded control valve that is designed to fail in the "as-is" position upon loss of air supply. For loss of electrical power, the valve is designed to fail to the "cold" position.

Motor-operated valves isolate the F/S System from the associated cascade cell A-stream and B-stream lines. Power to operate these valves comes from relays on the Auxiliary MCCs, which are supplied from the building electrical system (Section 3.4.1). 480 VAC and 24 VDC power is required to operate the MOVs and their relays, respectively.

3.1.3.5 Confinement Systems

As long as the F/S Systems are operated at or below atmospheric pressure, breaches of the pressure boundary would tend to result in atmospheric air inleakage. All volumes of the F/S Systems that contain UF_6 are enclosed in an addition to the cell housings. All expansion joints for UF_6 are double-wall and supplied with dry air buffers to induce buffer leakage and not UF_6 outleakage.

Ionization-type UF_6 detectors in the F/S system enclosures will detect any leakage of UF_6. The detectors will activate alarm circuits during a fire or PG outleakage (Section 3.1.1.11.2).

3.1.4 Cold Recovery System

Obtaining a UF_6 negative in gaseous diffusion process equipment results in the accumulation of purge gases with relatively low concentrations of UF_6. In-leakage of atmospheric air into process equipment containing UF_6 will result in the formation of UO_2F_2. Mixtures containing ClF_3, F_2, or nitrogen are used to remove these deposits. Removing these gas mixtures directly to the enrichment system is less desirable because it reduces the cascade efficiency. Therefore, the process equipment containing gas mixtures can be processed directly or via surge drums to one of two cold recovery systems, returned back to the cascade, or evacuated through chemical traps to atmosphere.

One cold recovery system is located in X-330 at the east central side and the other in the center of X-333. Both systems are located on the operating floor. Purge gases and UF_6 reaction products are stored here until they can either be cold trapped or returned to the cascade. These gases typically have low UF_6 concentrations. The gas mixture, of sufficient UF_6 concentration, is first passed through refrigerated cold traps, to condense nearly all of the UF_6, and then through chemical traps where traces of UF_6 are removed prior to being discharged to atmosphere by means of an air jet exhauster. When the cold traps are full, they are valved off, heated, and the solid UF_6 is sublimed to holding drums (flashing operation). After assay determination, the UF_6 is returned to the cascade.

Gas mixtures from cascade process equipment can be vented through cold recovery equipment or stored in drums for future disposal. The venting operations from cascade process equipment are monitored by a continuous recording instrument. Continuous samplers are also operated on the discharge of the air ejectors to quantify vent emissions. The concentration being vented is controlled to comply with the regulatory requirements cited in Section 5.1. Section 3.1.4.6 describes monitoring systems.

A cold recovery system primarily consists of a surge drum room, holding drum room, refrigeration room, a chemical trap room, piping manifold, cold traps, calibration and sample manifold, and control instrumentation necessary to perform the cold trapping operation safely. Surge drums and chemical traps are normally provided in banks with each bank consisting of multiple drums or traps.

3.1.4.1 Operation

The cold recovery systems were designed to operate at slightly above atmospheric pressure for maximum efficiency. Recovery of uranium from ClF_3 reaction products requires operating pressures be reduced so that the ClF_3 and its by-products will pass on through the cold trap. Reaction products are the result of the numerous chemical reactions that take place between ClF_3, F_2, and any moisture or other reactive materials in the process equipment. One of the possible reaction products in the gas is chlorine dioxide (ClO_2), which can be formed as ClF_3 reacts with excess water. Any UF_6 recovered by conditioning/drying treatments is separated from reaction products (and unreacted ClF_3 or F_2) by means of cold trapping. The remaining contaminants are vented to the atmosphere, and the cold-trapped UF_6 is subsequently vaporized and returned to the surge drums and then to the cascade.

The surge drum valve manifold allows the material from any bank of cold recovery surge drums or process equipment to be routed through the cold traps. The lines from the outlet of the cold traps route the non-condensibles to the chemical traps, and these gases are then vented to the atmosphere by means of an air ejector. UF_6 in a gaseous state is routed to the holding drums for temporary storage.

The cold recovery systems are provided with the instrumentation necessary for controlling the trap pressure, temperature, flow rate, and for monitoring of the gas stream for uranium before it is vented to atmosphere.

Several, different types of controlled heating systems are used to maintain piping, pipe housings, surge drum rooms, and holding drum rooms at temperatures well above the UF_6 condensation point at atmospheric pressure. The Surge Drum Room Temperature Instrumentation is important to safety as described in Section 3.1.4.3.2.

The cold traps are operated at an optimum low temperature to more efficiently remove the uranium from the vent gases and yet allow the noncondensing gases to pass on through. The pressure within the cold traps is limited during freeze mode when trapping material contains reaction products. There are no pressure limits for purge gas material, which contain no ClF_3.

The concentration of ClF_3 and coolant in gases that are cold trapped must be limited to prevent liquefaction in the cold traps. Before the content of any surge drum or process equipment is cold trapped, it must be sampled to determine the concentration of free fluorinating agent and/or coolant. There must be a minimum amount of free ClF_3 or F_2, or a combination of the two present to prevent the formation of ClO_2.

Care must be taken during the cold trapping of mixtures containing both ClF_3 and coolant to ensure that pressure and temperature limits are not exceeded. It is necessary to take precautions to prevent liquefaction of these compounds in the inlet head of the cold trap, which could lead to conditions causing a possible explosion. Cold trapping is stopped if ClF_3 liquification is detected.

The gas flows from the surge drums or process equipment through cold trap(s). The inlet head temperature is maintained at a temperature range to prevent plugging with frozen UF_6. The cold trap(s) will remove up to 99.9% of the UF_6 before the gas passes through chemical traps, where residual UF_6 is removed. The gases being exhausted to the atmosphere are monitored by continuous vent monitors as stated in Section 5.1. In addition, the cold recovery vents are monitored by space recorders that provide Operations with "real time" UF_6 vent concentrations for evaluating the need to make process adjustments. During normal operations, the plant's operating philosophy is implemented at Cold Recovery by taking prescribed actions when the trap outlet vents. The program controls provide assurance that PORTS airborne radionuclide emissions are in compliance with regulatory requirements as stated in Section 5.1. Space recorders are discussed further in Section 3.1.4.6.2.

When the cold traps become plugged, they are heated and controlled at a nominal operational setpoint to vaporize the UF_6 to the holding drums. The temperatures of the traps are recorded on temperature recorders and controlled by individual temperature controllers. Should the temperature control fail, a high-temperature audible and visual alarm will be actuated locally and in the ACR which will interrupt the power to the heaters (H trip). A high-high-temperature "trip" which will interrupt the heater power supply (HH trip) is provided on each trap.

The assay of the material in the holding drums is determined and the material is returned to the cascade.

During cold-trapping operations, data is taken by Operations personnel and recorded on a cold recovery data sheet which covers a 24-hour period and includes such things as cold-trap temperatures and pressures, surge drum pressure, inlet header pressure, and space recorder readings (parts per million uranium being vented).

The material resulting from the sodium fluoride (NaF) trap regeneration process (discussed in Section 3.1.4.6.3), depending upon the UF_6 concentration, can be returned to the cascade at a controlled rate, or cold trapped after being sampled for uranium and F_2.

3.1.4.2 Systems Description

3.1.4.2.1 X-330 Cold Recovery

There are seven banks of surge drums (A through G) associated with X-330 Cold Recovery that have a total nominal volume of 52,000 ft^3. The surge drum valving manifold allows material from any bank of surge drums to be routed through the desired cold trap(s). If a sufficient number of cold traps are available to maintain cold trapping operations, more than one cold trap may be used. In X-330, six cold traps (A through F) are provided. Four banks of chemical traps are provided to remove residual UF_6 from the vent streams. The traps are filled with sodium fluoride pellets or contain alumina. The chemical traps are further described in Section 3.1.4.3.4.

Holding drums are used to store UF_6 sublimed from the cold traps until it can be returned to the cascade. Located in the holding drum room is a relief drum (Section 3.1.4.3.1.3) that serves as a relief volume in case excessive pressure is encountered in a cold trap during a heating cycle.

3.1.4.2.2 X-333 Cold Recovery

Surge drums in this system are arranged in seven banks (A through G), with a total nominal volume of 81,400 ft^3. Holding drums and the relief drum are the same as those described for the X-330 Cold Recovery. This facility has three cold traps (A through C), NaF traps, and alumina traps. Because of the low assay found in this building, very large alumina traps are used. Air ejectors and vent headers are provided in this facility along with space recorders. As in the X-330 Cold Recovery, two separate venting operations may take place simultaneously.

Each of the X-330 and X-333 Cold Recovery Systems has two similar refrigeration systems. One is in operation while the other remains as a backup. The heating systems for the surge drum room and holding drum rooms control the temperature to maintain the UF_6 in a gaseous state. The Surge Drum Room Temperature Instrumentation is important to safety as discussed in Section 3.1.4.3.2.

3.1.4.2.3 Supplemental Purge (Pigtail) Cascade

The purpose of the supplemental purge (pigtail) cascade is to separate UF_6, coolant and light gases. The pigtail cascade uses available isotopic stages in a batch operation on an "as needed" basis. Any isotopic units or cells may be utilized.

The designated unit or group of cells is isolated from the rest of the cascade and processes gaseous material of a known composition. The selected unit is placed on recycle to separate the UF_6, coolant, and light gases. After equilibrium has been reached, the top cell(s) of the pigtail cascade are isolated and the lights are withdrawn. The material from the bottom cell(s) of the pigtail cascade is removed as necessary. Since the compressors were designed for isotopic separation, not lights separation, the unit does not operate at maximum efficiency. The maximum high-side pressure is established to ensure that no motors or electrical systems are overloaded.

3.1.4.3 Equipment Description

The containment function of the UF_6 Primary System; which includes surge drums, holding drums, cold traps, PG piping, valves, chemical traps, and other equipment that contains UF_6; is important to safety as discussed in Section 3.8. Consequences of a UF_6 release are mitigated by the Cold Recovery UF_6 Primary System. The equipment associated with cold recovery operations is discussed below.

3.1.4.3.1 Cold Traps

The cold traps consist of cylindrical pipes around, which is wrapped a refrigeration section used during cooling of the traps. In this section, copper tubes containing refrigerant run the length of the cold trap. Electric heaters, which envelop the cooling section, are used during the heating cycle. Water-resistant insulation wraps the heating section.

In the X-333 Cold Recovery area, the cold traps are administratively controlled to 3.0% ^{235}U assay. The cold traps in the X-330 Cold Recovery area are administratively controlled to 10% ^{235}U assay due to the piping configuration in the X-330 vent stack.

3.1.4.3.1.1 Cold Trap Instrumentation

Each cold trap has similar instrumentation. Pressure instrumentation indicates cold trap conditions. The pressure instrumentation is located inside a heated housing and is transmitted to a pressure readout device outside the heated enclosures.

Each cold trap has pressure instruments of sufficient range; one each for the inlet line, shell, and outlet line. Each cold trap also has pressure switch devices located on the inlet line and on the cold trap shell. If either pressure switch device is actuated during the heating cycle, it activates both audible and visible alarms locally and in the ACR; however, actuation of one pressure switch device will interrupt the heater circuit. Each cold trap has a pressure relief system which is important to safety and is discussed in Section 3.1.4.3.1.3.

3.1.4.3.1.2 Temperature Controls

There are multiple heater circuit controls for the cold trap heaters in the X-330 and in the X-333 Cold Recovery. During the heating cycle, the cold trap temperatures are controlled at a nominal operational setpoint through temperature controller (TC) relays.

Temperature control during the condensing (freeze-out) operation is accomplished by the sizing of the refrigerant expansion valve to the cold trap. An open temperature element during the heating cycle for flashing of the cold traps will cause the temperature recorder to go full scale, actuating the high temperature alarm and tripping all the heater circuits.

High temperature protection is provided by TCs. When any of the monitored TC temperature points on the Temperature Recording Controller reaches a nominal setpoint, an audible and visual alarm is actuated locally and in the ACR, and all the trap heater control circuits for that trap are also interrupted

If the TC fails to interrupt the heater circuits, a cutoff will open the heater circuits at a nominal setpoint.

3.1.4.3.1.3 Cold Trap Pressure Relief System

The cold traps are equipped with a pressure relief system. This system is designed to prevent inadvertent over-pressurization and rupturing of the cold traps which could result in the release of UF_6 and other toxic gases such as ClF_3. Each cold trap has a rupture disc and a relief valve set to release at or below the MAWP. The Cold Trap Pressure Relief System is important to safety as discussed in Section 3.8.

A relief drum serves as a pressure relief volume for the cold traps in case of excessive pressures, which could be encountered during the flashing operation or heating cycle. The entire contents of a cold trap can be vaporized into a relief drum. The relief drums have pressure instrumentation that will actuate audible and visual alarms both locally and in the ACR, should the pressure in the drum reach a preset limit. This alarm only serves to warn the operator that a relief system has been activated or a leak in the system has developed. In the event E or F cold traps in X-330 Cold Recovery should be over-pressured, they would relieve pressure into the "F" bank surge drums. The relief drum is designed to hold the contents of one cold trap containing solid UF_6 and is maintained at a pressure of ≤0.3 psia to insure that the rupture disc will rupture at approximately 35 psig. The relief control valve is set to open or close at setpoint values to prevent material in the relief drum from being released into the Cold Recovery area should a leak develop in a cold trap after the rupture disc has ruptured. The small relief drum would be above atmospheric pressure should this ever occur and the relief valve would provide containment of the material within the relief drum.

Plant air is required to operate the pressure blind multipliers (PBMs), which activate the pressure blind switches (PBSs). The PBSs provide a signal to the solenoid on the control valve, which opens or closes the control valve. Loss of air to the PBMs will result in control valve failure (fail in the open position) and the PBMs will read zero pressure. Plant air is required for the control valves to operate so that the Cold Trap Pressure Relief System meets its safety function. The air supply is a support system, which is important to safety as described in Section 3.8.

The PBSs and the solenoid valves associated with the control valves require 120 VAC power to operate. Loss of 120 VAC power will result in control valve failure (fail in the open position); the PBSs will not operate the solenoid valves. Therefore, electrical power is necessary to operate the control valve solenoids so that the Cold Trap Pressure Relief System meets its safety function. The 120 VAC power is a support system, which is important to safety as described in Section 3.8.

3.1.4.3.2 Cold Recovery Surge Drums

Each cold recovery system has seven banks of surge drums (A through G) connected by nickel-lined steel pipe with single-wall monel expansion joints. Each bank of drums has inlet and outlet G-17 MOVs that enable the EBS to either evacuate from or discharge into the drums. Code Inspection performs an external inspection annually and ultrasonic thickness gauge inspections when requested.

These surge drums perform three different functions:

1. Storage of "lights" (N_2, O_2, and coolant mixtures) or UF_6 removed from the cascade, to stabilize upset situations until the material can be processed for disposal.
2. Storage of material generated when equipment UF_6 negatives are required. UF_6 and purge gas from these activities are stored until they can be processed for disposal.

3. Storage of cell treatment gases or mixtures containing ClF_3 and/or F_2 until the material can be processed for disposal.

The cold recovery surge drums when used for cell service activities are described in Section 3.1.1.5.2.

Surge Drum Pressure/Room Temperature Instrumentation

The Surge Drum Pressure/Room Temperature Instrumentation provides pressure and temperature readings used in Nuclear Material Control and Accountability inventory calculations. The Surge Drum Pressure/Room Temperature Instrumentation is important to safety as described in Section 3.8.

Each cold recovery surge drum bank has similar pressure instrumentation. Pressure instrumentation is locally mounted and the readout devices are slaved to the ACR's purge and evacuation booster panel. The pressure monitoring instrumentation consists of PBMs located on each surge drum bank, local PIs, pressure converters, PRs, alarm indicators, and remote PIs. The PBMs in conjunction with the local PIs allow operators to verify that surge drum pressures do not exceed setpoint values. Transducers transmit surge drum pressure readings to an indicator in X-300.

Temperature systems for the surge drum room are discussed in Section 3.1.4.5. These systems maintain room temperatures above the UF_6 condensation point at atmospheric pressure.

There are no pressure and temperature alarms associated with the Cold Recovery surge drums that are important to safety. However, a low surge drum room temperature alarm for X-333 A through D surge drums and E through G surge drums is provided.

Operator oversight ensures that setpoint limits are not exceeded. Operator actions are taken on loss of power.

3.1.4.3.3 Holding Drums

Holding drums are provided to store, the UF_6 that has been separated from the "light" contaminants until it can be returned to the cascade through the building service headers. The holding drums are piped into a manifold that will allow them to be valved into the cold traps, the building evacuation header, or the PG return header. Each holding drum has a pressure instrument with sufficient pressure range for the process conditions encountered. A pressure switch device is connected with this instrument to activate both audible and visual alarms, locally and in the ACR.

Low temperature alarms for the holding drum rooms are set to actuate at a minimum temperature sufficient to keep UF_6 in a vapor state for the pressures and UF_6 concentration encountered, and sound both audible and visual alarms locally and in the respective ACRs.

3.1.4.3.4 Chemical Traps

3.1.4.3.4.1 Alumina Traps

Alumina trap(s), which will absorb UF_6, are used for wet-air evacuations, or disposal of other gases that do not contain ClF_3 or F_2 in concentrations greater than 1 mole percent or have a UF_6 concentration greater than 250 ppm uranium.

The alumina traps in the X-330 Cold Recovery area consist of two banks of traps. These traps are of a geometrically safe design. The X-333 Cold Recovery utilizes five alumina traps; the amount of alumina in each of these traps is limited by the Nuclear Criticality Safety Approval to permit safe trapping of material containing UF_6 with assays up to the limit prescribed by Nuclear Criticality Safety (NCS).

3.1.4.3.4.2 Sodium Fluoride Traps

Two banks of NaF traps are located in each of the X-330 and X-333 Cold Recovery areas. The traps are used primarily for cold-trapping operations involving gases containing ClF_3 or F_2, which are inert to NaF. From the NaF traps, the light contaminants are vented to atmosphere.

Each bank of NaF traps is changed when trap efficiency drops to unacceptable levels due to deterioration of the NaF pellets. NaF traps are operated at ambient temperatures to improve UF_6 trapping capability.

NaF traps are regenerated when the vent stream concentrations of uranium begin to increase and can no longer be controlled or a differential pressure is indicated across the traps. Regeneration means that the uranium is removed from the NaF by introducing a mixture of N_2 and F_2 into the traps at a controlled rate, at elevated temperatures, driving off the uranium and permitting the NaF to be reused.

3.1.4.3.5 Piping and Valves

All the piping associated with the surge drum manifold is nickel-lined, heavy gauge steel pipe with welded joints. The valves associated with the surge drum manifold are typically G-17 valves. The maximum surge drum pressure is operationally limited to below atmospheric pressure when reaction products and/or UF_6 are present.

Piping associated with the cold traps is monel pipe with welded joints.

3.1.4.3.6 Chlorine Trifluoride Storage Pig

ClF_3 is administered from a storage pig in the X-330, located outside the south wall of Cold Recovery. The storage pig is connected to the ClF_3 storage drum, which is connected to the control panel near the space recorder cabinet in X-330. ClF_3 is provided to the space recorders to prevent the formation of uranium deposits.

3.1.4.3.7 Air Ejectors and Vent Stacks

In the X-330 Cold Recovery, air ejectors are used to eject vent gases above the process building roof. Two venting operations can take place simultaneously, provided one is a wet-air evacuation and one is from a cold trapping operation.

The X-333 is supplied with air ejectors for venting reaction products and for wet-air evacuations.

3.1.4.4 Building Confinement Systems

Toxic materials are confined within the surge drums, holding drums and associated piping of the X-330 and X-333 Cold Recovery areas. The weakest points in the system are the monel expansion joints installed in the piping connecting the surge drums. The piping associated with the cold traps has no expansion joints and the entire system is constructed to withstand much higher pressures than the maximum operational pressure. The entire process takes place at subatmospheric pressure so that any leak would result in ambient air leaking into the system.

Secondary confinement is provided by the building and pipe housings. The surge drum room and holding drum rooms are normally closed off and provide good secondary confinement. The trap room area can be closed off and the ventilation system shut down from outside the area. Only the E and F cold traps, in X-330 Cold Recovery, are open so that no secondary confinement is afforded.

3.1.4.5 Heating and Ventilation Systems

All external piping associated with the cold traps is insulated and trace heated. The X-330 Cold Recovery surge drum room, holding drum room, and pipe housings are electrically heated and controlled at approximately 150°F. Heating for the X-333 Cold Recovery surge drum room, holding room, and pipe housings is provided by the plant steam system. The surge drum rooms are provided with temperature elements and TIs. There are no alarms associated with the Surge Drum Room Temperature Instrumentation that are important to safety. Temperature readings are necessary to ensure UF_6 in surge drums is maintained in a gaseous state. The Surge Drum Room Temperature Instrumentation is important to safety and is discussed in Section 3.1.4.3.2.

The primary sources of ventilation for the X-330 and X-333 Cold Recovery areas are supplied by the process buildings ventilation system. (Described in detail in Section 3.1.1.)

3.1.4.6 Monitoring and Protection Systems

3.1.4.6.1 Cold Trap Pressure and Flow Rate Control Instrumentation

Pressure and temperature control is essential to successfully remove UF_6 from gas mixtures to prevent liquefaction of the ClF_3 and coolant in the cold trap. The flow of material through the cold trap is maintained with control valves and attendant instrumentation.

Air failure to these instruments, control valves or air ejector would result in the control valves closing and isolating the system.

Should the system control valves fail open, increasing the flow to the jet, there would be no adverse effects because the space recorder would immediately show an increase in parts per million UF_6 requiring the operator to take immediate action.

3.1.4.6.2 Space Recorders

Space recorders are ionization chamber type process analyzer instruments, which detect, measure, and record very small amounts of uranium in the vent stream. If the vent gas contains uranium, alpha particles that are emitted ionize the gas in the chamber. The ionization level depends upon the assay of the various uranium isotopes and the uranium concentration. The space recorder will provide an alarm both locally and in the ACR, when the reading exceeds the alarm setpoint. The ionization chamber and piping (where pressures are elevated) are inside heated cabinets.

The X-330 Cold Recovery has space recorders to permit two venting operations simultaneously. The X-333 Cold Recovery has space recorders with sample lines connected to both vent stacks and the seal exhaust header. A verification sample is pulled every four hours during cold trapping, and on request, to verify accuracy of the space recorder.

One Trace Uranium Analyzer (TRUAN) is installed in parallel with the space recorders at Cold Recovery in both the X-330 and X-333. The TRUANs are being evaluated as possible replacements for the aging space recorders. TRUAN sample flow is acquired from the existing space recorder sample lines. The maximum sample flow utilized by the TRUANs is 100 milliliters (ml) per minute. This sample flow is relatively small compared to the normal sample flow of the space recorders, and therefore will have no adverse effect on the operation of the space recorders. At no time shall the TRUAN be utilized as a replacement for the space recorders or the continuous monitors.

3.1.4.6.3 Sodium Fluoride Trap Monitoring and Control

The NaF traps have their own resistance type heating and associated heat controller. The heat controller will provide a continuous control signal to maintain the NaF trap temperature at the desired setpoint. There is a high temperature alarm associated with each NaF trap that will alarm locally and in the ACR to prompt operator response. A digital recorder will provide temperature trending for all NaF traps. The temperature recorder has a high temperature alarm that actuates both audible and visual alarms locally and in the ACR.

3.1.4.7 Radiation Monitoring

Personnel perform radiation surveys, as needed, using a survey meter to locate deposits in surge drum and holding drum vent lines, or to estimate the amount of uranium contained in alumina traps.

3.1.4.8 Hazardous Materials

Reaction products resulting from cell conditioning treatments typically contain N_2, UF_6, ClF_3, and F_2. The remainder of this gas could contain traces of ClF, ClO_2F, HF, Cl_2, ClO_2, and Cl_2O. At times there could be as much as 50,000 scf of this type of material stored in different surge drums in each Cold Recovery System.

3.1.4.9 Fire Protection Systems

The only combustible contained in the cold recovery systems is the lubricating oil used in the refrigeration units. There are no combustible materials used in the construction of these facilities.

The greatest fire hazard to these facilities is the large quantity of process lubricating oil used to lubricate the process motor and compressor bearings, which may leak into these facilities. In such events, the oil is caught and/or cleaned up using procedural controls.

Portable fire extinguishers are located inside the buildings. Both of the cold recovery areas are provided with wet-pipe automatic sprinkler systems. No sprinkler heads are located inside the surge drum and holding drum rooms.

3.1.4.10 Communications

Both cold recovery areas have both, PAX telephone systems and an emergency phone connected directly to the X-300 Plant Control Facility. Paging horns and the evacuation horns are located throughout the process buildings.

Table 3.1-1. Physical Properties of UF_6

Sublimation point (14.7 psia) (76 cm Hg)	133.8°F (56.6°C)
Triple point	22 psia (114 cm Hg), 147.3°F (64.1°C)
Density, solid (68°F) (20°C)	317.8 lb/ft^3 (5.1 g/cc)
Liquid (147.3°F) (64.1°C)	227.7 lb/ft^3 (3.6 g/cc)
Liquid (200°F) (93°C)	215.6 lb/ft^3 (3.5 g/cc)
Liquid (235°F) (113°C)	207.1 lb/ft^3 (3.3 g/cc)
Liquid (250°F) (121°C)	203.3 lb/ft^3 (3.3 g/cc)
Heat of sublimation (147°F) (64°C)	58.2 Btu/lb
Heat of fusion (147°F) (64°C)	23.5 Btu/lb
Heat of vaporization (147°F) (64°C)	35.1 Btu/lb
Heat of solution in water (77°F) (25°C), heat evolves	258.2 Btu/lb
Critical pressure	668.8 psia (3,458 cm Hg)
Critical temperature	446.4°F (230.2°C)
Specific heat solid (81°F) (27°C)	0.114 Btu/lb
Specific heat liquid (162°F) (72°C)	0.130 Btu/lb

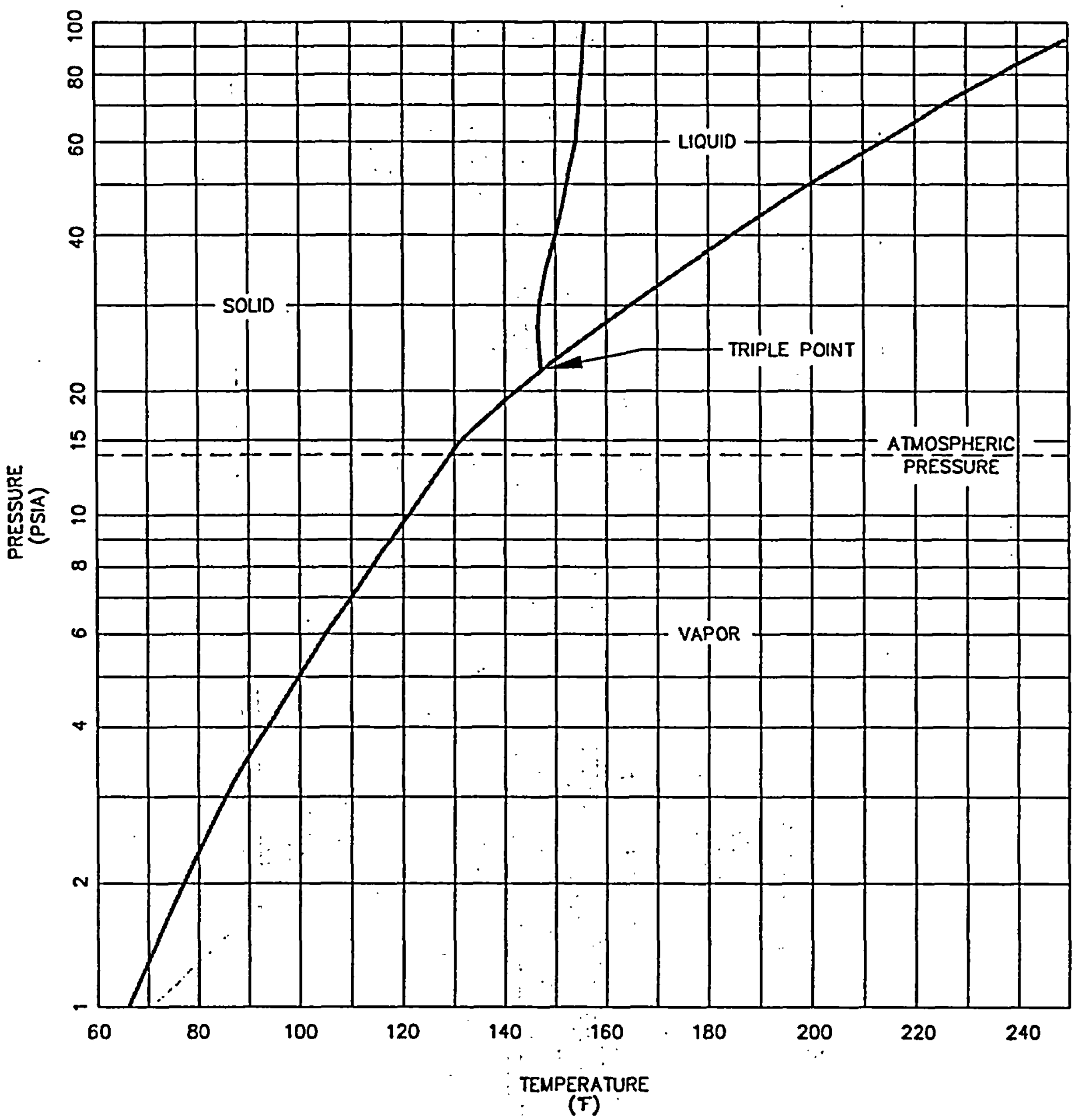

Figure 3.1-1 UF_6 Phase Diagram

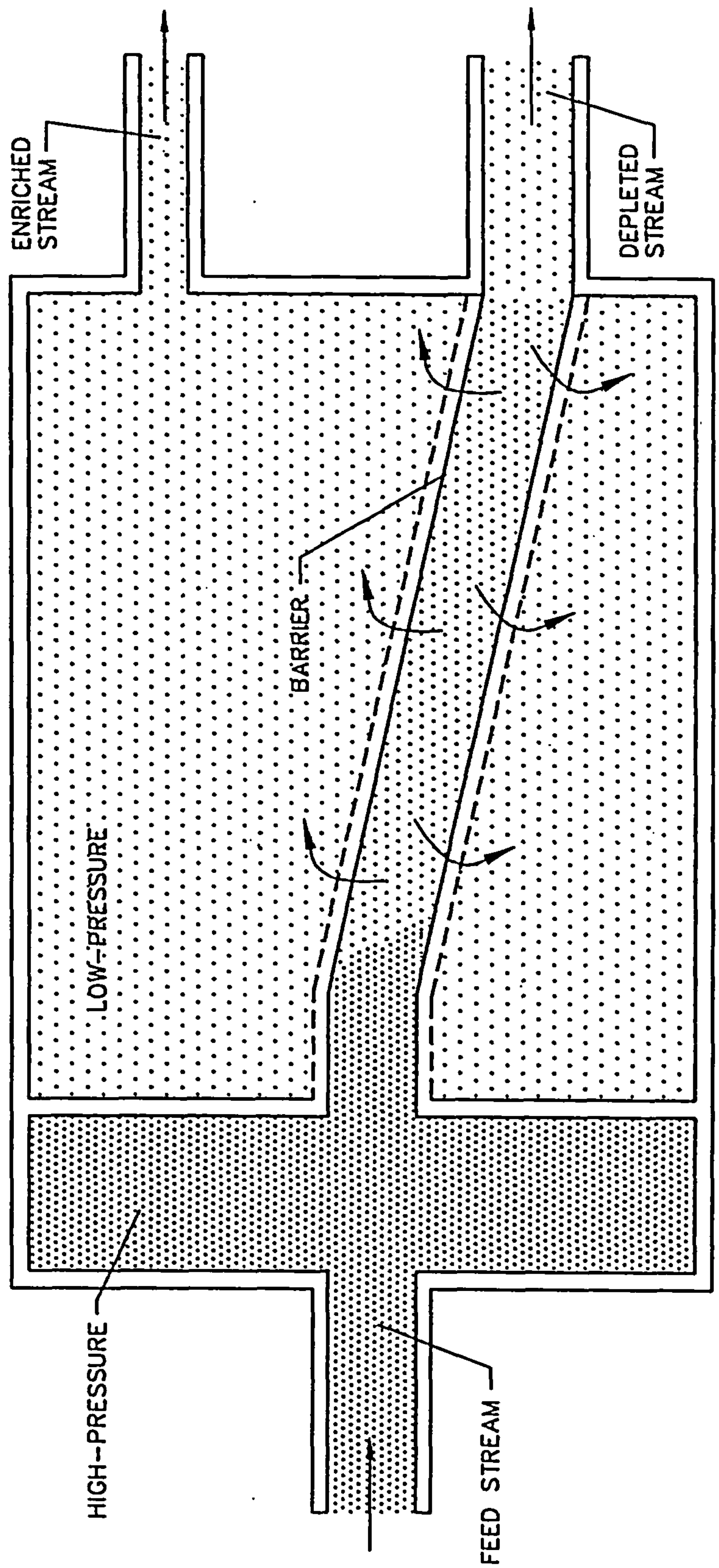

Figure 3.1-2 Gaseous Diffusion Through a Barrier Tube

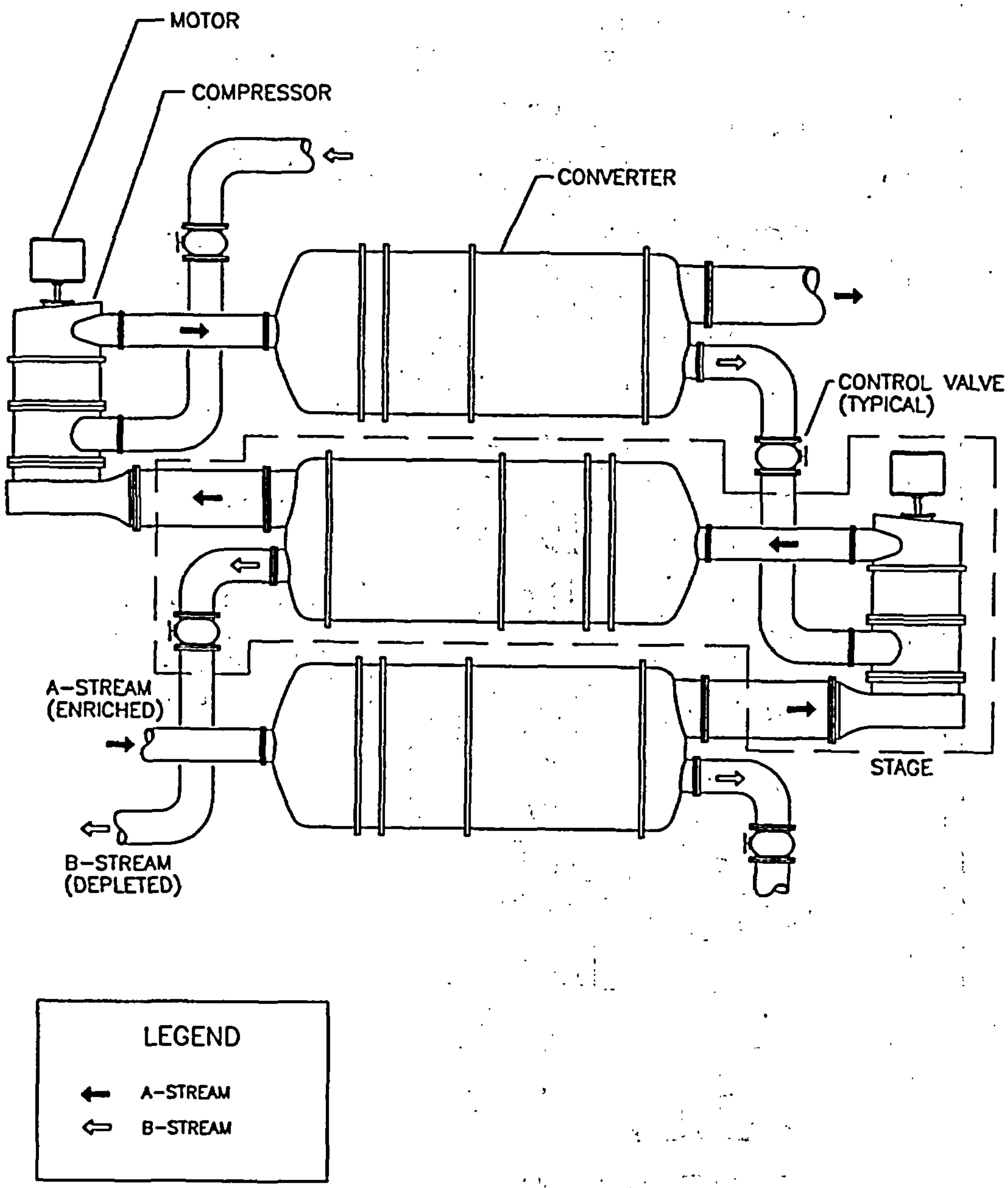

Figure 3.1-3 The Principle Components of a Stage

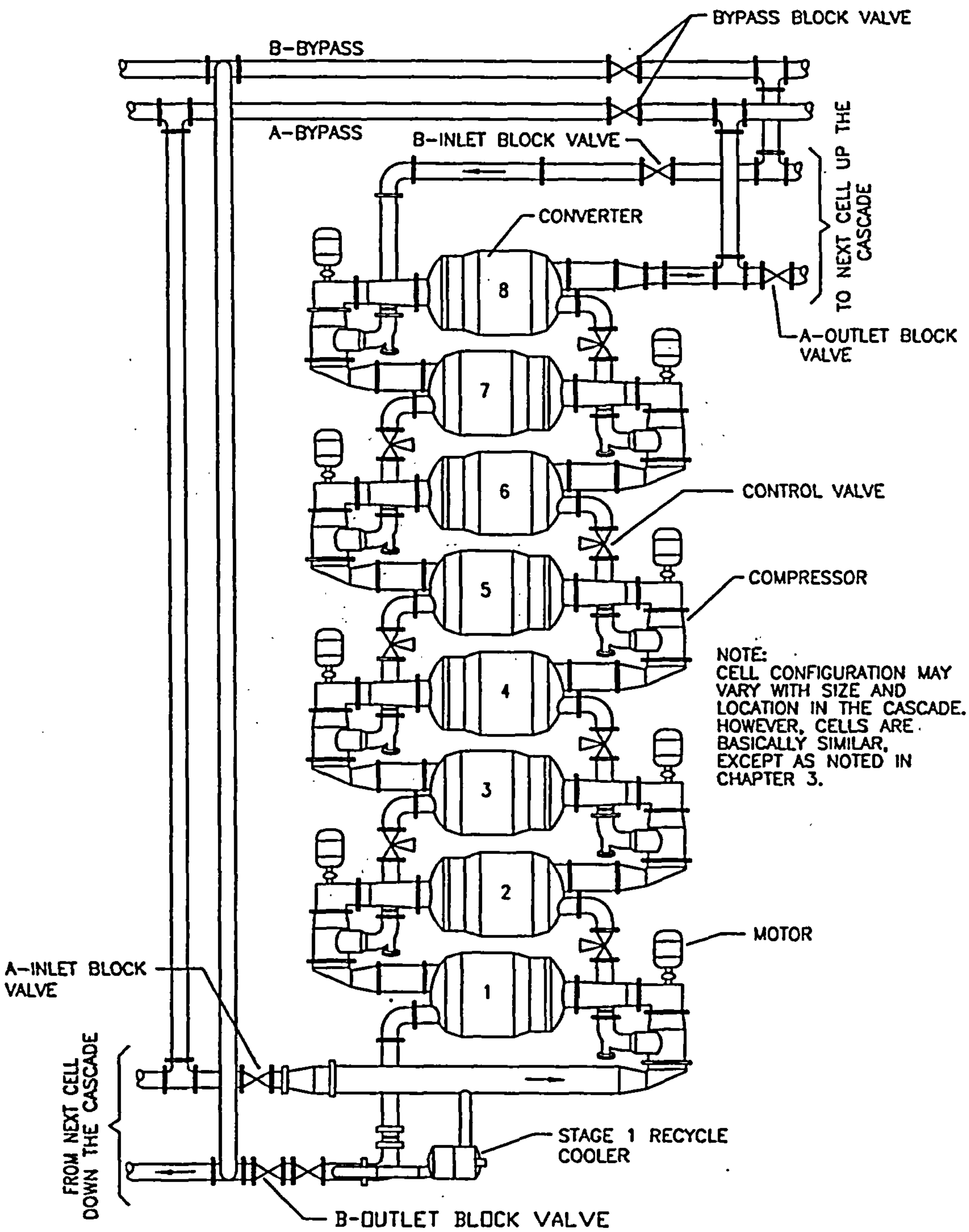

Figure 3.1-4 The Principal Components of a Cell

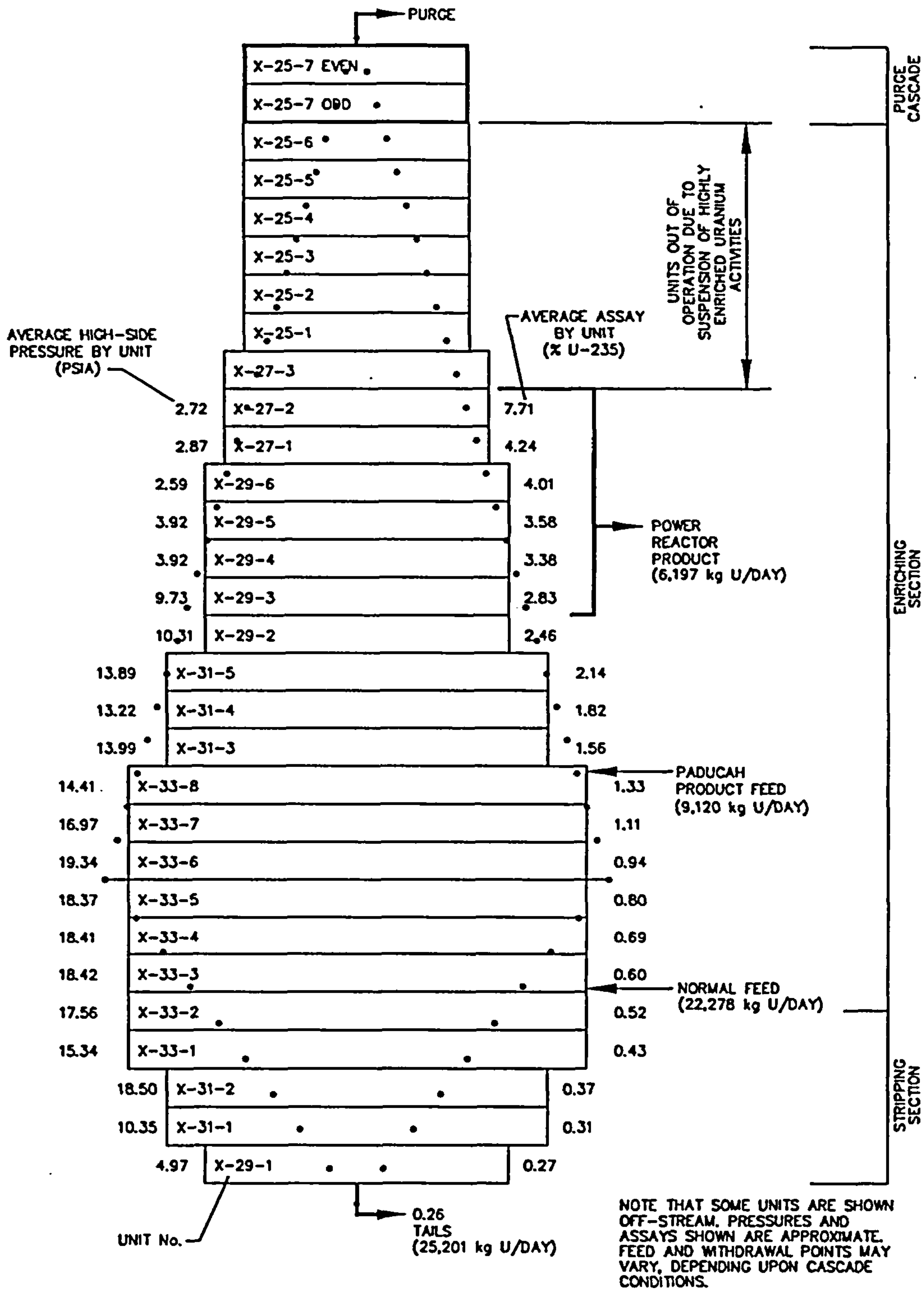

Figure 3.1-5 Representative PORTS Cascade Shape at 2260 MW

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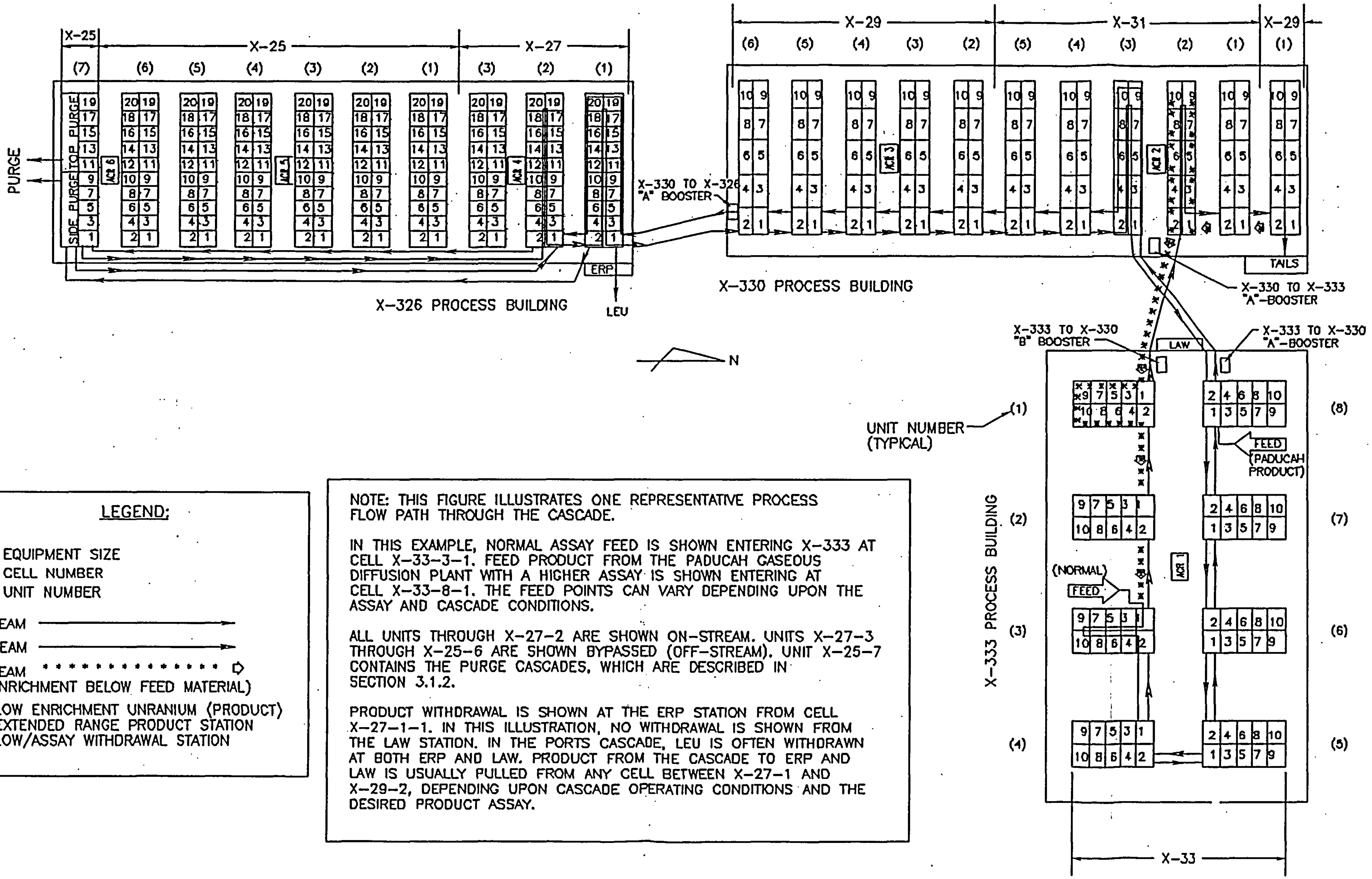

LEGEND:

X-nn EQUIPMENT SIZE
[n] CELL NUMBER
(n) UNIT NUMBER
"A" STREAM
"B" STREAM
"A" STREAM (WITH ENRICHMENT BELOW FEED MATERIAL)

LEU– LOW ENRICHMENT UNRANIUM (PRODUCT)
ERP– EXTENDED RANGE PRODUCT STATION
LAW– LOW/ASSAY WITHDRAWAL STATION

NOTE: THIS FIGURE ILLUSTRATES ONE REPRESENTATIVE PROCESS FLOW PATH THROUGH THE CASCADE.

IN THIS EXAMPLE, NORMAL ASSAY FEED IS SHOWN ENTERING X–333 AT CELL X–33–3–1. FEED PRODUCT FROM THE PADUCAH GASEOUS DIFFUSION PLANT WITH A HIGHER ASSAY IS SHOWN ENTERING AT CELL X–33–8–1. THE FEED POINTS CAN VARY DEPENDING UPON THE ASSAY AND CASCADE CONDITIONS.

ALL UNITS THROUGH X–27–2 ARE SHOWN ON-STREAM. UNITS X–27–3 THROUGH X–25–6 ARE SHOWN BYPASSED (OFF-STREAM). UNIT X–25–7 CONTAINS THE PURGE CASCADES, WHICH ARE DESCRIBED IN SECTION 3.1.2.

PRODUCT WITHDRAWAL IS SHOWN AT THE ERP STATION FROM CELL X–27–1–1. IN THIS ILLUSTRATION, NO WITHDRAWAL IS SHOWN FROM THE LAW STATION. IN THE PORTS CASCADE, LEU IS OFTEN WITHDRAWN AT BOTH ERP AND LAW. PRODUCT FROM THE CASCADE TO ERP AND LAW IS USUALLY PULLED FROM ANY CELL BETWEEN X–27–1 AND X–29–2, DEPENDING UPON CASCADE OPERATING CONDITIONS AND THE DESIRED PRODUCT ASSAY.

Figure 3.1-6 PORTS Cascade Layout and a Typical Process Flow Path

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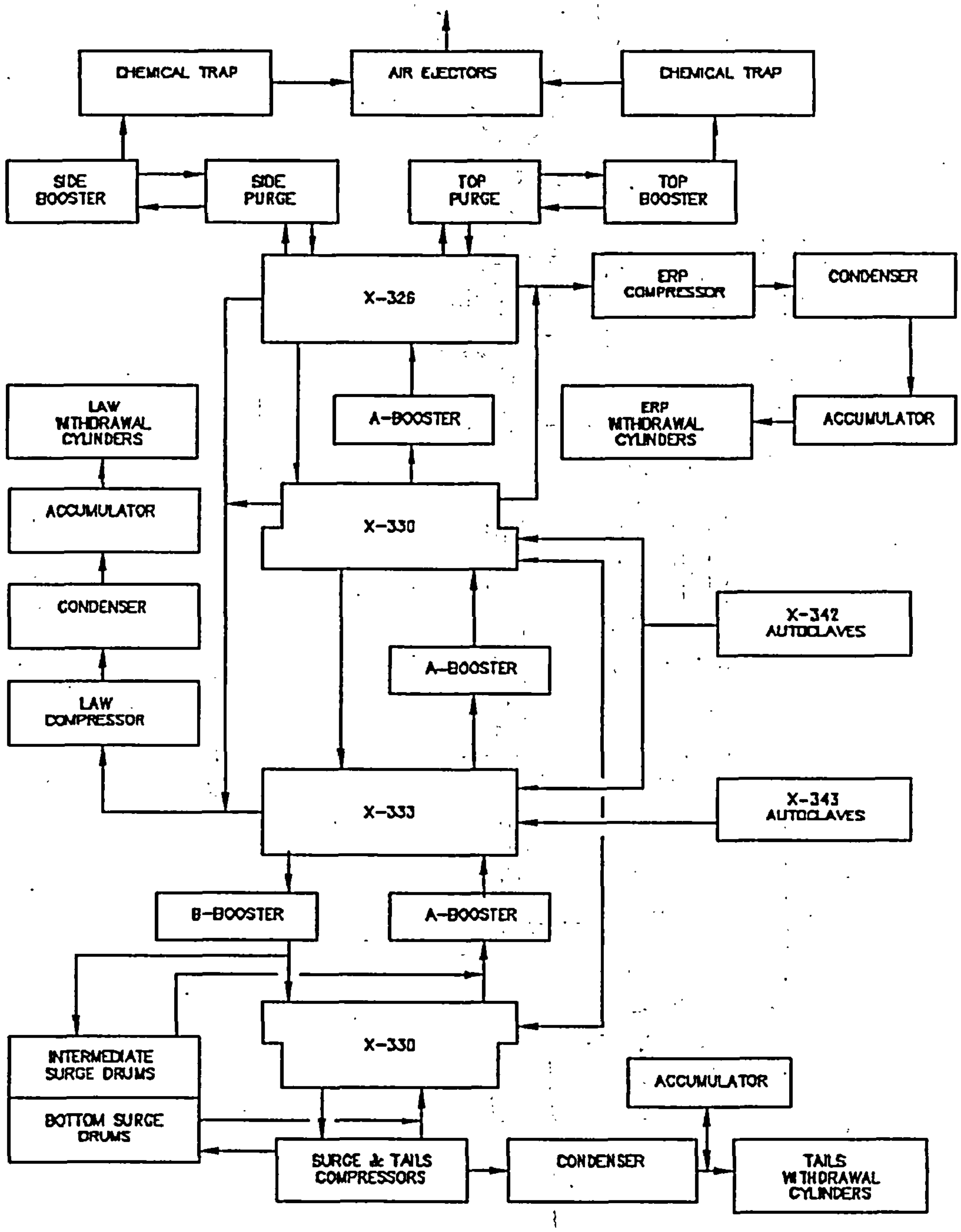


Figure 3.1-7 Cascade System Interplant Flows

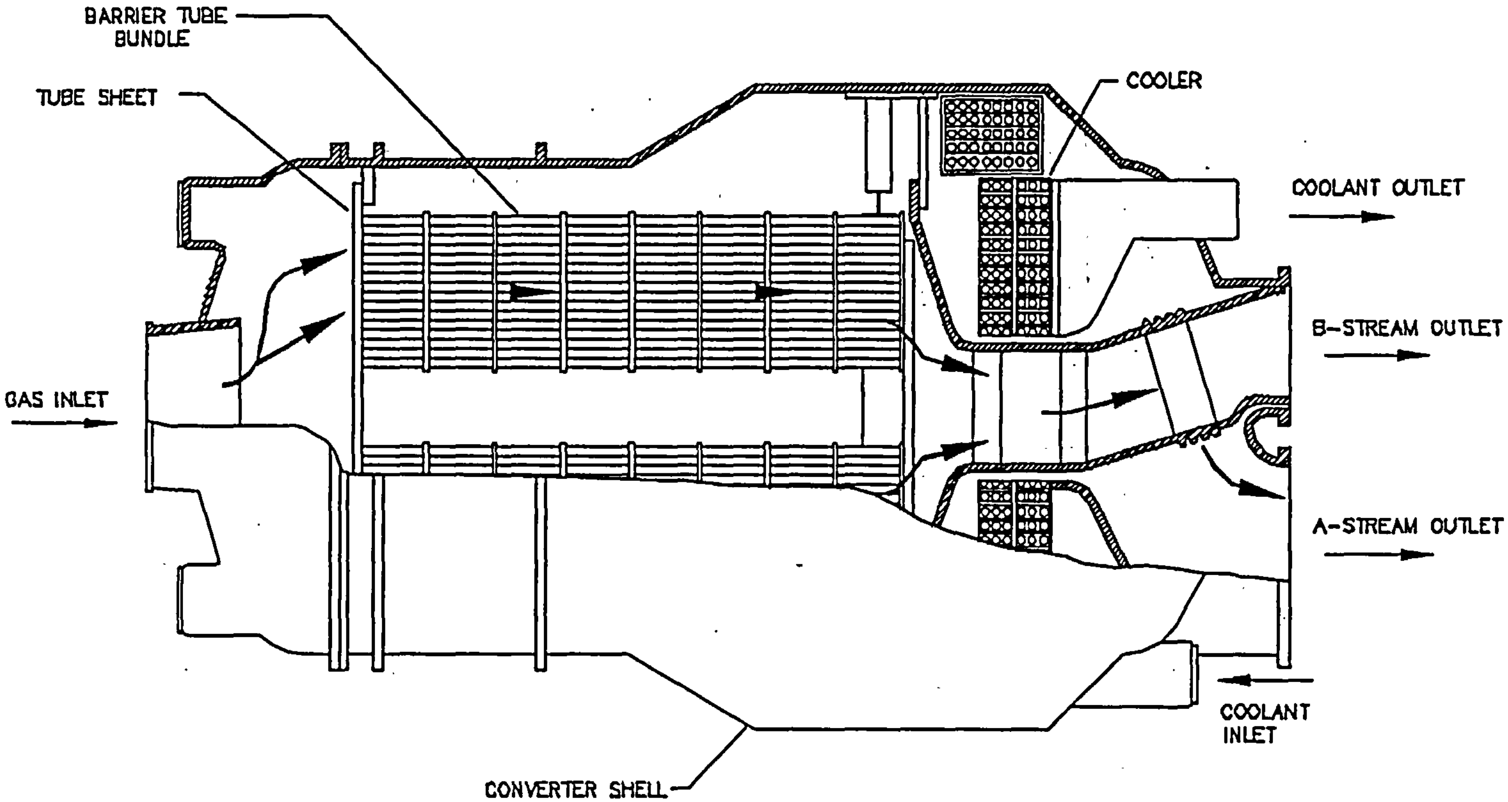


Figure 3.1-8 Typical Large-Size Converter

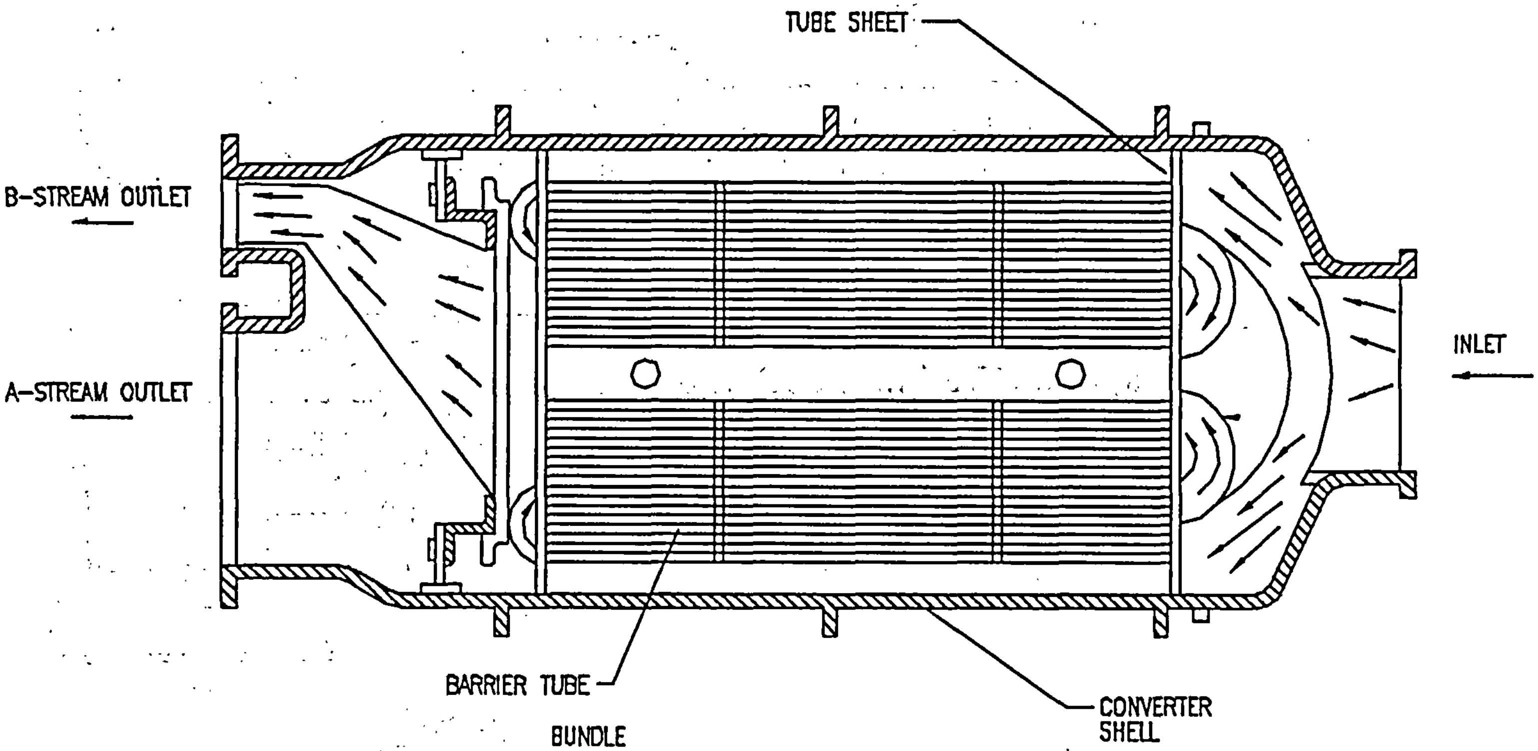


Figure 3.1-9 Typical Small-Size Converter

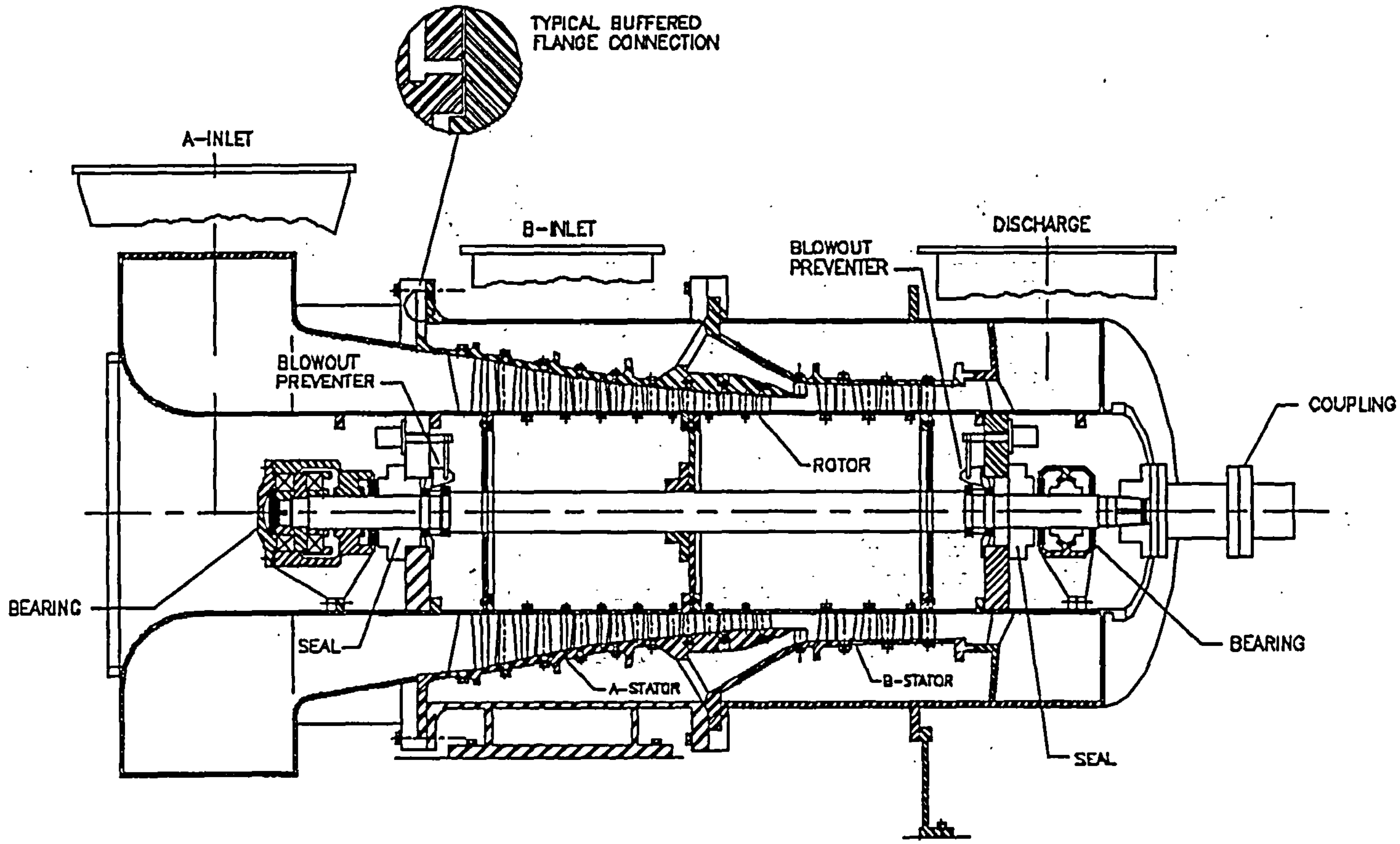


Figure 3.1-10 Principal Component of an Axial Compressor

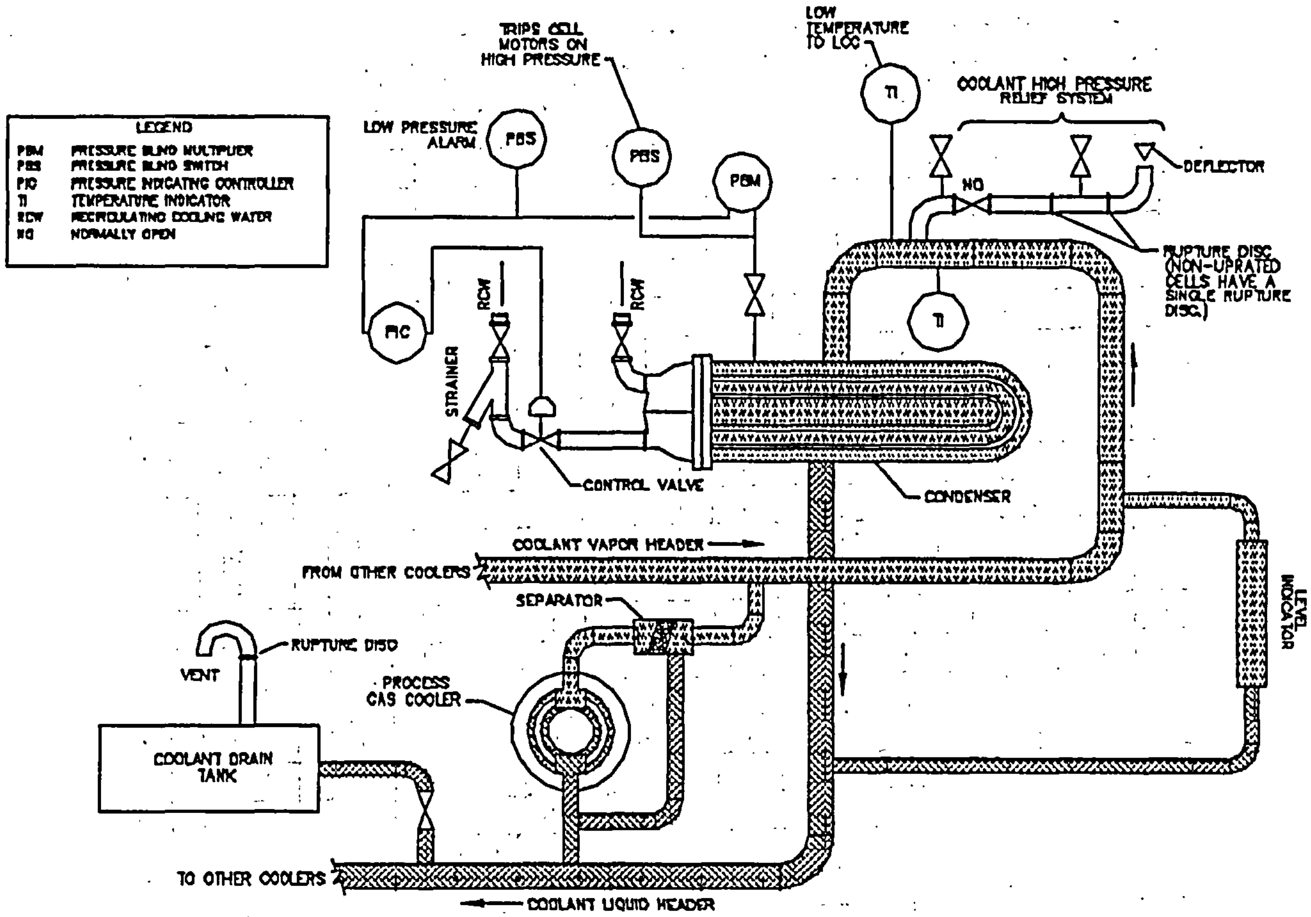


Figure 3.1-11 Cell Coolant System

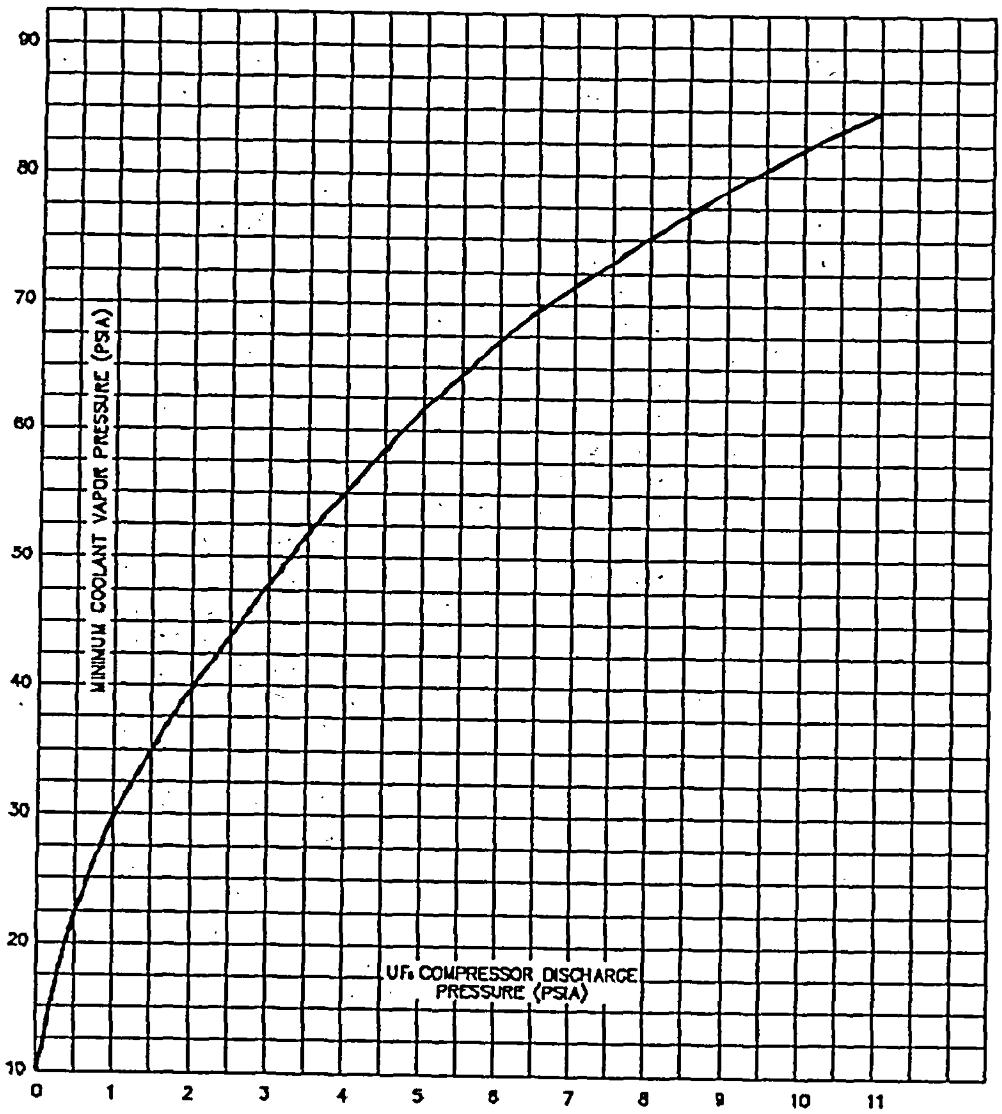


Figure 3.1-12 Always Safe Coolant Pressure at Low Speed Operation

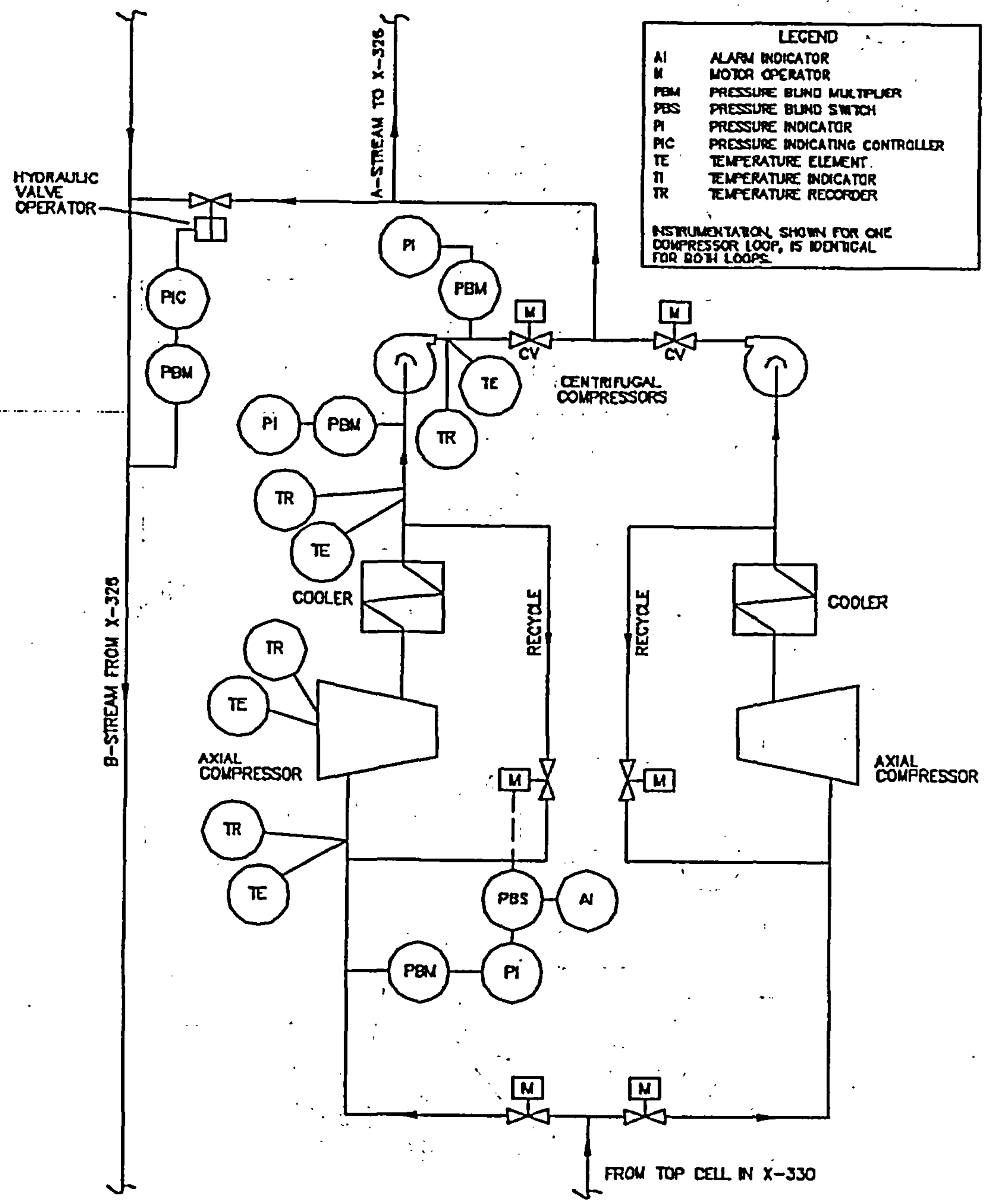


Figure 3.1-13 Two-Stage X-330 to X-326 A-Stream Booster Station

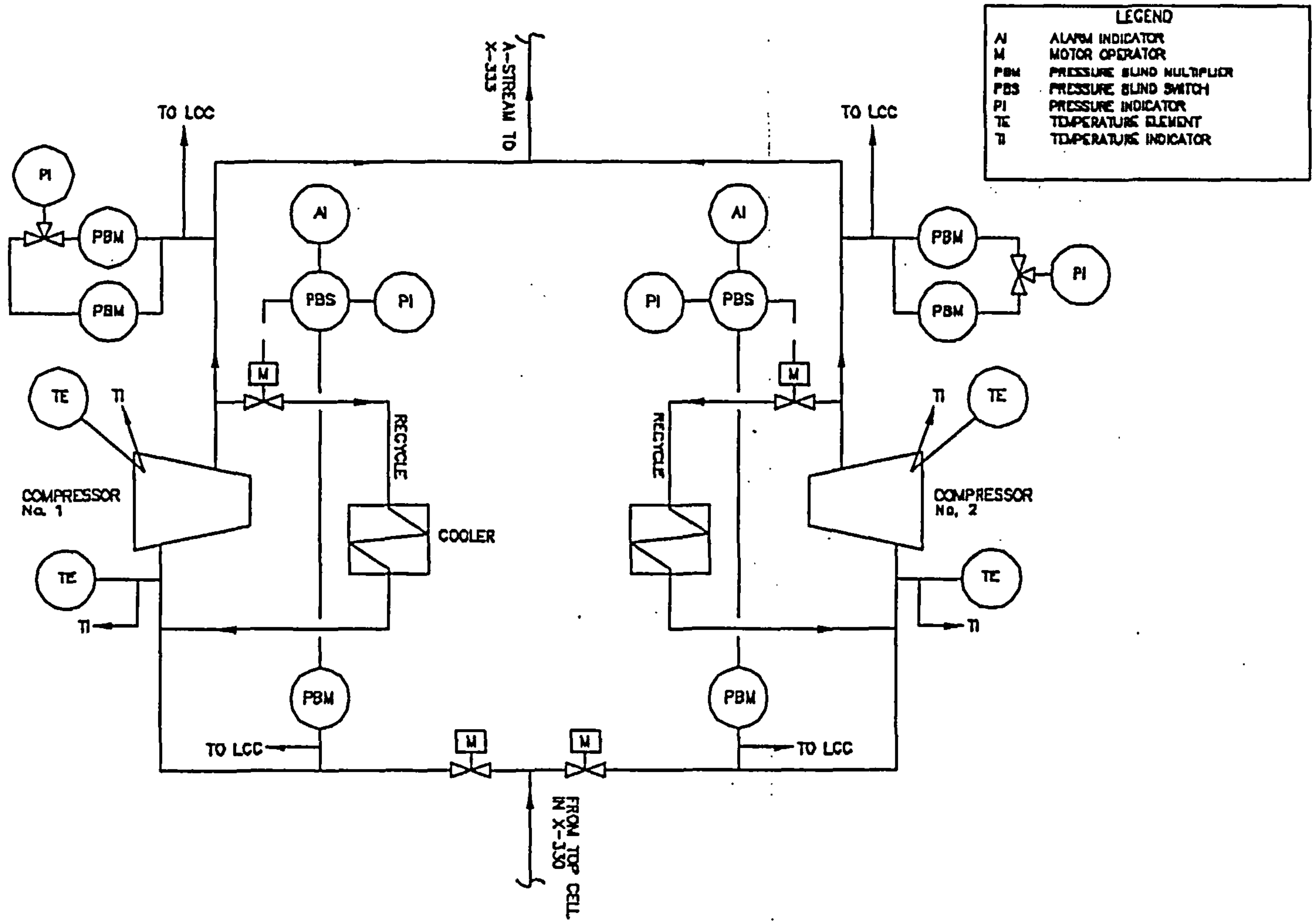


Figure 3.1-14 Typical Single Booster Station

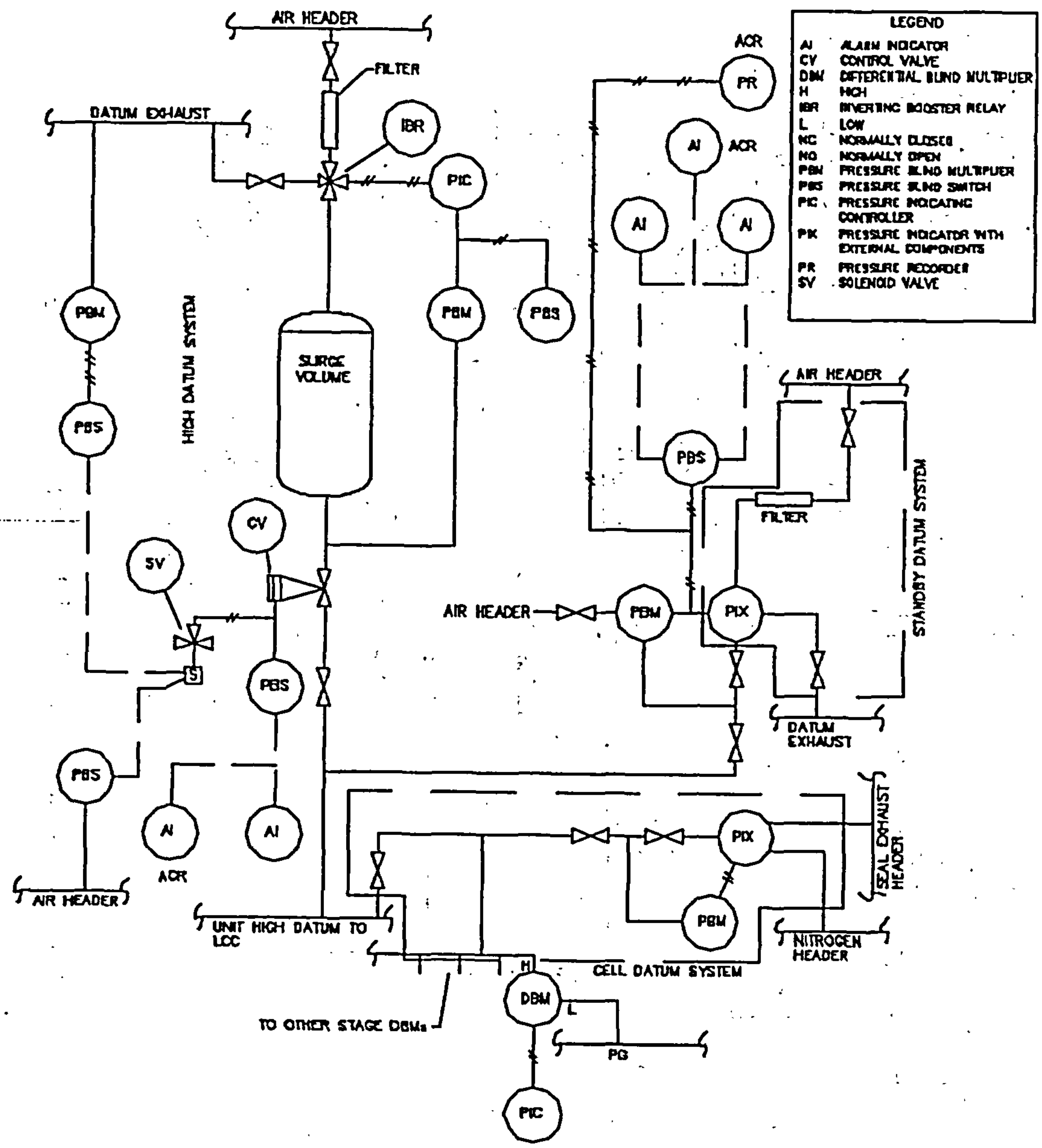


Figure 3.1-15 Typical High, Standby, and Cell Datum Systems in X-330 and X-326

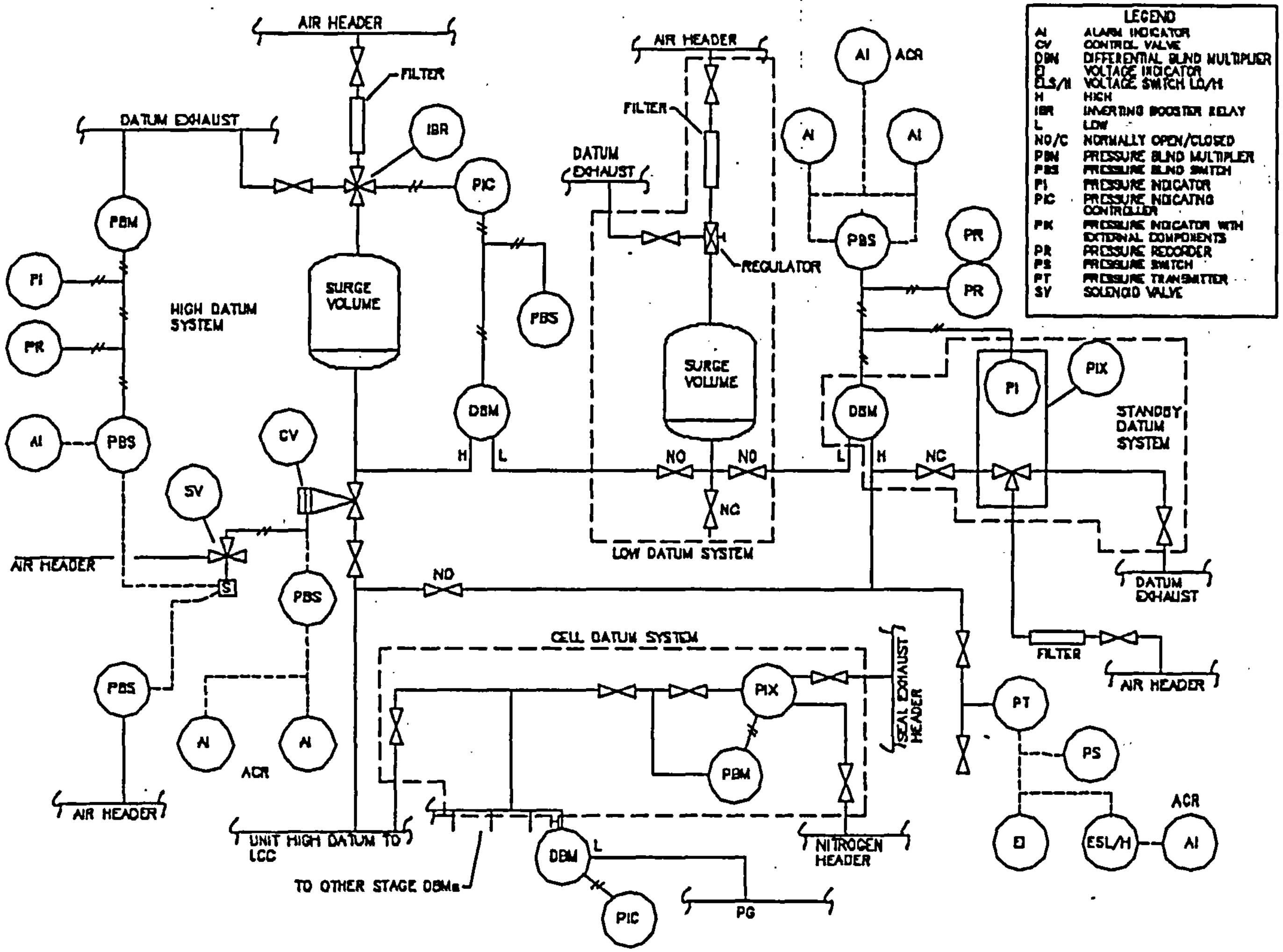


Figure 3.1-16 Typical High, Low, Standby, and Cell Datum Systems in X-333

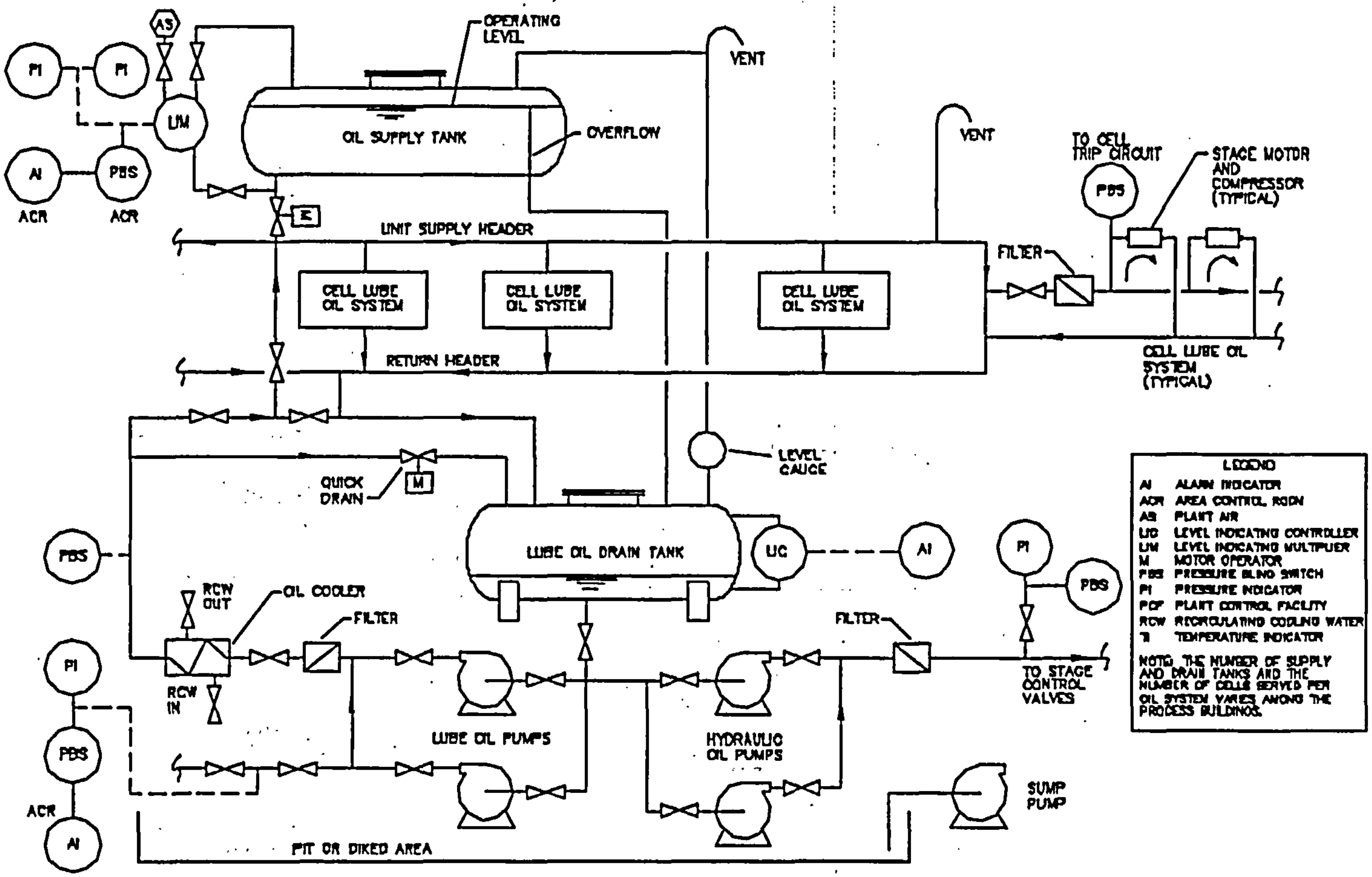


Figure 3.1-17 Principal Components of a Lube Oil and Hydraulic Oil System

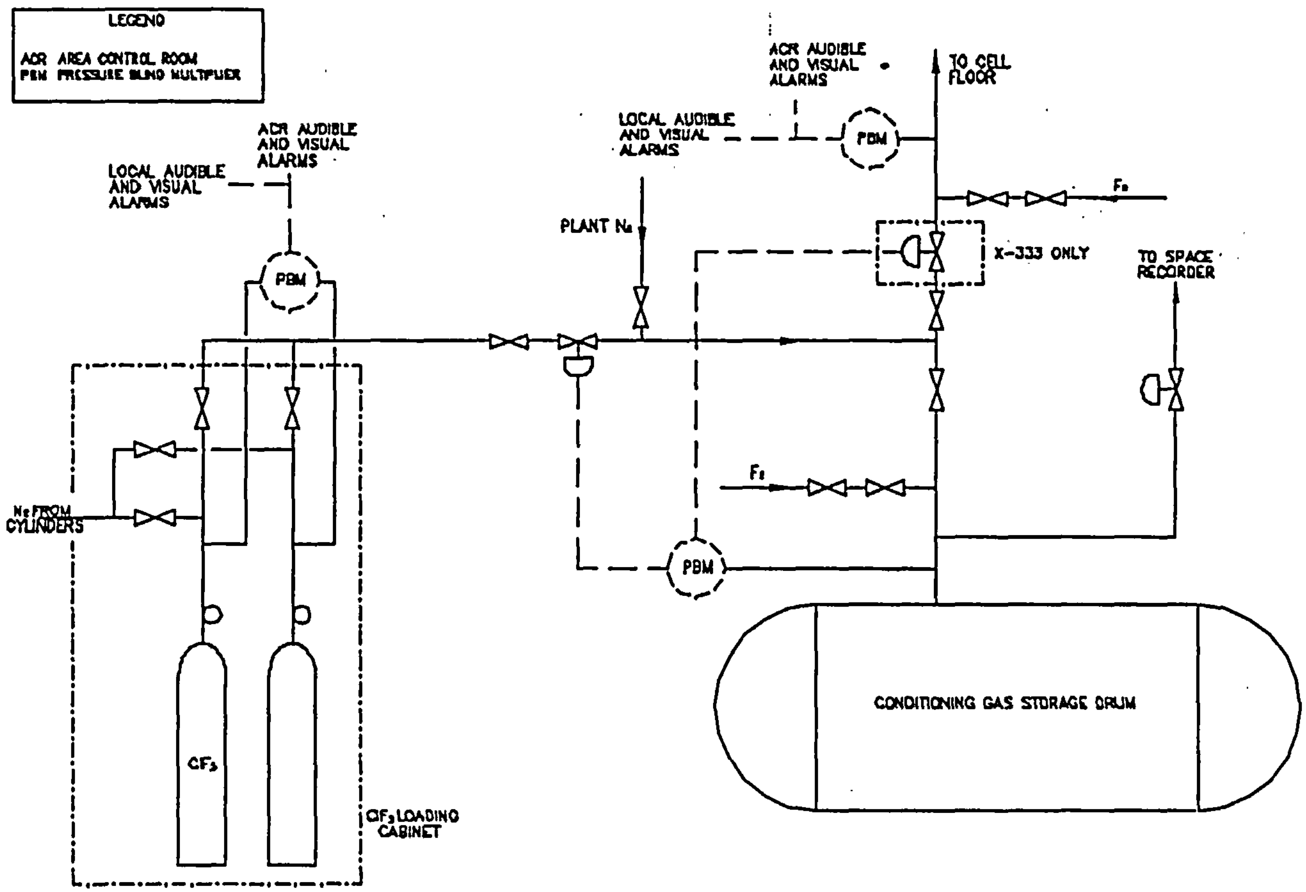


Figure 3.1-18 Principal Components of the Conditioning Gas Storage System

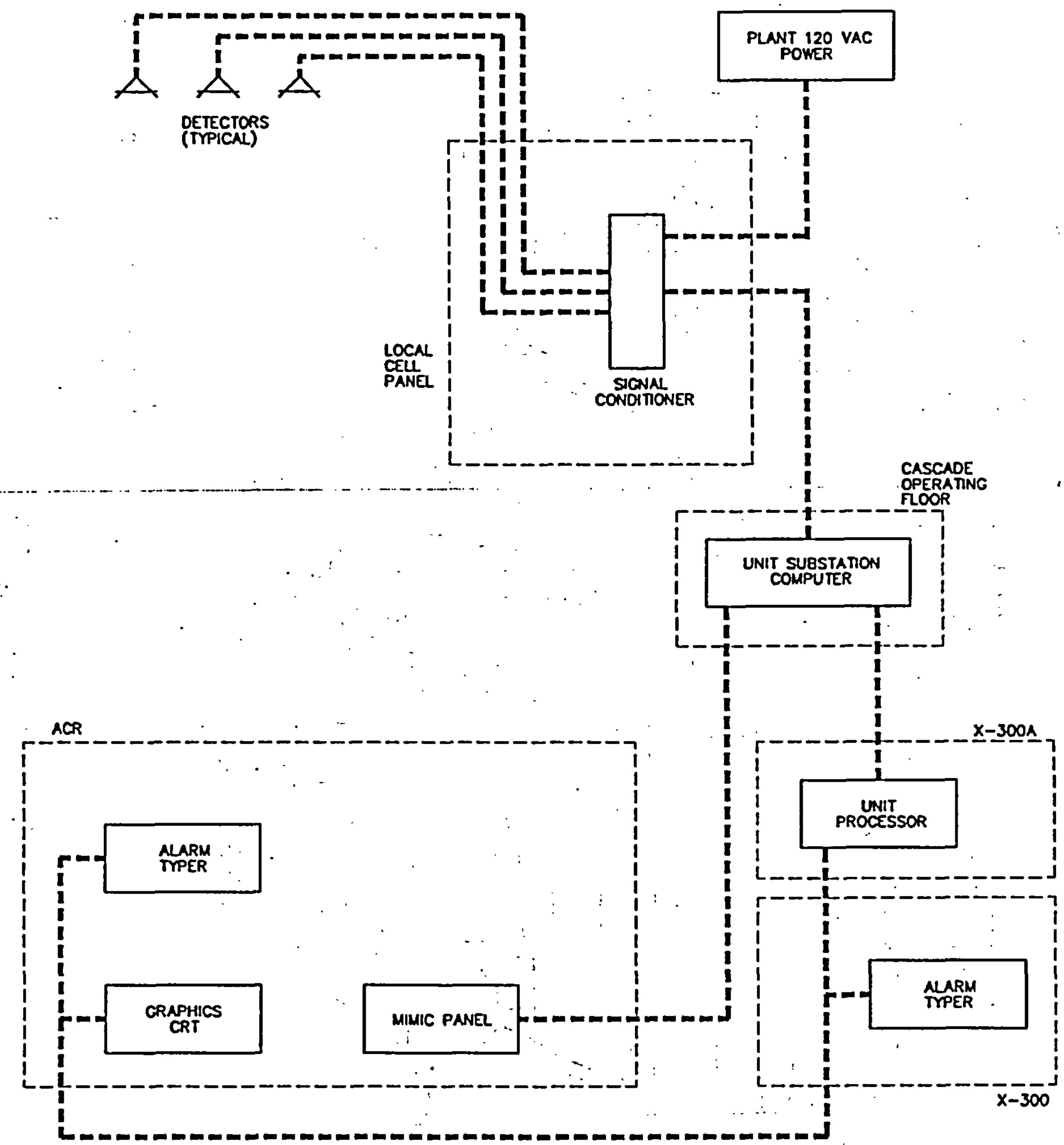
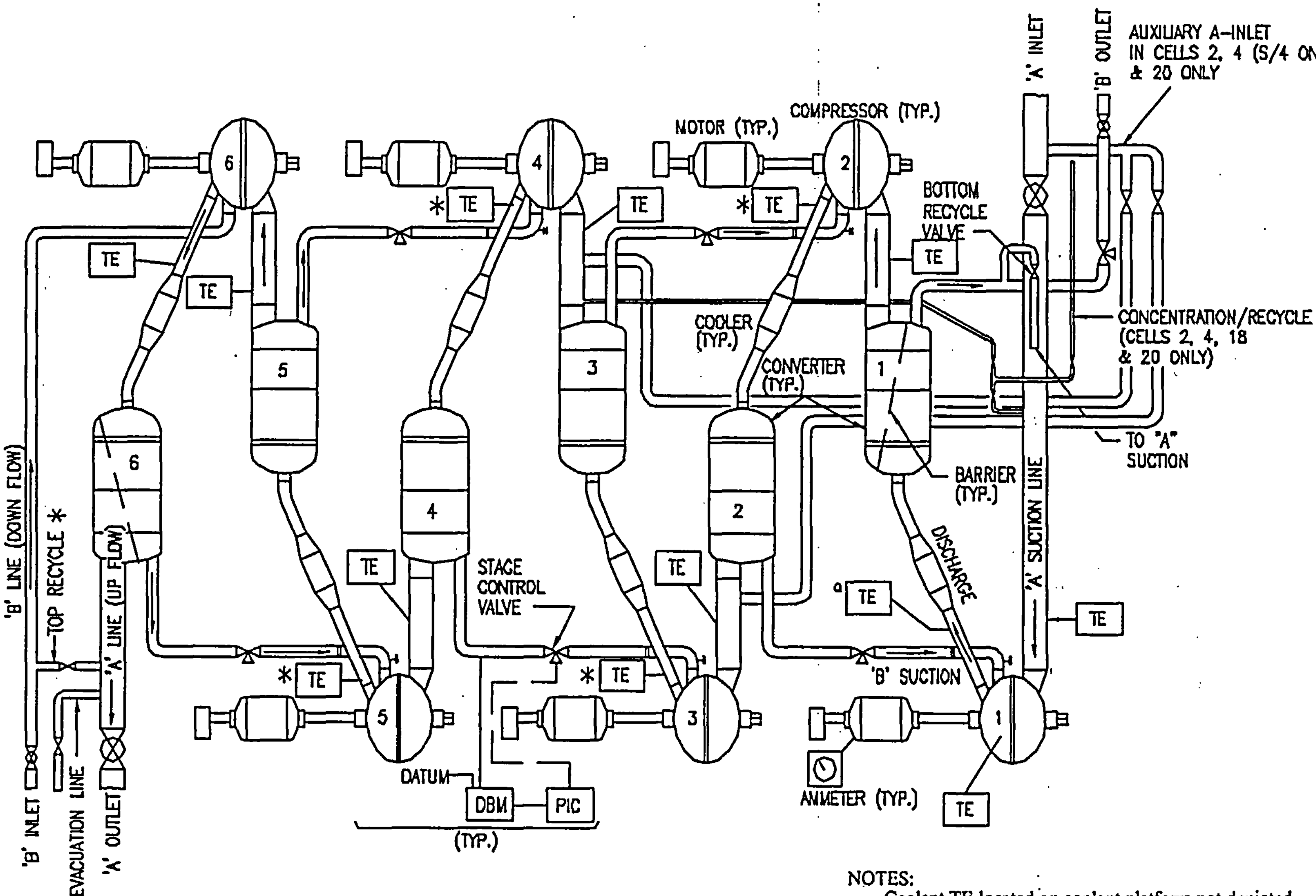


Figure 3.1-19 Typical CADP UF_6 Release Detection System



NOTES:
- Coolant TE located on coolant platform not depicted in Figure 3.1-20
-° TE on Stage 1 discharge for cells 6,8,10,12,14 &16
-*TE on Stage 2,3,4,5 discharge for cells 2,4 & 6

Figure 3.1-20 Typical Purge Cascade Cell

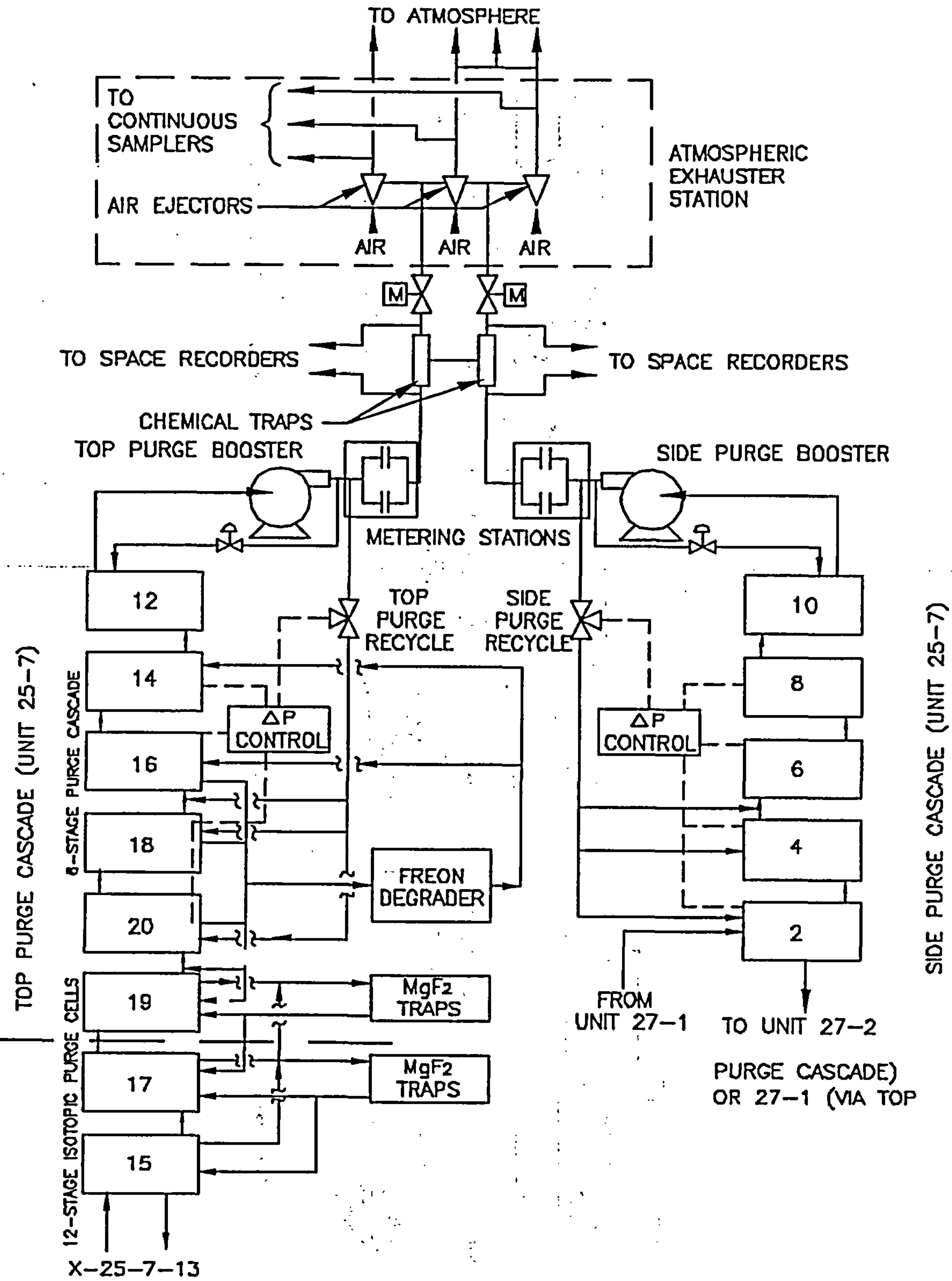


Figure 3.1-21 Top and Side Purge Cascades and Auxiliary Systems

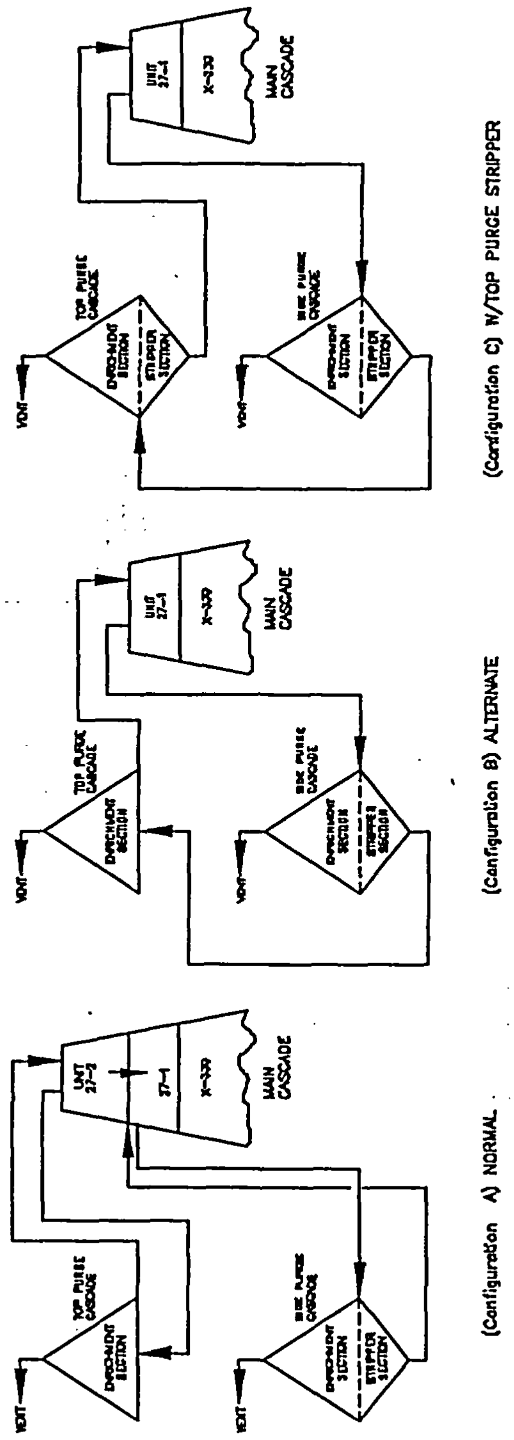


Figure 3.1-22 Normal and Alternative Purge Cascade Configuration

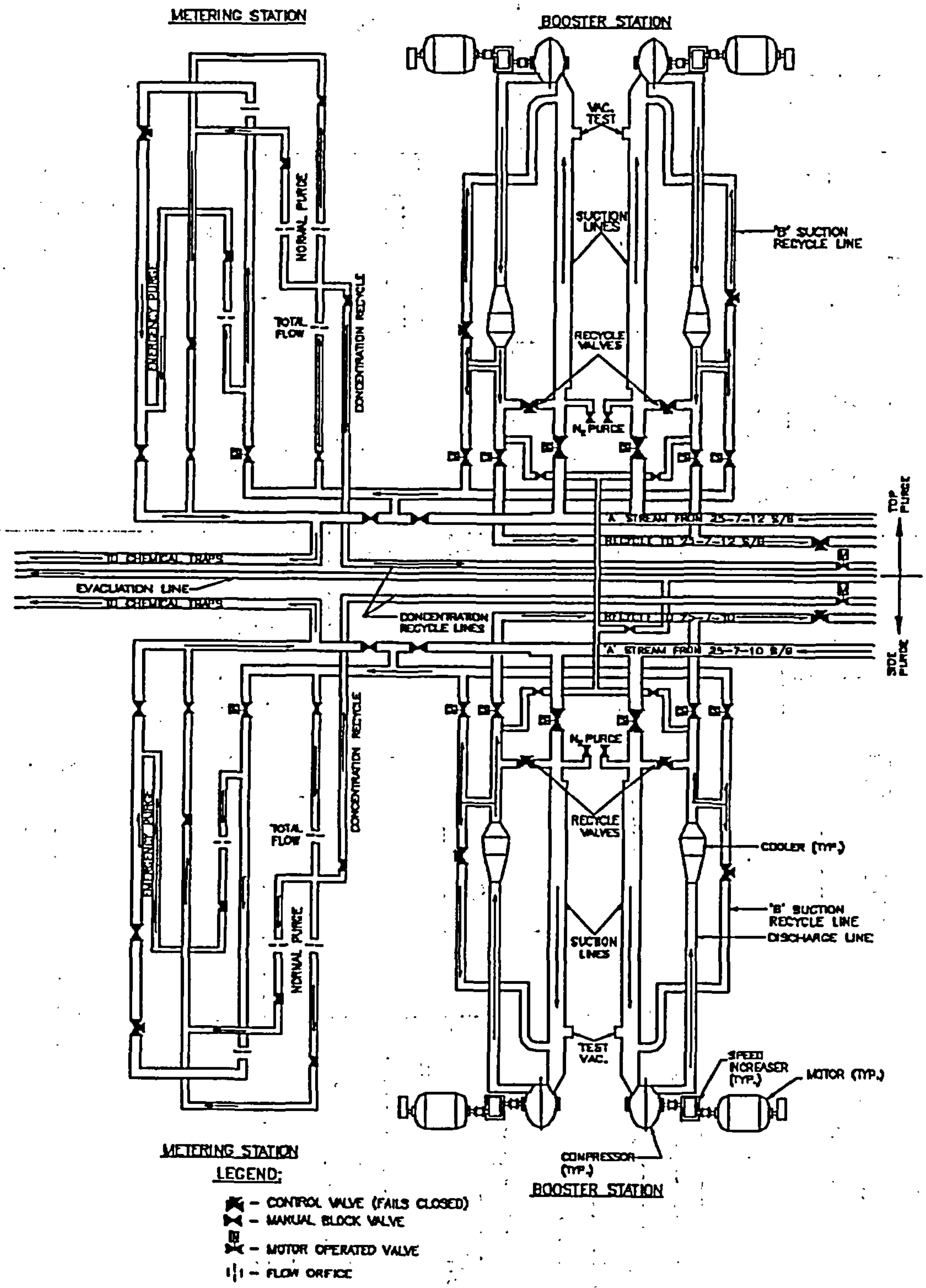


Figure 3.1-23 Purge Cascades Booster and Metering Stations

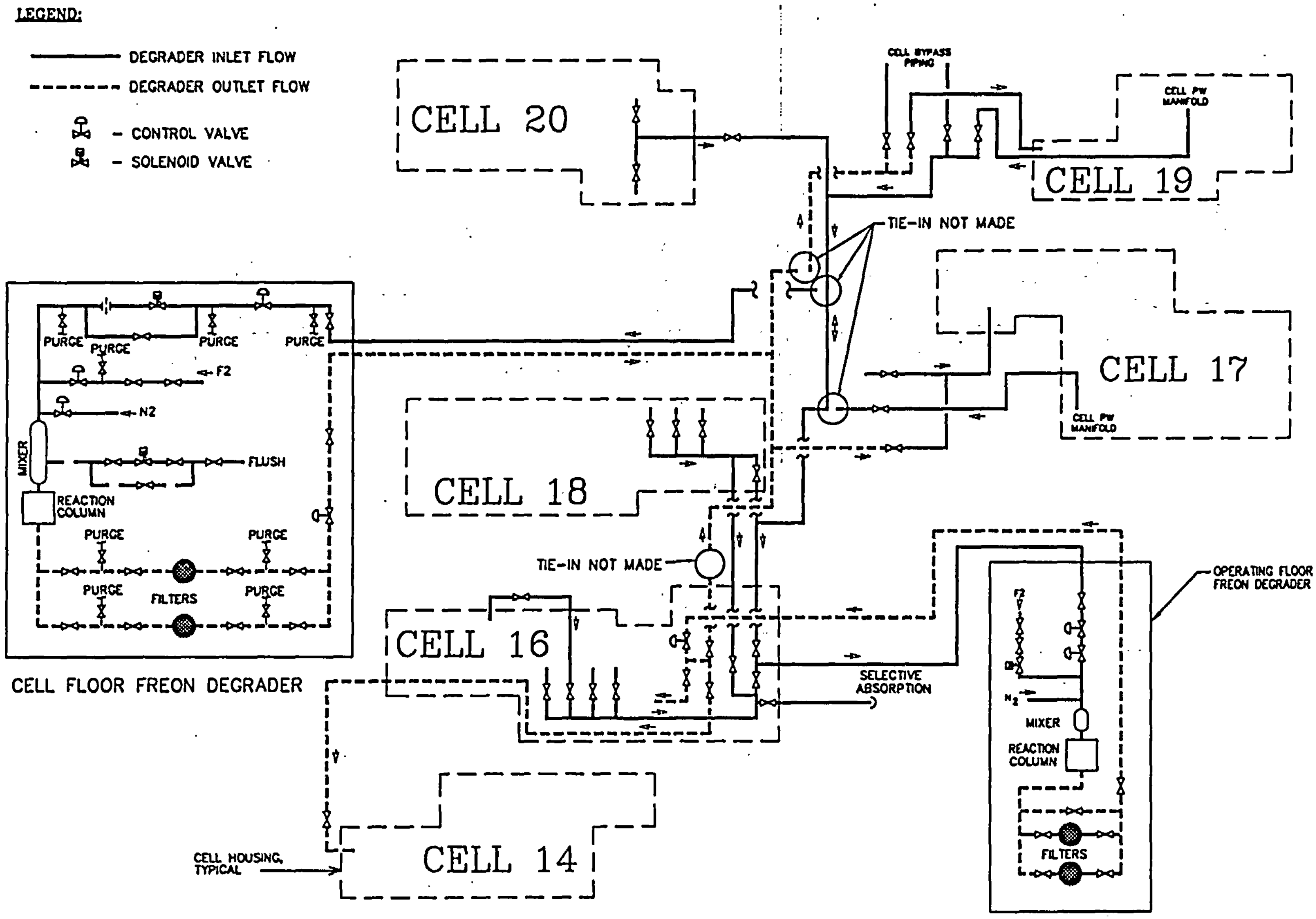


Figure 3.1-24 Freon Degrader System Piping Layout (X-326, Unit X-25-7)

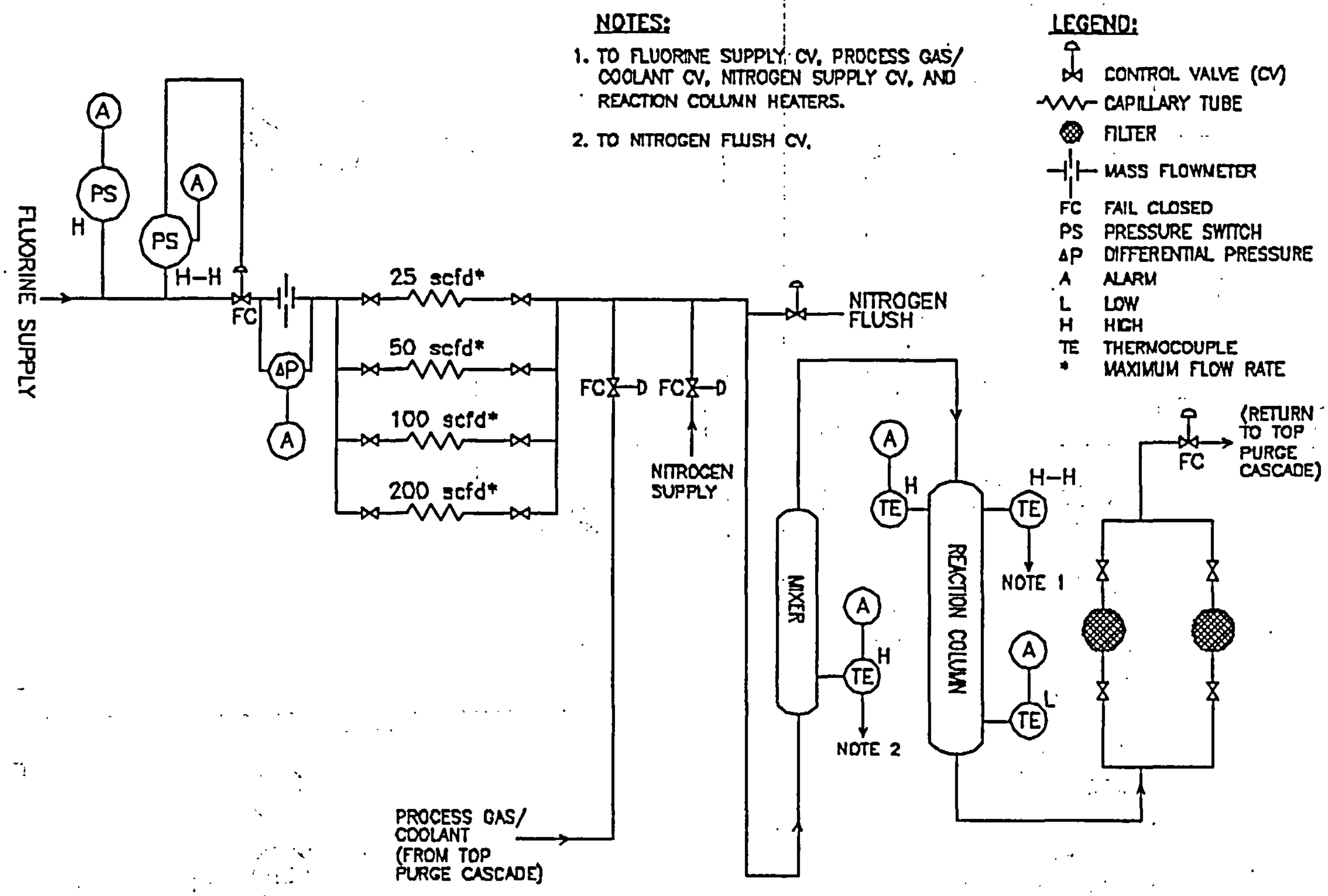


Figure 3.1-25 Cell Floor Freon Degrader System Simplified Flow Diagram

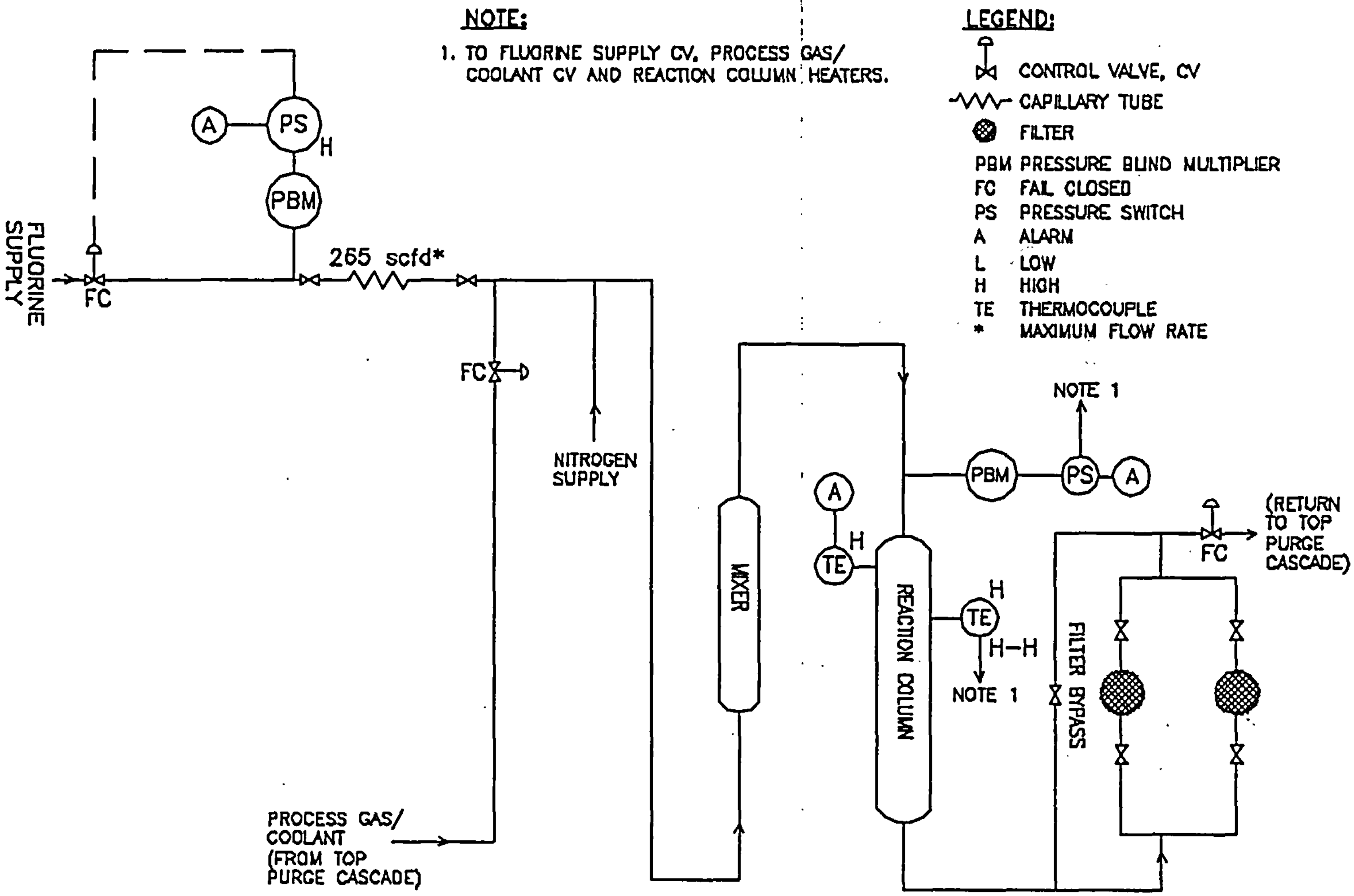


Figure 3.1-26 Operating Floor Freon Degrade System Simplified Flow Diagram

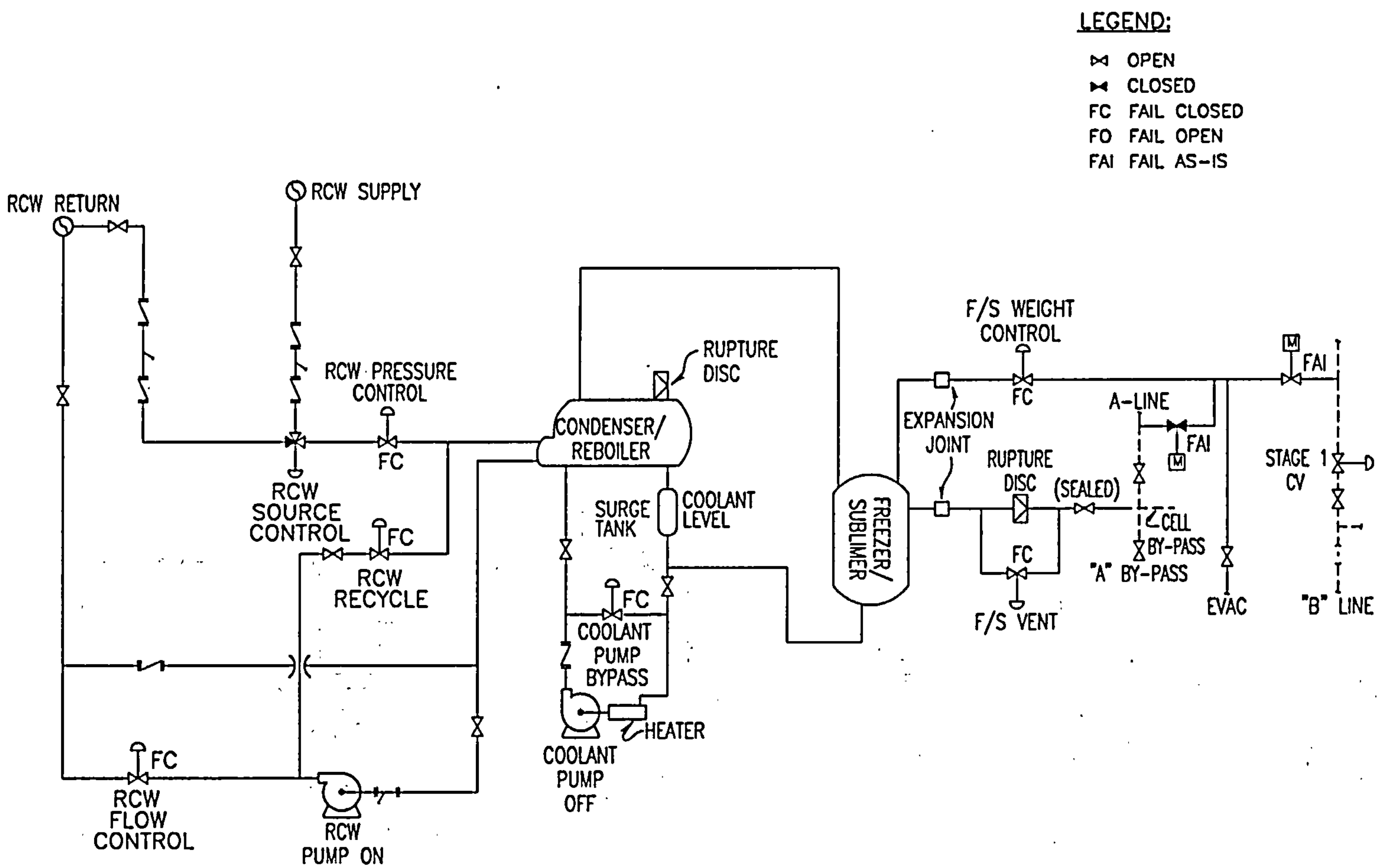


Figure 3.1-27 Operating Conditions for UF_6 Freeze Mode

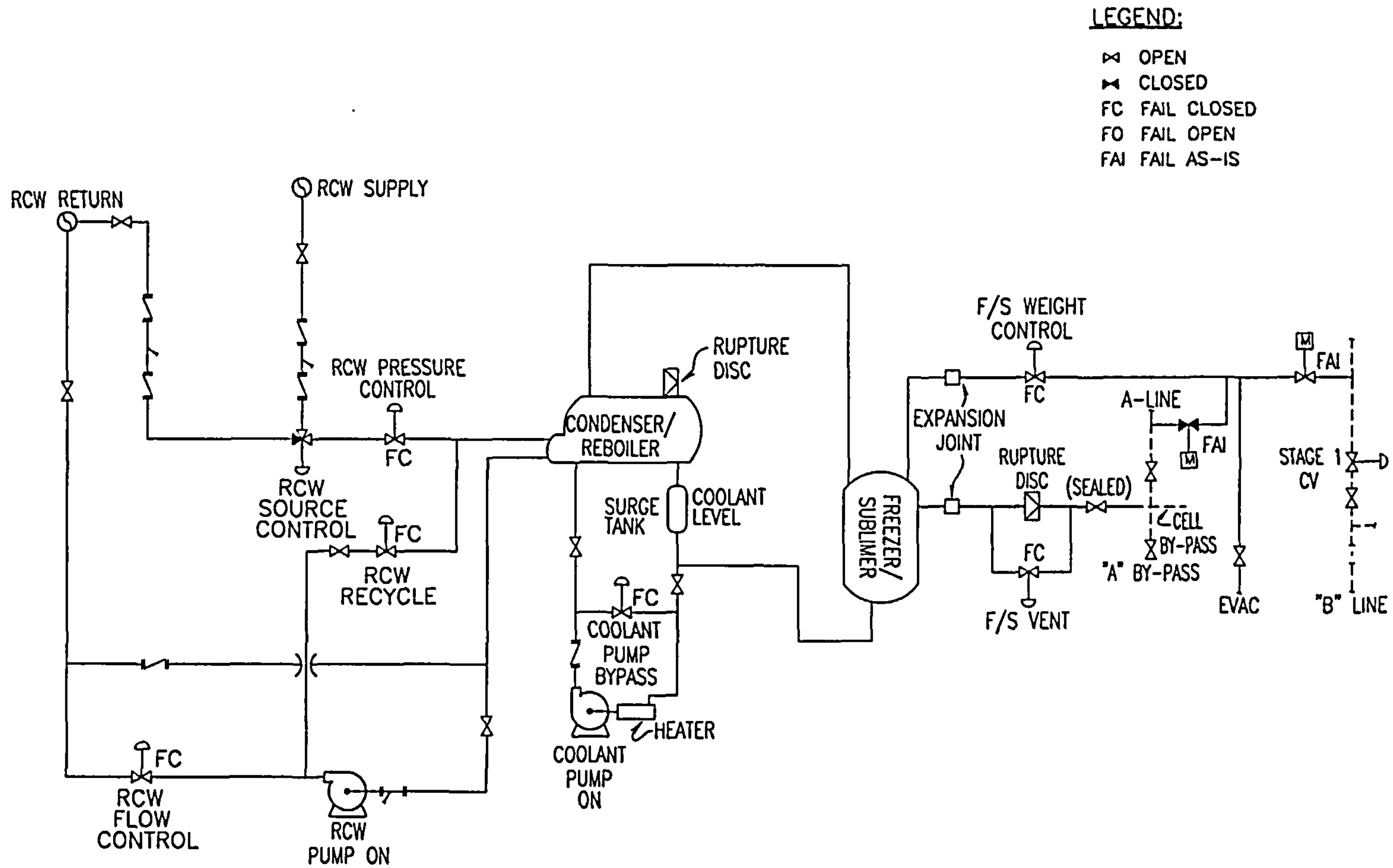


Figure 3.1-28 Operating Conditions for UF_6 Sublime Mode

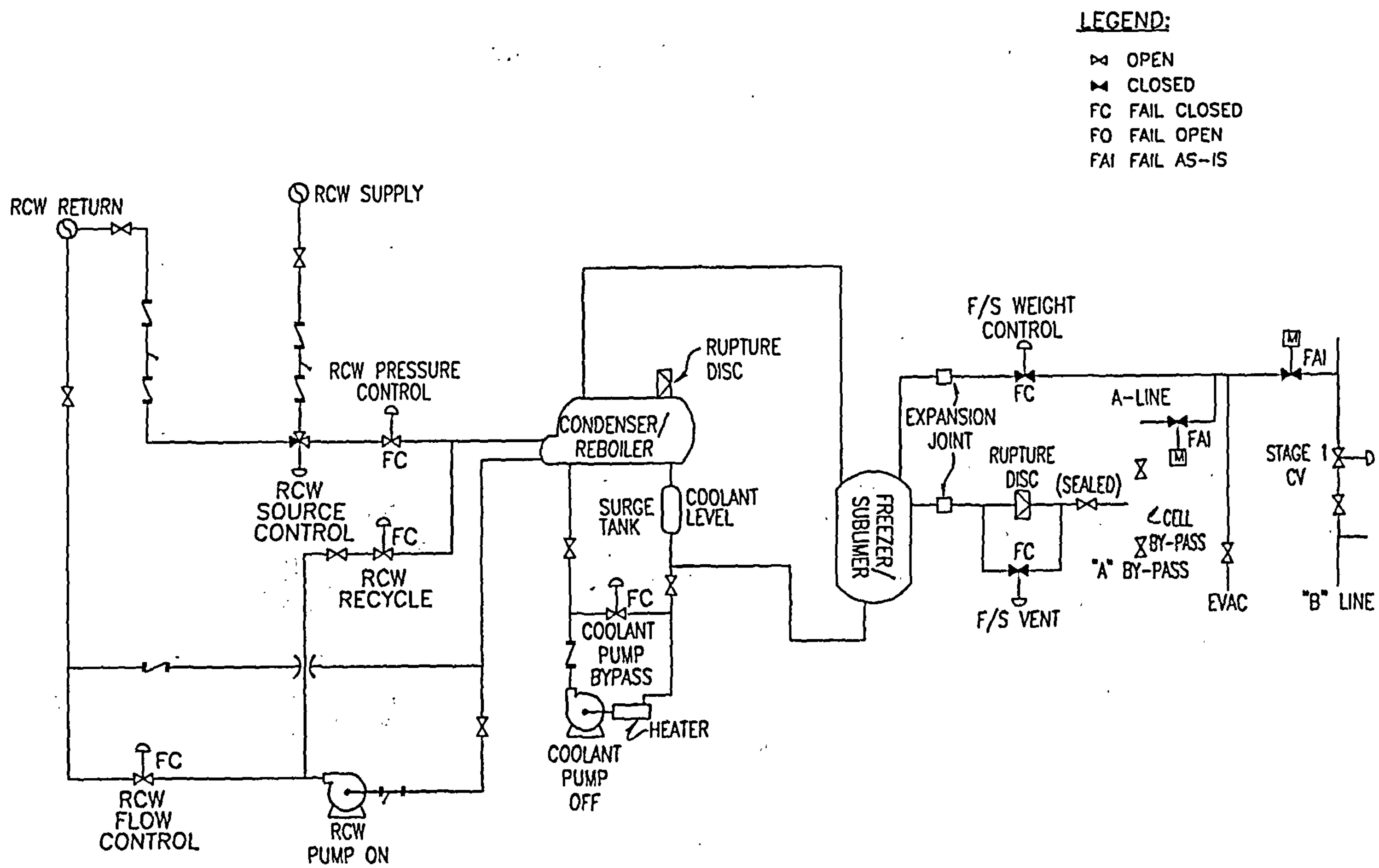


Figure 3.1-29 Operating Conditions for UF_6 Cold Standby Mode

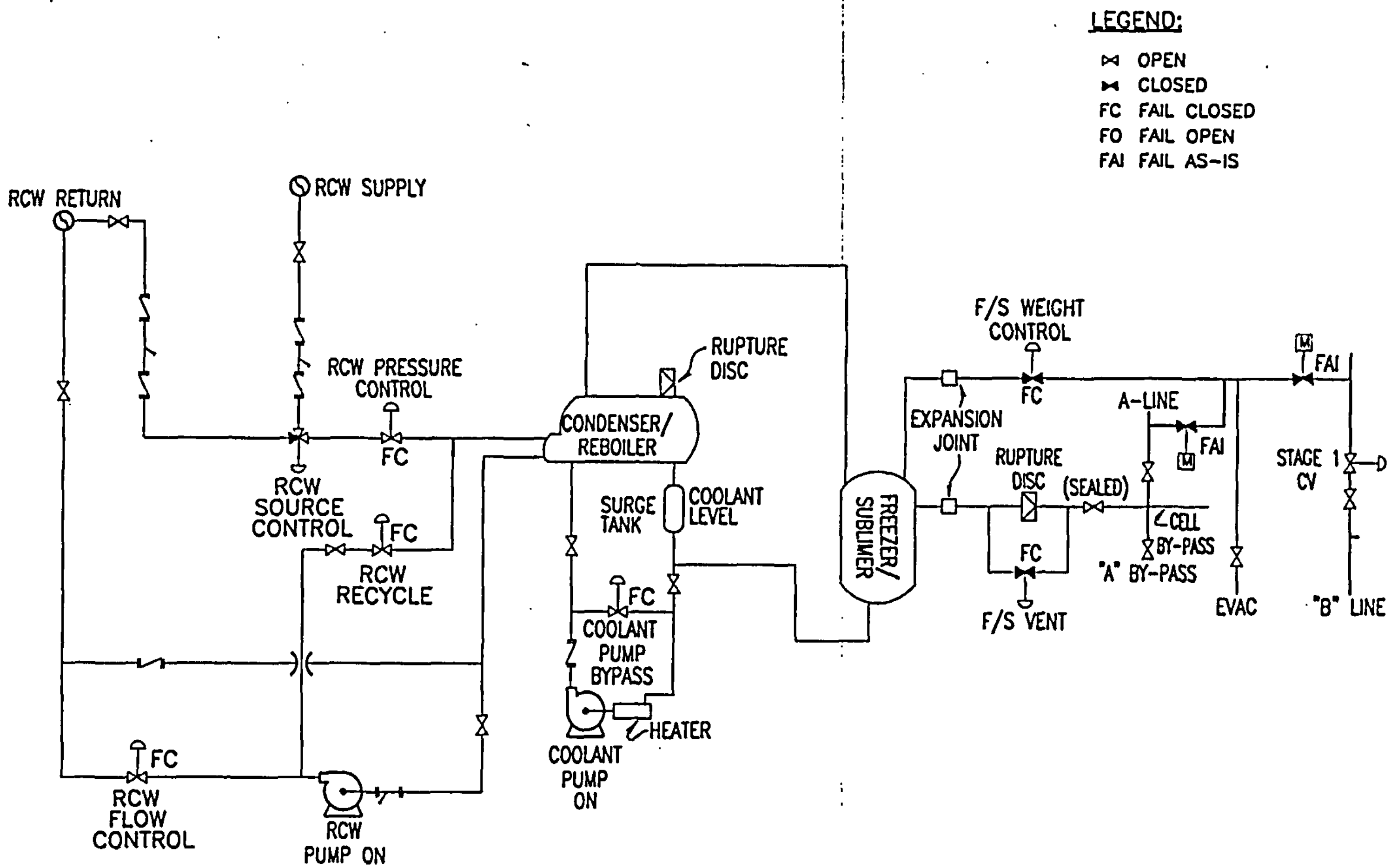


Figure 3.1-30 Operating Conditions for UF_6 Hot Standby Mode

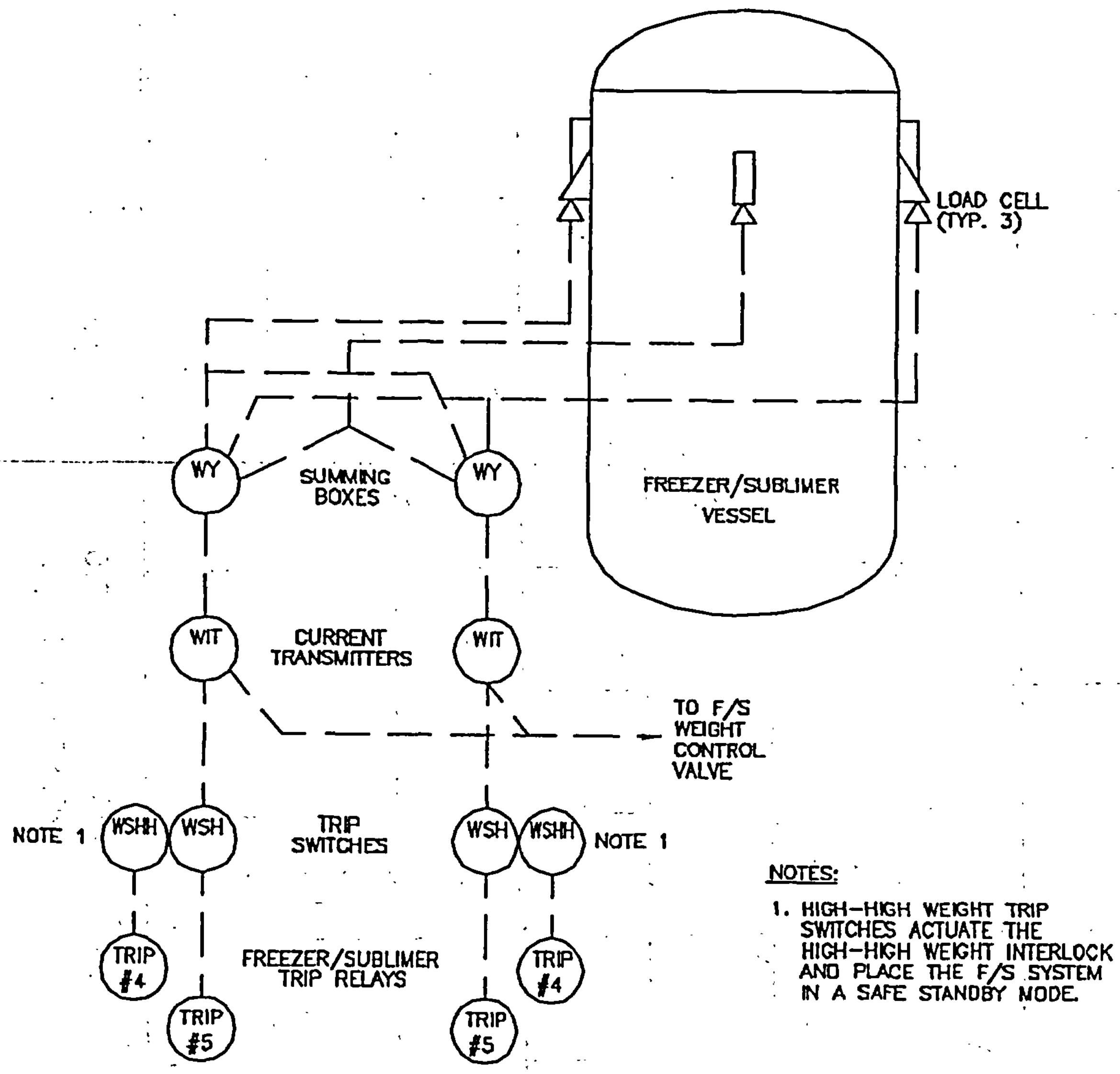


Figure 3.1-31 Freeze/Sublimer Safety Systems

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3.1-32
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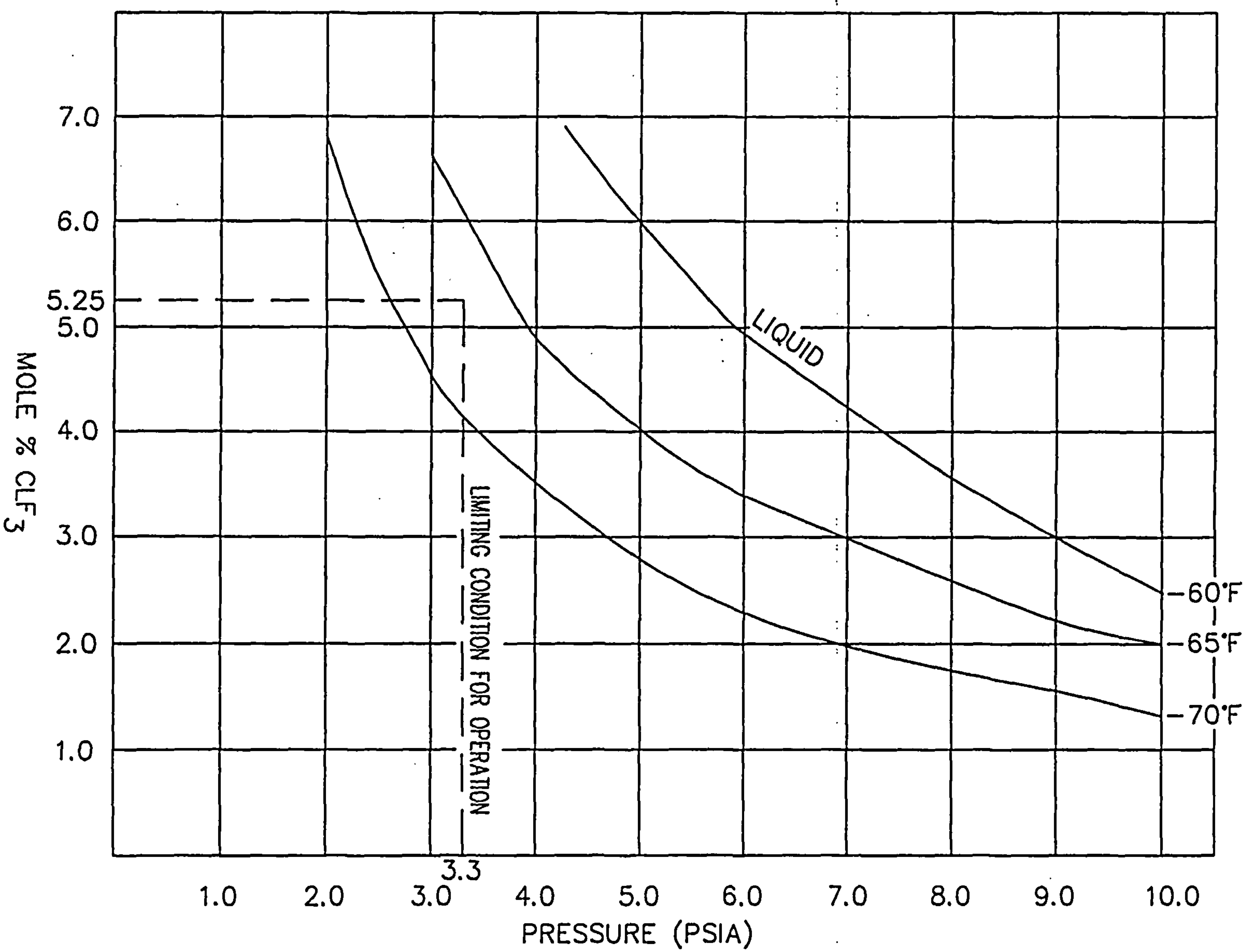

Figure 3.1-32 ClF_3 Phase Diagram

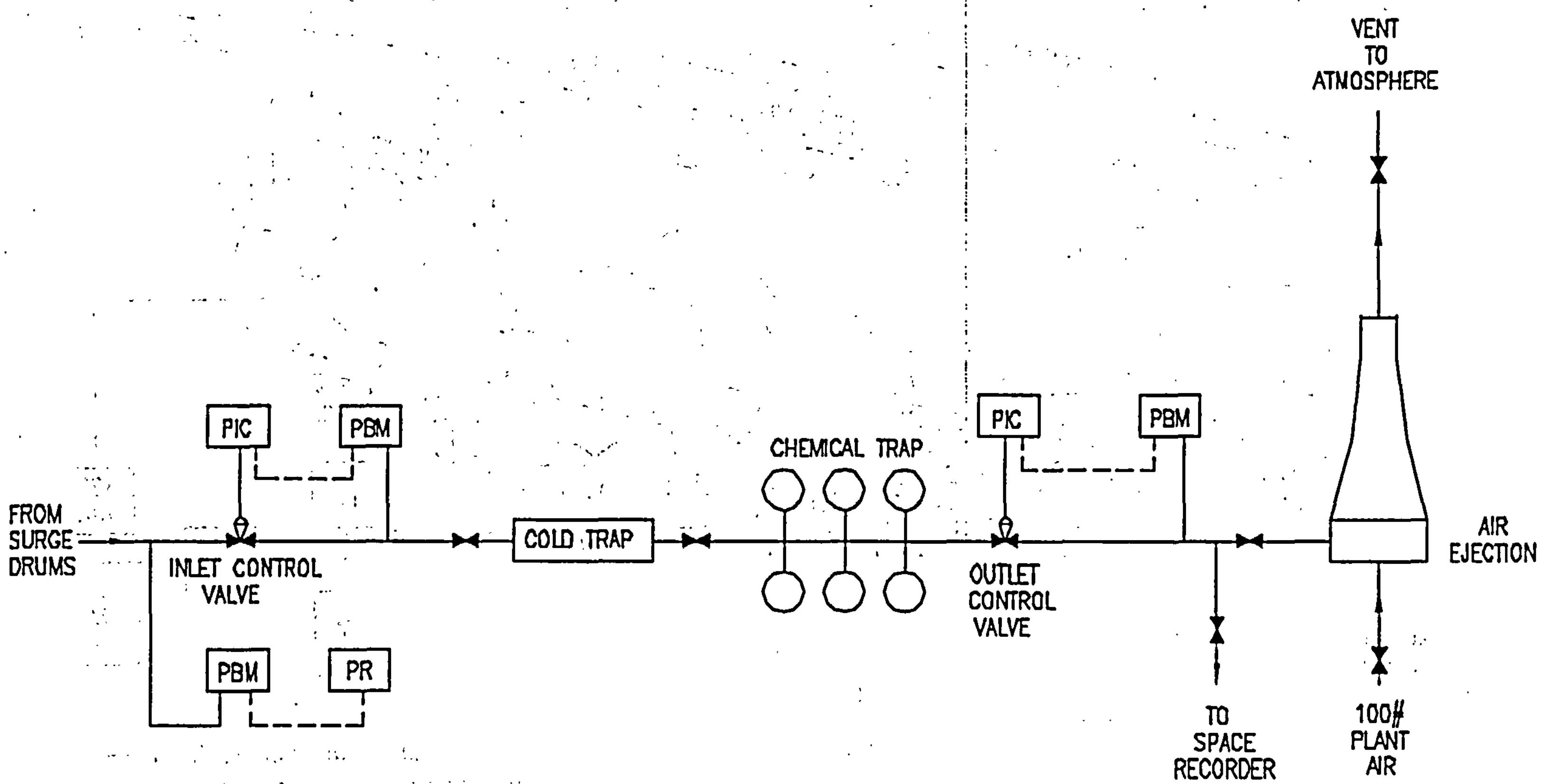

Figure 3.1-33 Simplified Cold Trap Control Diagram

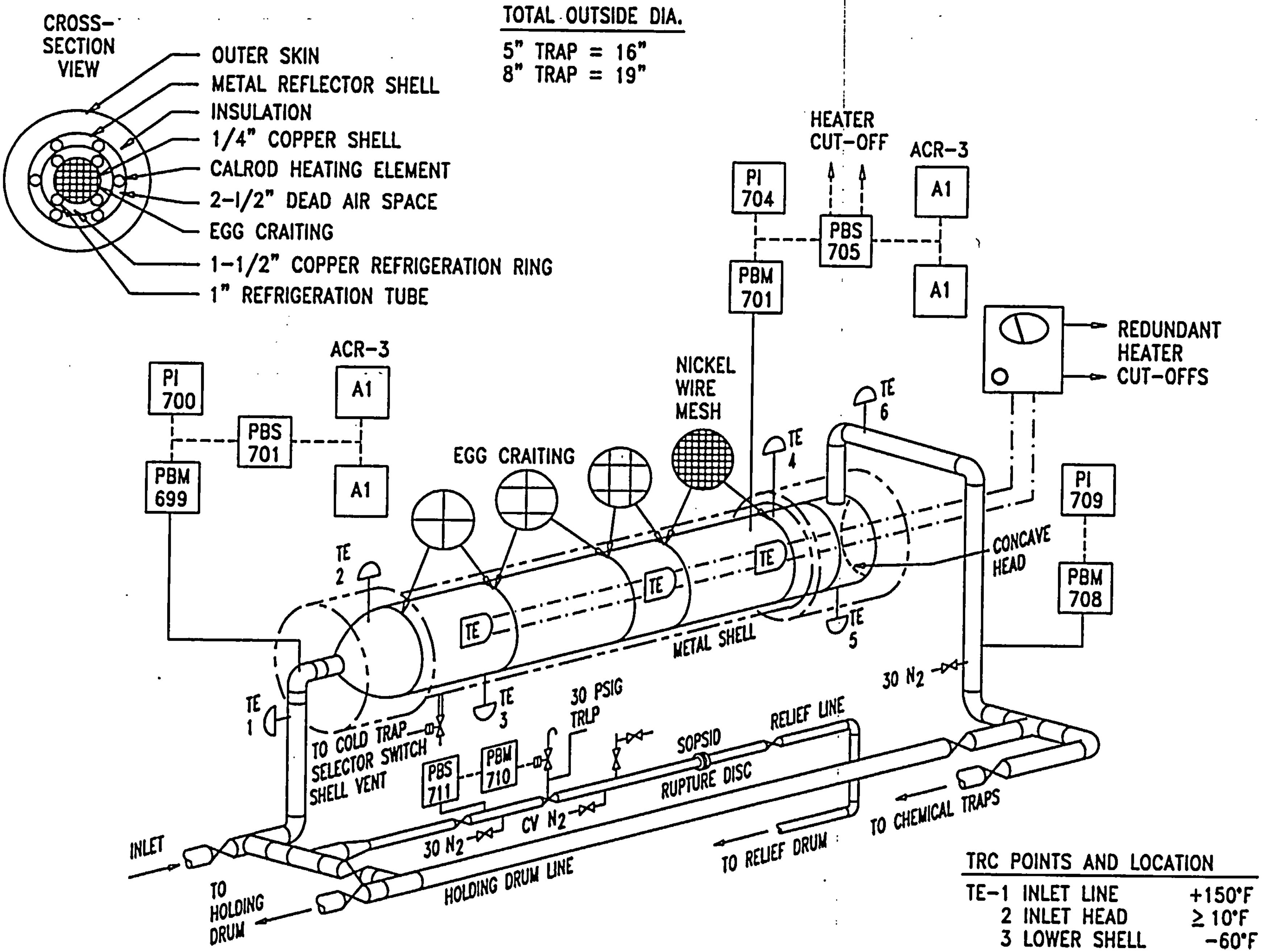

Figure 3.1-34 X-330 Cold Trap Design and Instrumentation

TRC POINTS AND LOCATION

TE-1	INLET LINE	+150°F
2	INLET HEAD	≥ 10°F
3	LOWER SHELL	-60°F
4	UPPER SHELL	-60°F
5	OUTER HEAD	-50°F
6	OUTER LINE	+150°F

3.2 UF_6 FEED, WITHDRAWAL, SAMPLING, HANDLING, AND CYLINDER STORAGE FACILITIES AND SYSTEMS

The various UF_6 feed, withdrawal, and sampling systems and UF_6 cylinder operations occur in a variety of facilities throughout the gaseous diffusion plant. These facilities and their related processes are identified in the following descriptions.

Facilities are provided for the feeding and withdrawing of UF_6 at various points along the enrichment cascade. The facilities are necessary to obtain material of the desired assays to fill customer orders and to prevent mixing of assays when introducing miscellaneous assays of UF_6 feed material into the cascade. All cascade feeding, whether from the X-342A, Feed, Vaporization & Fluorine Generation Building, the X-343, Feed, Vaporization & Sampling Building, or from any of the various side feed locations, is performed by transferring UF_6 gas from a cylinder through heated line(s) into the appropriate point in the cascade, which contains similar assay material as the material being fed. Regardless of the location of the feeding operation, feed headers are available for distribution of the UF_6 to the appropriate location in the cascade.

Cascade UF_6 withdrawals are also performed at various locations. As with feed operations, there are both fixed and portable withdrawal facilities; however, some withdrawals involve liquid UF_6 transfers. These UF_6 liquid phase withdrawals are performed at three fixed facilities: the Tails Withdrawal Station in X-330, the Low Assay Withdrawal Station in X-333 and the Extended Range Product Station in X-326. These withdrawals involve the compression and condensation of UF_6. Gas phase withdrawals may be performed at the Product Withdrawal facility in the X-326, Process Building, or at any local cell control panel in the isotopic cascade, using portable equipment, and at X-326 line recorder sampling lines in the Area Control Rooms.

Assay control for all enriched products withdrawn from the cascade is verified by samples taken at the withdrawal station and/or the withdrawal point. To ensure that the product material meets the customers' requirements for both assay and purity, additional sampling is required.

Pre-sampling operations, as required, are performed at X-343. The sample/transfer operation is performed at X-344A, UF_6 Sampling Facility. The shipping and receiving activities for large cylinder (2½, 10- and 14-ton cylinders) toll enrichment orders are normally performed at the X-344A facility. Shipping and receiving activities for large cylinder toll normal and Paducah product feed is normally performed at X-343. Shipping and receiving of sample containers is normally performed at X-344A.

A cylinder containing solid UF_6 can be transported along any plant-site street and can typically be found in any of the process buildings; X-344A; X-343; X-342A; X-710, Technical Services Building; X-760, Chemical Engineering Building; X-705, Decontamination Building; in addition to X-745 outside UF_6 cylinder storage.

The uranium enrichment operations at PORTS have been shutdown and the majority of the enrichment cascade equipment placed in a shutdown or "cold standby" condition (See Section 3.1 for more detail). The uranium feed and withdrawal operations have been drastically curtailed due to the shutdown of enrichment operations. The X-343 and X-344A facilities are utilized for the receipt, sampling, transfer and shipping of uranium material. The autoclave facilities in the X-342A are utilized primarily for sampling with venting and limited feed to the cascade. The withdrawal facilities at

Tails and LAW are also maintained in standby condition. The ERP and PW facilities, as well as side feed and withdrawal capabilities are maintained operational to support the cascade equipment deposit removal and to support the processing of vent gases from the X-340 complex operations.

The following sections describe in more detail the operations identified above.

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3.2.1 Cascade UF_6 Feed and Sampling Systems

The following facilities/locations perform feed and sampling functions:

- X-343, Feed, Vaporization & Sampling Building,
- X-342A, Feed, Vaporization & Fluorine Generation Building,
- X-344A, UF_6 Sampling Facility, and
- Side Feed at X-326, X-330, & X-333.

3.2.1.1 X-343 Feed Vaporization & Sampling Building

The X-343 facility is the usual receiving point for all inbound uranium hexafluoride (UF_6) natural assay (0.7% ^{235}U) and Paducah product feed material. This feed material is received in large cylinders (10-ton and 14-ton). The X-343 facility is the usual shipping point for the empty cylinders after they are fed to the cascade.

The X-343 building consists of a high bay area, an adjoining west service area (low bay) and an adjacent open crane runway area on both the north and south ends. The building is constructed of braced structural steel with insulated metal siding on the high bay and service areas. The building floors are reinforced concrete slabs on fill and the roofs are insulated steel rib decking with built up roofing. The building structures are important to safety as described in Section 3.8.

The X-343 facility is equipped with seven steam-heated autoclaves. All seven units are designed for feed or vapor-phase sampling operations and are connected to the cascade feed headers. Three of the seven autoclaves have seven-foot diameters and are equipped with cylinder rollers to allow the cylinder valve to be positioned below the UF_6 liquid/gas phase boundary for liquid phase sampling. The remaining four autoclaves have six-foot diameters and are not equipped for cylinder rotation. The six-foot autoclave positions can be used for cylinders to collect sample flushes from dumping 5- and 12-inch cylinders or from evacuation for pressure control in the event of a pressure excursion during initial cylinder heating as well as other material that may not be sent to the cascade as discussed below. The autoclaves and related important to safety systems are described in Section 3.2.1.1.1.

There are two oil interceptors in the X-343. The first oil interceptor, located in the X-343 basement contains borosilicate-glass raschig rings as a nuclear criticality safety control. The second oil interceptor, located on the first floor of X-343, does not contain raschig rings.

If a cylinder requires liquid phase sampling it is picked up with the overhead crane and placed into a feed and sampling (seven-foot) autoclave. The cylinder is then heated, sampled, weighed, and returned to storage with the overhead crane. The sample container is taken to the X-710, Technical Services Building for chemical and isotopic analyses. The sample flush is either sent to the cascade or to the dump cylinder described in more detail in Section 3.2.1.1.1.

As a general administrative control, cylinders containing liquid UF_6 are moved only by overhead cranes. After a cool down period at ambient temperature, as specified in plant administrative controls, mobile equipment, such as straddle carriers and forklifts, may be used. Criteria for UF_6 cylinder cooling and transport are discussed in Section 3.2.4.5. After analytical results of feed cylinder samples are available, the cylinders may be scheduled for feeding. The cylinders can be fed from any of the seven autoclaves where they are heated, the cylinder contents are vaporized, and transferred to the cascade through a manifold system of three feed headers, metering stations, and cascade feed piping. During the cylinder feed cycle, feed operations controls the feed rate and setpoints are established by personnel in the X-300, Plant Control Facility (PCF). When a cylinder has fed out to the point where the desired feed rate

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cannot be maintained, the cylinder is valved off and a full preheated cylinder in another autoclave is valved on to maintain the feed rate. The feed plant personnel will then evacuate the residual contents of the cylinder to the cascade through an available feed header. The noncondensible gases are also evacuated to the cascade through an available feed header. This evacuation of residual material is to assure the net weight (heel) is within shipping limits (50 lb UF_6 or less) for "empty" cylinders. Once evacuated, the autoclave cylinder pigtail is purged, evacuated, and disconnected. The emptied cylinder is then placed on a scale, weighed for accountability and then moved to the X-343 outside storage lot or an adjacent lot east of X-343.

The feed and sample system in the X-343 Building is equipped with dump cylinder and surge volume cylinder capability. These dump/surge volume cylinders are large UF_6 cylinders installed on the cylinder supports of shell open autoclaves. The operation is discussed in more detail below.

The X-343 facility is equipped with cold trap banks to support operation when the cascade is not used. Each cold trap bank is a metal enclosure that provides housing for three refrigeration chambers, the refrigeration equipment for each chamber, and the associated controls. Each refrigeration chamber provides housing for a 12-inch cylinder (cold trap cylinder). The refrigeration chambers are designed to operate in series or individually as needed. The cold trap refrigeration chambers have weighing systems to monitor cold trap cylinder weight and temperature controllers to maintain the temperatures necessary to freeze UF_6 in the cold trap cylinders. Gas concentrations sent to the cold traps are diluted as necessary to prevent the accumulation of explosive gases in the cold trap cylinders. The cold trap operation is discussed in more detail in Section 3.2.1.1.5.

Downstream of the cold traps are chemical traps used to trap UF_6 that might pass through the cold traps. Flow through these chemical traps is maintained by the use of air ejectors. These ejectors exhaust to the vent stack. A continuous/real time vent monitor, located prior to the gases leaving the building, will monitor the evacuation vent line. The continuous portion of the monitor provides integrated release information to demonstrate compliance with OEPA emission limits. The real time portion of the monitor provides operations with an alarm to investigate the evacuation system for chemical trap break through or system off-normal operation.

3.2.1.1.1 Autoclaves

There are seven steam heated autoclaves in the X-343 facility designed to heat UF_6 cylinders containing material enriched to 5 weight percent ^{235}U or less. Five autoclaves can be used to heat cylinders for cascade feeding and/or sampling. Three of the seven are equipped with the roll mechanisms for liquid phase UF_6 sampling.

The X-343 facility contains seven autoclave positions with feed capability. The autoclaves are also used for dumping 5- and 12-inch cylinders. Dumping consists of installing the cylinder in the autoclave. The contents are then heated, liquefied and flashed to a designated dump cylinder. Three of these positions (five, six and seven) have the capability to liquid sample UF_6 cylinders. As a part o the cold trap evacuation process, autoclave positions one, two, three and four have the capability to be used as dump/surge volume cylinder locations when they are not functioning as autoclaves. Autoclave positions one and two (six-foot autoclaves) can be used as autoclaves for preheating and special cylinder burping, but can be converted for use as dump/surge volume cylinder locations when necessary. When not available for use as autoclaves, positions three and four are used as dump/surge cylinder locations only.

The dump cylinder is used to receive residual UF_6 remaining in the autoclave sample loops following sampling operations. The dump cylinder is also used to evacuate material for dumping 5- and 12-inch cylinders or for pressure control in the event of a pressure excursion during initial cylinder heating. The UF_6 is flashed from the liquid phase, transferred in the vapor phase, and solidified in the dump cylinder. The surge volume cylinder receives the gas impurities from the product cylinders and autoclave sample loops. If the gas composition is such that explosive mixtures (>11 mole percent ClF_3, >10 mole percent R-114) could be produced or liquefaction could occur in the cold traps, the surge volume cylinder contents are diluted with an appropriate gas, e.g., dry air, as necessary. If the surge volume cylinder contents are not sampled to determine dilution, the contents are diluted with at least 50 psia of an appropriate gas. The dump cylinder and surge volume pressures are monitored to verify a dump or transfer of material has occurred and to verify the flow path from the autoclave is closed.

The Autoclave Nuclear Safety Upgrades (NSU) Project results in different system descriptions applying to certain autoclave systems and components depending on whether it pertains to an "upgraded autoclave" or to a "non-upgraded autoclave" (only applies to autoclaves 3 & 4, which are no longer used as autoclaves for heating cylinders). The following discussions indicate which configuration is being described when such clarification is required.

The autoclave heads have penetrations for the following UF_6 piping and utility services:

- UF_6 line,
- Steam inlet,
- Steam control valves pressure tap (upgraded autoclaves only),
- Condensate drain,
- Blowdown exhaust line,
- Shell vent,
- Roll motor buffer air inlet and outlet (seven-foot autoclaves only),
- Electrical power cable (seven-foot autoclaves only),
- Air supply line for back-up safety valve,
- Steam sample tubes (2),
- Internal pressure tap,
- Thermocouple leads,
- Pressure relief line, and
- Vacuum relief line.

The electric motor which drives the cylinder rollers inside a seven-foot feed/sampling autoclave is encased in a buffered enclosure. The buffer is dry air at a pressure greater than or equal to the maximum normal operating pressure of the autoclave and is provided to protect the motor from steam inleakage during normal operation. Figure 3.2-1 shows a diagram of a six-foot feed autoclave; the X-343 seven-foot feed and sample autoclaves are diagrammed in Figure 3.2-2.

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Differences between upgraded and non-upgraded autoclaves involve the programmable logic controller (PLC) configurations and the containment valve configurations for the various shell penetrations. The discussion below describes these differences.

Non-Upgraded Autoclaves (only Autoclaves 3 & 4)

All lines except the shell vent, feed header, vacuum relief, pressure relief, and roll motor buffer air supply lines have two automatic containment valves. The shell vent line has a manual valve, in addition to the automatic containment valve, that is closed during autoclave operation except when steam is being released at the end of a feeding cycle. The feed header line can be double isolated by closing one of the main feed header lines downstream of the autoclave feed valve. Even if this fails to isolate the autoclave during an upset event, there would be no release of UF_6 to the atmosphere. The vacuum relief line has a relief valve that is maintained in the closed position by autoclave pressure. The pressure relief line is equipped with a rupture disc and a relief valve. The roll motor buffer air supply line has a check valve downstream from the automatic containment valve. Although the check valve does provide containment mitigation, it is neither tested nor credited as a containment valve.

Each non-upgraded autoclave includes a single PLC that monitors field devices (pressure switches, temperature switches, condensate level switches, conductivity switches, etc.) to provide appropriate signals to the solenoids that operate containment valves. Loss of signal from the PLC will result in closure of all automatic containment valves.

Upgraded Autoclaves

The upgraded autoclaves are modified so that, except for the shell vent line, each autoclave head penetration that is protected by automatic containment valves has two such containment valves. The containment configurations of the shell vent line and the high pressure relief line are unchanged from those of the non-upgraded autoclaves. The vacuum relief line and the roll motor buffer air supply line each have been modified to include an additional automatic containment valve. The UF_6 feed line has been modified to include a new containment valve just upstream of the existing "F" valve. The "F" valve remains as a feed control valve that is not credited nor tested as a containment valve. The steam inlet line is modified to include an additional steam control valve in parallel with the existing control valve. Actuators for both of these control valves are connected to a new autoclave internal pressure tap. This steam control valve pressure tap is protected by two automatic containment valves.

The upgraded autoclaves also include two PLCs that are configured to provide limited backup capability. Each PLC receives inputs from the field devices and provides output to one of the two containment valves on each shell penetration that is protected by two automatic containment valves. One PLC provides output to one valve on each line, and the other PLC provides output to the other valve on each line. Each PLC monitors the containment signal from the other PLC so that a containment output from either PLC to its set of containment valves will result in a containment output from the other PLC to its set of containment valves.

3.2.1.1.1.1 Autoclave Operations

The feed-only autoclaves are six feet in diameter and are American Society of Mechanical Engineers (ASME) code-rated for a maximum allowable working pressure (MAWP) of 163 psig. The roller-equipped feed/sampling autoclaves are seven feet in diameter and are rated for 165 psig. Each autoclave is approximately 23 feet long with one end (the head) being fixed in position and the remainder (the shell) being moveable on a wheel/rail system. In the closed position, the shell is secured to the head with a locking ring. A seal is maintained between the head and shell with an O-ring located in a machined groove in the sealing face of the head. A single building hydraulic system serves the seven X-343 autoclaves providing motive power for shell travel and locking ring operation. The hydraulic system serves to open the shell sufficiently to allow placement of a UF_6 cylinder into the autoclave.

Cylinder contents are fed to the cascade as a gas with the cylinder valve in the nominal 12 o'clock position. To liquid-phase sample the cylinder in a roller equipped feed/sample autoclave, the cylinder is rolled so the cylinder valve is between the 3 and 9 o'clock positions, within the UF_6 liquid phase.

Cylinder heating is accomplished by pressurizing the autoclave with steam from a nominal 50 psig header. The pressurized steam is supplied through a pressure reduction and regulation system designed to deliver steam at two flow rates. The higher flow rate is required for initial autoclave and cylinder heatup when the system steam condensation rate is high and/or the blowdown exhaust system air eliminators are open. The air eliminators are thermostatically-controlled vent valves, which allow air trapped in the autoclave to be vented during the initial stages of the heating cycle. The air eliminators automatically close when the temperature in the blowdown line reaches the actuation level for the valve.

Fill limits for UF_6 cylinders are established to allow adequate room for UF_6 expansion upon heating. The desired void volume is dependent upon whether the cylinder is a heavy wall cylinder, a thin wall cylinder, or whether the internal volume is certified by water weight. Various certified cylinder models are placed in designated heating categories (A, B, and C) to maintain at least a 5% void volume for cylinders containing product and 3% void volume with tails material. Uncertified volume cylinders are categorized to maintain at least a 7% void volume with product and 5% void volume with tails material. The following cylinders based on their accountability weight and void volume calculations can be heated to 235 °F in order to empty them: 48OM cylinders containing PGDP Feed Plant produced, near-normal, enriched material (0.70 – 0.73) with accountability weights less than 25,500 pounds of UF_6. Category C cylinders are damaged or overfilled cylinders which are fed either by controlled feeding with temperature and pressure controls below the UF_6 triple point (maximum cylinder skin temperature of 145°F and maximum cylinder pressure of 20 psia), or by cold feeding – feeding with cylinder at ambient temperature.

A steam regulator controls the internal steam pressure of the non-upgraded autoclaves. The flow through the valve is determined by three forces acting on a metallic diaphragm actuator. Two forces on the bottom of the diaphragm cause the valve to close: a preset spring, and steam pressure fed through tubing from a tap located downstream of the valve. A remotely supplied air pressure (loading pressure) on the top of the diaphragm causes the valve to open. With the loading pressure and spring force held constant, the flow through the valve is modulated by the down stream pressure.

The configuration of the steam regulator system for the upgraded autoclaves in X-343 is modified as follows. A second steam regulator valve is installed in parallel with the first regulator valve. Also, steam pressure is fed to the bottom of the actuator diaphragms for each valve through tubing that taps directly into the autoclave shell head. The upgraded and non-upgraded configurations for the steam control system in X-343 are shown in Figures 3.2-1 and 3.2-2.

Steam pressure and flow are controlled by changing the loading pressure on the steam regulator valves. The autoclaves use two preset loading pressures for high and low flow steam. A solenoid valve switches either of two loading pressure air supply regulators into the system to apply air pressure to the top of the valve. The switching solenoid is controlled by a temperature recorder that monitors the cylinder wall temperature via two magnetically attached thermocouples. The recorder is equipped with an internal switch set below 212°F to control the autoclave steam pressure. Before the cylinder wall temperature reaches 212°F the steam regulator is switched from the higher loading pressure to the lower loading

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pressure. At the lower loading pressure, the steam regulator controls the pressure in the autoclave steam inlet line to a maximum of 8 psig when heating Category A cylinders and 2.5 psig when heating Category B cylinders. This is equivalent to approximately 235°F and 220°F respectively. At high flow the pressure in the steam supply line is approximately 12 psig. This is equivalent to approximately 245°F. Normal controlled heating of Category A cylinders is at approximately 220°F.

After a cylinder is placed in an autoclave it is connected by a pigtail to the UF_6 line leading to the UF_6 manifold outside the autoclave. The UF_6 manifold includes pressure sensing instrumentation that allows the operator to monitor UF_6 cylinder pressure. The pressure instrumentation also serves cylinder pressure safety systems that are described later (Section 3.2.1.1.1.2). The pigtail connection at the cylinder valve includes an air operated cylinder safety valve between the cylinder valve and the pigtail. This cylinder safety valve allows the cylinder to be isolated from the pigtail when the autoclave shell is closed. To prevent cylinder rupture caused by overpressurization, UF_6 pressure is monitored prior to and during the heating cycle. UF_6 cylinders exhibiting an excessive cold pressure (greater than 10 psia) are cold burped to remove contaminant gases that can cause excessive pressure to result upon heating.

During initial heating of a UF_6 cylinder, if the rate of pressure rise indicates to the operator that indicated cylinder pressure would be less than the minimum allowable value within one hour (allowable value of $\leq$ 65 minutes), then an obstruction may be present between the cylinder and the pressure element. If this is observed then the status of steam input is checked. If steam flow had already been established, then steam flow is isolated, the autoclave is placed in the shut down mode and opened, and the cylinder safety valve and cylinder valve are verified open. The autoclave is then reclosed and the heating cycle is reinitiated. A check of cylinder valve clarity is made; if valve clarity cannot be established, then the cause is investigated and corrected before further heating of the cylinder. In addition to operator monitoring, the Low Cylinder Pressure Shutoff System (Section 3.2.1.1.1.2.10) serves to ensure that the cylinder valve and pigtail are opened to the cylinder pressure monitoring circuit. The UF_6 pressure monitoring instrumentation also serves the UF_6 Cylinder High Pressure Autoclave Steam Shutoff System (Section 3.2.1.1.1.2.8). Upon reaching setpoint pressure, this system initiates steam shutoff.

At the conclusion of a heating cycle, steam is exhausted from the autoclave through the blowdown exhaust system. This system consists of an air-jet ejector (aspirator) connected to the blowdown piping and is capable of exhausting steam from any one or all of the autoclaves simultaneously. A check valve located in each autoclave blowdown line prevents steam exhausted from one autoclave from entering another autoclave. A vacuum breaker is employed to allow air to enter the autoclave. The Autoclave Locking Ring Interlock System (Section 3.2.1.1.1.2.5) is designed to prevent the autoclave from being opened unless the autoclave pressure is within ±0.5 psig.

The autoclaves are equipped with systems that are designed to detect a release of UF_6 and initiate containment. HF is formed by the reaction of UF_6 with water when released inside the autoclave. The Autoclave Conductivity Monitoring System (Section 3.2.1.1.1.2.6) is designed to detect small concentrations of HF resulting from a small release of UF_6 that would not produce an appreciable autoclave pressure increase.

In the event of a large release of UF_6 inside an autoclave, the HF gas produced will increase the pressure in the autoclave. The Autoclave Shell High Pressure Containment Shutdown System (Section 3.2.1.1.1.2.1), upon sensing setpoint pressure, will initiate containment shutdown.

The amount of HF gas produced by a release of UF_6 is directly proportional to the amount of water available to react with the UF_6. The High Condensate Level Shutoff System (Section 3.2.1.1.1.2.3) is designed to prevent an excessive accumulation of condensate inside the autoclave.

An initial water inventory test is performed on each new autoclave to determine the amount of water normally entrained within an operating autoclave. The autoclaves are not full containment vessels in that some leakage through the autoclave seals and containment valves occurs. The allowable leak rates for the autoclaves, while in containment, are defined in the Technical Safety Requirements. If condensate beyond normal operating drainage were to accumulate in the autoclave and a large UF_6 release were to occur, the pressure vessel limits could be exceeded and the Autoclave Shell High Pressure Relief System (Section 3.2.1.1.1.2.11) would vent excess material outside the facility.

In addition to the important to safety systems described in Section 3.2.1.1.1.2, the following systems are present to support operational control of the autoclaves:

- The Roll Motor Interlock System prevents the use of the cylinder roll motors in the seven-foot autoclaves unless the autoclave shell is open by more than three feet. The function of this system is to ensure that the operator has a clear view of the pigtail during cylinder roll operations. The shell position is monitored by limit switches. If the shell is open more than three feet, the cylinder roll motor may be operated.
- The Steam Interlock System is designed to prevent admitting steam to an autoclave unless the locking ring is closed and locked. The position of the locking ring is monitored by limit switches. When these switches confirm locking ring closure, contacts in the electric power supply to the solenoid valve are closed. This permits opening the steam control valve.

3.2.1.1.1.2 Autoclave Important to Safety Systems

The following are descriptions of autoclave systems and components identified as important to safety in Section 3.8. Where applicable, separate descriptions are provided for "upgraded autoclaves" and "non-upgraded autoclaves" to reflect description changes resulting from the Autoclave NSU Project.

3.2.1.1.1.2.1 Autoclave Shell High Pressure Containment Shutdown System

The Autoclave Shell High Pressure Containment Shutdown System responds to pressure sensing instrumentation to stop the input of steam, close containment valves, and activate audible and visual alarms if high autoclave pressure is detected. Containment valve shutdown can be initiated by either of two pressure switches that will activate upon detecting an internal autoclave setpoint pressure. Either switch opens the control circuit to a PLC. The PLC provides an output that de-energizes the solenoid valves that operate the containment valve actuators, thereby causing the containment valves to close. The control circuit to the PLC can also be opened by use of manually operated switches located at the autoclave control panel and in the building control room. Automatic containment valves actuated by this system are present on the following shell head penetrations:

- UF_6 line,
- Steam inlet,
- Steam control valves pressure tap (upgraded autoclaves only),
- Condensate drain,

- Blowdown line,
- Shell vent,
- Buffer air inlet and outlet (seven-foot autoclaves only),
- Steam (conductivity) sample tubes (2), and
- Vacuum relief line.

Activation of this system also provides a direct interface with the locking ring interlock system via the containment logic. The logic is programmed so that containment shutdown also prevents operation of the hydraulic system thus preventing operation of the locking ring.

All automatic containment valves that fail to the closed position are either spring-to-close or air-to-close. Those valves that require air to close are equipped with air reserve tanks (a separate tank for each such valve). Therefore, with the exception of those valves specified below, the automatic containment valves fail to the closed position on the loss of the plant air system or on loss of electrical signal to the solenoids that control the pneumatic signal to the containment valve actuators. The exceptions to this fail closed configuration are the "F" valves located in the UF_6 feed lines for non-upgraded autoclaves. These "F" valves will fail as-is.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

3.2.1.1.1.2.2 Autoclave Primary Containment System

The Autoclave Primary Containment System includes the autoclave vessel and all penetrations out to and including the required containment valves. The autoclave penetrations and associated containment valves are described in the preceding discussion of the autoclave shell high pressure containment shutdown 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.

Penetrations to the autoclave are protected by one of the following methods: (1) two automatic containment valves, (2) one valve that is normally closed and manually operated and one automatic containment valve, (3) the autoclave high 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.

3.2.1.1.1.2.3 High Condensate Level Shutoff System

The High Condensate Level Shutoff 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 block valve if condensate is detected in the drain line at the actuation level.

In the event of a large release of UF_6 inside an autoclave, hydrogen fluoride (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 directly beneath the autoclave. Each level probe consists of a level sensing element that drives an associated level switch. These switches are closed when the condensate level in the drain line is below the probes and open when the condensate level in the drain line reaches the probes. Should either condensate level probe detect a high condensate level, the steam supply block valve will close automatically. A closure signal is also provided to the steam control valve, however, no credit is taken for this valve because it is not a positive seat valve and no operability requirements are defined for it.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.4 Pigtail Line Isolation System

The Pigtail Line Isolation System is initiated by the feed operators in the event of a UF_6 release from a process line to close the autoclave containment valves. The system is designed so that isolation can be accomplished within 30 seconds of detecting a release. The operator can accomplish isolation from the building control room by pushing the containment shutdown push buttons for each autoclave. Initiating containment shutdown on a given (upgraded) autoclave achieves double isolation of the UF_6 line. The "F" valves on non-upgraded autoclaves are credited with containment; the "F" valves on upgraded autoclaves are not credited with containment.

The valves needed to isolate an autoclave from the cascade close on loss of air. However, the actuators for the cylinder safety valves require air to close the valves. If the building air supply system fails, backup air tanks (one for each cylinder safety valve) provides air to the actuators to close the cylinder safety valves. Therefore, the building air supply system or the backup air is required for the pigtail line isolation system to isolate the autoclaves.

The isolation signal from the hand switches on the control panel in the building control room is fed to a PLC that processes the information and provides signals to the appropriate containment valves. Loss of signal from the PLC will result in isolation of the autoclave.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system with the exception of the "F" valves for non-upgraded autoclaves, which will fail as-is.

3.2.1.1.1.2.5 Autoclave Locking Ring Interlock System

The Autoclave Locking Ring Interlock System includes components that are designated as important to safety as defined in Section 3.8 as well as other components that, while not classified as important to safety, are operationally important in that they serve to prevent damage to equipment.

The system consists of two pressure switches and associated control relay circuitry. One pressure switch is set to monitor excessive high internal autoclave pressure (greater than 0.5 psig), and the other switch monitors excessive low internal pressure (less than −0.5 psig). When the autoclave pressure is within ±0.5 psig, both switches are closed and the circuit to the hydraulic control system is completed, allowing normal hydraulic control function. If the pressure is above 0.5 psig, the high pressure switch opens and interrupts the circuit to the hydraulic control system to prevent opening of the locking ring. Similarly, if the internal pressure is less than -0.5 psig, the low pressure switch opens and hydraulic control is interrupted.

Although two pressure switches are associated with autoclave locking ring interlock system, only the high pressure switch is credited as important to safety as described in Section 3.8. The low pressure switch is intended to protect the hydraulic system from excessive stress that could be experienced if an attempt to open the autoclave was made when the autoclave was at a significant internal vacuum.

The system is fail safe in that electrical or control circuit interruption causes the relay contact to be open, deactivating the hydraulic system necessary for locking ring movement.

3.2.1.1.1.2.6 Autoclave Conductivity Monitoring System

The Autoclave Conductivity Monitoring System is designed to detect small concentrations of HF resulting from a small release of UF_6 that would not produce an appreciable autoclave pressure increase. Two small diameter lines direct steam from the autoclave to separate water-cooled condensers and reservoirs. Each reservoir contains a conductivity cell to measure the conductivity of the condensate flowing through the reservoirs. If either cell measures conductivity above the setpoint, the system initiates containment shutdown and activates appropriate alarms.

The conductivity monitoring system also includes a flow switch and a sanitary water tap. The flow switch will signal steam shutdown upon loss of cooling water flow to either condenser. Sanitary water, which has sufficient conductivity to simulate a small release of UF_6, is used to test the operation of the conductivity monitoring system prior to each time the autoclave is used.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.7 UF_6 Cylinder High Temperature Autoclave Steam Shutoff System

The UF_6 Cylinder High Temperature Autoclave Steam Shutoff System activates to stop the input of steam to the autoclave and to sound appropriate alarms if the cylinder wall temperature approaches a specified setpoint. This system maintains the initial condition of an acceptable temperature inside the cylinder by closing the steam supply block valve when a high cylinder wall temperature is detected, thereby helping to minimize the potential for exceeding the cylinder heating temperature safety limit. This system consists of thermocouples magnetically attached to the cylinder wall. Each thermocouple is connected to its own temperature switch that is calibrated for the type of cylinder being heated. If the cylinder wall temperature reaches the setpoint for the type of cylinder being heated, an isolation signal is sent to the steam supply block valve. The temperature switches also provide a closure signal to the steam control valve, however, no credit is taken for this valve because it is not a positive seat valve and no operability requirements are defined for it.

The signals from the high-temperature switches are fed to a PLC that processes the information and provides a signal to the steam supply block valve. Loss of signal from the PLC will result in isolation of the steam supply.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.8 UF_6 Cylinder High Pressure Autoclave Steam Shutoff System

The UF_6 Cylinder High Pressure Autoclave Steam Shutoff System detects cylinder pressure and isolates the steam supply to shut off heat 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 block valve to close if the cylinder pressure reaches the high cylinder pressure setpoint. A closure signal is also provided to the steam control valve, however, no credit is taken for this valve because it is not a positive seat valve and no operability requirements are defined for it.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.9 Autoclave Shell High Steam Pressure Shutdown System

The Autoclave Shell High Steam Pressure Shutdown System is designed to detect a high steam pressure and to isolate the steam supply line from the autoclave should a high steam pressure condition exist. This system has three pressure switches. One switch is set to initiate steam shutdown. The other two switches, upon sensing setpoint pressure, will cause not only steam shutdown but also autoclave containment shutdown (Section 3.2.1.1.1.2.1). The steam shutdown setpoint is dependent on the category of the cylinder being heated and the type of autoclave being used.

At the high steam pressure setpoint the pressure switch opens a control circuit to a logic module/PLC. Output from the logic module/PLC de-energizes the solenoid causing the steam block valves to close. A closure signal is also provided to the steam control valve, however, no operability requirements are defined for it and its steam shutdown capability is not credited in the accident analysis.

Activation of this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.10 Low Cylinder Pressure Shutoff System

The Low Cylinder Pressure Shutoff System is designed to minimize the potential for heating a cylinder when unobstructed flow of UF_6 through the 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 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 this system produces audible and visual alarms at the autoclave local control panel and in the building control room.

The system is fail safe upon loss of electrical power or the plant air system.

3.2.1.1.1.2.11 Autoclave Shell High Pressure Relief System

Each autoclave is equipped with an Autoclave Shell High Pressure Relief system to prevent the internal pressure from exceeding 110% of the MAWP as determined by Section VIII of the ASME Pressure Vessel Code. This system consists of a pressure relief valve and rupture disc, each rated at or below the MAWP. The rupture disc is necessary only to prevent constant exposure of the pressure relief valve to steam that is present during normal operation. Such constant exposure could cause undesirable corrosion and scaling of the valve, which, in turn, could cause the valve to weep or otherwise fail to perform its design function.

Pressure above the rating of the pressure relief valve would be vented outside the building. The relief valve closes when the autoclave pressure drops below the rated setpoint of the valve to limit the amount of any release. Reaction products would not be released through the pressure relief valve at pressures below the set point of the valve. 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.

The pressure rupture disc performs a passive safety function as a component of the autoclave primary containment system.

3.2.1.1.2 Scales

Scales are used to weigh UF_6 cylinders in various applications throughout the enrichment process.

Scales are discussed in Section 3.2.4.2

3.2.1.1.3 UF_6 Primary System

3.2.1.1.3.1 Piping and Valves

The UF_6 primary system is considered the primary means of containment for UF_6. The system includes piping and valves from, but not including, the second autoclave containment valve to the exit point from the X-343 facility. This system is important to safety as discussed in Section 3.8.

3.2.1.1.3.2 UF_6 Cylinder Pigtails

UF_6 cylinder pigtails are discussed in Section 3.2.5.

3.2.1.1.4 Cranes and Rigging

Handling of UF_6 cylinders at the various facilities requires a multitude of cranes and hoists as well as numerous slings and fixtures, each designed for the specific cylinder handling requirements at each facility. Cranes are discussed in Section 3.2.4.2.

3.2.1.1.5 X-343 Cylinder/Piping Evacuation

The X-343 facility is equipped with an evacuation system for evacuating small quantities of UF_6, purge gases, or light gases from the cylinders, autoclaves, and associated piping.

This evacuation is accomplished by valving the system to be evacuated into a feed header, the X-333 evacuation line, a dump/surge volume cylinder, or the X-343 cold trap/chemical trap system. The feed or evacuation line returns the wastes to the cascade. Evacuations to the cold traps from the dump/surge volume cylinders are diluted as necessary to reduce impurity concentrates and then sent to the cold traps. The cold traps solidify the residual UF_6 then vent the gases through the chemical traps to further reduce the UF_6 content prior to venting to the atmosphere via the vent stack. The cold traps are designed and operated in a manner that minimizes the potential for overfilling cold trap cylinder with UF_6.

A cold trap cylinder is difficult to overfill because the configuration of the cold trap cylinder is such that UF_6 trapping will cease before overfilling conditions can be reached, and because operations can periodically monitor the cold trap cylinder weights using the cold trap scale. If cold trap cylinder overfilling does occur, the cold trap can not cause a cylinder rupture because the cold traps have defrost controls that limit the defrost cycle such that cold trap cylinder temperatures will not reach levels that would cause a rupture. The defrost controls limit the refrigerant temperature to an approximate maximum value of 135° F. The maximum refrigerant temperature is seen as it exits the compressor and enters the cold trap well. The defrost controls monitor refrigerant temperature as it exits the cold trap well and enters the compressor, stopping the defrost cycle when the refrigerant reaches approximately 50° F.

In order to meet customer specifications and ensure safe operations, cylinder burping is performed as necessary. Cylinder burping is performed in X-343 to eliminate the gaseous impurities prior to sampling and transferring product to the customer cylinders in the X-344. Burping is performed by opening a cylinder to remove the gas volume to the cascade or surge volume cylinder. The surge volume cylinder material is diluted prior to being sent to the cold traps to prevent liquefaction of ClF_3 or R-114 in the cold traps. Impurity concentrations are monitored to determine the amount of dilution required. If the ClF_3 or R-114 molar concentrations exceed 11% and 10% respectively, dilution must be performed prior to cold trapping. Dilution must be performed to the extent that R-114 molar concentration is reduced below 5.22% so that normal cold trapping operations can not reconcentrate R-114 above its explosive limit. Molar concentrations for ClF_3 and R-114, 11% and 10% respectively, are the minimum concentrations required to support an explosive reaction at a maximum cold trap operating pressure of 8.3 psia. If monitoring equipment is not in service, dilution is performed assuming maximum impurity concentration for the PGDP product cylinders.

The cold trap system in X-343 includes three cold trap banks with each bank consisting of three refrigeration chambers. Each chamber may contain a 12-inch diameter cylinder. A minimum of two refrigeration chambers with 12-inch cylinders must be operable to support cold trapping operations. The X-343 building cold trap distribution system will allow any cold trap bank to be connected to any of the autoclaves using the cold trap header piping. Cold trap pressure is expected to vary periodically as the cold traps are first charged from the autoclave systems and then subsequently vented via the air ejector. The pressure variation can result in momentary liquefaction of small amounts of ClF_3 during high-pressure operation. Any liquefied ClF_3 is then immediately vaporized when the air ejector evacuates the cold traps to lower pressures. The cold traps will be operated at temperatures and pressures to ensure that both ClF_3 and R-114 do not liquefy in the 12-inch cylinder. Cold trap temperatures in the X-343 are maintained at or above negative 65° F, and pressures are maintained in a range of zero to 8.3 psia. Small quantities of ClF_3 may liquefy temporarily during operations, however, cold trap operation is such that ClF_3 will be vacuum vaporized and vented by the finish of the cylinder venting and trapping operation via the air ejector and stack. Hence, there is no accumulation in the 12-inch cylinder. The X-343 cold trap banks are connected to chemical traps, then to a common vacuum header. Vacuum is maintained using a two-stage air ejector to evacuate light gases from the system.

The cold traps and the cold trap distribution system are operated from the control room panel and the local control panel. The evacuation air ejector valving can be operated from the control room panel or control can be transferred to the local control panel.

3.2.1.1.6 UF_6 Release Detection System

The UF_6 release detection system in X-343 provides audible and visual alarms in the event that a UF_6 release occurs. Detectors are located over the autoclaves, on the Z-Header catwalk, and on the ground floor between the control panels for autoclaves 4 and 5. 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 alarm indications. The detection system is important to safety as described in Section 3.8.

The detectors are similar to those used in the Cascade Automatic Data Processing (CADP) UF_6 Release Detection Systems, except that the alarm indicator lamp and the associated circuitry in the detector base have been retained in the feed facility detector systems. See Section 3.1.1.11.2 for a description of the detectors.

The system control units consist of a power supply for converting 120 VAC to nominal 220 VDC for the supervised detector circuit and contacts for alarm circuits, trouble signals, and other control circuits. The control enclosures also contain detector status lamps, control switches, and test switches. The control units are designed for multiple protection zones. This detector system has detection and alarm functions only. Activation of a single detector activates audible and visual alarms at the system control panel.

The 120 VAC power system supplies the detector system from a local distribution panel in X-343. Power is fed from the distribution panel to the detector system control unit. 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. Because the 120 VAC power system provides power to the detector circuits and the alarm circuits in the facility, it is required for the detector system to perform its safety functions.

3.2.1.1.7 Fire Protection

The X-343 facility is of non-combustible construction. The hydraulic oil used for autoclave shell movement and locking ring operation is a combustible material that is present in sufficient quantity to be a potential fire hazard. In the event of a hydraulic oil leak, the oil is contained and/or cleaned up in accordance with plant procedures.

Tractor-trailer rigs with as much as 500 gallons of diesel fuel on board may be present in the facility. This quantity of diesel fuel presents a fire hazard that bounds that associated with the hydraulic oil. The fire protection system as described in Section 3.6.1 is designed to protect against the greater hazard of the diesel fuel.

The fire protection program for this facility is in accordance with Section 5.4.

3.2.1.2 X-342A Feed Vaporization Building

The X-342A facility occupies the east portion of the large X-344A/342A complex and was the former primary location for feed sampling and cascade feed vaporization. Another important function performed in the X-342A facility is the manufacture of fluorine which is described in Section 3.4.7.

The X-342A building is constructed with a high bay crane area and an adjacent single story area with a small plenum chamber room on top. The single story section is attached to the southeast corner of the X-344A building. This section contains various structural in-fill shear walls that add to lateral stiffness. The high bay is located to the south of the single story section. The west end of the high bay section contains a roll-up door for access. The building structures are important to safety as defined in Section 3.8.

The X-342A facility is equipped with two seven-foot diameter feed and sample autoclaves with the same basic design and operation as the three feed and sample autoclaves in X-343.

Two and one-half-ton, 10-ton, and 14-ton cylinders of UF_6 for customer orders may be sampled in the X-342A autoclaves. Then the liquid-filled cylinders are removed from the autoclaves and transferred to an adjacent "cool down" area. When the cylinders have cooled for the specified cooldown period defined in Section 3.2.4.5 to solidify the UF_6, they are moved from the area.

Directly beneath the X-342A autoclaves is a sump that receives autoclave condensate. The sump has two pumps that discharge through an oil interceptor to a storm drain. Since the geometry of both the sump and the interceptor are geometrically unfavorable, they contain borosilicate-glass raschig rings as a nuclear criticality safety control.

If contamination of the sump results from a UF_6 release, the operator can shut off the pumps and close valves to minimize contamination of the drains.

3.2.1.2.1 Autoclaves

Except as noted below, the descriptions of the X-343 feed and sampling autoclaves, their operation, and their safety systems, addressed in Section 3.2.1.1.1, also apply to the X-342A autoclaves.

The configuration of the shell vent lines for the X-342A autoclaves differs from that of the X-343 autoclaves only in that the positions of the manual valves and the automatic containment valve are interchanged. In X-342A the manual valve is upstream (closer to the autoclave) relative to the automatic valve, the reverse of the configuration in X-343. Figure 3.2-3 depicts the X-342A feed and sample autoclaves.

The upgraded autoclaves in X-342A are not modified to include a second steam regulator valve nor have they been provided with a direct steam pressure tap for the steam regulator valve actuators.

With respect to the X-342A pigtail line isolation system, the hand switches are located at the feed control panel in the high bay area as well as at the exit doors for the facility.

Activation of important to safety systems will produce audible and visual alarms at the autoclave local control panel. X-342A does not have a building control room.

3.2.1.2.2 Scales

Scales are discussed in Section 3.2.4.2

3.2.1.2.3 UF_6 Primary System

3.2.1.2.3.1 Piping and Valves

The UF_6 primary system is considered the primary means of containment for UF_6. The system includes piping and valves outside the second autoclave containment valve to the exit point from the X-342A facility. This system is important to safety as discussed in Section 3.8.

3.2.1.2.3.2 UF_6 Cylinder Pigtails

UF_6 cylinder pigtails are discussed in Section 3.2.5.

3.2.1.2.4 Cranes and Rigging

Cranes are discussed in Section 3.2.4.2.

3.2.1.2.5 X-342A Evacuation System

The X-342A facility evacuates residual UF_6, purge gases and lights to the cascade through feed headers.

3.2.1.2.6 UF_6 Release Detection System

The UF_6 release detection system in X-342 facility provides audible and visual alarms in the event that a UF_6 release occurs. Detectors are located over the autoclaves, over the HF storage room, and inside the HF storage room. The detection system has detection and alarm functions only. Activation of a single detector will actuate audible and visual alarms at the system control panel. 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 alarm indications. The detection system is important to safety as described in Section 3.8.

The description of the X-343 UF_6 release detection system components and their operation addressed in Section 3.2.1.1.6 also applies to X-342A.

The 120 VAC power system supplies the detector system from a local distribution panel in the X-342A facility. Power is fed from the distribution panel to the detector system control unit. Because the 120 VAC power system provides power to the detector circuits and the alarm circuits in the facility, it is required for the detector system to perform its safety functions.

3.2.1.2.7 Fire Protection

The X-342A facility is of non-combustible construction. The hydraulic oil used for autoclave shell movement and locking ring operation is a combustible material that is present in sufficient quantity to be a potential fire hazard. In the event of a hydraulic oil leak, the oil is contained and/or cleaned up in accordance with plant procedures.

Each autoclave has an independent hydraulic oil system which consists of a welded steel atmospheric pressure oil reservoir (25 gallons), a closed-case electric motor driven pump, high pressure piping system, electrically controlled block valves and piston actuators. The two 25 gallon reservoirs, located in the basement of the building, are cross connected and are thus considered a single 50 gallon reservoir. The hydraulic system operates between 1,200 and 1,400 psig with a pressure release valve set at 2,200 psig. The electrically controlled block valves are operated with spring loaded "deadman" switches.

The hydraulic oil used has a piloted ignition flash point and an auto ignition temperature such that it is classified as not flammable or combustible (but may support combustion under fire conditions) and self-extinguishing once the source of energy is removed.

The fire protection system is described in Section 3.6.1. The fire protection program for this facility is in accordance with Section 5.4.

3.2.1.3 X-344A UF_6 Sampling Facility

The X-344A facility is the processing and usual shipping/ receiving point for low assay (5% enrichment or less) toll product UF_6. Toll product withdrawn from the enrichment cascade into 10-ton cylinders is brought to X-344A to be sampled and transferred into the smaller (2-1/2-ton) customer cylinders that are approved for transport over highways and railways. Special shipping packages are used to protect the full product cylinders in shipment.

The X-344A building is an irregularly shaped structure comprised of three main parts: a two story section, a single story section and a third section comprised of two high bay areas. The single story section is located to the east of the two story section. A three inch gap (open space) separates the two sections. The high bays section is located to the south of the two story section and shares the structural steel framing and non-reinforced concrete block wall with that section. The two story section and the high bays section share a trussed roofing system, while the single story section has an independent roof. The roofs are constructed of 1-1/2 inch metal decking with built-up roofing. Also, the southern wall of the single story section is attached to the X-342A building. The building structures are important to safety as described in Section 3.8.

The ground floor of the facility consists of two high-bay areas that are served by overhead cranes and have large roll-up doors to allow entry of semi-tractor/trailer rigs, straddle carriers, forklifts, and railcars. Cool down positions are accessed by crane through the west side of the building. The sampling and transfer operations are carried out in X-344A using any of the four autoclaves present in the north high bay. Shipping and receiving activities can be carried out in either the north or south bay using any of the overhead bridge cranes. Cylinder unloading can also occur outside the building in the X-745-B cylinder storage lot.

The transfer system in the X-344 Building is equipped with dump cylinder capability. This dump cylinder may collect the UF_6 remaining after a sample operation or purge and evacuation cycle if the transfer line to the cascade is not used. The dump cylinder is utilized to receive residual UF_6 remaining in the autoclave sample and transfer loops during sampling and transfer operations. The dump cylinder is also used to evacuate material for dumping 5- and 12-inch cylinders or for pressure control in the event of a pressure excursion during initial cylinder heating. The UF_6 is flashed from the liquid phase, transferred in the liquid or vapor phases, and solidified in the dump cylinder. The dump cylinder pressure is monitored to verify a dump or transfer of material has occurred and to verify that the flow path from the autoclave is closed.

The X-344 Facility is equipped with cold trap banks to support operation when the Cascade is not used. Each bank is a metal enclosure that provides housing for three refrigeration chambers, the refrigeration equipment for each chamber, and the associated controls. Each refrigeration chamber provides housing for a 12-inch cylinder (cold trap cylinder). The refrigeration chambers are designed to operate in series or individually as needed. The cold trap refrigeration chambers have weighing systems to monitor cold trap cylinder weight and temperature controllers to maintain the temperatures necessary to freeze UF_6 in the cold trap cylinders. The cold trap operation is discussed in more detail in Section 3.2.1.3.5.

Downstream of the cold traps, chemical traps are used to trap UF_6 that might pass through the cold traps. Flow through these chemical traps is maintained by air ejectors. The ejectors exhaust to the vent stack. A continuous/real time vent monitor, located prior to the gases leaving the building, monitors the evacuation vent line. The continuous portion of the monitor provides integrated release information to demonstrate compliance with OEPA emission limits and the real time portion of the monitor provides operations with an alarm to investigate the evacuation system for chemical trap break through or system off-normal operation.

3.2.1.3.1 Autoclaves

The four autoclaves located in X-344A are eight-foot, containment-type units with cylinder rolling and tilting devices to facilitate sampling and transfer of UF_6 contained in 12-inch, 30-inch or 48-inch cylinders. The autoclaves have an MAWP of 150 psig. Figures 3.2-4, 3.2-5, and 3.2-6 show diagrams of the X-344A autoclaves. Any one or all of the autoclaves may be equipped with magnesium fluoride traps to reduce technetium-99 concentrations to meet ASTM specifications for UF_6 product. The autoclave heads have penetrations for the following UF_6 piping and utility services:

- UF_6 line,
- Steam inlet,
- Condensate drain,

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- Blowdown line and pigtail roughing filter,
- Shell vent (autoclaves 1 and 2 only),
- Roll/tilt motor buffer air inlet and outlet,
- Electrical power cable,
- Air supply line for back-up safety valve,
- Steam sample tubes (2),
- Internal pressure tap,
- Thermocouple leads, and
- Pressure relief and vacuum relief line.

The electric motor that drives the cylinder roll and tilt mechanisms is encased in a buffered enclosure. The buffer is dry air at a pressure greater than or equal to the maximum normal operation pressure of the autoclave and is to protect the motor from steam inleakage during normal operation.

3.2.1.3.1.1 Autoclave Operations

A typical toll transfer operation consists of placing a 10-ton enriched product cylinder into an autoclave with the valve in the 12 o'clock position. The cylinder is lowered into place with the overhead crane positioning the cylinder on rollers. Once the cylinder is in position, an air-operated cylinder safety valve is attached to the cylinder valve and a copper pigtail is used to connect the cylinder safety valve to the UF_6 line. The UF_6 line either leads directly to the sample/ transfer manifold outside the autoclave, or, if present, to the technetium traps system. A technetium traps manifold permits the UF_6 line to bypass any, all, or none of the traps prior to connecting with the sample/transfer manifold outside the autoclave.

The conductivity cells are tested. After the connections are leak-tested, the cylinder valve is opened, the cylinder cold pressure or vacuum is measured, the autoclave is closed, and the steam is supplied to the autoclave. During the heatup mode, the technetium traps are always bypassed. When heatup is completed, the steam supply is shut down and the autoclave is evacuated. The UF_6 vapor which was introduced into the UF_6 pressure monitoring circuit is evacuated to the cascade, to the dump cylinder, or to the cold trap system and then evacuated to the atmosphere; and the pigtail is loosened to allow rotation of the cylinder so the valve is at the 6 o'clock position. The "back" end of the cylinder is tilted upward to allow for the valve to be positioned as low in the liquid UF_6 level as possible. Tilting the cylinder allows for a liquid drain leaving a minimal amount of UF_6 in the parent cylinder. After the cylinder has been rolled and tilted, the pigtail is tightened, leak tested, the technetium traps optionally valved in, and the autoclave re-closed. The steam is turned on again to maintain the desired temperature of approximately 220°F until the transfer is complete. The operation of the steam supply system described in Section 3.2.1.1.1.1 also applies to the X-344A autoclaves.

The transfer will typically consist of filling four 2-1/2-ton "daughter" cylinders from each 10-ton "parent" cylinder. (In this document the term daughter cylinder is used to refer to any receiving cylinder into which UF_6 is being transferred.) Final sampling for customer acceptance is performed simultaneously with the transfer by withdrawing two approximately 1,500-gram liquid samples and, in some cases, an additional smaller (usually 200 grams) sample. Additionally, small in process samples (less than or equal to 12 grams) may be withdrawn into P-10 laboratory sample containers. The sampling is effected by momentarily diverting the flowing UF_6 from the transfer line into a sampling manifold which is calibrated to contain either 200 grams or 1,500 grams depending on the size of the "sample loop" which was isolated by valves. The flow to the 2-1/2-ton cylinder is resumed and the isolated quantity of UF_6 is then allowed to drain into an appropriate sample cylinder/container which is cooled with liquid nitrogen to assure total condensation of the sample quantity.

The sample manifold and the UF_6 line are enclosed in electrically heated housings, whereas the pigtails connecting the 2-1/2-ton and sample cylinders are wrapped with electrical heaters and insulated to prevent the UF_6 from "freezing out" in the lines. The 2-1/2-ton cylinder rests on a scale while being filled to a specified weight tolerance.

Transfer operations may also be conducted using 21/2-ton and 14-ton cylinders as parent cylinders. A transfer from one of these types of cylinders is similar to the operation described above with the exception that 2-1/2-ton parent cylinders are completely disconnected from the autoclave manifold during roll and tilt. In addition, technetium cleanup operations on near-normal enrichment material can involve the loading/unloading of full liquid UF_6 cylinders associated with sampling and/or processing of UF_6 through technetium traps.

The autoclaves may also be used for sampling of 12 inch, 2-1/2-ton, 10-ton or 14-ton cylinders without transferring the contents. Sampling is performed in a similar manner as described above except that a small quantity of UF_6 is allowed to flow through the sample manifold to "flush" the system and is then evacuated to the cascade, to the dump cylinders, or to cold traps. Flushing removes any traces of UF_6 deposited in the manifold during the prior operation. After the manifold has been flushed, the sample is taken.

The autoclaves are also used for sample dumping. Sample dumping is accomplished by installing 5-, 8-, or 12-inch cylinders or a rack of sample containers in the autoclave. The cylinders or sample containers are installed in the inverted position to allow draining of liquid UF_6. The contents are then heated, liquefied and transferred to a dump cylinder.

Sample containers may also be installed on the dump rack in the upright position so that they may be vaporized and evacuated directly back to the cascade. Once line clarity is verified, evacuation is begun immediately, which prevents cylinder pressure from ever reaching the maximum allowable value for vaporization of UF_6 during the heating cycle.

The X-344A autoclaves are equipped with a roll/tilt interlock system and a steam interlock system that are configured and operate in a similar manner to that of the corresponding systems associated with the seven-foot autoclaves in X-343 and X-342A. See Section 3.2.1.1.1.1 for a discussion of these systems.

3.2.1.3.1.2 X-344A Autoclave Important to Safety Systems

The following are systems descriptions for autoclave systems and components identified as important to safety systems in Section 3.8.

Audible and visual alarms resulting from activation of important to safety systems are produced at the autoclave local control panel. X-344A does not have a building control room.

3.2.1.3.1.2.1 Autoclave Shell High Pressure Containment Shutdown System

The description of the configuration and operation of the Autoclave Shell High Pressure Containment Shutdown System provided in Section 3.2.1.1.1.2.1 for the X-343 autoclaves also applies to the X-344A autoclaves except as noted below.

Automatic containment valves actuated by this system are present on the following shell head penetrations:

- UF_6 line,
- Steam inlet,
- Condensate drain,
- Blowdown line and pigtail roughing filter,
- Shell vent (autoclaves 1 and 2 only),
- Buffer air inlet and outlet,
- Steam (conductivity) sample tubes (2), and
- Pressure relief/vacuum relief line.

With the exception of those components specified below, all automatic containment valves fail to the closed position on the loss of the plant air system or on loss of electrical signal to the solenoids that control the pneumatic signal to the containment valve actuators. The exceptions to this fail closed configuration are the parent cylinder safety valves located between the cylinder and the pigtail at each autoclave, which will fail as-is. Activation of this system produces audible and visual alarms at the autoclave local control panel.

3.2.1.3.1.2.2 Autoclave Primary Containment System

The autoclave primary containment system includes the autoclave vessel and all penetrations out to and including the required containment valves. The autoclave penetrations and associated containment valves are described in the preceding discussion of the autoclave shell high pressure containment shutdown 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.

Penetrations to the autoclave are protected by one of the following methods: (1) two automatic containment valves, (2) one valve that is normally closed and manually operated or the autoclave high 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.

3.2.1.3.1.2.3 High Condensate Level Shutoff System

The description of the configuration and operation of the High Condensate Level Shutoff System provided in Section 3.2.1.1.1.2.3 for the X-343 autoclaves also applies to the X-344A autoclaves.

3.2.1.3.1.2.4 Pigtail Line Isolation System

The pigtail line isolation system is controlled by a network of manual alarm pushbuttons and relay control wiring located throughout the X-344 complex to initiate containment of all four autoclaves and shut down of building ventilation systems. The system is initiated by operator action in the event of a UF_6 release from a transfer or sample line to close the autoclave containment valves. The system is designed so that isolation can be accomplished within 30 seconds of initiation by the operator upon leaving the facility. The manual isolation buttons are provided at the facility exit points.

The parent cylinder safety valve, the daughter cylinder safety valve and the transfer line containment valve on each autoclave provide isolation of the transfer line in the event of a release of UF_6 outside the autoclave. The valves needed to isolate an autoclave close on loss of air or electric power. However, the actuators for the cylinder safety valves on both the parent and the daughter cylinders require air to close the valves. If the building air supply system fails, a backup air volume (one per autoclave) provides air to the actuators to close the parent cylinder safety valves; operator action or containment signal is required to initiate closure. For the daughter cylinder safety valve, a backup air volume with a pilot valve is provided. On loss of plant air supply, the pilot valve will open and the back-up air volume will be released to close the safety valve. The cylinder safety valve is the only containment valve for the daughter cylinder.

The isolation signal from any of the manual pushbuttons in the building is fed to a PLC that processes the information and provides signals to the appropriate containment valves. Loss of signal from the PLC will result in containment of the autoclave.

3.2.1.3.1.2.5 Autoclave Locking Ring Interlock System

The discussion provided in Section 3.2.1.1.1.2.5 also applies to autoclaves 3 and 4 in X-344A. The portion of Section 3.2.1.1.1.2.5 that pertains to the high pressure switch applies to autoclaves 1 and 2. The Locking Ring Interlock Systems for autoclaves 1 and 2 are not equipped with low pressure switches.

3.2.1.3.1.2.6 Autoclave Conductivity Monitoring System

The discussion given in Section 3.2.1.1.1.2.6 also applies to the X-344A autoclaves.

3.2.1.3.1.2.7 UF_6 Cylinder High Temperature Autoclave Steam Shutoff System

The discussion given in Section 3.2.1.1.1.2.7 also applies to the X-344A autoclaves.

3.2.1.3.1.2.8 UF_6 Cylinder High Pressure Autoclave Steam Shutoff System

The discussion given in Section 3.2.1.1.1.2.8 also applies to the X-344A autoclaves, except pressure transmitters connected to the UF_6 line are mounted outside the autoclave.

3.2.1.3.1.2.9 Autoclave Shell High Steam Pressure Shutdown System

The discussion given in Section 3.2.1.1.1.2.9 also applies to the X-344A autoclaves.

3.2.1.3.1.2.10 Low Cylinder Pressure Shutoff System

The discussion given in Section 3.2.1.1.1.2.10 also applies to the X-344A autoclaves.

3.2.1.3.1.2.11 Autoclave Shell High Pressure Relief System

Each autoclave is equipped with an Autoclave Shell High Pressure Relief system to prevent the internal pressure from exceeding 110% of the MAWP as determined by Section VIII of the ASME Pressure Vessel Code. This system consists of a pressure relief valve and rupture disc, each rated at or below the MAWP. The rupture disc is necessary only to prevent constant exposure of the pressure relief valve to steam that is present during normal operation. Such constant exposure could cause undesirable

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corrosion and scaling of the valve, which, in turn, could cause the valve to weep or otherwise fail to perform its design function.

Pressure above the rating of the pressure relief valve would be vented. Due to the configuration of the equipment in the X-344A, the pressure relief valve exhaust is inside the building. The relief valve is designed to close when the autoclave pressure drops below the rated setpoint of the valve to limit the amount of any release. 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.

The pressure rupture disc performs a passive safety function as a component of the autoclave primary containment system.

3.2.1.3.2 Scales

Scales are discussed in Section 3.2.4.2

3.2.1.3.3 UF_6 Primary System

3.2.1.3.3.1 Piping and Valves

The UF_6 primary system is considered the primary means of containment for UF_6. The system includes sample and transfer piping and valves from, but not including, the second autoclave containment valve. This system is important to safety as discussed in Section 3.8.

3.2.1.3.3.2 UF_6 Cylinder Pigtails

UF_6 cylinder pigtails are discussed in Section 3.2.5.

3.2.1.3.4 Cranes and Rigging

Cranes are discussed in Section 3.2.4.2.

3.2.1.3.5 X-344A Evacuation System

The X-344A Facility is equipped with an evacuation system for the purpose of evacuating small quantities of UF_6, purge gases or light gases from the autoclaves and associated piping (similar to the X-343 Cylinder/Piping Evacuation discussed in Section 3.2.1.1.5). This evacuation returns UF_6-containing gases from pigtail purging, cylinder evacuations and cylinder sampling to the cascade via a tie-in to the X-342 PG tie lines or to the cold traps/chemical traps. The cold trap/chemical trap system traps residual UF_6 and vents lights to the atmosphere through the chemical traps. Administrative controls are established on cylinder initial cold pressure and purity to ensure that cylinders processed will have minimal impurities and will not pose any significant chemical reaction hazards. The cold traps are designed and operated in a manner that minimizes the potential for overfilling cold trap cylinders with UF_6.

A cold trap is difficult to overfill because the configuration of the cold trap cylinder is such that UF_6 trapping will cease before overfilling conditions can be reached, and because operations can periodically monitor the cold trap cylinder weights using the cold trap scales. If cold trap cylinder overfilling does occur, the cold trap can not cause a cylinder rupture because the cold traps have defrost controls that limit the defrost cycle such that cold trap temperatures will not reach levels that would cause a rupture. The defrost controls limit the refrigerant temperature to an approximate value of 135° F. The maximum refrigerant temperature is seen as it exits the compressor and enters the cold trap well. The defrost controls monitor refrigerant temperatures as it exits the cold trap well and enters the compressor, stopping the defrost cycle when the refrigerant reaches approximately 50° F.

The cold trap system in X-344 includes three cold trap banks with each bank consisting of three refrigeration chambers. Each chamber may contain a 12-inch cylinder. A minimum of two refrigeration chambers with 12-inch cylinders must be operable to support cold trapping operations. The X-344 cold trap evacuation system allows any cold trap bank to be connected to any of the four autoclaves using the cold trap header piping. Cold trap pressure is expected to vary periodically as the cold traps are first charged from the autoclave systems and then subsequently vented via the air ejector. Most of the impurities in product cylinders will be removed prior to processing in X-344. If a product cylinder does not meet specifications (cylinder cold pressure check < 10 psia and product purity ≥ 0.675 gU/g) it is taken to the X-343 for burping; therefore, ClF_3 and R-114 are not a concern. The X-344 cold trap operating temperatures are a nominal negative 90° F and are not allowed to go below negative 105° F. The X-344 cold trap operating pressure is not limited, but should not exceed 14.5 psia. The X-344 cold trap banks are connected to chemical traps, then to a common vacuum header. Vacuum is maintained using a two-stage air ejector to evacuate light gases from the system.

The cold traps and cold trap distribution system are operated from the autoclave panel. The evacuation air ejector valving can be operated from the local control panel.

3.2.1.3.6 UF_6 Release Detection System

The UF_6 release detection system in X-344A facility provides audible and visual alarms in the event that a UF_6 release occurs. Detectors are located in the north high bay over the autoclaves. The detector system has detection and alarm functions only. Activation of a single detector activates audible and visual alarms at the system control panel. The detectors and alarm push buttons 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 alarm indications. The detection system is important to safety as described in Section 3.8.

The description of the X-343 UF_6 release detection system components and their operation addressed in Section 3.2.1.1.6 also applies to X-344A.

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The 120 VAC power system supplies the detector system from a local distribution panel in the X-342A facility. Power is fed from the distribution panel to the detector system control unit. Because the 120 VAC power system provides power to the detector circuits and the alarm circuits in the facility, it is required for the detector system to perform its safety functions.

3.2.1.3.7 Fire Protection

The X-344A facility is of non-combustible construction. The hydraulic oil used for autoclave shell movement and locking ring operation is a combustible material that is present in sufficient quantity to be a potential fire hazard. In the event of a hydraulic oil leak, the oil is contained and/or cleaned up in accordance with plant procedures.

The description of the X-342A hydraulic system also applies to the X-344A hydraulic system except that in X-344A the 25 gallon reservoirs are not cross connected (i.e., there are four separate systems).

The fire protection system is described in Section 3.6.1. The fire protection program for this facility is in accordance with Section 5.4.

3.2.1.4 Side Feed Facilities

Facilities are provided to allow introduction of various assays of UF_6 to the equivalent assay point in the isotopic cascade.

The side feeding of UF_6 requires that the cylinder temperature be at, or elevated only slightly above, ambient temperature. There is no secondary containment provided for heating UF_6 cylinders at side feed facilities. Secondary containment is unnecessary because the pressures obtained for adequate sublimation rates are at, or slightly above, the cascade pressure (i.e., below atmospheric pressure). No attempt is made to liquefy UF_6 at side feed facilities.

Because low levels of heat may be applied to side feed cylinders and no attempt is made to liquify the UF_6, the resultant low UF_6 pressures make this operation the preferred method for removal of UF_6 from damaged cylinders, or any time a slow feed rate is desired.

Side feed operations use a heat lamp, a heat ring, or no heat. A heat ring is fitted to the cylinder. The cylinder is placed on a stand and connected with a pigtail to the appropriate cell connection. Control samples are taken to match the feed assay and select the proper cell location. In X-326, the cylinder is connected to the cell charge connection while in the X-330 and X-333 Buildings it is connected to the Local Cell Control Center manifold. This is necessary because of the higher pressures at the charge connections in the X-330 and X-333. The rate of feeding is controlled by the amount of heat applied and the cell connection pressure.

3.2.1.4.1 UF_6 Cylinder Pigtails

UF_6 cylinder pigtails are discussed in Section 3.2.5.

3.2.1.4.2 Cranes and Rigging

Cranes are discussed in Section 3.2.4.2.

3.2.2 Product (ERP and LAW) and Tails Withdrawal Facilities

Cascade UF_6 withdrawals are performed at various locations. Three permanently established facilities are provided for the withdrawal of intermediate assay liquid UF_6 (normally 1.0% to 5% ^{235}U) and depleted UF_6, which is often referred to as "tails" (normally 0.2% to 0.47% ^{235}U). Occasionally, UF_6 with an assay greater than 5% ^{235}U can be withdrawn.

UF_6 liquid phase withdrawals are performed at the X-330, Tails Withdrawal (Tails) Station, the X-326, Extended Range Product (ERP) Withdrawal Station, and the X-333, Low-Assay Withdrawal (LAW) Station. The Tails Station is located in the northeast corner of the X-330, Process Building, the ERP Station is in the northeast corner of the X-326, Process Building, and the LAW Station is in the west center of the X-333, Process Building. The process buildings are important to safety as discussed in Section 3.8 and are described further in Section 3.1.1.1.5.

The withdrawal process is similar for all three withdrawal facilities. The gas stream is compressed, using two stages of centrifugal compressors, to a pressure and temperature above the triple point of UF_6 and then cooled to condense the vapor. Liquid UF_6 is then either collected in an accumulator or drained into a cylinder at a withdrawal position. Figures 3.2-7, 3.2-8, and 3.2-9 depict the typical process flow of UF_6 in each withdrawal facility.

The compressors and their gas coolers and coolant condensers are located on the second floor of the process buildings. The accumulators, associated piping, UF_6 condensers, and valves are located on or just below the mezzanine level between floors. Withdrawal positions (manifolds, scales and carts) are located on the ground floor of the process building. The compressors, coolers, accumulators, manifolds and associated piping are enclosed in heated housings or are heat traced and insulated.

The ERP Station has three withdrawal positions that are serviced by two independent withdrawal loops (ERP-1 and ERP-2). The LAW Station has four withdrawal positions with two independent withdrawal loops (LAW-A and LAW-B). Because each station has two independent withdrawal loops, each can withdraw two different assays at the same time. Depleted UF_6 can be withdrawn through four withdrawal positions at the Tails Station. The Tails Station can also withdraw enriched UF_6 from any of the four positions. In the event of Tails shutdown, the ERP or LAW Stations could be used to withdraw depleted UF_6.

Because of the very close assay tolerance required when filling a cylinder and the necessity to maintain accurate inventories of "in-process" UF_6, assay monitoring is provided for each withdrawal loop. Liquid-filled UF_6 cylinders are moved only by air-operated carts inside the withdrawal areas. Overhead cranes and railcars are used to handle liquid UF_6 cylinders in the outside storage area.

The major systems of the withdrawal facilities consist of the following components:

- UF_6 Primary System (Sections 3.2.2.1.1, 3.2.2.2.1, 3.2.2.3.1),
  - Compressors
  - Piping, Valves, Expansion Joints, and Accumulators
  - Coolant and Condensing Systems
- Monitoring and Protection Systems (Sections 3.2.2.1.2, 3.2.2.2.2, 3.2.2.3.2), and

   - High Pressure Venting and Compressor Shutdown
   - Outleakage Detection
   - Assay Monitoring
- Cylinders and Cylinder Handling (Section 3.2.4).

3.2.2.1 Extended Range Product Station

3.2.2.1.1 UF_6 Primary System

The UF_6 Primary System (i.e., compressors, valves, equipment containing UF_6, and piping) is considered the primary means of containment for UF_6 and includes both a UF_6 gas system and a UF_6 liquid system. The gaseous UF_6 system provides a containment boundary for UF_6. The liquid UF_6 system provides a pressure boundary and a transfer of UF_6 in the liquid state. The UF_6 Primary System is important to safety as described in Section 3.8.

3.2.2.1.1.1 Compressors

ERP withdrawal employs Allis-Chalmers (AC)-12.5 or Worthington (W) centrifugal compressors for the first stage of compression. Under normal conditions, the first stage compressors operate at pressures below atmospheric. The second stage of compression is performed by Worthington centrifugal compressors.

Lube oil is supplied for lubrication of the bearings of withdrawal compressors and motors. The design of the equipment and the lube oil interface maintains no direct contact between the lube oil system and the process gas system.

Pressure switches located on the lube oil supply lines to the compressors protect them from damage due to low oil pressure. Other compressor trip circuits activate if the coolant pressure rises above a predetermined range (Section 3.2.2.1.1.3), or when a compressor overloads (Section 3.2.2.1.2).

X-300can shut down the compressors for the ERP Station.

3.2.2.1.1.2 Piping, Valves, Expansion Joints, and Accumulators

3.2.2.1.1.2.1 Piping

The piping and other elements of the compression/liquefaction process are used to transfer the UF_6 vapor or liquid into receiving cylinders. These are essentially passive, primary containment systems. All of the piping is permanently installed. Pigtails are used to connect the receiving cylinders to the withdrawal manifolds and are discussed in Section 3.2.5. Pigtails are important to safety as discussed in Section 3.8.

3.2.2.1.1.2.2 Valves

Valves in the UF_6 Primary System are important to safety as a pressure boundary to control UF_6 from being released. All of the valves over three inches in diameter are the G-17 type. G-17 valves that are routinely exposed to pressures above atmosphere during normal operation have the bellows buffered and are monitored by the buffer system instrumentation described in Section 3.2.2.1.2.6. Valves less than or equal to three inches in diameter are plug valves or bellows sealed valves.

Air-operated control valves, automatic isolation valves, and high-pressure vent valves are designed to fail in the safe position in case of an air failure; thereby isolating the high-pressure section of the compression/liquefaction loop and venting the compressors back to the cascade.

3.2.2.1.1.2.3 Expansion Joints

Expansion joints are located between piping and fixed equipment on the suction and/or discharge lines of the compressors. They allow for thermal expansion of the piping and for small differences in pipe alignment. Space between the double walls of expansion joints is buffered.

3.2.2.1.1.2.4 Accumulators

Accumulators are located in the liquid withdrawal line to provide storage of liquid UF_6 during withdrawal interruptions. Each withdrawal loop has its own accumulators. The accumulators are separated from other withdrawal loops by double block valves to prevent mixing of materials of different assays between the withdrawal loops. The size of these accumulators helps to determine the maximum allowable assay that may be withdrawn through that loop.

To ensure compliance with the cylinder assay limitations, administrative controls require periodic laboratory-analysis verification of continuous mass spectrometer assay determination and double block valves between loops when two different assays are being withdrawn at the same facility.

3.2.2.1.1.3 Coolant and Condensing Systems

The ERP Station has one coolant system, which serves both ERP compression loops. An evaporative coolant is used to remove the heat of compression and condense the product. The coolant pressure is maintained at least 5 psi above UF_6 pressure and 5 psi above water pressure; allowing coolant to pass into the Recirculating Cooling Water (RCW) or the UF_6 systems in the event of a leak. Both the process gas (PG) cooler and UF_6 condenser are served by one coolant system, which is cooled by RCW.

Gas coolers cool the PG as it leaves the first stage of compression and the second stage recycle. UF_6 Condensers cool and condense the PG after the second stage of compression. The UF_6 condensers have tubes designed to condense PG on the tube side and evaporate coolant on the shell side while operating at <60 psia on the UF_6 side. The UF_6 pressure and temperature relationship must be maintained to prevent liquefaction anywhere except in the condenser.

The ERP coolant system has the same high-pressure protection as previously described for process cells (Section 3.1.1.2.5). When the compressor motors are tripped due to high coolant pressure, the inlet motor operated valves (MOVs) automatically close. The coolant systems for ERP are also provided with the following protection instrumentation:

- Water Flow Control—To maintain the coolant pressure, a controller is provided to regulate the flow of RCW to the coolant condenser. The ERP Pressure Blind Controller is important to safety and is discussed further in Section 3.2.2.1.1.3.1.
- Coolant/Water Pressure Trip—To prevent water from entering the coolant system, pressure switches are provided to close the water inlet valve. The ERP Pressure Switches are important to safety and are discussed further in Section 3.2.2.1.1.3.2.

- Coolant Pressure/PG Pressure Switch—To prevent liquid UF_6 from entering the coolant system, pressure switches are provided to trip the compressors at ERP if the coolant vapor pressure approaches within the setpoint values of PG pressure in the condenser.
- Coolant Pressure Switch—To prevent the compressors from overheating, a pressure switch is provided to trip the compressor when the coolant pressure exceeds the setpoint value.
- Rupture Disc—To prevent overpressurization of the coolant system, the coolant condenser is provided with a rupture disc that is set to relieve at or below the setpoint values. This disc is part of the Coolant High Pressure Relief System, which is important to safety and discussed further in Section 3.2.2.1.1.3.3.

3.2.2.1.1.3.1 ERP Pressure Blind Controller

The ERP Station is equipped with a pressure controller to control the flow of RCW to the coolant condenser. Controlling the flow of RCW enables the coolant pressure to be maintained within setpoint values. The system is important to safety as described in Section 3.8.

Air-operated control valves in the RCW supply line regulate RCW flow to the coolant condenser. Each control valve operates independently within a predetermined RCW input pressure range. The pressure blind controller opens or closes the control valves in order to maintain the coolant pressure. Alarms are annunciated in the local control room (LCR) and area control room (ACR) if the coolant setpoints are exceeded.

The control valves fail in the closed position on loss of air. Therefore, there are no support systems required for the ERP Pressure Blind Controller to perform its safety function.

3.2.2.1.1.3.2 ERP Pressure Switches

The ERP Station is equipped with pressure switches to prevent RCW from entering the coolant should the RCW pressure increase or the coolant pressure decrease. The system is important to safety as described in Section 3.8.

When the coolant pressure drops to a setpoint value or the RCW pressure rises to a setpoint value RCW flow to the coolant condenser is shut off. Pressure switches are used to close the motor operated block valve in the RCW supply line. Alarms are annunciated in the LCR and ACR if the setpoints are exceeded.

On loss of power to the motor operated block valve, the valve fails in the current operating position. Loss of power to the ERP Station will trip the compressors, which then initiates the High Pressure Vent (HPV) system. When the compressors trip, the heat of compression to the UF_6 is removed and the coolant pressure will start to drop. As the coolant pressure starts to drop, the RCW control valves as described above close to control the coolant pressure. As the RCW control valves close, the RCW pressure in the coolant condenser decreases and the coolant pressure will remain above the RCW pressure on loss of power. Therefore, there are no support systems required for the ERP Pressure Switches to perform their safety function.

3.2.2.1.1.3.3 Coolant High Pressure Relief System

The ERP Station is equipped with coolant overpressure protection. In the event of coolant overpressure, the system is utilized to lower the coolant system pressure, protecting the UF_6 system. This system is important to safety as described in Section 3.8. Figure 3.2-7 shows the Coolant High Pressure Relief System.

The Coolant High Pressure Relief System is designed to relieve coolant pressure prior to rupturing the coolant system when the withdrawal coolant pressure reaches a design limit. The system activates prior to rupturing the coolant system, thus protecting the UF_6 primary system piping and equipment. The coolant condenser is provided with a rupture disc that is set to relieve at or below the MAWP. The rupture disc can be isolated from the system by closing a manual block valve.

3.2.2.1.1.4 Materials of Construction

Surfaces normally in contact with UF_6 process gas or liquid UF_6, are constructed with corrosion resistant material and are compatible with UF_6 and conditioning gas. All centrifugal compressors used in the withdrawal process have similar construction. The piping, valves, and expansion joints with all-welded bellows are constructed of materials that are compatible with UF_6 operations. Pigtails are used for required flexible connections and are discussed further in Section 3.2.5. Gas coolers are constructed with materials that are compatible with UF_6 operations. UF_6 condensers are constructed with tubes using all welded construction. Accumulators are constructed of pipe that will withstand pressures higher than will be encountered in service. Nickel, monel, aluminum, and copper have proven to be satisfactory materials for UF_6 operation and for corrosion protection.

3.2.2.1.2 Monitoring and Protection System

3.2.2.1.2.1 High Pressure Venting Isolation and Compressor Shutdown

The HPV System is provided for the ERP Station and can be initiated by UF_6 outleakage detection, high compressor discharge pressure, automatic trip of compressors, or by manual actuation. An air-operated control valve can be used to reduce compressor inlet pressure to achieve the desired operating level.

Each compression loop at the ERP Station has HPV isolation that operates independent of activities in the other compression loop (except when the withdrawal crossover switch is active). The crossover switch is activated when the crossover line is in use, to close the HPV valves of the withdrawal position being used (see Section 3.2.2.1.3 for a discussion of the crossover line). The HPV consists of a line installed from the discharge (or inlet line to the orifice station) line of the second stage compressor to the vent return header. An air-operated valve is installed in this line for the purpose of relieving pressure from the loop, when necessary. HPV isolation of the loop includes isolating the orifice station, closing the inlet MOV to the station, and isolating the withdrawal cylinder. If the HPV circuits are activated, either manually or automatically, the entire compression loop will isolate and vent to the vent return header without any further operator action.

The stage 1 compressor discharge instrumentation which provides for the HPV on each compressor loop is located in the recycle line or the discharge line of the first stage compressor. It consists of two pressure switches. The pressure switch-high (PSH) activates both audible and visual alarms locally and in the ACR. If the pressure switch-high-high (PSHH) is allowed to be energized, the HPV circuit will isolate the affected loop and vent it to the cascade. The PSHH is set so that automatic HPV (isolation and venting) will occur if a break in process piping occurs, total seal failure occurs, or a PG cooler ruptures allowing a large volume of coolant to enter the compression loop.

A Pyrotronics system monitors the outleakage detectors located outside the heated housing above the compressors on the cell floor. If either of the two detectors fire over the same compressor, a UF_6 outleakage alarm will occur. If both detectors fire over the same compressor a HPV time delay relay is actuated. This gives the operator time to evaluate the situation and prevent HPV from activating if HPV activation would compromise safety. If a compressor motor trips, the affected loop will isolate and vent. The Pyrotronics Smoke Detection System is discussed further in Section 3.2.2.1.2.2.3.

Remote manual initiation of the HPV circuits can be performed from the compressor area, LCR, and ACR. Should the HPV circuits fail, the operator at the control panel can perform manual isolation, compressor shutdown, and venting.

3.2.2.1.2.1.1 Motor Load Indicators

Motor load indicators are used in the ERP facility to monitor 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 3.8.

Motor load indicators provide an indication of abnormal compressor operations. Ammeters, located in the LCR, are used routinely in normal operations to monitor the power levels of withdrawal motors. The ampere loading on the motors that drive the compressors are one indication of pending problems or failures. Operators look for large changes in motor loads to indicate process problems. 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.

3.2.2.1.2.1.2 Compressor Motor Manual Trip System

The Compressor Motor Manual Trip System provides the capability to rapidly deenergize the withdrawal compressor motors. This safety system takes credit for only the second stage compressor trip function. The purpose of this trip capability is to aid in the prevention and mitigation of releases during operations by (1) maintaining primary system temperature/pressure below allowable values, (2) reducing heat and/or friction, and (3) minimizing the amount of UF_6 released. This trip capability, one switch for each second stage compressor, is actuated from the LCR. Individual motor trip is provided in the LCR. The ACR trip function provides complete station motive shutdown. Emergency trip can be accomplished from the PCF, although this capability does not trip individual compressors but deactivates the entire withdrawal facility. Emergency trip can also be accomplished from the seal panel on the cell floor for either ERP-1 or ERP-2.

The trip circuit for W-1 and W-3 compressors are powered by 250 VDC control power. The DC power system and its interface with the compressor motor manual trip system is described in Section 3.4.1. The DC power uses battery backup to ensure that on loss of power the motors can be tripped. Therefore, the 250 VDC power is required for the Compressor Motor Manual Trip System to perform its safety function. The 250 VDC power supply is a support system important to safety as described in Section 3.8.

Compressor W-2 uses 120 VAC for control power. Loss of power will result in compressor shutdown. Therefore, 120 VAC power is not required for the Compressor Motor Manual Trip System to perform its safety function.

In the event of a withdrawal system failure, the manual trip system is utilized to shut down the compressors and motors to prevent further UF_6 releases from occurring in compression areas. This system is important to safety as described in Section 3.8.

3.2.2.1.2.2 Outleakage Detection System

Three separate smoke-detection systems are used to monitor the ERP Station where operating pressures exceed or may exceed atmospheric pressure. The CADP Detector Systems monitor for UF_6 outleakage in the compressor and withdrawal areas. The High-Voltage Smoke Detector System is designed to detect outleakage in the accumulator/condenser area whereas; the Pyrotronics Smoke Detector Systems monitor the compressor and withdrawal positions. Each system is described in the following sections.

3.2.2.1.2.2.1 Cascade Automatic Data Processing Detector Systems

In the ERP Station, CADP detectors are located in the compressor housings, outside the housings over the compressor seals, in the withdrawal piping housings, above the withdrawal mezzanine, and above the withdrawal positions. The CADP 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. Detection of a UF_6 release results in audible and visual alarm indications in the ACR. The CADP system is described in more detail in Section 3.1.1.11.2. The UF_6 detectors located in the compressor housings are important to safety and are discussed separately below.

In the event of a UF_6 release in the compressor area or withdrawal room, an alarm will sound in the ACR when the CADP system is in the manual mode. When in the manual mode the detector systems operate independent of the computers. The alarm condition notifies operating personnel that immediate investigation and corrective action must be taken.

The CADP provides the only compressor area coverage inside the compressor housing. However, in case of failure of the CADP detector system, the Pyrotronics systems will be relied upon to monitor the compressor area outside the housing. Should either system fail, a continuous smoke watch will be provided.

<u>UF_6 Release Detection System</u>

The compressor housings are equipped with a UF_6 Release Detection System. The CADP system operates as described above and in Section 3.1.1.11.2. UF_6 detector heads are located in each compressor housing. The detectors are operated in the manual mode during operation of the ERP Station. Upon detection of a UF_6 release, an alarm in the ACR is actuated. This system is important to safety as described in Section 3.8.

The 120 VAC electric power supply to the detector systems in the withdrawal facilities is supplied from the plant process auxiliary power system and fed from local distribution panels to the detector system control units located in the withdrawal facilities. The signal conditioning units convert 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits and energize relays that initiate alarm circuitry upon release detection. Release detection results in audible and visual alarms at the signal conditioner located at the facility and in the ACR. Loss of 120 VAC power will result in loss of detection and alarm circuits. Therefore, the 120 VAC power supply is necessary for the UF_6 Release Detection System to perform its safety function. The 120 VAC and 200 VDC are support systems, which are important to safety as described in Section 3.8.

3.2.2.1.2.2.2 High-Voltage Smoke Detector System

The High-Voltage (Intel) Smoke Detector System monitors for a UF_6 release in the accumulator and condenser area. This system provides alarm annunciation (compressor area, LCR, and ACR); the operator initiates corrective action.

UF_6 detectors in these systems operate by means of a cold cathode tube and dual ionization chambers—one chamber to detect UF_6 reaction products with moisture 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 ionized particles in the air increases, the resistance across the detection chamber decreases, which causes a voltage increase at the starter electrode of the cold cathode tube. When the voltage at the cathode starter reaches a characteristic point, the cathode tube produces an output signal. This signal is an alarm only signal when the firing voltage drops by a characteristic quality.

The signal conditioning units convert 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits and energize relays that initiate alarm circuitry upon detector actuation. Release detection results in audible and visual alarms at the facility and in the ACR.

3.2.2.1.2.2.3 Pyrotronics Smoke Detector Systems

The Pyrotronics Smoke Detector Systems monitor for a UF_6 release in the withdrawal and compressor positions. Low-voltage detectors are used to monitor outside the heated housing of each withdrawal and compressor position. The Pigtail Line Isolation System can be actuated by the pyrotronics smoke detection system. The Pigtail Line Isolation System is important to safety and discussed separately below.

Actuation of the Pyrotronics detectors in the compressor area initiates a time delay relay, which will activate the HPV system as discussed in Section 3.2.2.1.2.1.

The principal components of the withdrawal facility Pyrotronics Smoke Detector Systems are ionization-type detectors, a system control unit, electrical cabling, and a power supply. The detectors function by means of dual ionization chambers—one chamber to detect UF_6 products with moisture 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.

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 signal circuit. The control panels also contain a battery pack to temporarily supply 24 VDC to the detectors in the event of loss of AC power.

Actuation of any compressor or withdrawal position detector initiates audible and visual alarms in the withdrawal facility and in the ACR.

Pigtail Line Isolation System

The withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions. The low-voltage UF_6 release detectors located above each withdrawal drain position, are part of the Pyrotronics Smoke Detection System. Figure 3.2-10 shows a typical Pigtail Line Isolation System. Activation of either low-voltage detector above any withdrawal position pigtail will initiate isolation of that withdrawal position causing the following actions to occur: (1) closes the manifold safety valve; (2) closes the cylinder safety valve; (3) turns off power to pigtail heat tracing; and (4) initiates alarms in the withdrawal area, the LCR, and in the ACR.

The UF_6 line isolation valves associated with the Pigtail Line Isolation System include an air-operated cylinder safety valve (plug valve with vane operation and air-to-close), a diaphragm-actuated manifold safety valve (globe valve with air-to-open and spring-to-close), and valves associated with the air supply closure system (Figure 3.2-10). The cylinder safety valve is attached to the cylinder at the connection between the cylinder valve and the UF_6 pigtail. The cylinder safety valve remains in the open position until the air solenoid valve closes, which then causes the compressed air reservoir to discharge and close the cylinder safety valve. The compressed air reservoir is present in the system to ensure that air is available to close the cylinder safety valve in the event of a loss of plant air. The operator may manually operate the cylinder safety valve. The manifold safety valve is attached to the withdrawal manifold at the connection between the liquid UF_6 piping and the UF_6 pigtail. This valve uses air to open, and it fails closed upon loss of air supply. The manifold safety valve can be operated electrically, from outside the withdrawal room, if the need exists to close the valve remotely.

If the automatic Pigtail Line Isolation System fails to close due to a system failure, an emergency liquid-drain block valve in the withdrawal manifold can be closed from outside the withdrawal room or an air-operated block valve associated with the gamma spectrometer can be closed from outside the withdrawal room. These manually operated valves are independent of the automatic Pigtail Line Isolation System and are used as a backup to that system.

UF_6 release detectors are required for the automatic actuation of the Pigtail Line Isolation System. Manual actuation of the Pigtail Line Isolation System is also provided. Additionally, an operator can initiate isolation of the withdrawal positions by manually closing a UF_6 liquid drain line block valve.

A 120 VAC power circuit is used to develop the 24 VDC power supply for the UF_6 release detection circuit. The power supply for the detectors is backed up with a 24 VDC battery pack in the event of a power failure. A 120 VAC power circuit also feeds the solenoid valves that actuate the pigtail isolation valves. The pigtail isolation valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power.

Each Pigtail Line Isolation System valve and the associated pigtail are electrically heated (some use heat lamps) to maintain a temperature necessary to keep the UF_6 liquid during withdrawal operations. Initiation of the Pigtail Line Isolation System shuts off 120 VAC power to the pigtail heat tracing.

The plant air system provides the motive power for the Pigtail Line Isolation System valves. The manifold safety valve requires air to open; therefore, loss of building air will cause the valve to fail in the closed position, isolating the withdrawal position from its liquid source. The cylinder safety valve requires air to close. An air reserve volume tank provides this air. The air reservoir has a volume of air sufficient for valve closure.

In the event of a pigtail failure, the system is utilized to isolate the pigtail to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.8.

3.2.2.1.2.3 Assay Monitoring

Mass spectrometers and gamma spectrometers are used to monitor the assay of UF_6 at this withdrawal facility.

Samples are normally taken at 4-hour intervals for laboratory analysis and verification of assay determinations performed by the spectrometers. When both the mass and gamma spectrometers are out of service, laboratory samples are collected every two hours, or more frequently as directed by the Cascade Controller/Coordinator.

3.2.2.1.2.3.1 Mass Spectrometers

Mass spectrometers provide an on-line means for monitoring material enrichment at withdrawal stations and ensuring the enrichment limitations are not exceeded. The mass spectrometer automatically traps, analyzes the sample, and records the assay. This information is used to control target cylinder assay.

The ERP Station has two spectrometers that monitor the ^{235}U assay downstream of the compressor coolers. A third spectrometer acts as backup in the event that either of the primary units fails during withdrawal station operation.

Failure of any component of this system, other than laboratory standards and computer software, requires that alternate sampling be initiated. Alternate sampling can include the use of the gamma spectrometer or laboratory samples. Mass spectrometers are important to safety as discussed in Section 3.8.

3.2.2.1.2.3.2 Gamma Spectrometers

Gamma spectrometers are used to continuously monitor the ^{235}U assay for both liquid UF_6 loops of the withdrawal process. A gamma spectrometer is located downstream of each of the accumulators. The gamma spectrometer and its isolation system operate off the plant 120 VAC power system as well as the plant air supply. Figure 3.2-11 shows a typical gamma spectrometer and isolation system. This system is classified as important to safety as described in Section 3.8.

Monitoring probes are located on the liquid UF_6 line (condensation loop within the heated housing) between the accumulators and the withdrawal position. If the ^{235}U assay exceeds a preset value, audible and visual alarms are actuated locally, in the LCR, and in the ACR. An air-operated valve, located on the liquid UF_6 line between the accumulator and the withdrawal position, is automatically closed by deenergizing a solenoid valve on the plant air supply shutting off air to the isolation valve. The isolation valve then fails closed halting liquid UF_6 flow to the withdrawal cylinder. The isolation valve can also be closed remotely.

If the gamma spectrometer isolation system fails to close due to a failure in the system, the isolation valve can be closed electrically from outside the withdrawal room. Since the operator is required to ensure assay limits are not exceeded and an alternate method of sampling is approved, support system failure is not a concern.

The 120 VAC power to operate the gamma spectrometer and isolation system is supplied from power panels. The 120 VAC power supplies not only the spectrometer instrument cabinet but also feeds the solenoid valves that actuate the isolation valves. The gamma spectrometer isolation valves are designed to close (i.e., fail-safe) upon loss of 120 VAC.

The plant air system provides the motive power for the gamma spectrometer isolation valves. The isolation valve requires air to open, therefore loss of building air will allow the valve to fail in the closed position.

The alarm point has been set above cylinder assay limits to allow operators some leeway at lower assays. Automatic operation of the gamma spectrometer and the liquid drain shutoff valve are tested semiannually.

3.2.2.1.2.4 Scales and Scale Carts

Each cylinder is placed on an air-driven cart equipped with cradles to accommodate the cylinder so that the cylinder can be moved to a scale and positioned for filling. The scales and scale carts are important to safety as discussed in Section 3.8. Both the scales and scale carts are discussed in more detail in Section 3.2.4.2.

The scale cart is provided with a movement prevention system with an interlock to prevent the scale cart from moving during withdrawal operations. The scale-cart air-supply hose is locked to the hose reel with a key-operated padlock, which prevents moving the scale cart while the pigtail is connected to the cylinder. An administrative control requires that the air interlock key be placed on the pigtail before being connected to the cylinder. After the pigtail is purged and leak-rated, the pigtail may be disconnected and the air interlock key removed.

The scale pits in ERP are filled to a minimum depth of 6 inches with borosilicate-glass raschig rings as required in the nuclear criticality safety program. This depth is verified during routine inspection and additional raschig rings are added if necessary. The raschig rings meet the requirements for composition and ring dimensions from American National Standard Institute (ANSI)/ANS-8.5, as described in Chapter 1, Appendix A. The scale pits in the ERP Station are checked weekly for the presence of liquid. If more than one inch of liquid is detected, the pits are pumped.

3.2.2.1.2.5 High Vent Header Pressure Alarm

The plant auxiliary feed and vent return headers are normally used to supply UF_6 and to vent the withdrawal station to its withdrawal point. High vent header pressure alarms are provided for each compression loop to warn of high vent header pressure, which could result from inadvertent closing or a misvalving operation in the station's vent return header. This pressure blind switch (PBS), when actuated sounds an alarm when the vent header pressure reaches a setpoint value.

3.2.2.1.2.6 Buffer Systems

Alarms for the high- and low-pressure systems are provided both locally and in the ACR when a component failure occurs. Alarms for the variable pressure systems are provided locally. This permits adequate time for isolation and replacement of failed or damaged components.

Selected valves, flanges, and expansion joints in the withdrawal facilities are buffered with plant air or nitrogen. The Buffer Systems provide a type of secondary containment for the process system to prevent a release of UF_6 to the atmosphere should the primary system have a small breach at a buffered location. The monitoring and control panels for the buffer systems in the withdrawal facilities provide a means of identifying failures in compressor flanges, valve bellows, and double wall expansion joints.

Double walled expansion joints are buffered in the space between the walls to detect for a single wall failure. Compressor flanges are buffered in the interstitial space between the flange gaskets. Valves are buffered in the bellows.

Systems are employed to supply the appropriate amount of buffer gas to the equipment components due to pressure differentials across the compression/liquefaction loop. The high-pressure buffer control panel provides buffer gas to buffered components after the second stage of compression. The low-pressure buffer control panel supplies buffer gas to most of the remaining components. G-17 valves, which function in both the high-pressure and low-pressure systems, cannot withstand the full range of differential pressures that might be seen with a single source of buffer gas, therefore, the buffer gas is supplied to these valves at a variable pressure based on the process gas pressure. A nitrogen system supplies buffer gas to the suction, discharge, and casing flanges on some of the compressors in the ERP Station and the system is monitored with pressure gauges.

Each main control panel has the same instrumentation and alarms for the high- and low-pressure systems: 1) flow meter is set to activate at a preset limit above the normal flow rate; and 2) pressure differential switches (high and low) are set to activate at preset limits above and below the normal operating pressure. When an alarm is received, the buffer control panel must be checked to determine which buffered component may have caused the alarm and the corrective action to be taken.

3.2.2.1.2.7 Radiation Alarms

A radiation warning system, Criticality Accident Alarm System (CAAS), monitors the ERP facility for nuclear excursions. The CAAS is important to safety as discussed in Section 3.8 and is described further in Section 3.6.2.

3.2.2.1.3 Operation

The ERP Station utilizes pneumatically and electrically operated indicators, controllers and alarms to accomplish the compression/liquefaction process. Table 3.2-1 lists the various controls and alarms associated with this facility.

Product is withdrawn from equipment where process pressures are normally below atmospheric pressure, yet high enough to meet the withdrawal stations' pressure requirements. Each compression loop (ERP-1 and ERP-2) has an air-to-open control valve at the inlet of each loop with instrumentation to automatically control the desired suction pressure to the first stage of compression. The flow rate through the station determines the condensation and withdrawal rate.

Two recycle lines are provided for these compression loops. One recycles gas from the gas cooler outlet to the suction of the first stage of compression; the other recycles gas from the second stage compressor discharge back to the cooler inlet. Operating characteristics dictate that these recycle valves are not to be fully opened or fully closed, which may cause the compressors to surge or overheat. Therefore, these valves are normally operated in the manual mode.

Normally, the second stage compressor discharges into an orifice station having flow elements and control valves. Flow rates to the condenser can be controlled with this instrumentation, but normally the control valves are on manual control and the flow rate is only monitored. The control valves are connected to the HPV circuit as discussed in Section 3.2.2.1.2.1.

The gas then enters the UF_6 condenser and is cooled. The PG is condensed to a liquid flowing by gravity to the accumulator(s). Each condenser is vented through a vent return line having an automatically air-operated control valve to remove light gases (lights) from the condenser. The maximum amount of liquid UF_6 in the condenser and piping, associated with ERP-1 or ERP-2, is approximately 100 lb each.

To remove the lights from a product cylinder (burping), the liquid valve on the withdrawal manifold is closed and the evacuation valve opened. This will transfer the lights from the cylinder to the vent return header.

The accumulators float on line just below the condensers to provide a large volume for UF_6 when withdrawal interruptions are required. Each withdrawal loop is provided with two accumulators. A level indicator and high-level alarm are provided. An air-operated valve closes when the gamma spectrometer alarm actuates. It also can be closed at the discretion of the operator from outside the withdrawal room. The maximum amount of liquid UF_6 in the accumulator associated with ERP-1 is approximately 1,000 lb, and the accumulator associated with ERP-2 is approximately 2,700 lb.

The ERP Station incorporates a crossover line to link each of the withdrawal loops. This line allows the condensed PG from one loop to discharge into the withdrawal manifold and cylinder of the other loop. Double block valves separate the condensed PG in each loop.

Entering the withdrawal manifold, the liquid UF_6 passes through a manually operated block valve. This valve can be closed from outside the withdrawal room.

The liquid withdrawal line goes from the heated housing to the first air-operated pigtail-isolation valve. The pigtail-isolation valves are discussed in Section 3.2.2.1.2.2.3 and are shown in Figure 3.2-10. Pigtail usage is discussed in Section 3.2.5.

The ERP withdrawal area has a mezzanine accessed only by a ladder. Accumulators and condensers are enclosed in a heated housing or are heat traced and insulated in this area. Due to the limited access to the mezzanine area, no personnel are allowed there during cylinder change operations. The ERP withdrawal room has manually operated sliding or roll-up doors to allow the scale carts to be moved in and out of withdrawal position. Figure 3.2-12 provides the general layout of equipment within the withdrawal rooms.

3.2.2.1.4 Heating Systems

Compressors, coolers, condensers, accumulators, manifolds, and associated piping and valves are enclosed in heated housings or are heat traced and insulated. Piping and equipment are maintained at a temperature necessary to keep UF_6 in the desired phase.

3.2.2.1.5 Ventilation Systems

The ERP Station is located adjacent to the outside wall of the process building. Large doors on the outside wall of the withdrawal rooms can be opened to allow the scale carts to move the cylinders outside so that they can be removed from the carts to their temporary storage position by an overhead crane. Since the air pressure on the operating floor inside the process building is slightly below atmospheric pressure, there is a small amount of air exchange from inside the withdrawal room to inside the process building.

Portable air ventilation units may be used at the ERP withdrawal positions to provide personnel protection during cylinder filling operations. These portable ventilation units, which filter air through a High Efficiency Particulate Air (HEPA) filter, are used to collect "smoke" (airborne UF_6, HF, and/or finely divided uranyl fluoride [UO_2F_2]) released when ERP pigtails are connected/removed from cylinders containing UF_6.

3.2.2.1.6 Effects of Outages

Two assay product withdrawals can be performed at the ERP Station. The ERP Station may be used to withdraw tails material in the event of a Tails Station outage. Valving and piping arrangements are also designed so that a spare compressor can be used with either compression loop.

3.2.2.1.6.1 Power Failure

When a total power failure occurs, a diesel-driven generator supplies power to the withdrawal station's MOVs. Should the diesel generator fail to start or supply power, tie-breakers can be closed to another generator to supply backup power for closing the MOVs.

The air-operated valves are designed to fail in the safe position; consequently the withdrawal cylinders, condensers, accumulators, and compression loops would isolate and the vent valve would open, when either an air or electrical failure occurs.

3.2.2.1.6.2 Plant Air Failure

Failure of the plant air system requires shutdown of the withdrawal facilities. During an air supply failure there would be time for an orderly shutdown and isolation. The compressor recycle valves would open protecting the compressors. The RCW control valves to the coolant condenser would close causing the compressors to trip on high coolant pressure.

Over a prolonged outage, the condensers and accumulators can be drained and evacuated.

3.2.2.1.7 Fire Protection

The only significant combustible material contained in the withdrawal area is the lubrication oil used in the compressor and motor lubrication. There are no combustible materials used in the construction of this facility.

The greatest fire hazard to this facility is the large quantity of process lubricating oil used to lubricate the process motor and compressor bearing, which may leak into this facility. In such events, the oil is caught and/or cleaned up using procedural controls.

Portable fire extinguishers are located inside the building. The ERP withdrawal area is provided with wet-pipe automatic sprinkler systems.

3.2.2.2 Low Assay Withdrawal Station

3.2.2.2.1 UF_6 Primary System

The UF_6 Primary System (i.e., compressors, valves, equipment containing UF_6, and piping) is considered the primary means of containment for UF_6 and includes both a UF_6 gas system and a UF_6 liquid system. The gaseous UF_6 system provides a containment boundary for UF_6. The liquid UF_6 system provides a pressure boundary and a transfer of UF_6 in the liquid state. The UF_6 Primary System is important to safety as discussed in Section 3.8.

3.2.2.2.1.1 Compressors

LAW employs AC-12.5 or Worthington centrifugal compressors for the first stage of compression. Under normal conditions, the first stage compressors operate at pressures below atmospheric. The second stage of compression is performed by Worthington centrifugal compressors.

The lube oil system supplies oil for lubrication of the bearings of withdrawal compressors and motors. The design of the equipment and the lube oil interface maintains no direct contact between the lube oil system and the process gas system.

Pressure switches located on the lube oil supply lines to the compressors protect them from damage due to low oil pressure. Other compressor trip circuits activate if the coolant pressure rises above a predetermined range (Section 3.2.2.2.1.3), or when a compressor overloads (Section 3.2.2.2.2).

The PCF can shut down the compressors for the LAW Station.

3.2.2.2.1.2 Piping, Valves, Expansion Joints, and Accumulators

3.2.2.2.1.2.1 Piping

The piping and other elements of the compression/liquefaction process are used to transfer the UF_6 vapor or liquid into receiving cylinders. These are essentially passive, primary containment systems. All of the piping is permanently installed. Pigtails are used to connect the receiving cylinders to the withdrawal manifolds and are discussed in Section 3.2.5. Pigtails are important to safety as discussed in Section 3.8.

3.2.2.2.1.2.2 Valves

Valves in the UF_6 Primary System are important to safety as a pressure boundary to control UF_6 from being released. All of the valves over three inches in diameter are the G-17 type. G-17 valves that are routinely exposed to pressures above atmosphere during normal operation have the bellows buffered and are monitored by the buffer system instrumentation described in Section 3.2.2.2.2.6. Valves less than or equal to three inches in diameter are ball valves, plug valves, or bellows sealed valves.

Air-operated control valves, automatic isolation valves, and high-pressure vent valves are designed to fail in the safe position in case of an air failure; thereby isolating the high-pressure section of the compression/liquefaction loop and venting the compressors back to the cascade.

3.2.2.2.1.2.3 Expansion Joints

Expansion joints are located between piping and fixed equipment on the suction and/or discharge lines of the compressors. They allow for thermal expansion of the piping and for small differences in pipe alignment. The space between the double walls of expansion joints is buffered and connected to the buffer monitoring and alarm panel to provide detection of expansion joint failure (leakage).

3.2.2.2.1.2.4 Accumulators

Accumulators are located in the liquid withdrawal line to provide storage of liquid UF_6 during withdrawal interruptions. Each withdrawal loop has its own accumulators. The accumulators are separated from other withdrawal loops by double block valves to prevent mixing of materials of different assays between the withdrawal loops. The size of these accumulators helps to determine the maximum allowable assay that may be withdrawn through that loop.

To ensure compliance with the cylinder assay limitations, administrative controls require periodic laboratory-analysis verification of continuous mass spectrometer assay determination and physical lockout of withdrawal header valves and double block valves between loops when two different assays are being withdrawn at the same facility.

3.2.2.2.1.3 Coolant and Condensing Systems

The LAW Station has two coolant systems. These systems use an evaporative coolant. One coolant system supports the PG coolers, removing the heat of compression, and the other system supports the UF_6 condensers, providing the proper temperature control for the condensation of UF_6. The coolant pressure is maintained at least 5 psi above UF_6 pressure and 5 psi above water pressure; allowing coolant to pass into the RCW or the UF_6 systems in the event of a leak. RCW cools both coolant systems.

Gas coolers cool the PG as it leaves the first stage of compression and the second stage recycle. UF_6 condensers cool and condense the PG after the second stage of compression. The UF_6 condensers have tubes designed to condense PG on the tube side and evaporate coolant on the shell side while operating at <60 psia design pressure on the UF_6 side. The UF_6 pressure and temperature relationship must be maintained to prevent liquefaction anywhere except in the condenser.

The LAW coolant systems have the same high-pressure protection as previously described for process cells (Section 3.1.1.2.5). The coolant systems for LAW are also provided with the following protection instrumentation:

- Coolant/Water Pressure Trip—To prevent water from entering the coolant system, pressure switches are provided to close the water inlet valve. The LAW Pressure Switches are important to safety and are discussed in Section 3.2.2.2.1.3.1.
- Water Flow Control—To maintain the coolant pressure controllers are provided to regulate the flow of RCW to the coolant condensers in the PG cooler and UF_6 condenser loops.
- Coolant Pressure/PG Pressure Switch—To prevent liquid UF_6 from entering the coolant system, pressure switches are provided to initiate HPV at LAW if the coolant vapor pressure approaches within the setpoint value of PG pressure in the condenser.
- Coolant Pressure Switch—To prevent the compressors from overheating, a pressure switch is provided to trip the compressor when the coolant pressure exceeds the setpoint value.

- Rupture Disc—To prevent overpressurization of the coolant system, each coolant condenser is provided with a rupture disc that is set to relieve at or below the setpoint value. These discs are part of the Coolant High Pressure Relief System, which is important to safety and discussed further in Section 3.2.2.2.1.3.2.

3.2.2.2.1.3.1 LAW Pressure Switches

The LAW Station coolant condensers (in both the PG cooler and UF_6 condenser loops) are equipped with pressure switches to prevent RCW from entering the coolant should the RCW pressure increase or the coolant pressure decrease. The system is important to safety as described in Section 3.8.

When the coolant pressure drops to a setpoint value or the RCW pressure rises to a setpoint value RCW flow to the coolant condenser is shut off. Pressure switches are used to close the air-operated block valve in the RCW supply line. Alarms are annunciated in the ACR if the setpoints are exceeded.

Loss of air to the block valve results in the valve failing closed. Therefore, there are no support systems required for the LAW Pressure Switches to perform their safety function.

3.2.2.2.1.3.2 Coolant High Pressure Relief System

The LAW Station is equipped with coolant overpressure protection. In the event of a coolant overpressure, the system is utilized to lower the coolant system pressure, protecting the UF_6 system. This system is important to safety as described in Section 3.8. Figure 3.2-8 shows the Coolant High Pressure Relief System.

The Coolant High Pressure Relief System is designed to relieve coolant pressure prior to rupturing the coolant system when the withdrawal coolant pressure reaches a design limit. The system activates prior to rupturing the coolant system, thus protecting the UF_6 primary system piping and equipment. Each condenser is provided with a rupture disc that is set to relieve at or below the MAWP. The rupture disc can be isolated from the system by closing a manual block valve.

3.2.2.2.1.4 Materials of Construction

Surfaces normally in contact with UF_6 process gas or liquid UF_6, are constructed with corrosion resistant material and are compatible with UF_6 and conditioning gas. All centrifugal compressors used in the withdrawal process have similar construction. The piping, valves, and expansion joints with all-welded bellows are constructed of materials that are compatible with UF_6 operations. Pigtails are used for required flexible connections and are discussed further in Section 3.2.5. Gas coolers are constructed with materials that are compatible with UF_6 operations. UF_6 condensers are constructed with tubes using all welded construction. Accumulators are constructed of pipe that will withstand pressures higher than will be encountered in service. Nickel, monel, aluminum, and copper have proven to be satisfactory materials for UF_6 operation and for corrosion protection.

3.2.2.2.2 Monitoring and Protection System

3.2.2.2.2.1 High Pressure Venting Isolation and Compressor Shutdown

The HPV is provided for the LAW Station and can be initiated by UF_6 outleakage detection, high compressor discharge pressure, or low UF_6/coolant differential pressure or by manual actuation. An air-operated control valve can be used to reduce compressor inlet pressure to achieve the desired operating level.

Each compression loop at the LAW Station has HPV isolation that operates independent of activities in the other compression loop (except when the withdrawal crossover switch is active). The crossover switch is activated when the crossover line is in use to close the HPV valves of the withdrawal position being used (see Section 3.2.2.2.3 for further discussion of the crossover line). The HPV consists of a line installed from the discharge (or inlet line to the orifice station) line of the second stage compressor to the vent return header. An air-operated valve is installed in this line for the purpose of relieving pressure from the loop, when necessary. HPV isolation of the loop includes isolating the orifice station, closing the inlet MOV to the station, and isolating the withdrawal cylinder. If the HPV circuits are activated, either manually or automatically, the entire compression loop will isolate and vent to the vent return header without any further operator action.

The stage 1 compressor discharge instrumentation which provides for the HPV on each compressor loop is located in the recycle line of the first stage compressor. It consists of two pressure switches. The PSH activates both audible and visual alarms locally and in the ACR. If the PSHH is energized, the HPV circuit will isolate the affected loop and vent it to the cascade. The PSHH is set so that automatic HPV (isolation and venting) will occur if a break in process piping occurs, total seal failure occurs, or a PG cooler ruptures allowing a large volume of coolant to enter the compression loop.

A Pyrotronics system monitors the outleakage detectors located outside the heated housing above the compressors on the cell floor. If either of the two detectors fire over the same compressor, a UF_6 outleakage alarm will occur. If both detectors over the same compressor fire a HPV time delay relay is actuated. This gives the operator time to evaluate the situation and prevent HPV from activating if HPV activation would compromise safety. The Pyrotronics Smoke Detection System is discussed further in Section 3.2.2.2.2.2.3.

Remote manual initiation of the HPV circuits can be performed from the compressor area, LCR, and ACR. Should the HPV circuits fail, the operator at the control panel can perform manual isolation, compressor shutdown, and venting.

3.2.2.2.2.1.1 Motor Load Indicators

Motor load indicators are used in the LAW facility to monitor 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 3.8.

Motor load indicators provide an indication of abnormal compressor operations. Ammeters, located in the ACR, are used routinely in normal operation to monitor the power levels of withdrawal motors. The ampere loading on the motors that drive the compressors are one indication of pending problems of failures. Operators look for large changes in motor loads to indicate process problems. 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.

3.2.2.2.2.1.2 Compressor Motor Manual Trip System

The Compressor Motor Manual Trip System provides the capability to rapidly deenergize the withdrawal compressor motors. This safety system takes credit for only the second stage compressor trip function. The purpose of this trip capability is to aid in the prevention and mitigation of releases during operations by (1) maintaining primary system temperature/pressure below allowable values, (2) reducing heat and/or friction, and (3) minimizing the amount of UF_6 released. This trip capability, one switch for each second stage compressor, is actuated from the ACR. The ACR trip function provides complete station motive shutdown. Emergency trip can also be accomplished from the PCF, although this capability does not trip individual compressors but deactivates the entire withdrawal facility.

The trip circuit is powered by 120 VAC control power. Loss of power will result in compressor shutdown. Therefore, the Compressor Motor Manual Trip System is fail-safe on loss of 120 VAC power. 120 VAC power is not required for the Compressor Motor Manual Trip System to perform its safety function.

In the event of a withdrawal system failure, the manual trip system is utilized to shut down the compressors and motors to prevent further UF_6 releases from occurring in compression areas. This system is important to safety as described in Section 3.8.

3.2.2.2.2.2 Outleakage Detection System

Four separate smoke-detection systems are used to monitor the LAW Station where operating pressures exceed or may exceed atmospheric pressure. The CADP Detector Systems monitor for UF_6 outleakage in the compressor and withdrawal areas. The High-Voltage Smoke Detector System is designed to detect outleakage in the accumulator/condenser area whereas, the Pyrotronics Smoke Detector Systems monitor the compressor and withdrawal positions. The Pyr-A-Alarm Smoke Detection System monitors the withdrawal room. Each system is described in the following sections.

3.2.2.2.2.2.1 Cascade Automatic Data Processing Detector Systems

In the LAW Station, CADP detectors are located in the compressor housing, outside the compressor housing over the compressor seals, and in the withdrawal room. The CADP 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. Detection of a UF_6 release results in audible and visual alarm indications in the ACR. The CADP system is described in more detail in Section 3.1.1.11.2. The UF_6 detectors located in the compressor housings are important to safety and are discussed separately below.

In the event of a UF_6 release in the compressor area or withdrawal room, an alarm will sound in the ACR when the CADP system is in the computer or manual mode. When in the manual mode the detector systems operate independent of the computer. An alarm is initiated through the CADP system when in the computer mode. The alarm condition notifies operating personnel that immediate investigation and corrective action must be taken.

The CADP provides the only compressor area coverage inside the compressor housing. However, in case of failure of the CADP detector system, the Pyrotronics systems will be relied upon to monitor the compressor area outside the housing. Should either system fail, a continuous smoke watch will be provided.

UF$_6$ Release Detection System

The compressor housings are equipped with a UF$_6$ Release Detection System. The CADP system operates as described above and in Section 3.1.1.11.2. UF$_6$ detector heads are located in each compressor housing. The detectors are normally operated in the computer mode. Upon detection of a UF$_6$ release, an alarm in the ACR is actuated. On loss of power in the computer mode, an alarm is initiated indicating system failure; the operator then initiates the manual mode. This system is important to safety as described in Section 3.8.

The 120 VAC electric power supply to the detector systems in the withdrawal facilities is supplied from the plant process auxiliary power system and fed from local distribution panels to the detector system control units located in the withdrawal facilities. The signal conditioning units convert 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits, control the detector system operating mode as either computer or manual, and energize relays that initiate alarm circuitry upon release detection. Release detection results in audible and visual alarms at the signal conditioner located at the facility and in the ACR. The 120 VAC power to operate the UF$_6$ Release Detection System is used for the computer operating mode and an audible signal circuit. Loss of 120 VAC power will result in loss of detection and alarm circuits. Therefore, the 120 VAC power supply is necessary for the UF$_6$ Release Detection System to perform its safety function. Loss of power to the CADP unit processor would alarm through the central computer to the ACR. The 120 VAC and 200 VDC power are support systems, which are important to safety as described in Section 3.8.

3.2.2.2.2.2.2 High-Voltage Smoke Detector System

The High-Voltage (Intel) Smoke Detector System monitors for a UF$_6$ release in the accumulator and condenser area. This system provides alarm annunciation (compressor area, LCR, and ACR); the operator initiates corrective action. Detector operation is discussed in more detail in Section 3.2.2.1.2.2.2.

3.2.2.2.2.2.3 Pyrotronics Smoke Detector Systems

The Pyrotronics Smoke Detector Systems monitor for a UF$_6$ release in the withdrawal and compressor positions. Low-voltage detectors are used to monitor outside the heated housing of each withdrawal and compressor position. The Pigtail Line Isolation System can be actuated by the Pyrotronics smoke detection system. The Pigtail Line Isolation System is important to safety and discussed separately below.

Actuation of any compressor area detector initiates audible and visual alarms in the withdrawal facility and in the ACR. Actuation of the Pyrotronics detectors in the compressor area also initiates a time delay relay, which will activate the HPV as discussed in Section 3.2.2.2.2.1. Detector operation is discussed further in Section 3.2.2.1.2.2.3.

Pigtail Line Isolation System

The withdrawal facility is equipped with a UF$_6$ release detection and isolation system for the withdrawal positions. The low-voltage UF$_6$ release detectors located above each withdrawal drain position are part of the Pyrotronics Smoke Detection System. Figure 3.2-10 shows a typical Pigtail Line Isolation System. Activation of either low-voltage detector above any withdrawal position pigtail will initiate isolation of that withdrawal position causing the following actions to occur: (1) closes the manifold safety valve; (2) closes the cylinder safety valve; (3) turns off power to pigtail heat tracing; and (4) initiates alarms in the withdrawal area, the LCR, and in the ACR.

The UF_6 line isolation valves associated with the Pigtail Line Isolation System include an air-operated cylinder safety valve (plug valve with vane operation and air-to-close), a diaphragm-actuated manifold safety valve (globe valve with air-to-open and spring-to-close), and valves associated with the air supply closure system (Figure 3.2-10). The cylinder safety valve is attached to the cylinder at the connection between the cylinder valve and the UF_6 pigtail. The cylinder safety valve remains in the open position until the air solenoid valve closes, which then causes the compressed air reservoir to discharge and close the cylinder safety valve. The compressed air reservoir is present in the system to ensure that air is available to close the cylinder safety valve in the event of a loss of plant air. The operator may manually operate the cylinder safety valve. The manifold safety valve is attached to the withdrawal manifold at the connection between the liquid UF_6 piping and the UF_6 pigtail. This valve uses air to open, and it fails closed upon loss of air supply. The manifold safety valve can be operated electrically, from the LCR, if the need exists to close the valve remotely.

If the automatic Pigtail Line Isolation System fails to close due to a system failure, an air-operated block valve associated with the gamma spectrometer can be closed from the exterior of the withdrawal room. The air-operated valve associated with the gamma spectrometer is independent of the automatic Pigtail Line Isolation System and is used as a backup to that system.

UF_6 release detectors are required for the automatic actuation of the Pigtail Line Isolation System. Manual activation of the Pigtail Line Isolation System is also provided. Additionally, an operator can initiate isolation of the withdrawal positions by manually closing the air-operated valve associated with the gamma spectrometer.

A 120 VAC power circuit is used to develop the 24 VDC power supply for the UF_6 release detection circuit. The power supply for the detectors is backed up with a 24 VDC battery pack in the event of a power failure. A 120 VAC power circuit also feeds the solenoid valves that actuate the pigtail isolation valves. The pigtail isolation valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power.

Each Pigtail Line Isolation System valve and the associated pigtail are electrically heated to maintain a temperature necessary to keep the UF_6 liquid during withdrawal operations. Initiation of the Pigtail Line Isolation System shuts off 120 VAC power to the heat tracing.

The plant air system provides the motive power for the Pigtail Line Isolation System valves. The manifold safety valve requires air to open; therefore, loss of building air will cause the valve to fail in the closed position, isolating the withdrawal position from its liquid source. The cylinder safety valve requires air to close. An air reserve volume tank provides this air. The air reservoir has a volume of air sufficient for valve closure.

In the event of a pigtail failure, the system is utilized to isolate the pigtail to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.8.

3.2.2.2.2.2.4 Pyr-A-Alarm Smoke Detection System

The Pyr-A-Alarm Smoke Detector System monitors for a UF_6 release in the withdrawal area. High-voltage detectors are used to monitor the withdrawal positions and, upon detection of a UF_6 release, close the withdrawal room ventilation system and initiate sump pump shutdown.

3.2.2.2.2.3 Assay Monitoring

Mass spectrometers and gamma spectrometers are used to monitor the assay of UF_6 at this withdrawal facility.

Samples are normally taken at 4-hour intervals for laboratory analysis and verification of assay determinations performed by the spectrometers. When both mass and gamma spectrometers are out of service, laboratory samples are collected every two hours, or more frequently as directed by the Cascade Controller/Coordinator.

3.2.2.2.2.3.1 Mass Spectrometers

Mass spectrometers provide an on-line means for monitoring material enrichment at withdrawal stations and ensuring the enrichment limitations are not exceeded. The mass spectrometer automatically traps, analyzes the sample, and records the assay. This information is used to control target cylinder assay.

The LAW Station has two spectrometers that monitor ^{235}U assay downstream of the compressor coolers.

Failure of any component of this system, other than laboratory standards and computer software, requires that alternate sampling be initiated. Alternate sampling can include the use of the gamma spectrometer or laboratory samples. Mass spectrometers are important to safety as discussed in Section 3.8.

3.2.2.2.2.3.2 Gamma Spectrometers

Gamma spectrometers are used to continuously monitor the ^{235}U assay for both liquid UF_6 loops of the withdrawal process. There is one gamma spectrometer for each of the two withdrawal loops. The gamma spectrometer and its isolation system operate off the plant 120 VAC power system as well as the plant air supply. Figure 3.2-11 shows a typical gamma spectrometer and isolation system. This system is classified as important to safety as described in Section 3.8.

Monitoring probes are located on the liquid UF_6 line between the accumulators and the withdrawal manifold. If the ^{235}U assay exceeds a preset value, audible and visual alarms are actuated locally, in the LCR, and in the ACR. An air-operated valve, located on the liquid UF_6 line between the accumulator and the withdrawal manifold, is automatically closed by deenergizing a solenoid valve on the plant air supply shutting off air to the isolation valve. The isolation valve then fails closed halting liquid UF_6 flow to the withdrawal cylinder. The isolation valve can also be closed remotely.

If the gamma spectrometer isolation system fails to close due to a failure in the system, the isolation valve can be closed electrically from the withdrawal room, ACR, or LCR. Since the operator is required to ensure assay limits are not exceeded and an alternate method of sampling is approved, support system failure is not a concern.

The 120 VAC power to operate the gamma spectrometer and isolation system is supplied from power panels. The 120 VAC power supplies not only the spectrometer instrument cabinet but also feeds the solenoid valves that actuate the isolation valves. The gamma spectrometer isolation valves are designed to close (i.e., fail-safe) upon loss of 120 VAC.

The plant air system provides the motive power for the gamma spectrometer isolation valves. The isolation valve requires air to open, therefore loss of building air will allow the valve to fail in the closed position.

The alarm point has been set above cylinder assay limits to allow operators some leeway at lower assays. Automatic operation of the gamma spectrometer and the liquid drain shutoff valve are tested semiannually.

3.2.2.2.2.4 Scales and Scale Carts

Each cylinder is placed on an air-driven cart equipped with cradles to accommodate the cylinder so that the cylinder can be moved to a scale and positioned for filling. The scales and scale carts are important to safety as discussed in Section 3.8. Both the scales and scale carts are discussed in more detail in Section 3.2.4.2.

The scale cart is provided with a movement prevention system with an interlock to prevent the scale cart from moving during withdrawal operations. The scale-cart air-supply hose is locked to the hose reel with a key-operated padlock, which prevents moving the scale cart while the pigtail is connected to the cylinder. An administrative control requires that the air interlock key be placed on the pigtail before being connected to the cylinder. After the pigtail is purged and leak-rated, the pigtail may be disconnected and the air interlock key removed.

The scale pit in LAW is filled to a minimum depth of 6 inches with borosilicate-glass raschig rings as required in the nuclear criticality safety program. This depth is verified during routine inspections and additional raschig rings are added if necessary. The raschig rings meet the requirements for composition and ring dimensions from ANSI/ANS-8.5, as described in Chapter 1, Appendix A. The scale pit has an automatic sump pump to transfer any liquid accumulating in the scale pit to a reservoir tank. The scale pit in the LAW Station is checked weekly for the presence of liquid. If more than one inch of liquid is detected, the pit is pumped.

3.2.2.2.2.5 High Vent Header Pressure Alarm

The plant auxiliary feed and vent return headers are normally used to supply UF_6 and to vent the withdrawal station to its withdrawal point. High vent header pressure alarms are provided for each compression loop to warn of high vent header pressure, which could result from inadvertent closing or a misvalving operation in the station's vent return header. This PBS, when actuated, sounds an alarm when the vent header pressure reaches a nominal 7.5 psia.

3.2.2.2.2.6 Buffer Systems

Selected valves, flanges, and expansion joints in the withdrawal facilities are buffered with plant air or nitrogen. The Buffer Systems provide a type of secondary containment for the process system to prevent a release of UF_6 to the atmosphere should the primary system have a small breach at a buffered location. The monitoring and control panels for the buffer systems in the withdrawal facilities provide a means of identifying failures in compressor flanges, valve bellows, and double wall expansion joints.

Double walled expansion joints are buffered in the space between the walls to detect for a single wall failure. Compressor flanges are buffered in the interstitial space between the flange gaskets. Valves are buffered in the bellows or between shaft packing.

Systems are employed to supply the appropriate amount of buffer gas to the equipment components due to pressure differentials across the compression/liquefaction loop. The high-pressure buffer control panel provides buffer gas to buffered components after the second stage of compression. The low-pressure buffer control panel supplies buffer gas to most of the remaining components. G-17 valves, which function in both the high-pressure and low-pressure systems, cannot withstand the full range of differential pressures that might be seen with a single source of buffer gas, therefore, the buffer gas is supplied to these valves at a variable pressure based on the process gas pressure.

Alarms for the high- and low-pressure system at the local panel and ACR, and the variable pressure alarm in the ACR are provided when a component failure occurs. This permits adequate time for isolation and replacement of failed or damaged components.

Each main control panel has the same instrumentation and alarms for the high- and low-pressure systems: 1) flow meter is set to activate at a preset limit above the normal flow rate; and 2) pressure differential switches (high and low) are set to activate at preset limits above and below the normal operating pressure. When an alarm is received, the buffer control panel must be checked to determine which buffered component may have caused the alarm and the corrective action to be taken.

3.2.2.2.2.7 Radiation Alarms

A radiation warning system, CAAS, monitors the LAW facility for nuclear excursions. The CAAS is important to safety as discussed in Section 3.8 and is further described in Section 3.6.2.

3.2.2.2.3 Operation

The LAW Station utilizes pneumatically and electrically operated indicators, controllers and alarms to accomplish the compression/liquefaction process. Table 3.2-1 lists the various controls and alarms associated with this facility.

Product is normally withdrawn from equipment where process pressures are below atmospheric pressure, yet high enough to meet the withdrawal stations' pressure requirements. Each compression loop (LAW-A and LAW-B) has an air-to-open control valve at the inlet of each loop with instrumentation to automatically control the desired suction pressure to the first stage of compression. The flow rate through the station determines the condensation and withdrawal rate.

Two recycle lines are provided for these compression loops. One recycles gas from the gas cooler outlet to the suction of the first stage of compression; the other recycles gas from the second stage compressor discharge back to the cooler inlet. Operating characteristics dictate that these recycle valves are not to be fully opened or fully closed, which may cause the compressors to surge or overheat. Therefore, these valves are normally operated in the manual mode.

Normally, the second stage compressor discharges into an orifice station having flow elements and control valves. Flow rates to the condenser can be controlled with this instrumentation, but normally the control valves are on manual control and the flow rate is only monitored. The control valves are connected to the HPV circuit as discussed in Section 3.2.2.2.2.1.

The gas then enters the PG condenser and is cooled. The PG is condensed to a liquid flowing by gravity to the accumulator(s). Each condenser is vented through a vent return line having an automatically air-operated control valve to remove light gases (lights) from the condenser. The maximum amount of liquid UF_6 in the condenser and piping, associated with LAW-A or LAW-B, is approximately 100 lb each.

To remove the lights from a product cylinder (burping), the liquid valve on the withdrawal manifold is closed and the evacuation valve opened. This will transfer the lights from the cylinder to the vent return header.

The accumulators float on line just below the condensers to provide a large volume for UF_6 when withdrawal interruptions are required. Each withdrawal loop is provided with two accumulators. A level indicator and high-level alarm are provided. The accumulator outlets are joined; an air-operated valve controls flow leaving the accumulator. The valve closes when the gamma spectrometer alarm actuates. It also can be closed at the discretion of the operator from the withdrawal room, ACR, and LCR. The maximum amount of liquid UF_6 in the accumulator, associated with LAW-A or LAW-B, is approximately 2,700 lb each.

The LAW Station incorporates a crossover line to link each of the withdrawal loops. This line allows the condensed PG from one loop to discharge into the withdrawal manifold and cylinder of the other withdrawal loop. Double block valves separate the condensed PG in each loop.

Before entering the withdrawal manifold, the liquid UF_6 passes through the air-operated valve associated with the gamma spectrometer. This valve can be closed from outside the withdrawal room.

The liquid withdrawal line goes from the heated housing to the first air-operated pigtail-isolation valve. The pigtail-isolation valves are discussed in Section 3.2.2.2.2.2.3 and are shown in Figure 3.2-10. Pigtail usage is discussed in Section 3.2.5. Figure 3.2-13 provides the general layout of equipment within the withdrawal rooms.

3.2.2.2.4 Heating Systems

Compressors, coolers, condensers, accumulators, manifolds, and associated piping and valves are enclosed in heated housings. Piping and equipment are maintained at a temperature necessary to keep UF_6 in the desired phase. The condenser and accumulator housings and pipe housings are heated with steam that is controlled thermostatically.

3.2.2.2.5 Ventilation Systems

The LAW Station is located adjacent to the outside wall of the process building. Large doors on the outside wall of the withdrawal rooms can be opened to allow the scale carts to move the cylinders outside so that they can be removed from the carts to their temporary storage position by overhead cranes. Since the air pressure on the operating floor inside the process building is slightly below atmospheric pressure, there is a small amount of air exchange from inside the withdrawal room to inside the process building.

At LAW, exhaust fans are turned on during cylinder change operations to expel small quantities of UF_6 that may escape during the disconnecting of pigtails. Air from the LAW exhaust duct in the north wall of the withdrawal room is discharged through a HEPA filter into the track alley just north of the withdrawal area roll-up doors. The LAW ventilation system is automatically shut down when the gas release alarm system has been manually actuated.

In addition to withdrawal operations, LAW compressors can be used to boost UF_6 flow streams for cold feed purposes. This technique maximizes cold feed sublimation rates by minimizing the static pressure of the cold feed cylinder. LAW valving and compressor operating characteristics are those encountered in standby mode with the suction valve open.

3.2.2.2.6 Effects of Outages

Two assay product withdrawals can be performed at the LAW Station. The LAW Station may be used to withdraw tails material in the event of a Tails Station outage. Valving and piping arrangements are also designed so that a spare compressor can be used with either compression loop.

3.2.2.2.6.1 Power Failure

When a total power failure occurs, a diesel-driven generator supplies power to the withdrawal station's MOVs. Should the diesel generator fail to start or supply power, tie-breakers can be closed to another generator to supply backup power for closing the MOVs.

The air-operated valves are designed to fail in the safe position; consequently the withdrawal cylinders, condensers, accumulators, and compression loops would isolate and the vent valve would open, when either an air or electrical failure occurs.

3.2.2.2.6.2 Plant Air Failure

Failure of the plant air system requires shutdown of the withdrawal facilities. During an air supply failure there would be time for an orderly shutdown and isolation. The compressor recycle valves and vent valves actuate protecting the compressors. The RCW control valves to the coolant condensers would close causing the compressors to trip on high coolant pressure.

Over a prolonged outage, the condensers and accumulators can be drained and evacuated.

3.2.2.2.7 Fire Protection

The only significant combustible material contained in the withdrawal area is the lubrication oil used in the compressor and motor lubrication. There are no combustible materials used in the construction of this facility.

The greatest fire hazard to this facility is the large quantity of process lubricating oil used to lubricate the process motor and compressor bearing, which may leak into this facility. In such events, the oil is caught and/or cleaned up using procedural controls.

Portable fire extinguishers are located inside the building. The LAW withdrawal area is provided with wet-pipe automatic sprinkler systems.

3.2.2.3 Tails Withdrawal Station

3.2.2.3.1 UF_6 Primary System

The UF_6 Primary System (i.e., compressors, valves, equipment containing UF_6, and piping) is considered the primary means of containment for UF_6 and includes both a UF_6 gas system and a UF_6 liquid system. The gaseous UF_6 system provides a containment boundary for UF_6. The liquid UF_6 system provides a pressure boundary and transfer of UF_6 in the liquid state. The UF_6 Primary System is important to safety as discussed in Section 3.8.

3.2.2.3.1.1 Compressors

Tails withdrawal utilizes an AC-38 centrifugal compressor for the first stage of compression. The first stage compressor is used as a bottom surge booster compressor in addition to the first stage of compression. For this reason, it has a large suction volume. Depending upon the desired withdrawal rate, either one or two Worthington centrifugal compressors may be used in parallel for the second stage of compression. There is also one AC-12 centrifugal compressor located in this system.

Lube oil is supplied for lubrication of the bearings of withdrawal compressors and motors. The design of the equipment and the lube oil interface maintains no direct contact between the lube oil system and the process gas system.

Pressure switches located on the lube oil supply lines to the Worthington compressors protect them from damage due to low oil pressure. Another compressor trip circuit activates when a compressor overloads (Section 3.2.2.3.2).

The PCF can shut down the compressors for the Tails Station.

3.2.2.3.1.2 Piping, Valves, Expansion Joints, and Accumulators

3.2.2.3.1.2.1 Piping

The piping and other elements of the compression/liquefaction process are used to transfer the UF_6 vapor or liquid into receiving cylinders. These are essentially passive, primary containment systems. All of the piping is permanently installed. Pigtails are used to connect the receiving cylinders to the withdrawal manifolds and are discussed in Section 3.2.5. Pigtails are important to safety as discussed in Section 3.8.

3.2.2.3.1.2.2 Valves

Valves in the UF_6 Primary System are important to safety as a pressure boundary to control UF_6 from being released. All of the valves over three inches in diameter are the G-17 type valve. G-17 valves that are routinely exposed to pressures above atmosphere during normal operation have the bellows buffered and are monitored by the buffer system instrumentation described in Section 3.2.2.3.2.5. Valves less than or equal to three inches in diameter are plug valves or bellows sealed valves.

Air-operated control valves and automatic isolation valves are designed to fail in the safe position in case of an air failure; thereby isolating the high-pressure section of the compression/liquefaction loop.

3.2.2.3.1.2.3 Expansion Joints

Expansion joints are located between piping and fixed equipment on the suction and/or discharge lines of the compressors. They allow for thermal expansion of the piping and for small differences in pipe alignment. The space between the double walls of expansion joints is buffered.

3.2.2.3.1.2.4 Accumulators

Accumulators are located in the liquid withdrawal line to provide storage of liquid UF_6 during withdrawal interruptions. Each withdrawal loop has its own accumulators. The accumulators are separated from other withdrawal loops by double block valves to prevent mixing of materials of different assays between the withdrawal loops. The size of these accumulators helps to determine the maximum allowable assay that may be withdrawn through that loop.

To ensure compliance with the cylinder assay limitations, administrative controls require periodic laboratory-analysis verification of continuous mass-spectrometer assay determination and physical lockout of withdrawal header valves and double block valves between loops when two different assays are being withdrawn at the same facility.

3.2.2.3.1.3 Coolant and Condensing Systems

The Tails Station has one coolant system, which serves both Tails compression loops. A non-evaporative coolant is used to remove the heat of compression and condense the PG. The coolant pressure is maintained at least 5 psi above UF_6 pressure and 5 psi above water pressure; allowing coolant to pass into the RCW or the UF_6 systems in the event of a leak. Both the PG cooler and UF_6 condenser are served by one coolant system, which is cooled by RCW.

Gas coolers cool the PG as it leaves the first stage of compression and the second stage recycle. UF_6 condensers then cool and condense the PG after the second stage of compression. The UF_6 condensers have tubes designed to condense PG on the tube side. The UF_6 pressure and temperature relationship must be maintained to prevent liquefaction anywhere except in the condenser.

If enriched uranium (up to 5% assay) is being withdrawn at Tails, the coolant must be analyzed for water content. If water content is above 50 ppm, the coolant must be drained and dried and the leak repaired before the withdrawal begins.

3.2.2.3.1.4 Materials of Construction

Surfaces normally in contact with UF_6 process gas or liquid UF_6, are constructed with corrosion resistant material and are compatible with UF_6 and conditioning gas. All centrifugal compressors used in the withdrawal process have similar construction. The piping, valves, and expansion joints with all-welded bellows are constructed of materials that are compatible with UF_6 operations. Pigtails are used for required flexible connections and are discussed further in Section 3.2.5. Gas coolers are constructed with materials that are compatible with UF_6 operations. UF_6 condensers are constructed with tubes using all welded construction. Accumulators are constructed of pipe that will withstand pressures higher than will be encountered in service. Nickel, monel, aluminum, and copper have proven to be satisfactory materials for UF_6 operation and for corrosion protection.

3.2.2.3.2 Monitoring and Protection System

3.2.2.3.2.1 High Pressure Venting Isolation and Compressor Shutdown

The Tails Station is operated with the UF_6 supply pressure well below atmospheric pressure if withdrawing tails. If withdrawing product at the Tails Station, the UF_6 supply pressure can exceed atmospheric pressure when the withdrawal cell is operating above atmospheric pressure. Conditions requiring HPV (e.g., excessive pressure or smoke detectors actuation) generate alarms only; the operator must manually activate the HPV system when needed. Remote operation of the required valves is performed from the ACR, or an air lock located near the compressor area on the cell floor. Pressing the HPV pushbutton closes selected compressor boundary valves, shuts down the desired compressor and closes manifold safety valves. The two AC-38 compressors do not have this circuitry; however, there are MOVs on the inlet of the compressor that can be operated from the ACR.

3.2.2.3.2.1.1 Motor Load Indicators

Motor load indicators are used in Tails facility to monitor 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 3.8.

Motor load indicators provide an indication of abnormal compressor operation. Ammeters, located in the ACR, are used routinely in normal operation to monitor the power levels of withdrawal motors. The ampere loading on the motors that drive the compressors are one indication of pending problems or failures. Operators look for large changes in motor loads to indicate process problems. 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.

3.2.2.3.2.1.2 Compressor Motor Manual Trip System

The Compressor Motor Manual Trip System provides the capability to rapidly deenergize the withdrawal compressor motors. This safety system takes credit for only second stage compressor trip function. The purpose of this trip capability is to aid in the prevention and mitigation of releases during operations by (1) maintaining primary system temperature/pressure below allowable values, (2) reducing heat and/or friction, and (3) reducing the amount of UF_6 released. This trip capability, one switch for each compressor, is actuated from the ACR. The ACR trip function provides complete station motive shutdown. Emergency trip can also be accomplished from the PCF, although this capability does not trip individual compressors but deactivates the entire withdrawal facility.

The circuit is powered by 250 VDC control power. The DC power system and its interface with the Compressor Motor Manual Trip System is described in Section 3.4.1. The DC power uses battery backup to ensure that on loss of power the motors can be tripped. Therefore, the 250 VDC power is required for the Compressor Motor Manual Trip System to perform its safety function. The 250 VDC is a support system, which is important to safety as described in Section 3.8.

In the event of a withdrawal system failure, the manual trip system is utilized to shut down the compressors and motors. This system is important to safety as described in Section 3.8.

3.2.2.3.2.2 Outleakage Detection System

Three separate smoke-detection systems are used to monitor the Tails Station where operating pressures exceed or may exceed atmospheric pressure. The CADP Detector Systems monitor for outleakage in the compressor and condenser/accumulator areas. The High-Voltage Smoke Detector Systems are designed to detect outleakage in the condenser/accumulator area; whereas the Pyrotronics Smoke Detector Systems monitor the compressors and withdrawal positions. Each system is discussed below.

3.2.2.3.2.2.1 Cascade Automatic Data Processing Detector Systems

In the Tails Station, CADP detectors are located in the compressor housing, the condenser/accumulator pipe housings, and the pipe housings above the cooler. The CADP 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. Detection of a release results in audible and visual alarm indications in the ACR. The CADP is described in more detail in Section 3.1.1.11.2. The UF_6 detectors located in the compressor housings are important to safety and are discussed separately below.

In the event of a UF_6 release in the compressor area or condenser/accumulator area, an alarm will sound in the ACR when the CADP system is in the manual mode. When in the manual mode the detector systems operate independent of the computers. An alarm is initiated through the CADP system when in the computer mode. The alarm condition notifies operating personnel that immediate investigation and corrective action must be taken.

The CADP provides the only compressor area coverage inside the compressor housing. However, in case of failure of the CADP Detector Systems, a continuous smoke watch will be provided or the station will be vented.

<u>UF_6 Release Detection System</u>

The compressor housings are equipped with a UF_6 Release Detection System. The CADP system operates as described above and in Section 3.1.1.11.2. UF_6 detector heads are located in each compressor housing. The detectors normally operate in the computer mode. Upon detection of a UF_6 release, an alarm in the ACR is actuated. On loss of power in the computer mode, the manual mode is initiated and an alarm is initiated indicating system failure. This system is important to safety as described in Section 3.8.

The 120 VAC electric power supply to the detector systems in the withdrawal facilities is supplied from the plant process auxiliary power system and fed from local distribution panels to the detector system control units located in the withdrawal facilities. The signal conditioning units convert 120 VAC power to 200 VDC to provide the necessary voltage for the detector circuits, control the detector system operating mode as either computer or manual, and energize relays that initiate alarm circuitry upon release detection. Release detection results in audible and visual alarms at the signal conditioner located in the ACR and visual alarms at the facility. The 120 VAC power to operate the UF_6 Release Detection System is used for the computer operating mode. Loss of 120 VAC power will result in loss of detection and alarm circuits. Therefore, the 120 VAC power supply is necessary for the UF_6 Release Detection System to perform its safety function. Loss of power to the CADP unit processor would alarm through the central computer to the ACR. The 120 VAC and 200 VDC power are support systems, which are important to safety as described in Section 3.8.

3.2.2.3.2.2.2 High-Voltage Smoke Detector Systems

The High-Voltage (Intel) Smoke Detector Systems monitor for a UF_6 release in the accumulator and condenser area. This system provides alarm annunciation (withdrawal area and ACR); the operator initiates corrective action. Detector operation is discussed in more detail in Section 3.2.2.1.2.2.2.

3.2.2.3.2.2.3 Pyrotronics Smoke Detector Systems

The Pyrotronics Smoke Detector Systems monitor withdrawal and compressor positions. Low-voltage detectors are used to monitor outside the heated housing of each withdrawal and compressor position. The Pigtail Line Isolation System can be actuated by the Pyrotronics Smoke Detection System. The Pigtail Line Isolation System is important to safety and discussed separately below. Actuation of any compressor area detector initiates audible and visual alarms in the withdrawal facility and in the ACR. Detector operation is discussed further in Section 3.2.2.1.2.2.3.

<u>Pigtail Line Isolation System</u>

The withdrawal facility is equipped with a UF_6 release detection and isolation system for the withdrawal positions. The low-voltage UF_6 release detectors located above each withdrawal position are part of the Pyrotronics Smoke Detection System. Figure 3.2-10 shows a typical Pigtail Line Isolation System. Activation of either low-voltage detector above any withdrawal position pigtail will initiate isolation of that withdrawal position causing the following actions to occur: (1) closes the manifold safety valve; (2) closes the cylinder safety valve; (3) turns off power to pigtail heat tracing; and (4) initiates alarms in the withdrawal area and in the ACR.

The UF_6 line isolation valves associated with the Pigtail Line Isolation System include an air-operated cylinder safety valve (plug valve with vane operation and air-to-close), a diaphragm-actuated manifold safety valve (globe valve with air-to-open and spring-to-close), and valves associated with the air supply closure system (Figure 3.2-10). The cylinder safety valve is attached to the cylinder at the connection between the cylinder valve and the UF_6 pigtail. The cylinder safety valve remains in the open position until the air solenoid valve closes, which then causes the compressed air reservoir to discharge and close the cylinder safety valve. The compressed air reservoir is present in the system to ensure that air is available to close the cylinder safety valve in the event of a loss of plant air. The operator may manually operate the cylinder safety valve. The manifold safety valve is attached to the withdrawal manifold at the connection between the liquid UF_6 piping and the UF_6 pigtail. This valve uses air to open, and it fails closed upon loss of air supply. The manifold safety valve can be operated electrically, if the need exists to close the valve remotely.

If the automatic Pigtail Line Isolation System fails to close due to a system failure, an emergency liquid-drain block valve in the withdrawal manifold can be closed from outside the withdrawal room. The emergency liquid drain block valve can be remotely closed at Tails by manually operating a valve stem operator on the outside wall of the withdrawal room. These manually operated valves are independent of the automatic Pigtail Line Isolation System and are used as a backup to that system.

UF_6 release detectors are required for the automatic actuation of the Pigtail Line Isolation System. Manual actuation of the Pigtail Line Isolation System is also provided. Additionally, an operator can initiate isolation of the withdrawal positions by manually closing a UF_6 liquid drain line block valve, or electrically closes the appropriate manifold safety valve.

A 120 VAC power circuit is used to develop the 24 VDC power supply for the UF_6 release detection circuit. The power supply for the detectors is backed up with a 24 VDC battery pack in the event of a power failure. A 120 VAC power circuit also feeds the solenoid valves that actuate the pigtail isolation valves. The pigtail isolation valves are designed to close (i.e., fail-safe) upon loss of 120 VAC power.

Each Pigtail Line Isolation System valve and the associated pigtail are heated to maintain a temperature necessary to keep the UF_6 liquid during withdrawal operations. Initiation of the Pigtail Line Isolation System shuts off 120 VAC power to the pigtail heat tracing.

The plant air system provides the motive power for the Pigtail Line Isolation System valves. The manifold safety valve requires air to open; therefore, loss of building air will cause the valve to fail in the closed position, isolating the withdrawal position from its liquid source. The cylinder safety valve requires air to close. An air reserve volume tank associated with the cylinder safety valve provides this air. The air reservoir has a volume of air sufficient for valve closure.

In the event of a pigtail failure, the system is utilized to isolate the pigtail to minimize the amount of UF_6 released. This system is important to safety as described in Section 3.8.

3.2.2.3.2.3 Assay Monitoring

Mass spectrometers (and a gamma spectrometer during product withdrawal) are used to monitor the assay of UF_6 at this withdrawal facility. Verification samples are taken periodically for laboratory analysis.

3.2.2.3.2.3.1 Mass Spectrometers

Mass spectrometers provide an on-line means for monitoring material enrichment at withdrawal stations and ensuring the enrichment limitations are not exceeded. The mass spectrometer automatically traps, analyzes the sample, and records the assay. This information is also used to control target cylinder assay.

The Tails Station has two independent, highly accurate, computer-controlled mass spectrometers used to monitor the ^{235}U assay of the tails material at the discharge of the AC-38 compressor.

Failure of any component of the system, other than laboratory standards and computer software, requires that alternate sampling be initiated, if the alternate mass spectrometer is not available. Alternate sampling can include the use of the gamma spectrometer or laboratory samples. Mass spectrometers are important to safety as discussed in Section 3.8.

3.2.2.3.2.3.2 Gamma Spectrometer

The standby Tails Station loop is provided with a gamma spectrometer that is used when performing intermediate product withdrawals. The gamma spectrometer and its isolation system operate off the plant 120 VAC power system as well as the plant air supply. Figure 3.2-11 shows a typical gamma spectrometer and isolation system. This system is classified as important to safety as described in Section 3.8.

The monitoring probes are located off the liquid UF_6 line in the withdrawal manifold. If the ^{235}U assay exceeds a preset value, audible and visual alarms are actuated in the ACR. An air-operated valve, located on the liquid UF_6 line in the withdrawal manifold, is automatically closed by deenergizing a solenoid valve on the plant air supply shutting off air to the isolation valve. The isolation valve then fails closed halting liquid UF_6 flow to the withdrawal cylinder. The isolation valve can also be closed manually by a switch in the withdrawal room near the gamma spectrometer.

Since the operator is required to ensure assay limits are not exceeded and an alternate method of sampling is approved, support system failure is not a concern.

The 120 VAC power to operate the gamma spectrometer and isolation system is supplied from power panels. The 120 VAC power supplies not only the spectrometer instrument cabinet but also feeds the solenoid valve that actuate the isolation valve. The gamma spectrometer isolation valve is designed to close (i.e., fail-safe) upon loss of 120 VAC.

The plant air system provides the motive power for the gamma spectrometer isolation valve. The isolation valve requires air to open, therefore loss of building air will allow the valve to fail in the closed position.

The alarm point has been set above cylinder assay limits to allow operators some leeway at lower assays. Automatic operation of the gamma spectrometer and the liquid drain shutoff valve are tested semiannually.

3.2.2.3.2.4 Scales and Scale Carts

Each cylinder is placed on an air-driven cart equipped with cradles to accommodate the cylinder so that the cylinder can be moved to a scale and positioned for filling. The scales and scale carts are important to safety as discussed in Section 3.8. Both the scales and scale carts are discussed in more detail in Section 3.2.4.2.

The scale cart is provided with a movement prevention system with an interlock to prevent the scale cart from moving during withdrawal operations. The scale-cart air-supply hose is locked to the hose reel with a key-operated padlock, which prevents moving the scale cart while the pigtail is connected to the cylinder. An administrative control requires that the air interlock key be placed on the pigtail before being connected to the cylinder. After the pigtail is purged and leak-rated, the pigtail may be disconnected and the air interlock key removed.

The scale pits in Tails, are filled to a minimum depth of 6 inches with borosilicate-glass raschig rings as required in the nuclear criticality safety program. This depth is verified during routine inspections and additional raschig rings are added if necessary. The raschig rings meet the requirements for composition and ring dimensions from ANSI/ANS-8.5, as described in Chapter 1, Appendix A. The scale pits in the Tails withdrawal area are checked weekly for the presence of liquid. If more than one inch of liquid is detected, the pits are pumped.

3.2.2.3.2.5 Buffer Systems

Selected valves, flanges, and expansion joints in the withdrawal facilities are buffered with plant air or nitrogen. The Buffer Systems provide a type of secondary containment for the process system to prevent a release of UF_6 to the atmosphere should the primary system have a small breach at a buffered location. The monitoring and control panels for the buffer systems in the withdrawal facilities provide a means of identifying failures in compressor flanges, valve bellows, and double wall expansion joints.

Double walled expansion joints are buffered in the space between the walls to detect for a single wall failure. Compressor flanges are buffered in the interstitial space between the flange gaskets. The area inside the bellows is buffered.

Systems are employed to supply the appropriate amount of buffer gas to the equipment components due to pressure differentials across the compression/liquefaction loop. The high-pressure buffer control panel provides buffer gas to selected components downstream of the compressors. The low-pressure buffer control panel supplies buffer gas to first stage compressor suction flanges. G-17 valves which function in both the high-pressure system and low-pressure systems cannot withstand the full range of differential pressures that might be seen with a single source of buffer gas, therefore, the buffer gas is supplied to these valves at a variable pressure based on the process gas pressure. A nitrogen system provides buffer gas to the suction, discharge, and casing flanges on some of the compressors in the Tails Station and the system is monitored with pressure gauges.

Alarms for the high- and low-pressure system at the local panel and ACR, and the variable pressure system alarm at the ACR are provided when a component failure occurs. This permits adequate time for isolation and replacement of failed or damaged components.

Each main control panel has the same instrumentation and alarms for the high- and low-pressure systems: 1) flow meter is set at a preset limit above the normal flow rate; and 2) pressure differential switches (high and low) are set to activate at preset limits above and below the normal operating pressure. When an alarm is received, the buffer control panel must be checked to determine which buffered component may have caused the alarm and the corrective action to be taken.

3.2.2.3.2.6 Radiation Alarms

A radiation warning system, CAAS, monitors the Tails facility for nuclear excursions. The CAAS is important to safety as described in Section 3.8.

3.2.2.3.3 Operation

The Tails Station utilizes pneumatically and electrically operated indicators, controllers and alarms to accomplish the compression/liquefaction process. Table 3.2-1 lists the various controls and alarms associated with these facilities.

The tails withdrawal rate is controlled by a recycle valve on the second stage compressor. As the recycle valve is closed, the withdrawal rate is increased; when the recycle is open, condensing of UF_6 decreases. During normal operating conditions, the compressor will have an adequate suction pressure, thereby preventing it from going into surge and overheating.

Normally, the second stage compressor discharges into an orifice station having flow elements and control valves. Flow rates to the condenser can be controlled with this instrumentation, but normally the control valves are on manual control and the flow rate is only monitored.

The gas then enters the UF_6 condenser and is cooled. The PG is condensed to a liquid and flows by gravity to the withdrawal position. Each condenser is vented through a vent return line having an automatically air-operated control valve to remove light gases (lights) from the condenser. The maximum amount of liquid UF_6 in the condenser and piping associated with the Tails waste system or the Tails product system, is approximately 400 lb each.

The accumulators float on line just below the condensers to provide a large volume for UF_6 when withdrawal interruptions are required. A level indicator is provided. When withdrawing product, an air-operated valve closes when the gamma spectrometer alarm actuates. The accumulators at Tails only accumulate liquid UF_6 when the withdrawal position can't take all the flow. The excess then backs up into the accumulators. The maximum amount of liquid UF_6 in the accumulator associated with the Tails waste system is approximately 14,000 lb and that associated with the Tails product systems is approximately 2,800 lb.

Entering the withdrawal manifold, the liquid UF_6 passes through a manually operated block valve. This valve can be closed from outside the withdrawal room.

The liquid withdrawal line goes from the heated housing to the first air-operated pigtail-isolation valve. The pigtail-isolation valves are discussed in Section 3.2.2.3.2.2.3 and are shown in Figure 3.2-10. Pigtail usage is described in Section 3.2.5.

The Tails withdrawal area has a mezzanine accessed only by a stairway. Accumulators and condensers are enclosed in a heated housing in this area. Due to the limited access to the mezzanine area, no personnel are allowed there during cylinder change operations. The Tails withdrawal room has manually operated sliding doors to allow the scale carts to be moved in and out of withdrawal position. Figure 3.2-14 provides the general layout of equipment within the withdrawal rooms.

3.2.2.3.4 Heating Systems

Compressors, coolers, condensers, accumulators, manifolds, and associated piping and valves are enclosed in heated housings or are heat traced and insulated. Piping and equipment are maintained at a temperature necessary to keep UF_6 in the desired phase.

In the Tails area the compressor housings are electrically heated. The remaining pipe housings, condenser and accumulator housing are heated with steam that is thermostatically controlled.

3.2.2.3.5 Ventilation Systems

The Tails Station is located adjacent to the outside wall of the process building. Large doors on the outside wall of the withdrawal rooms can be opened to allow the scale carts to move cylinders outside so that they can be removed from the carts to their temporary storage position by overhead cranes. Since the air pressure on the operating floor inside the process building is slightly below atmospheric pressure, there is a small amount of air exchange from inside the withdrawal room to inside the process building.

Portable air ventilation units are located at the Tails withdrawal positions to provide personnel protection during cylinder filling operations. These portable ventilation units, which filters air through a HEPA filter, are used to collect "smoke" (airborne UF_6, HF, and/or finely divided UO_2F_2) released when Tails pigtails are connected/removed from cylinders containing UF_6.

3.2.2.3.6 Effects of Outages

The Tails Station normally has a complete compression loop on standby; it may be used for tails withdrawal or product withdrawals. The LAW and ERP Stations could be used to withdraw tails if needed.

3.2.2.3.6.1 Power Failure

When a total power failure occurs, a diesel-driven generator supplies power to MOVs to isolate tails from the bottom unit in the cascade. Should the diesel generator fail to start or supply power, tie breakers can be closed to another generator to supply backup power for closing the MOVs.

The air-operated valves are designed to fail in the safe position; consequently the withdrawal cylinders, condensers, accumulators, and compression loops would isolate, when either an air or electrical failure occurs.

3.2.2.3.6.2 Plant Air Failure

Failure of the plant air system requires shutdown of the withdrawal facilities. During an air supply failure there would be time for an orderly shutdown and isolation. The compressor recycle valves would open protecting the compressors.

Over a prolonged outage, the condensers and accumulators can be drained and evacuated.

3.2.2.3.7 Fire Protection

The only significant combustible material contained in the withdrawal area is the lubrication oil used in the compressor and motor lubrication. There are no combustible materials used in the construction of this facility.

The greatest fire hazard to this facility is the large quantity of process lubricating oil used to lubricate the process motor and compressor bearing, which may leak into this facility. In such events, the oil is caught and/or cleaned up using procedural controls.

Portable fire extinguishers are located inside the building. The Tails withdrawal area is provided with wet-pipe automatic sprinkler systems.

3.2.3 Top Product and Side Withdrawals

Historically, via both permanent facilities and portable equipment, enriched UF_6 was withdrawn from any point in the enrichment cascade by freezing out the UF_6 to the walls of chilled cylinders. Within the permanent facilities and via portable equipment, the UF_6 was withdrawn into approved cylinders whose diameters varied based on the assay being withdrawn. The portable withdrawal unit used for these withdrawals consisted of a refrigeration unit and/or a cylinder bath to chill the walls of the cylinder and occasionally a scale. This same methodology could still be used to freeze out small quantities of UF_6 for laboratory standards from the individual cell control centers (LCC) into approved sample cylinders/withdrawal cylinders.

The Product Withdrawal (PW) is a fixed facility located in the southwest corner of the X-326, Process Building that was used to withdraw (>20% ^{235}U) product. The UF_6 can be removed from the cascade by routing it through headers from the desired cell/stage to a withdrawal manifold and a series of chilled cylinder bath 'pots' within the PW Facility. Presently, only the PW headers and the approved 'refeed' (UF_6 sublimation) positions are used within the PW Facility.

The Side Withdrawal in the X-330 was operated in conjunction with the Interim Purge Drums and the AC-12.5 compressor of the X-330 to X-326 "A" booster. Side Withdrawal within the Interim Purge area of the X-330 is no longer accomplished. The recycle line to the AC-12.5 compressor has been removed and Interim Purge area is abandoned-in-place except piping associated with Interim Purge Surge drum operations.

Portable withdrawal units were also used to make Side Withdrawals via the Line Recorder sampling lines and sample manifold located in each unit of the Cascade. A cell containing the desired assay location would be selected and the sample flow from a pair of Line Recorder sampling lines would be passed through a portable withdrawal unit. The UF_6 would freeze out on the walls of the chilled cylinder and the non-condensibles would be returned to the cascade via the Line Recorder return line.

Small scale Side Withdrawals can be accomplished at any cell in the isotopic cascade via the cell's sampling line and blister manifold, within a cell's LCC. The withdrawal unit consists of a set of heated pigtails connected to the LCC's blister manifolds and an approved laboratory sample cylinder immersed in a bath of dry-ice (solid CO_2). The valves of the sample cylinder are heated during the withdrawal to prevent UF_6 from freezing out within these valves and the LCCs are bounded. The flow through the sample cylinder is created by the pressure differential across the stage containing the selected assay. The gas flow enters the sample cylinder via the High Side blister manifold and the UF_6 is condensed to internal surface, while the non-condensibles are returned to the Cascade through the A-suction blister manifold.

3.2.4 UF_6 Cylinders, Handling and Weighing, Shipping and Receiving, Storage, and Transportation

3.2.4.1 UF_6 Cylinders

The container used for packaging, transporting, and storage of UF_6 including movement or handling during processing and manufacturing operations is referred to as a "cylinder" or "UF_6 cylinder." Low-enriched UF_6 is collected, stored, and transported in cylinders except when it is in the gaseous diffusion enrichment process.

The larger cylinders are specially designed and manufactured for use in handling UF_6 in a solid, liquid, or gas phase outside of the gaseous diffusion enrichment process. There are many cylinder types based on assay and handling/storage requirements of the enriched UF_6 material in the cylinder.

The United States (US) began enrichment of UF_6 for national defense purposes in the 1940's. The UF_6 was owned, enriched, transported, and used by US government equipment and facilities. Since the initial transport of UF_6 in this country involved government owned material; the criteria and standards to package, transport, and store the cylinders was developed by the US Department of Energy and its predecessor agencies. The commercial use of enriched UF_6 was developed in the 1950's to provide fuel for privately owned utilities in nuclear electric power plants. The US government owned the UF_6 enrichment process and facilities until the enrichment process was privatized in 1998. The expansion of UF_6 into commercial usage resulted in many feed producers and enrichment service customers providing their own UF_6 cylinders; thus, creating many designs of UF_6 cylinders. A standard design of UF_6 cylinders was needed for the packaging UF_6 for transport including specific information on design, fabrication, and procurement of new UF_6 packaging. The US nuclear industry (government and private) through the ANSI issued ANSI N14.1 in 1971, "Packaging of Uranium Hexafluoride for Transport." The cylinder is inspected as required against the ANSI standard for UF_6 cylinders.

3.2.4.1.1 Cylinder Description and Function

The UF_6 cylinders nominally 5-inchs in diameter or greater are currently fabricated to ANSI N14.1 and US Department of Transportation (DOT) standards specially designed and designated for use in handling UF_6 in a solid, liquid, or gas phase outside the cascade. All cylinders have one or two specially designed valves for filling or withdrawing UF_6 from the cylinder. The terms heavy wall and thin wall are used in the description of some cylinders to distinguish between the cylinder wall thickness based on a design pressure of 200 psig and 100 psig respectively. The heavy wall cylinders are approved by the DOT for shipment of enriched UF_6. The thin wall cylinders are used for storage of UF_6 onsite and are approved by the US DOT to ship <1% UF_6 offsite. Liquid UF_6 cylinders, which are defined as cylinders with the capacity to hold more than 500 lb UF_6, are designated as important to safety and are described in Section 3.8. UF_6 cylinders with a capacity to hold no more than 500 lb UF_6 are treated separately from the larger cylinders in Section 3.8; however, they are also designated as important to safety.

UF_6 cylinders provide UF_6 pressure boundary integrity to minimize the potential for releasing UF_6 to the atmosphere.

Cylinders currently in service and not defined in ANSI N14.1 are acceptable for continued use, provided they are inspected, tested, and maintained in accordance with the intent of the ANSI standard. The following should be noted relative to how the ANSI standard applies to cylinders manufactured to the different revisions of the ANSI standard, cylinders manufactured prior to the issue of the standard, and the use of existing pre-ANSI manufactured cylinders:

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 used within their original design limitations.

- 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 DOT.

There are many cylinder types based on assay and handling/storage requirements of the enriched UF_6 material in the cylinder. The commonly used UF_6 cylinders and function of each is shown in Table 3.2-2

The type of UF_6 cylinder operation and the buildings and ancillary facilities associated with each operation are as follows (except transporting cylinders over plantsite streets and rail system):

- X-326 - ERP Station
  - Top Product Withdrawal (PW)
  - Side Feed and Side Withdrawal
  - Tails Withdrawal (at ERP)
- X-330 -Tails Depleted Uranium Withdrawal Station
  - Side Feed and Side Withdrawal
  - LAW
- X-333 - LAW Station
  - Tails Withdrawal (at LAW)
  - Side Feed and Side Withdrawal
- X-342A -Supplemental Cascade Feed
  - Large Cylinder UF_6 Sampling
  - Cold Cylinder Cascade Feed
  - Controlled Feed
- X-343 -Cascade Feed
  - Large Cylinder UF_6 Sampling
  - Large UF6 Cylinder Storage (X-343N and X-343S Cylinder Storage Pads)
  - Cold Cylinder Cascade Feed
  - Controlled Feed
  - Cold Trap Operations
  - Shipping and Receiving
- X-344A -Large Cylinder UF_6 Sampling
  - Product Cylinder Transfer

- Cylinder Blending
- Small Cylinder Storage
- Cold Trap Operations
- Shipping and Receiving Area

- X-705 Decontamination Building
- X-710 Technical Services Building
- X-745 Cylinder Storage Yards
- X-745B Toll Enrichment Process Gas Yard
- X-745F North Process Gas Stockpile Yard
- X-745G Cylinder Storage Yard
- X-760 Chemical Engineering Building

Refer to Figure 3.2-15 for facility locations.

The primary administrative control placed on large UF_6 cylinders utilized in the facilities identified in this section is not allowing any liquid UF_6 filled cylinder (2-1/2-ton and larger) to be handled with mobile equipment. Operational controls associated with liquefaction and feeding of UF_6 cylinders are discussed in Section 3.2.1.1.1.

UF_6 cylinders are not filled with UF_6 when there is a significant discrepancy between shipper UF_6 cylinder weight and received cylinder weight until resolution of the difference is determined. New cylinders are inspected after manufacture to ensure that they do not contain hydrocarbon oil. Filling a cylinder containing hydrocarbon oil with liquid UF_6 could result in overpressurizing the cylinder.

ANSI N14.1 places weight limits on the amount of UF_6 that can be in UF_6 cylinders when they are shipped and on cylinder damage that could threaten their integrity.

UF_6 cylinders to be heated in an autoclave have their void volume verified before heating. Cylinders that do not meet the required void volume and/or damaged cylinders that do not meet inspection restrictions are heated only in a controlled feeding mode of operation that prevents liquefaction of the UF_6. A cold pressure check is performed before initial heating to determine the presence of contaminants.

3.2.4.1.2 Cylinder Maintenance and Testing Requirements

New cylinder inspection and cleaning requirements are specified in ANSI N14.1. New cylinders are required to meet an internal cleanliness standard for assurance against vigorous reactions between liquid UF_6 and organic impurities.

A visual inspection is performed to ensure cylinder integrity before filling, heating, or shipping. A UF_6 cylinder is removed from service for repair, replacement, or re-evaluation when it has leaks, excessive corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that in the judgment of the inspection personnel, renders it unsafe or unserviceable.

Repairs to the cylinders are made in accordance with applicable code requirements for ASME vessels or the cylinder is rejected.

As part of the periodic hydrostatic test procedure, an air leak test is performed on the cylinders. The cleaned and empty cylinders are pressurized with air and checked visually for leaks as a post-hydrostatic check of any potential failure points.

3.2.4.2 UF_6 Cylinder Handling and Weighing

The gross weight of full UF_6 cylinders requires that a number of specialized devices be used to handle, lift, move, protect, receive, weigh, and ship UF_6 cylinders. Cylinders containing UF_6 come from both out-of-plant sources and in-plant sources. The UF_6 in the cylinders may contain UF_6 in a liquid or solid state. The types of handling equipment are:

- Truck Trailers—Heavy-duty truck trailers are used to receive and ship cylinders. The truck trailers are also used to transport cylinders over intraplant roadways and in the cylinder storage yards. Only cylinders containing solid UF_6 are placed on and transported by truck trailers.
- Trucks—Three types of non-trailer type trucks are used for transport of small UF_6 cylinders along plantsite routes: modified pickup, modified step-van, and standard utility van with a hydraulically operated tailgate. Only cylinders containing solid UF_6 are placed on and transported by non-trailer type trucks.
- Railcars—Railcars are used to receive and ship cylinders. Only cylinders containing solid UF_6 are placed on and transported by railcars.
- Protective Package—Protective packages (referred to as "overpacks") are used to protect cylinders containing greater than or equal to 1.0% ^{235}U from damage due to fire or accident when cylinders are transported between diffusion plants and to toll customers by truck trailers or railcars. Only cylinders containing solid UF_6 are placed in overpacks. Cylinders that are within accepted heel limits do not require a package.
- Scale Cart—Scale carts (commonly referred to as "withdrawal carts") are used to move cylinders to and from withdrawal areas and scales in various plant facilities. The carts also allow the cylinders to be moved to an access area to allow receiving or transferring by cranes and other cylinder handling devices. The UF_6 in these cylinders is in a liquid state or solid state.
- Cranes—Cranes are used in various plant facilities to move cylinders to and from truck trailers, railcars, autoclaves, scale carts, and protective packages. The cranes are both mobile and overhead types. Mobile cranes are used only for handling solid or empty cylinders. Overhead cranes are used for cylinders that may be empty or have UF_6 in a gaseous, liquid or solid state depending on the facility function.
- Cylinder Carriers—Cylinder carriers (referred to as "cylinder hauler" or "straddle carrier") are used to transport cylinders between plant facilities and in the cylinder storage areas. The two types of straddle carriers are the "grapple-type" and "squeeze-type." The UF_6 in these cylinders is in a solid state.
- Scales—Scales are used to weigh cylinders throughout the enrichment process. The cylinders may be empty or have UF_6 in a liquid or solid state depending on the facility function.

- Forklifts—Forklifts are used to transport cylinders between plant facilities and in the cylinder storage areas. The forklifts transport empty cylinders, full solid cylinders, or cylinders containing small heels.
- Cylinder Stacker—Cylinder stackers are designed specially for use in stacking cylinders in the cylinder storage yards and for transporting cylinders intraplant. The UF_6 in these cylinders is in a solid state.

Only overhead cranes are used in the feed, withdrawal, and sampling areas to handle 2-1/2-ton, 10-ton, and 14-ton cylinders containing liquid UF_6. Overhead cranes are used to handle liquid UF_6 cylinders in the outside storage area of any facility where cylinders are filled. Once the UF_6 in the cylinders has solidified, the cylinders are handled with either an overhead crane or mobile equipment. The use of cranes is further discussed in Section 3.2.4.2.1.1. Full (solidified) or empty 30-in cylinders or cylinders containing small heels are transported with a forklift via a special handling attachment. Forklift capacity takes into consideration the combined weight of the cylinder and handling attachment.

The primary administrative control placed on handling of liquid UF_6 cylinders is not allowing any liquid UF_6 filled cylinder (2-1/2-ton and larger) to be handled outside the feed, withdrawal, transfer, and cylinder storage and handling processes. As a general administrative control, mobile equipment such as straddle carriers and forklifts is never used to move cylinders of hot liquid UF_6. A cooldown period, as specified in Section 3.2.4.5, is provided to allow the UF_6 to solidify before cylinders are transferred from the outside cooldown storage area of any facility where cylinders are filled by mobile equipment. The 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 at ambient temperature before they are moved with handling equipment not approved for use with liquid UF_6 cylinders, and (3) only approved cylinder handling equipment with qualified operators shall be used for the purpose of maneuvering UF_6 cylinders. Administrative controls associated with cranes and lifting devices are discussed in Section 3.2.4.2.1.1.

The cylinder handling equipment involved with handling liquid UF_6 cylinders has been identified as design features for safety and will be described below.

3.2.4.2.1 Liquid UF_6 Cylinder Handling

When any cylinder containing liquid UF_6 is handled or moved, the standard precautions for handling liquid-filled cylinders include:

- Moving the cylinder as low to the ground as practical,
- Not moving cylinders over other liquid-filled cylinders,
- Installing a cylinder valve protector prior to moving liquid-filled cylinders (exceptions include minimal movement on scale carts to facilitate valve protector installation and/or cylinder weighing), and
- Placing the cylinder valve at the 12 o'clock position.

The equipment is inspected as required by Occupational Safety and Health Administration (OSHA) 1910.179 and 1910.184, and ANSI/ASME B30.2, 9, 10, and 20.

The primary concern for the liquid UF_6 cylinder handling and weighing equipment is to prevent dropping a liquid-filled UF_6 cylinder that could result in a cylinder failure event. The operational controls and alarms for the handling equipment are designed to protect the liquid-filled UF_6 cylinders in order to prevent the occurrence of a cylinder failure event.

3.2.4.2.1.1 Liquid UF_6 Cylinder Handling Cranes and Lifting Fixtures

The liquid 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 liquid-filled UF_6 cylinders. Table 3.2-3 lists the overhead cranes and hoists in use at the Portsmouth site for liquid UF_6 cylinder handling. Liquid UF_6 cylinder handling cranes and liquid UF_6 cylinder lifting fixtures are important to safety as discussed in Section 3.8.

The system includes the overhead cranes and lifting devices (e.g., rigging) used for moving liquid UF_6 cylinders at the feed, toll transfer and sampling, product withdrawal, and tails withdrawal facilities. Liquid UF_6 cylinder handling cranes are designated as important to safety and are discussed in Section 3.8. Each crane is equipped with the following:

- Primary Hoist holding brake,
- Secondary control braking system (either an eddy current brake or mechanical holding brake),
- Limit switch to prevent a collision between the load hook and trolley,
- Mechanical rail stops at the end of the bridge tracks to prevent the bridge from running off the end of the tracks,
- Mechanical rail stops at the end of the trolley tracks to prevent the trolley from running off the end of the tracks, and
- Direct pendant controls to allow operation by an operator positioned at the floor level (radio operation, if equipped).

Additionally, some cranes are equipped with:

- Geared up/down limit switch connected to the cable drum to prevent lowering or hoisting the load too far,
- Proximity sensor and/or limit switch at the end of the bridge tracks to prevent the bridge from running off the end of the tracks, and
- Proximity sensor and/or limit switch at the end of the trolley tracks to prevent the trolley from running off the end of the tracks.

The major components and their functions for a liquid UF_6 handling crane are:

- Bridge—The main support structure between leg/rails provides the means of traveling with loads.
- Trolley—A cart-like device supporting the hoist mechanism and provides the ability to traverse the width of the bridge (side to side across the bridge).

- 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.
- Reeving—All pulleys, sheaves, guides, blocks, and tackle to guide or reverse the wire rope direction to achieve force multiplication of the hoist.
- Rails—Structural rail track members to support the wheels of the bridge, bridge legs, and trolley wheels used to guide the direction of movement. Electrical power rail to provide power to the crane.
- Lifting Block—The attaching point for the load using a hook or lifting fixture secured to the end of the down (wire/cable) rope of the hoist.
- Emergency Stop Controls—Device when activated (manually) immediately interrupts power to all crane functions and controls.
- 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.

Liquid UF_6 cylinder handling cranes are supplied with ac power from the building electrical service.

The lifting fixtures, or rigging, used for liquid UF_6 cylinder handling consists of special slings and fixtures that are designed, type-accepted, and certified for the specific handling tasks at the various facilities. The H-frame lifting fixture provides the attaching point for single- and double-hook cranes to handle the UF_6 cylinders. The rigging is a combination spreader bar with four shackles designed for attachment to the four lifting lugs on the 10- and 14-ton cylinders. The H-frame-type fixture facilitates loading and unloading UF_6 cylinders into and from the autoclaves without the use of any freestyle or impromptu rigging practices. Belly bands are used in addition to a lifting fixture for cylinders being loaded and unloaded from the elevated autoclaves in X-344A. The sling or fixture used to handle a UF_6 cylinder shall have the appropriate tags documenting the load test and visual inspections. Slings, which do not have the appropriate tags, are returned to the maintenance area for recertification or disposal. Code inspectors inspects each sling and fixture that handles UF_6 cylinders every three months, while the users perform visual inspections for kinks, knots, cracked or bent hooks, and other obvious damage each shift prior to use. Liquid UF_6 lifting fixtures are designated as important to safety and are discussed in Section 3.8.

The cranes are equipped with controls to control all bridge, trolley, hoist, and polar device (if equipped). Each crane is also equipped with an emergency stop control button to immediately interrupt power to all crane functions and controls when activated. The crane braking systems (bridge, trolley, and hoist) are failsafe upon loss of ac electrical power. The cranes are designed so that when ac power is interrupted, only small compensatory movements occur to prevent the load from swinging. The hoist brake will prevent the load from dropping in the event of an ac power failure.

All of the cranes used for liquid UF_6 handling purposes are inspected according to procedure by the crane operator prior to first time crane use each shift to ensure proper operation and the absence of damage to the cables, brakes, and other critical items. The crane operators are instructed to notify their management upon finding cranes, which do not satisfy the criteria presented in the pre-operational procedure and checklist. The deficient crane is tagged according to procedural requirements. A monthly and annual inspection in accordance with standard industrial practices is conducted of all liquid UF_6

cranes, and an annual load test is conducted of cranes at their rated capacities. Any cranes which are new, altered, uprated, or repaired after extensive damage are load tested at no more than 125% of their rated capacity before being placed into service per OSHA requirements. The cranes are required to meet the inspection requirements of ANSI B30.2.

3.2.4.2.1.2 Liquid UF_6 Cylinder Handling Equipment

Liquid UF_6 cylinder handling equipment comprises scale carts. This equipment is described in the following subsections. Liquid UF_6 cylinder handling equipment is important to safety as discussed in Section 3.8.

<u>Scale Carts</u>

The system includes scale carts (commonly referred to as "withdrawal carts") and a movement prevention system for Process Building withdrawal carts. The scale cart is a special movable work platform rail car for handling and moving UF_6 cylinders containing solid, liquid and gaseous UF_6 from withdrawal positions to crane access areas or on and off platform scales. The movement prevention system prevents movement of the withdrawal carts located in the Process Buildings when a pigtail is connected to a UF_6 drain line manifold.

The scale cart is an air driven work platform equipped with cradles/saddles to accommodate the UF_6 cylinder. Scale carts are designed with wheels, driven by an air motor, and operated on a rail track system. There are two types of scale carts in use in the plant: high profile and low profile. Both carts are designed to prevent the platform from falling an excessive distance. The scale carts move cylinders to and from the withdrawal stations; scales and loading/unloading areas for each facility. Scale carts are supplied with plant air. Failure of the plant air supply to the scale carts prevents cart movement. The scale carts require a visual inspection for structural damage, degradation, cracks, distorted members and loose fasteners.

The movement prevention system has an interlock to prevent a Process Building withdrawal cart from moving while a pigtail is connected to a UF_6 drain line manifold. The interlock comprises a key-operated interlock switch that blocks the air supply to the cart drive motor when the interlock key is not in the lock. The cart air supply hose is locked to the hose reel with a key-operated padlock, which prevents moving the cart while the pigtail is connected to the UF_6 cylinder. An administrative control requires that the air supply interlock key be placed on the pigtail before being connected to the cylinder. After the cylinder is filled and the pigtail purged to a negative pressure, the pigtail may be disconnected and the interlock key removed. The withdrawal cart movement prevention system is used in all withdrawal facility operations where a pigtail is connected to a UF_6 drain line manifold.

3.2.4.2.2 UF_6 Cylinder Weighing System

The UF_6 cylinder weighing system provides the means to weigh the UF_6 cylinders in various applications in the enrichment process. The UF_6 cylinder weighing system includes Field Accountability Scales, Laboratory Accountability Balances, Mass Standard Calibration Balances, and Production Scales at the ERP, LAW, and Tails Stations. The UF_6 cylinder weighing system is important to safety as discussed in Section 3.8. The scales are used to weigh cylinders and provide a means to determine the amount of UF_6 in the cylinders. Each UF_6 cylinder is accurately weighed upon receipt, and the weighing is repeated after each processing step (accurate weights are made for all UF_6 cylinders handled on plantsite for economic and security reasons). Weights of inbound cylinders from customers must match the shipper's reported weights within accepted tolerances for the given cylinder. If not, a weight verification procedure is performed to assure that the scale is operating properly. All accountability scales used at the Portsmouth site are checked each operating shift, prior to use, against weight standards traceable to the National Institute of Standards and Technology (NIST). Production Scales are used to check fill limits, and are calibrated annually. The required accuracy of the scales is established in plant implementing procedures and ensures that cylinder weights will be within safe limits.

The fill limits for all UF_6 cylinders are set at a value to allow the cylinders to be heated within the specified limits without causing hydraulic rupture of the cylinder. The UF_6 cylinder weighing system is designated as important to safety and is discussed in Section 3.8. It is therefore necessary to have accurate weighing devices available to ensure that the cylinders are filled within acceptable limits before the processing begins.

Some scales have steel-decked platforms with recessed rails to allow a scale cart containing the UF_6 cylinder to be moved on and off the scale for weighing without removing the cylinder from the cart. The scales are a combination of mechanical and electronic weighing components.

Some UF_6 Cylinder Weighing Systems are supplied with ac electricity from the building electrical service. These scales will not function on loss of ac electrical power. Lack of a weight readout is obvious to the operator. Mechanical scales are unaffected by loss of ac electrical power.

3.2.4.3 UF_6 Cylinder Shipping and Receiving

UF_6 cylinder shipping and receiving operations are primarily conducted at two locations depending upon the U-235 assay and type of container; however, cylinder shipping and receiving may be conducted anywhere that UF_6 cylinder handling has been analyzed and approved. Large cylinders (10-ton and 14-ton) of feed material are received at either X-343 or X-344A. Tails material in large cylinders is periodically shipped from Portsmouth. Cylinders of toll enriched UF_6 in 2-1/2-ton cylinders are shipped and received at either X-343 or X-344A. Sample containers and 5-, 8-, and 12-inch cylinders are shipped from X-344A.

3.2.4.3.1 X-343 Feed Vaporization Facility

X-343 is the usual receiving point for all inbound UF_6 feed material (toll, normal, and Paducah product feed) in large cylinders (10-ton and 14-ton) as well as the usual shipping point for those empty cylinders after they are fed to the cascade. X-344A can also be used for this activity.

Received cylinders are off-loaded from trucks or railcars using overhead cranes. Once unloaded, the cylinders are inspected for physical damage. The cylinders are also pressure checked prior to heating for the presence of non-condensable gases, such as air, or volatile contaminants, such as hydrogen fluoride, which could cause excessively high pressure within the cylinder upon heating. The cylinders are weighed using scales termed "accountability scales" which are calibrated against (NIST) traceable (standard) weights. Scales are described in Section 3.2.4.2.

After a cylinder is inspected and weighed it is lifted and carried outside with an overhead crane where it is stored. Receipt information, including cylinder identity, weight and storage location, is entered into the Production Automated Scheduling System (PASS). This information is routinely transferred from PASS to the plant's Dynamic Nuclear Materials Control and Accountability System several times a day, thereby maintaining accountability of the nuclear materials received on plantsite.

After feeding, the emptied cylinders are handled and loaded onto trucks with one of the overhead cranes in the same manner as full cylinders are unloaded. This involves moving empty cylinders by forklift to the crane-serviced areas of X-343.

3.2.4.3.2 X-344A UF_6 Sampling Facility

X-344A is the usual processing and shipping/ receiving point for low assay (5% enrichment or less) toll product UF_6. Typically, toll product is withdrawn from the enrichment cascade into large (10- and 14-ton) cylinders. Before the material can be shipped, it must be sampled and transferred into the smaller (2-1/2-ton) cylinders approved for transport over highways and railways. Special protective structural packages (PSPs) are used to protect the full product cylinders in shipment. The majority of the ground floor is occupied by the two high-bay areas which are served by overhead cranes and have large roll-up doors to allow entry of truck, semi-trailers, straddle carriers, forklifts, and railcars. Shipping and receiving of sample containers is also performed at X-344A. X-343 can also be used for shipping/receiving cylinders.

3.2.4.4 Cylinder Storage

Cylinders containing UF_6 are stored at several locations near the processing areas served. Storage facilities are required for feed and product cylinder inventories due to the wide variation in receipt and shipment schedules. Storage areas are also required for tails cylinders inventories.

The storage yards have aisles to provide 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 (e.g., concrete and/or aggregate layer) for both transport and storage.

The cylinders may be placed on saddles (e.g., treated wood, concrete) to prevent rolling and allow stacking of the cylinders. The saddles also help in corrosion prevention by keeping the cylinders off the ground.

The primary safety considerations for storage of 2-1/2-ton, 10-ton, and 14-ton UF_6 cylinders are that the storage surface be reasonably level, have good drainage, and have a stable base. To assure that the storage pads are of substantial construction; applicable sections of all appropriate codes, standards, and specifications are used. Two and one-half ton cylinders containing solid UF_6 are stored directly on the pad or on cradles. Ten- and 14-ton cylinders are generally stored on cradles to spread the loading over a larger area of the cylinder than the stiffening rings provide. However, 10- and 14-ton cylinders are also staged without cradles while awaiting final storage. The cylinders are stored in an orderly arrangement to facilitate inventory, inspection, and cylinder retrieval; the storage arrangement also precludes rolling of the cylinders.

Enriched UF_6 (greater than or equal to 1 weight per cent ^{235}U) is stored in cylinders. Cylinder integrity is important for nuclear safety. The large (2.5 ton and larger size) full UF_6 cylinders are visually inspected at least once per year to identify any degradation of the integrity of the cylinder wall, valve, or plug. Cylinders that do not meet the inspection critieria are handled commensurate with the observed damage. Large cylinders containing enriched uranium are inspected for damage following occurrence of an evaluation basis earthquake at the site.

If a breached cylinder containing enriched UF_6 (greater than or equal to 1 weight per cent ^{235}U) is discovered during handling or inspection, the Plant Shift Superintendent (PSS) will be notified immediately so that appropriate actions can be initiated. As part of the initial response actions, the cylinder will be covered to prevent entry of precipitation or liquid water from any source, and repairs will be affected in accordance with directions from nuclear criticality safety. Water is not to be sprayed on a cylinder that 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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The primary safety considerations for indoor, small cylinder (less than 30 inch diameter) storage areas are to provide for criticality safe storage geometries, low combustible loadings, and proper aisleways for handling equipment for the placement and retrieval of UF_6 cylinders into and from storage locations. Typically, the storage arrangements at various small cylinder process storage areas consist of rows of metal racks and tubular holders which are made in such a manner as to provide built-in safe spacing between containers in storage. Containers are moved in these storage areas singly and are manually pushed about in wide-based carts or wagons along "safe pathways" marked on the floors. Main traffic arteries are marked by "safe aisleway" boundary lines also painted on the floors. The wide-base carts assure proper spacing between the cylinders being handled during the momentary period between storage and loading/unloading of interbuilding transport vehicles. These carts are also used throughout the site for temporary or in-process storage of small UF_6 cylinders.

Administrative controls are used to minimize the potential of fire while using cylinder handling equipment with combustible fuel.

Large cylinders of the 10-ton and 14-ton size are stored in the X-745B, Toll Enrichment Process Gas Yard, X-745F, North Process Gas Stockpile Yard, and X-745G, Cylinder Storage Yard and at two additional processing lots (X-343N and X-343S) at X-343. Empty feed cylinders can be stored east of X-343 in a gravel lot to await eventual return to the supplier. Product cylinders of the 2-1/2-ton size are stored at the X-745B, X-343N, and X-343S storage lots. Refer to Figure 3.2-15 for facility locations.

Small (<2-1/2-ton) low assay UF_6 cylinders and empty small cylinders are stored in the X-344 miscellaneous storage area. The X-344A vault is used for storage of 5-, 8-, and 12-inch UF_6 cylinders with less than 20% assay.

3.2.4.4.1 X-745B Toll Enrichment Process Gas Yard

X-745B is a concrete paved area located south and west of and adjacent to X-342/X-344. X-745B normally holds 2-1/2-ton cylinders and PSPs, which are used as 2-1/2-ton shipping overpacks. Additionally, the berms of streets surrounding B-Lot are used to store new tails cylinders. X-745B may also be used for staging 10-ton or 14-ton cylinders. Clean, empty 48-inch cylinders may be triple-stacked along these streets to provide accessibility with special forklift adapters or stackers to supply X-330 with empty cylinders. The 2-1/2-ton cylinders may be stored in double-rows, side by side, directly on the concrete slab. No special clearance provisions were made as 2-1/2-ton cylinders are handled with a special forklift attachment.

3.2.4.4.2 X-745F North Process Gas Stockpile Yard

X-745F comprises paved lots, which provide overflow storage for X-745B and may also be used to stockpile enriched product in 10-ton and 14-ton cylinders. The storage yard has both an east and west area. The East area is located north of and adjacent to X-342. The West area is adjacent to East yard.

3.2.4.4.3 X-745G Cylinder Storage Yard

X-745G is a paved area located north of X-344A, across the perimeter road and is used for the storage of tails cylinders and cylinders below 1% enrichment.

3.2.4.4.4 X-343N and X-343S Cylinder Storage Pads

X-343N and X-343S are adjacent to the north and south ends of X-343, and are considered a part of X-343. These concrete paved areas provide storage for 2-1/2-ton, 10-ton and 14-ton cylinders. Overhead cranes may be used to handle the cylinders throughout the entire receiving, sampling, weighing, and shipping cycles. Empty cylinders may be double-stacked on these storage pads.

3.2.4.4.5 Withdrawal Facilities Storage Areas

X-330 has a storage area immediately outside of the withdrawal room at the northeast corner of the building. The area is used for staging empty cylinders and for holding filled cylinders until the required solidification criteria defined in Section 3.2.4.5 have been satisfied. Overhead cranes handle cylinders within the storage area. Cylinders are moved into and out of the withdrawal area stations by scale carts. Cradles are provided to prevent cylinders containing liquid UF_6 from rolling after being detached from the crane fixture.

The X-326 ERP Station has a staging/storage area located immediately outside the withdrawal area near the northeast corner of the building. Several pairs of cradles can be positioned under the overhead crane to provide adequate storage and cylinder cool-down capacity to service the ERP Station needs. Cylinders are moved into and out of the withdrawal station area by use of scale carts. Typically, the empty 10-ton cylinders are delivered to this storage location by a straddle carrier. After the cylinders are filled, they are required to satisfy the solidification criteria defined in Section 3.2.4.5 before being transported by straddle carrier for weighing and subsequent storage in X-745F lots. This small storage pad is concrete paved.

A similar concrete storage pad and overhead crane is located at the west end of X-333 to service the LAW Station. The LAW Station also has rail access under the overhead crane.

3.2.4.5 UF_6 Cylinder Transport

Cylinders containing liquid UF_6 shall only be moved by overhead cranes or scale carts. Administrative controls prohibit using straddle carriers, forklifts, mobile cranes, trucks, or other "mobile equipment" to transport liquid UF_6 cylinders. Cylinder solidification and eligibility for transport are determined using the following solidification criteria:

48-inch cylinders containing less than 4,000 lb of UF_6 must cool for at least 24 hours,

- 48-inch cylinders containing 4,000-8,000 lb of UF_6 must cool for at least 48 hours,
- 48-inch cylinders containing more than 8,000 lb of UF6 must cool for at least 5 days,
- 30-inch cylinders (all assumed to be filled to limit) must cool for at least 3 days,
- 5-, 8-, and 12-inch cylinders must cool for at least 24 hours.

Liquid-filled cylinders are moved only by scale carts inside the tails and product (ERP and LAW) withdrawal areas. Liquid filled cylinders are moved into the outside storage area by scale carts and placed onto cradles by overhead cranes. Liquid filled cylinders are moved by crane, one at a time, and are not carried over other cylinders in the temporary storage yard, where they are stored until the solidification criteria defined in this section have been satisfied.

Most of the areas where UF_6 cylinders are handled, such as ERP, LAW, and Tails, and most of the small cylinder handling areas do not require excessive lift height for clearing obstacles. One exception is the X-344A autoclave area where cylinders must be lifted to a height of about 15 ft above floor level in order to facilitate loading and unloading from the autoclaves. Typically (toll operations), the cylinders being loaded are cold and contain solid UF_6 and cylinders being unloaded may contain up to approximately 1,500 lb of hot UF_6 (transfer). As a precaution, belly bands are placed around a 10- or 14-ton cylinder prior to handling for loading or unloading from elevated autoclaves in X-344A. During technetium cleanup operations, full cylinders containing liquid UF_6 may be loaded and unloaded.

Small cylinders containing solid UF_6 may be moved on carts in trucks. To prevent cart movement in the truck during transport, the carts are secured to the truck sidewalls.

Administrative controls limit the movement of cylinders containing liquid UF_6, so that intraplant transport involves only solid, subatmospheric release conditions.

See Section 3.2.4.2 for additional information on transport equipment.

3.2.4.5.1 UF_6 Cylinder Valve Protectors

After a cylinder containing liquid UF_6 is disconnected and weighed, a metal valve protector is installed over the cylinder valve. Valve protectors are metal covers that fit down over the cylinder valve and fasten in place to protect the valve from impacts that may cause a failure of valve integrity. This protective cover will remain over the valve until the solidification criteria defined in this section have been satisfied. An exception to this is for small movements of the scale cart to facilitate cylinder weighing or valve protector installation. UF_6 cylinder valve protectors are considered important to safety and are further discussed in Section 3.8.

3.2.5 UF_6 Cylinder Pigtails

3.2.5.1 General

Various feed, withdrawal, and sampling systems transfer UF_6 between processing systems and UF_6 cylinders, or from one UF_6 cylinder to another. Flexible tubing and the related hardware designed to connect UF_6 cylinders to these processing systems are commonly called pigtails. The UF_6 cylinder pigtails that are classified as important to safety are discussed in Section 3.8. These UF_6 cylinder pigtails are described in the following paragraphs. Other UF_6 cylinder pigtails that are not classified as important to safety, which generally handle only gaseous UF_6 are also used on site but are not further addressed herein.

3.2.5.2 Equipment Descriptions and Functions

The UF_6 cylinder pigtails comprise a pigtail assembly, including a cylinder safety valve, and gaskets. A pigtail assembly is fabricated of metal tubing equipped with fittings that allow the pigtail to be attached to a manifold or isolation valve at one end and the cylinder safety valve at the other end. Gaskets are used between the sealing surfaces of the pigtail assembly and the cylinder safety valve and equipment to which they are connected. UF_6 cylinder pigtails that are used outside of heated enclosures (i.e., autoclaves, heated housings) will have heat tape applied to the pigtail assembly and cylinder safety valve to prevent liquid UF_6 freezeout during its use.

UF_6 cylinder pigtails are used in Buildings X-326, X-330, X-333, X-342A, X-343, and X-344A. Refer to Section 3.8 for a discussion of the boundary definition of UF_6 cylinder pigtails.

A specific pigtail design is employed for each liquid UF_6 operation. All liquid UF_6 cylinder pigtails are fabricated and inspected per approved procedure in conjunction with the information provided by the applicable drawing. Prior to connecting a certified pigtail, it is visually inspected for defects and new pigtail gaskets are installed on each end fitting. This inspection is primarily intended to prevent the use of pigtails either in a damaged or worn condition. Pigtail gaskets are inspected upon receipt to assure compliance with established standards. Prior to disconnection, pigtails that have been in contact with UF_6 must be purged and evacuated several times to ensure that the pigtail does not include any easily removable UF_6. Prior to disconnection, an acceptable leak rate must be obtained per procedure to ensure that all UF_6 has been removed from the pigtail. The use of torches to heat pigtails and associated valves is prohibited. Used pigtails and cylinder safety valves must be handled in accordance with the applicable Nuclear Criticality Safety requirements. The pigtails must be free of organic contaminants that can react violently with the corrosive process liquids.

3.2.5.3 Maintenance and Testing Requirements

UF_6 cylinder pigtails are subjected to a hydrostatic test and a helium vacuum leak rate test as part of the certification procedure. Certified pigtails are provided with a certification tag. After certification, all newly made pigtail connections are tested per applicable procedure prior to admitting UF_6. These tests comprise a positive pressure leak rate test, a vacuum check, and a visual inspection. Plant experience has demonstrated that pigtails will fail these tests long before there is any structural weakness in the pigtail. The only normal maintenance performed on certified UF_6 cylinder pigtails is to replace the gaskets prior to making a new connection.

Table 3.2-1. Compression/Liquefaction Station Controls and Alarms

PROCESS CONDITION	CONTROLLING ACTIONS						
	Pigtail Valve Closes	Compressor Motor Trip	Close Station Suction MOV's	Coolant Pump Shutdown	Lube Pump Shutdown	Open Vent to Cascade	Alarm
Compressor Motor Trip			ERP			ERP	X
Lube Oil Pump Off		X	ERP			ERP	X
UF6 Release	X		ERP & LAW			ERP & LAW	X
High Cylinder Drain Weight							LAW
High Accumulator Weight							ERP & LAW
High Motor Load							X
Very High Motor Load		X	ERP			ERP	X
High Coolant Temperature							ERP & LAW
High Coolant Pressure		ERP & LAW	ERP			ERP	ERP & LAW
Low Coolant Pressure*							ERP & LAW
Low Lube Oil Pressure		X	ERP			ERP	X
Loss of Control Power		X	ERP	Tails	X	ERP	X
Compressor Discharge Pressure			ERP & LAW			ERP & LAW	X
High RCW Pressure*							ERP & LAW
Remote Manual Shut Down		X	Tails & ERP			ERP	X

X = ERP, LAW, and Tails Withdrawal Stations.
* High RCW Pressure or Low Coolant Pressure closes condenser RCW supply valve at ERP & LAW

Table 3.2-2 UF_6 Cylinder Fill, Temperature, and Assay Limits

Size Code	Container Code/ ANSI N14.1 *Model number*	Description	Off-site Shipments fill limit	Heel Limits	% ^{235}U assay	On-site use fill limit	Heating (°F) temperature operating/ maximum	% ^{235}U assay	H/U ratio
	U-tube 1/4 in.	HAP 2-valve				10 g		100	
	U-tube 3/8 in.	HAP 2-valve				30 g		100	
	U-tube 1/4 in.	HAP 3-valve				22 g		100	
	U-tube 3/8 in.	HAP 3-valve				34 g		100	
HT	910	1/4 in Hoke tube				9 g		100	
HT	910	5/8 in Hoke tube			100	65 g		100	
HT	910	5/8 in Hoke tube			100	65 g		100	
PF		P-10 tube	12 g		100	20 g Sm-12 g Lg-38g		100	
99	990	Buggy cold trap		20 g	100	1500 g		100	
1H	01	1 in Sample container			100	206 g		100	
1S	972/1S	1 in Sample container	454 g		100	454 g		100	
2S	03/2S	3 in. Harshaw type	2175 g*	20 g	100	2175 g*		100	
5L	AL	5 in Aluminum		45 g	100	55 lb (24,902 g)	220/235	100	
5S	ST	5 in Steel		45 g	100	55 lb (24,902 g)	220/235	100	
5A	05/5A	5 in Monel		45 g	100	55 lb (24,902 g)	220/235	100	
5B	5N/B	5 in Nickel	54.9 lb (24,902 g)	45 g	100	55 lb (24,902 g)	220/235	100	
8H	08	8.5 in Helium		227 g		245.00 lb	220/235	70	0.088
8S	08	8 in Steel				245 lb (111.130 kg)	220/235	96.65	0.088
8A	08/8A	8 in Monel	255 lb (115.665 kg)	227 g	12.5 g	255 lb (115.665 kg)	220/235	97.65	0.088

Table 3.2-2 UF_6 Cylinder Fill, Temperature, and Assay Limits (continued)

Size Code	Container Code/ ANSI N14.1 *Model number*	Description	Off-site Shipments fill limit	Heel Limits	% ^{235}U assay	On-site use fill limit	Heating (°F) temperature operating/ maximum	% ^{235}U assay	H/U ratio
10	10	10-in.		454 g		350 lb (158.756 kg)		70	0.088
12	12A	12 in, 1 valve (3/4 in)	460 lb (208.651 kg)	454 g	5.0	460 lb (208.651 kg)	235/250	40.0	0.088
12	12MD	12 in, 2 valve (1 in)		454 g	5.0	460 lb (208.651 kg)	235/250	40.0	0.088
12	12FN	12 in, 2 valve (1 in)				430 lb (195.0 lb)	235/250	40.0	0.088
13	12B	12 in, 2 valve (3/4 in)	460 lb (208.651 kg)	454 g	5.0	460 lb (208.651 kg)	235/250	40.0	0.088
30A	30/30A	2-1/2 T, Concave	4950 lb (2,245 kg)	25 lb	5.0‡	4950 lb	235/250	5.0	0.088
30B	30/30B	2-1/2 T, Convex	5020 lb (2,277 kg)	25 lb	5.0‡	5020 lb	235/250	5.0	0.088
48A	48/48A	10-T, Heavy wall	21,030 lb (9,539 kg)	50 lb	<1.0 ****	21,030 lb	235/250	4.5	0.088
(Cylinder Nos. 1-5000)									
48X	X/48X	10-T, Heavy wall	21,030 lb (9,539 kg)	50 lb	4.5 ‡	Private or DOE owned	235/250	4.5***	0.088
4B	T/48T	10-T, Thin wall	Tails storage	50 lb		20,700 lb (9,389 kg)	220/235	4.5	0.088
								<1.0	0.3
(Cylinder Nos. 5001 -9230)									
4F	F/48F	14-T, Heavy wall	27030 lb (12260 kg)	50 lb	< 1.0 ****	27,030 lb (12,260 kg)	220/235	4.5 *****	0.088
(Cylinder Nos. 9231-9660)									
4Y	Y/48Y	14-T, Heavy wall	27560 lb (12500 kg)	50 lb	< 1.0 ****	27,560 lb (12,500 kg)	235/250	4.5 *****	0.088
(Cylinder Nos. 9661-9999)									

Table 3.2-2 UF_6 Cylinder Fill, Temperature, and Assay Limits (continued)

Size Code	Container Code/ ANSI N14.1 *Model number*	Description	Off-site Shipments fill limit	Heel Limits	% ^{235}U assay	On-site use fill limit	Heating (°F) temperature operating/ maximum	% ^{235}U assay	H/U ratio
4Y	OM/480M Allied	14-T, Thin wall	27030 lb (12260 kg)	50 lb	< 1.0 ****	27,030 (12,260 kg)	220/235	4.5 *****	0.088
(Cylinder Nos. AC0001-400)									
4G	OM/48G	14-T, Thin wall	Tails storage	50 lb	< 1.0 ****	26,070 lb	200/210	4.5 *****	0.088
								< 1.0	0.3
(Cylinder Nos. 111820 and below)									
4G	OM/48G	14-T, Thin wall	26,840 lb**	50 lb	< 1.0 ****	28,000 lb	220/235	4.5 *****	0.088
								< 1.0	0.3
(Cylinder Nos. 111821 and above)									
4G	HX/48H, 48HX	14-T, Thin wall w/skirt	Tails storage Normal	50 lb	< 1.0 ****	27,030 lb (12,260 kg)	220/235	4.5 *****	0.088
								< 1.0	0.3
(Cylinder Nos. 148513-151000)									
4G	H/48H	14-T, Thin wall w/skirt	Tails storage Normal	50 lb	< 1.0 ****	27,030 lb (12,260 kg)	220/235	4.5 *****	0.088
								< 1.0	0.3
(Cylinder Nos. 151001-15XXXX)									

* Fill limit for stamped cylinder is 4.9 lb or 2222g. Fill limits for older, unstamped containers are 2175 g.
** Fill limits may be slightly higher but must not exceed a 95% liquid volume based on actual cylinder volume.
*** 5.0% ^{235}U assay for properly identified intraplant 10-ton cylinders.
**** < 1.0% ^{235}U assay offsite limit as no overpack is available.
***** 4.5% ^{235}U assay is permissible onsite per NCSA
‡ H/U - 0.088

Table 3.2-3 Cranes for Handling Liquid UF_6 Cylinders

Location	Type	Capacity	Primary Use
X-326 ERP	Bridge **	20 Tons	Loading/unloading scale carts of liquid UF_6
X-330 Tails	Bridge	(2) 20 Tons	* Loading/unloading scale carts of liquid UF_6
X-333 LAW	Bridge	20 Tons	Loading/unloading scale carts of liquid UF_6
X-342A Feed	Bridge	20 Tons	* Sampling, feeding & weighing of liquid UF_6 cylinders
X-342A Feed	Bridge	18 Tons	* Sampling, feeding & weighing of liquid UF_6 cylinders
X-343 Feed	Bridge **	(2) 20 Tons	* Sampling, feeding & weighing of liquid UF_6 cylinders, and Shipping/Receiving
X-344A North	Bridge **	(3) 20 Tons	* Transferring & weighing of liquid UF_6 cylinders, and Shipping/Receiving
X-344A South	Bridge	(2) 20/17 Tons	* Shipping, receiving, weighing
X-326 PW	Monorail	(2) 500 lb	Product Withdrawals, Weighing

* Multiple crane trolleys bridging a common pair of rails

** Radio-controlled

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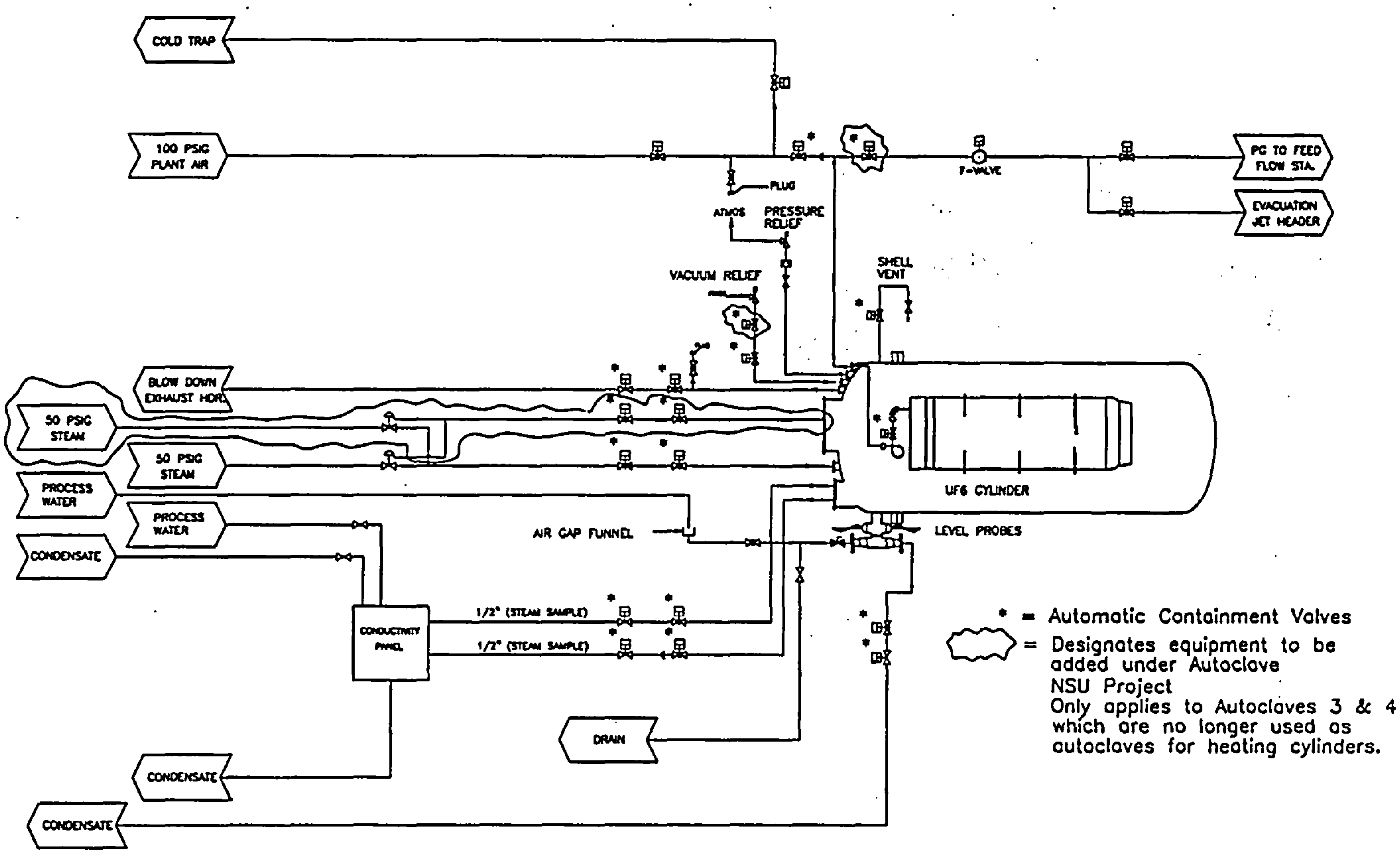

Figure 3.2-1. Diagram of a Six Foot Feed Autoclave, X-343

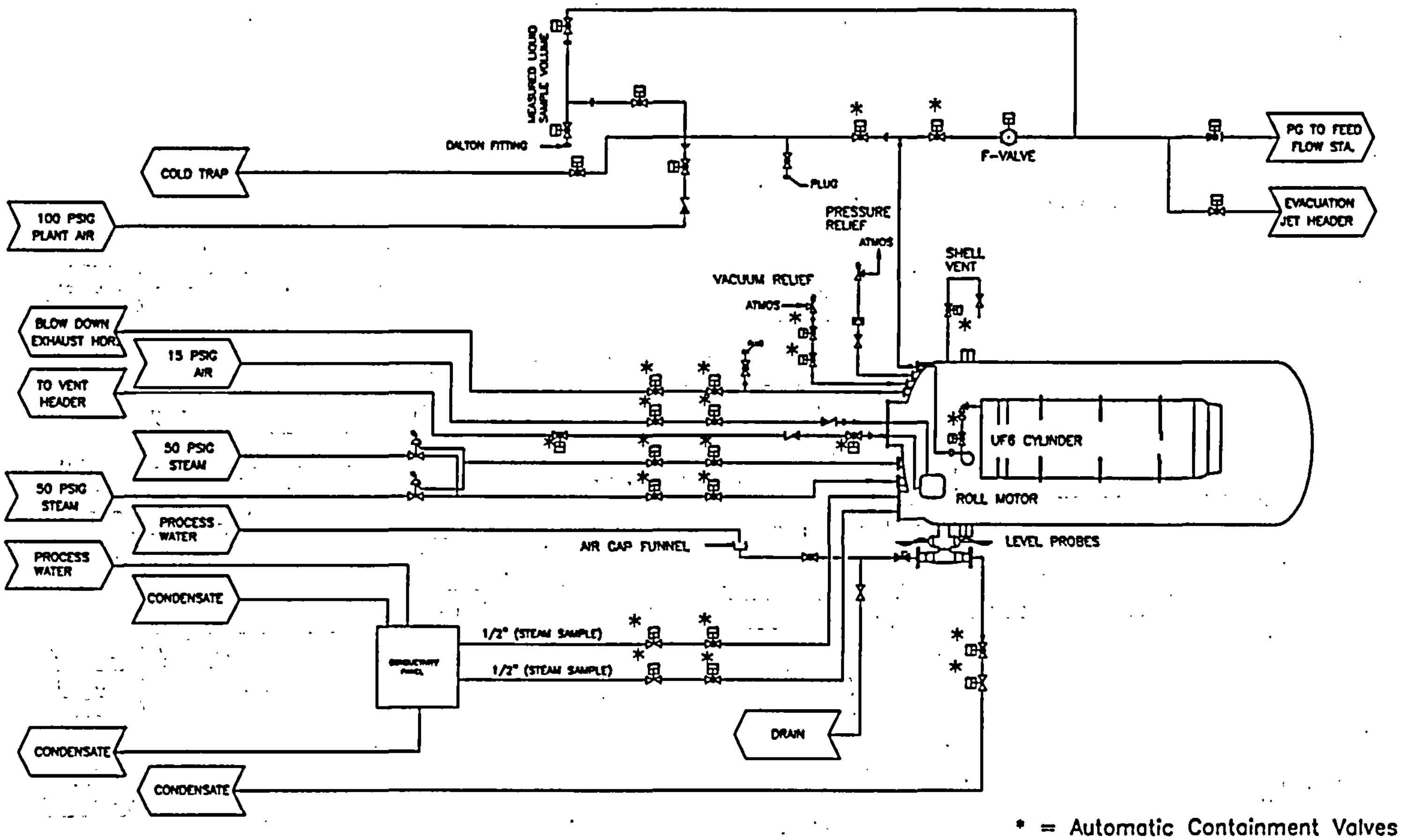

Figure 3.2-2. Diagram of a Seven Foot Feed and Sample Autoclave, X-343

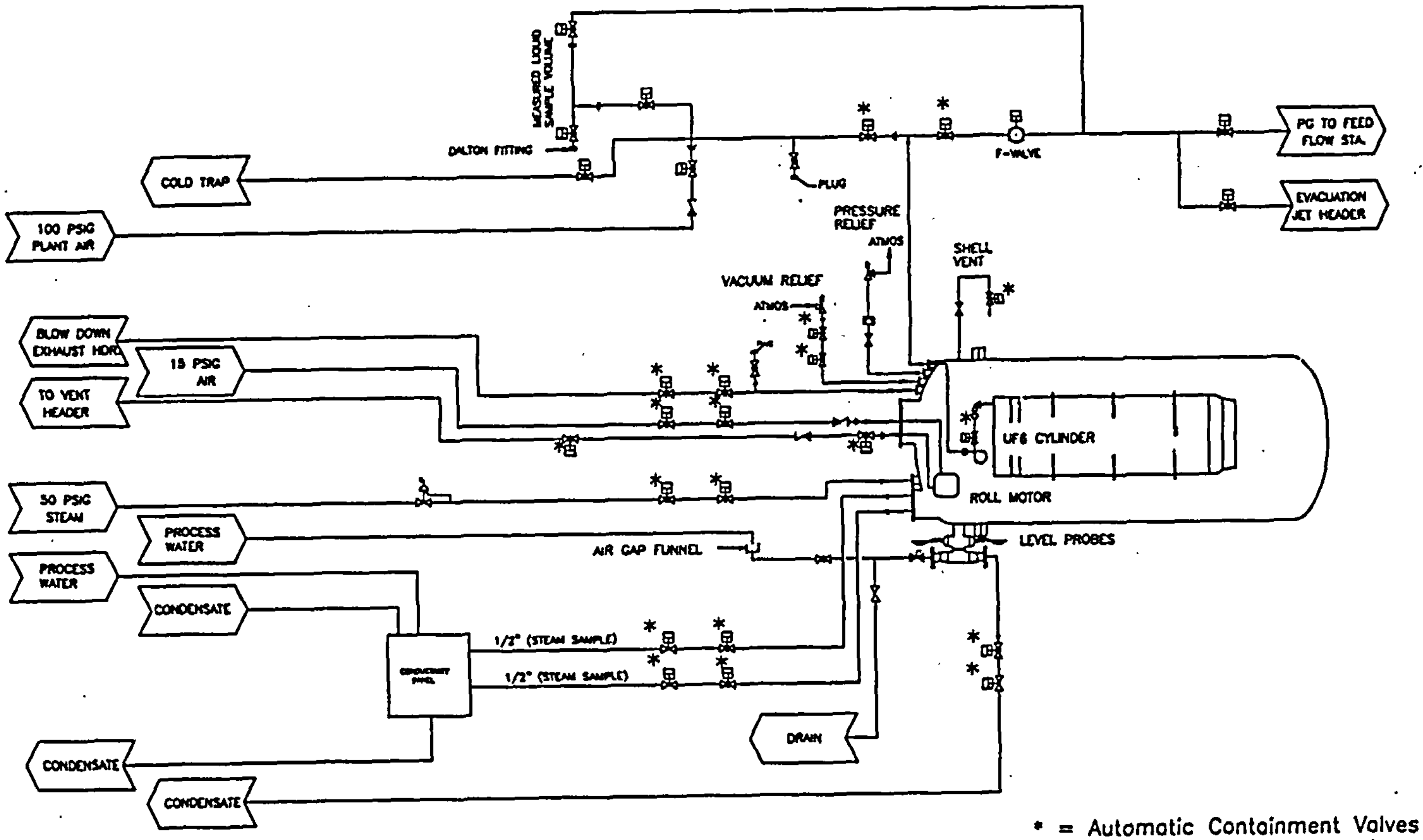

Figure 3.2-3. Diagram of a Seven Foot Feed and Sample Autoclave, X-342A

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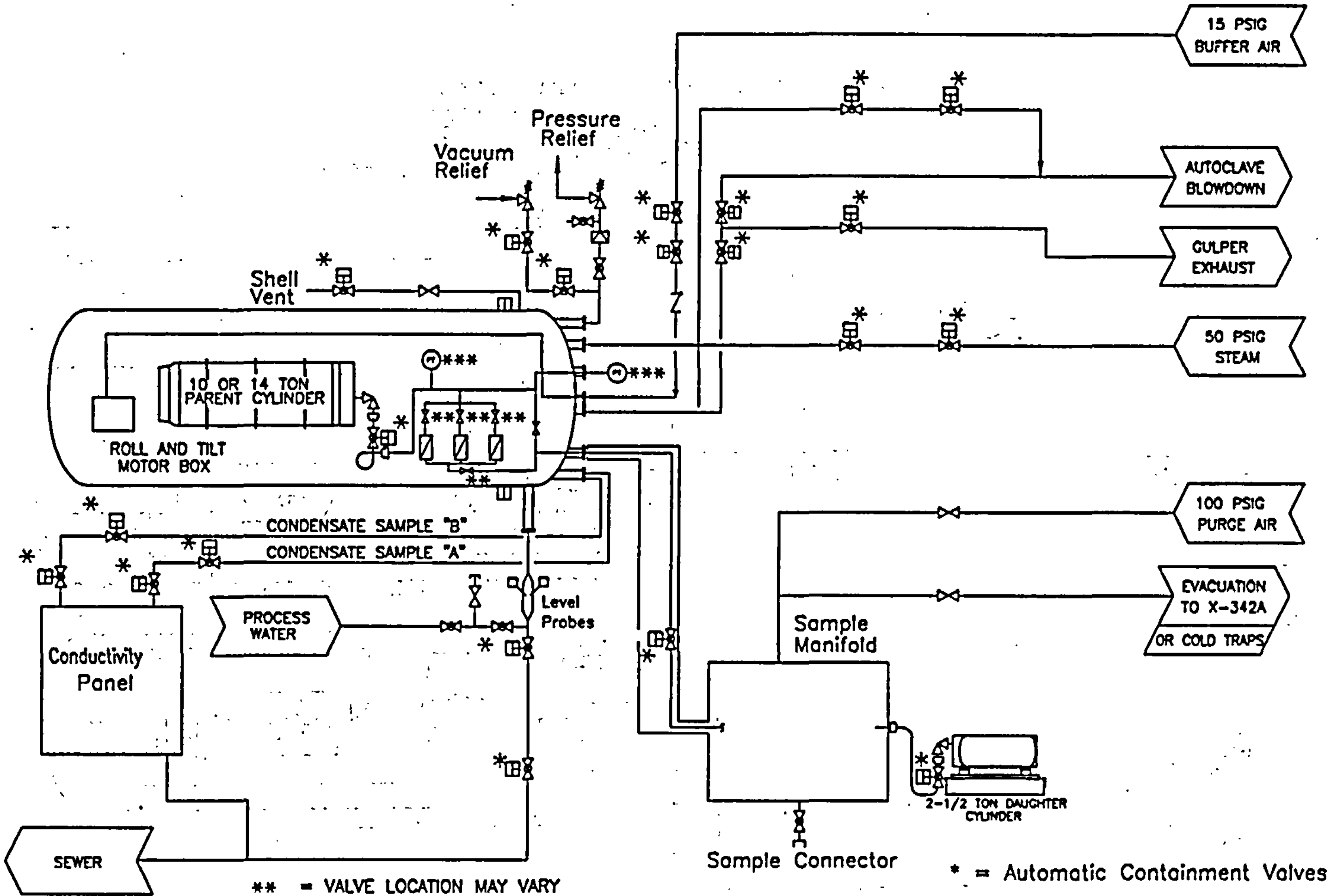
3.2-4



** = VALVE LOCATION MAY VARY DEPENDING ON TRAP DESIGN

*** = ACTUAL TRANSMITTER LOCATION MAY VARY, OUTSIDE LOCATION INCORPORATES THE USE OF A HERMETICALLY SEALED INERT LIQUID FILLED UMBILICAL CORD

NOTE: AUTOCLAVE MAY OPERATE WITH OR WITHOUT Tc TRAPS INSTALLED.

Figure 3.2-4. Diagram of X-344A Sample and Transfer Autoclave 1

AUTOCAD/DRT
08-20-03
3.2-4

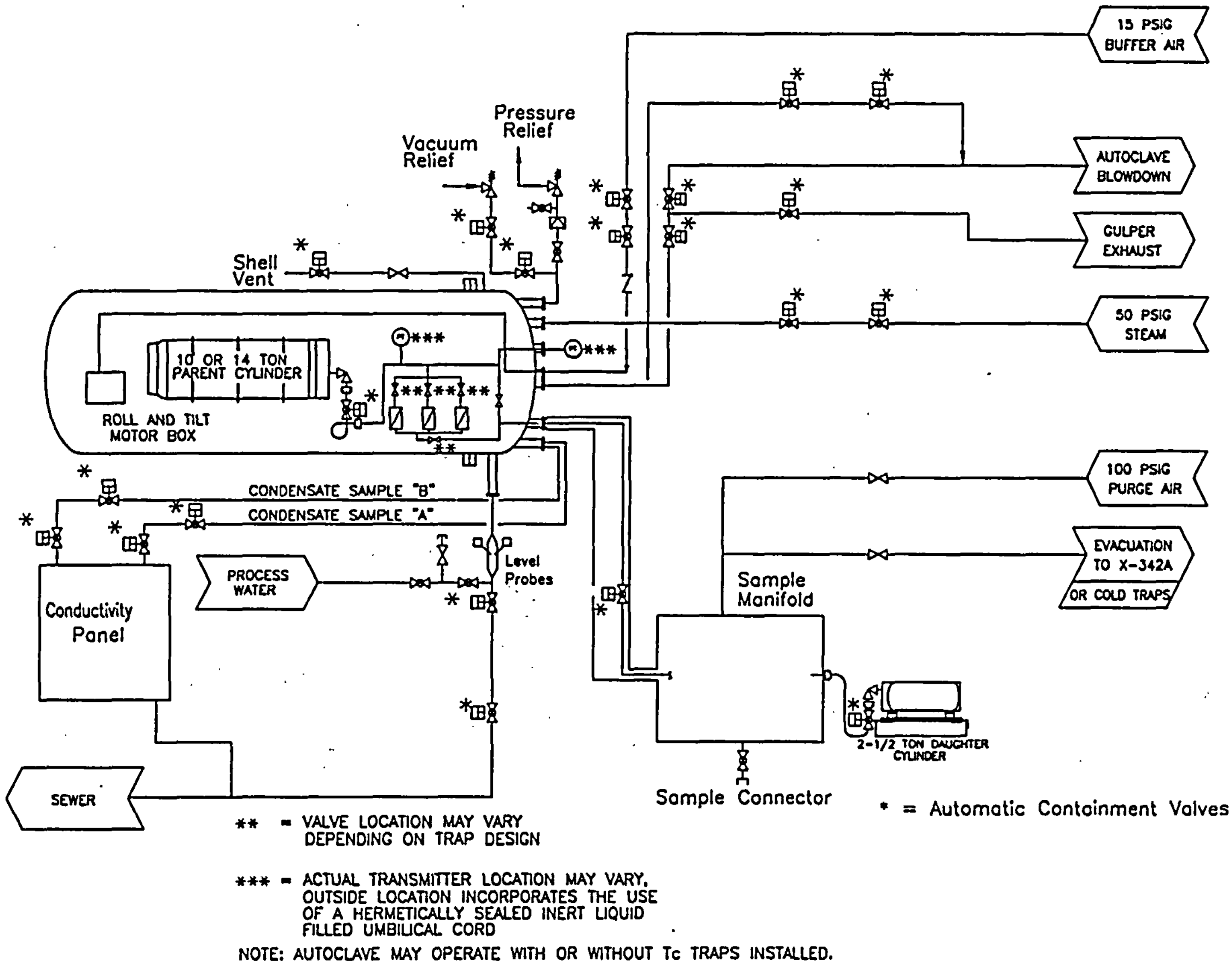
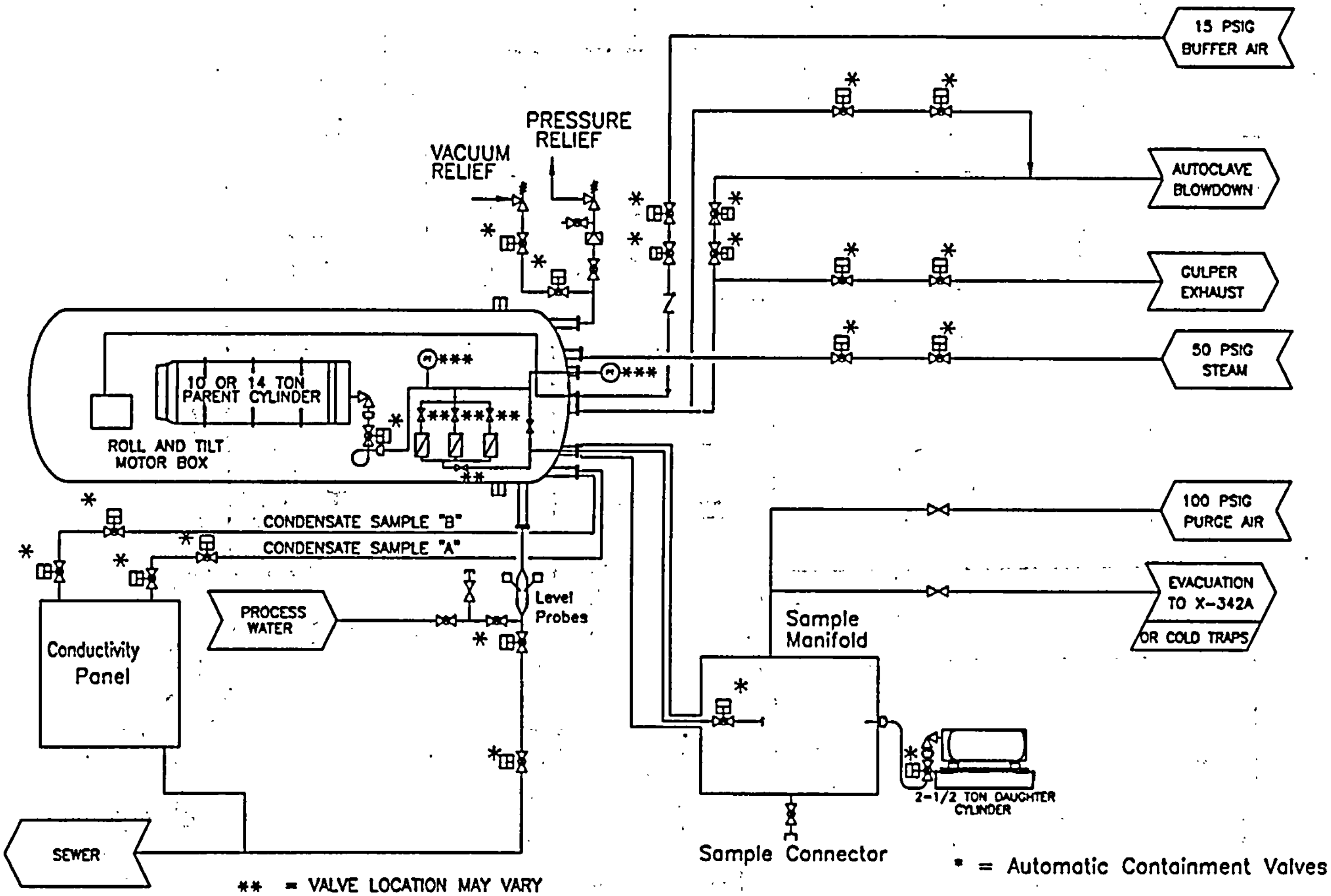


Figure 3.2–5. Diagram of X–344A Sample and Transfer Autoclave 2



** = VALVE LOCATION MAY VARY DEPENDING ON TRAP DESIGN

*** = ACTUAL TRANSMITTER LOCATION MAY VARY, OUTSIDE LOCATION INCORPORATES THE USE OF A HERMETICALLY SEALED INERT LIQUID FILLED UMBILICAL CORD

NOTE: AUTOCLAVE MY OPERATE WITH OR WITHOUT Tc TRAPS INSTALLED.

Figure 3.2-6. Diagram of a X-344A Sample and Transfer Autoclaves 3 and 4

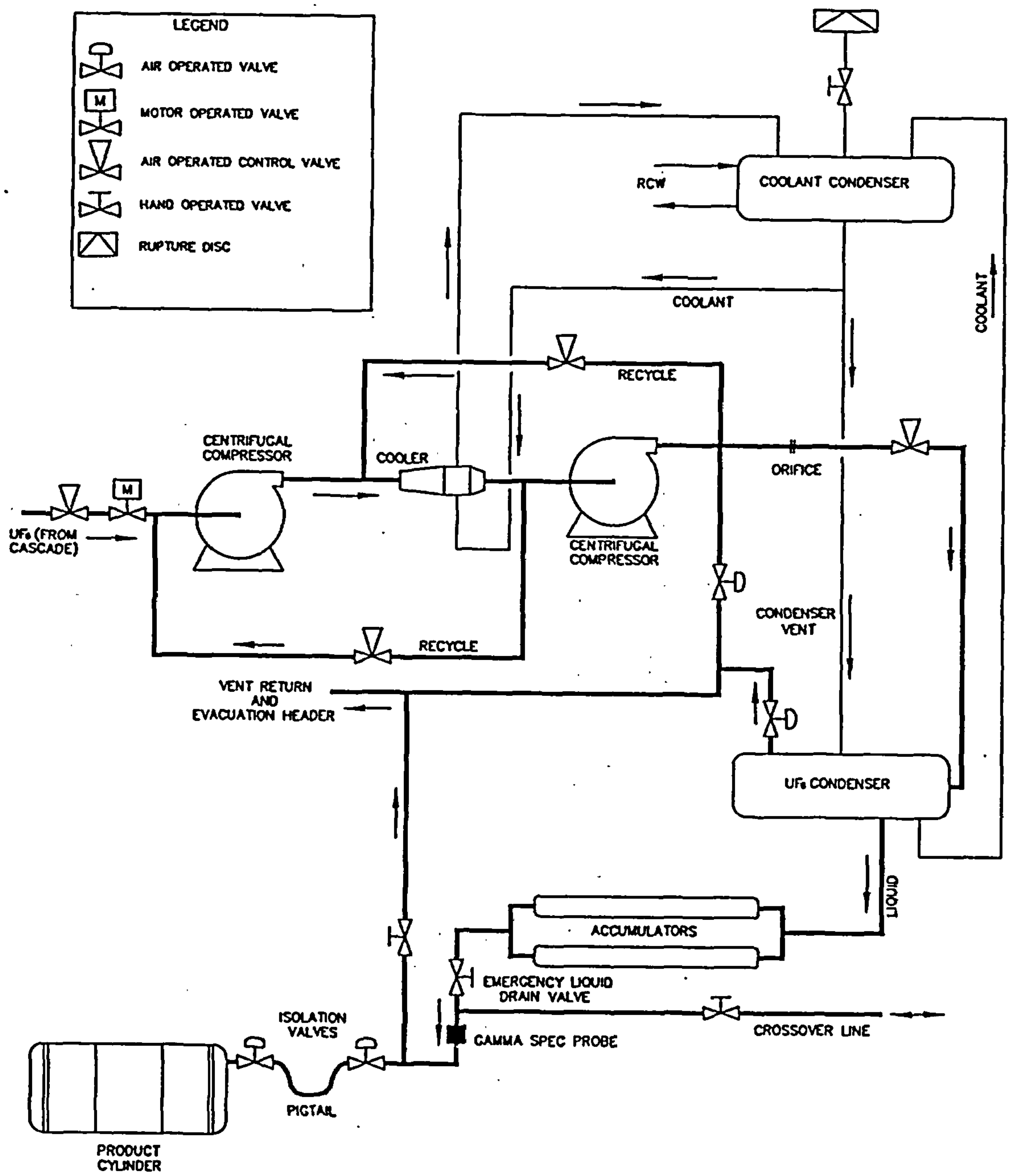


Figure 3.2-7 Typical Extended Range Product Withdrawal Flow Diagram.

AUTOCAD/DRT
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3.2-7

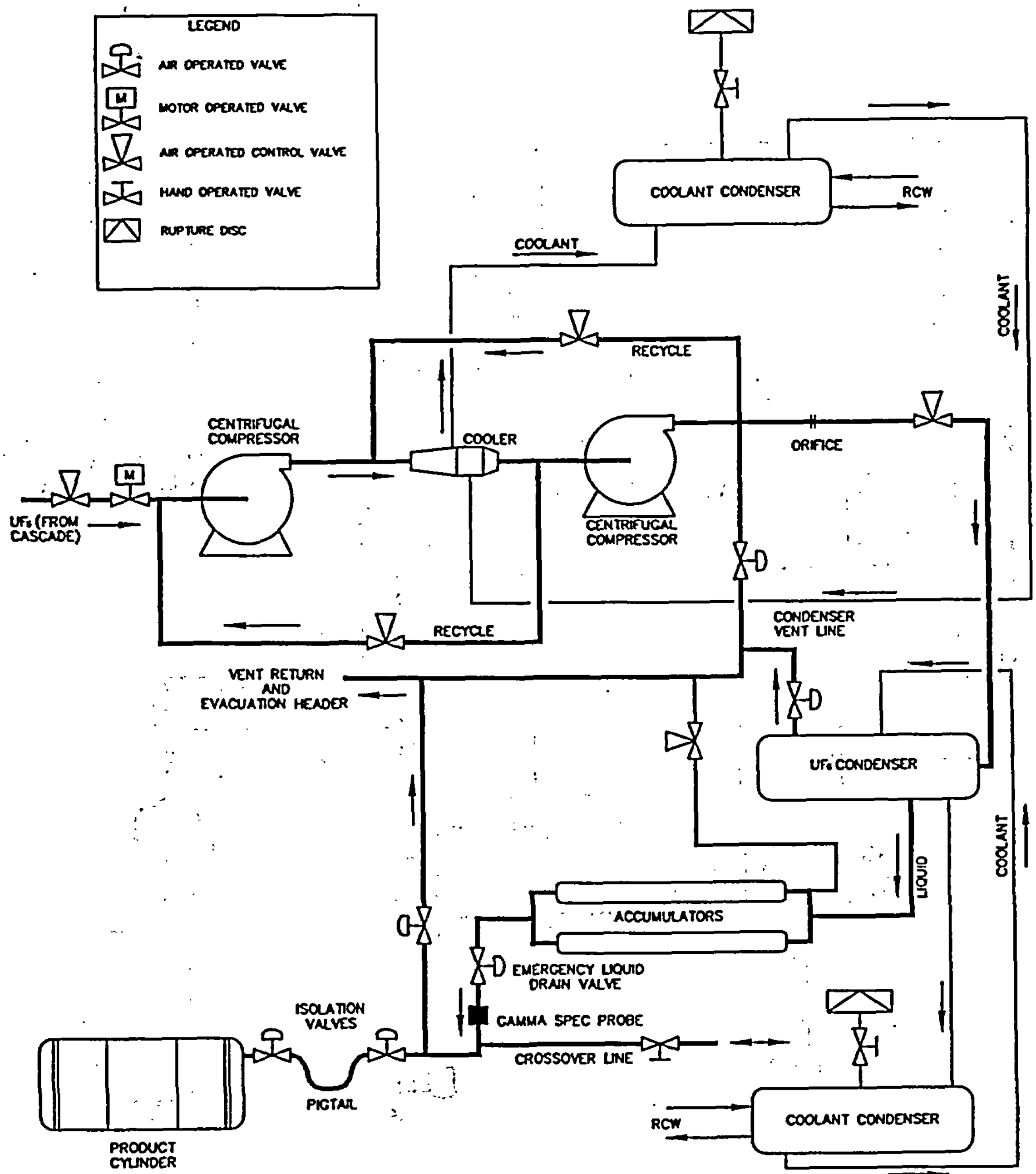

Figure 3.2-8 Typical Low Assay Withdrawal Flow Diagram.

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3.2-8

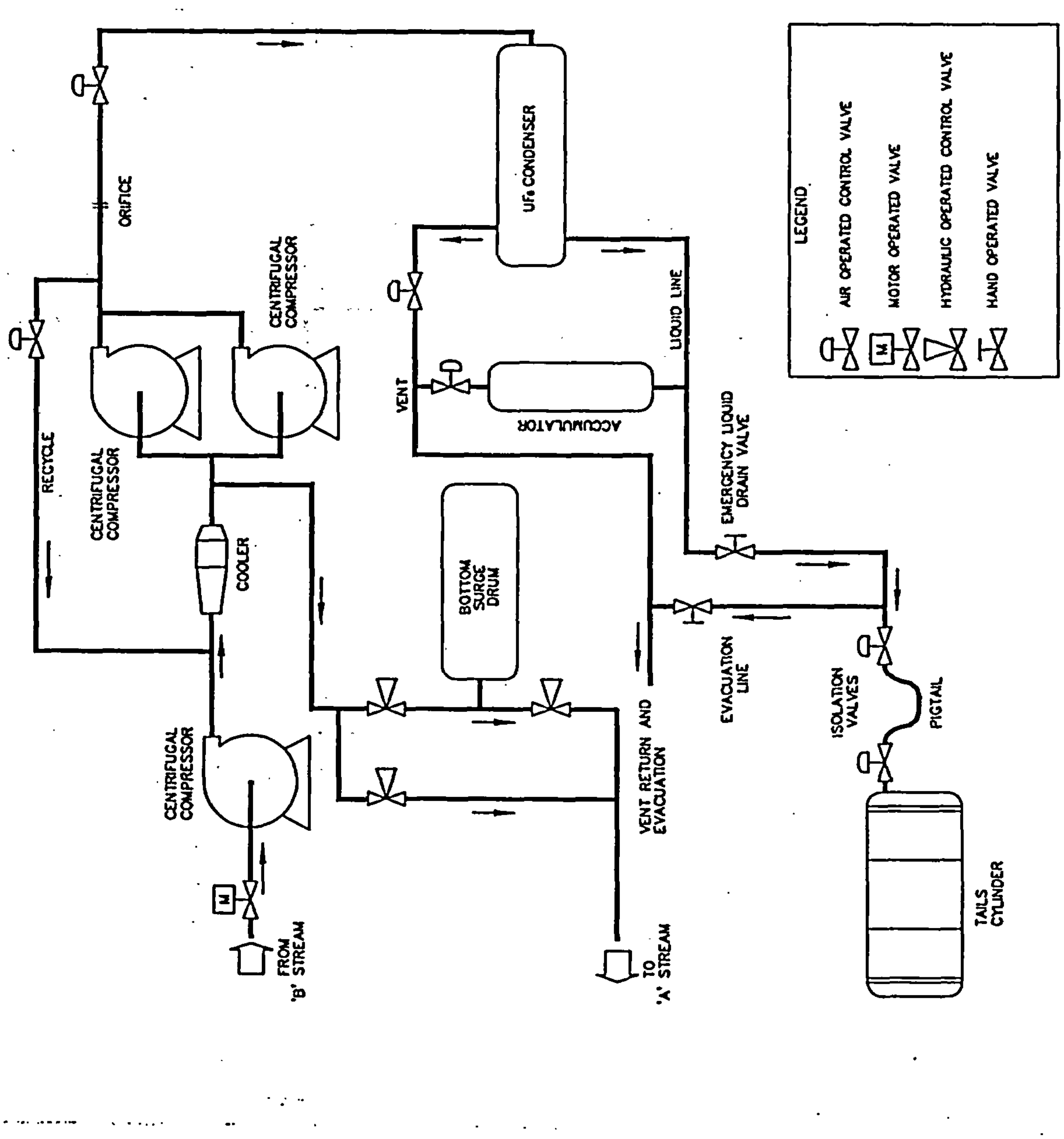

Figure 3.2-9 Typical Tails Withdrawal Flow Diagram.

AUTOCAD/DRT
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3.2-9

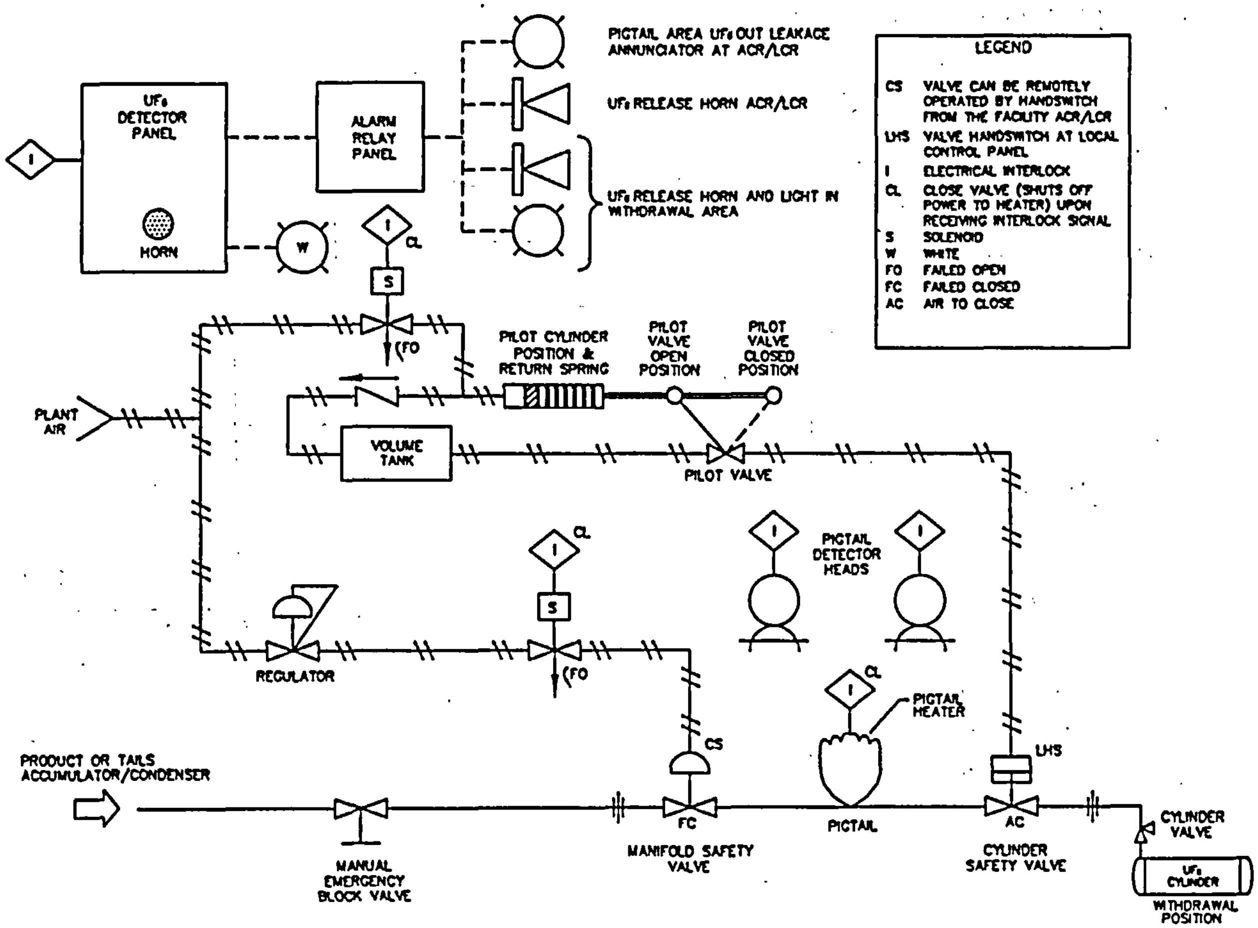

Figure 3.2-10 Typical Pigtail Line Isolation System (Product and Tails Withdrawal)

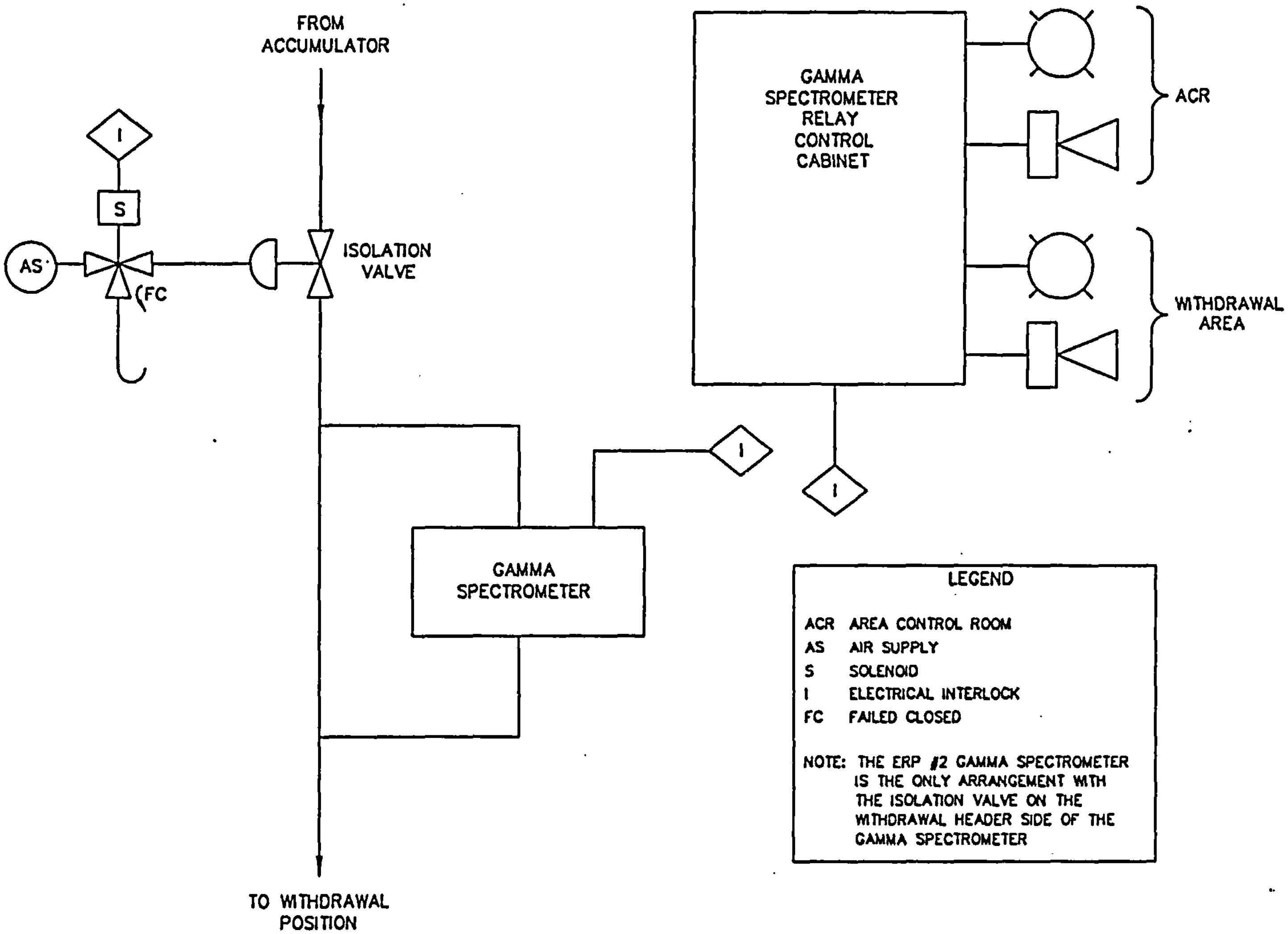

Figure 3.2–11 Typical Gamma Spectrometer and Isolation Valve Logic.

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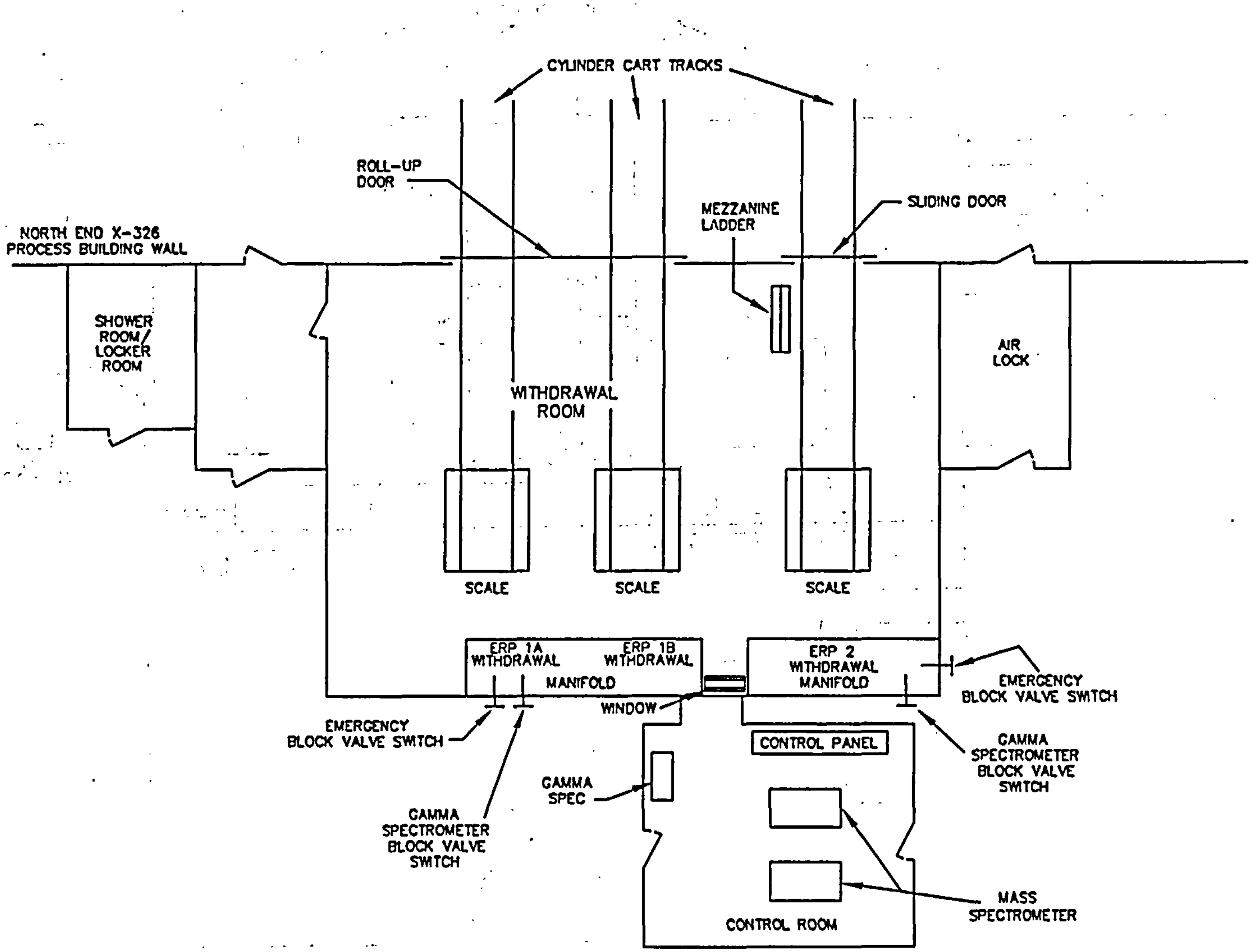

Figure 3.2-12 Extended Range Product Withdrawal Area.

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3.2-13

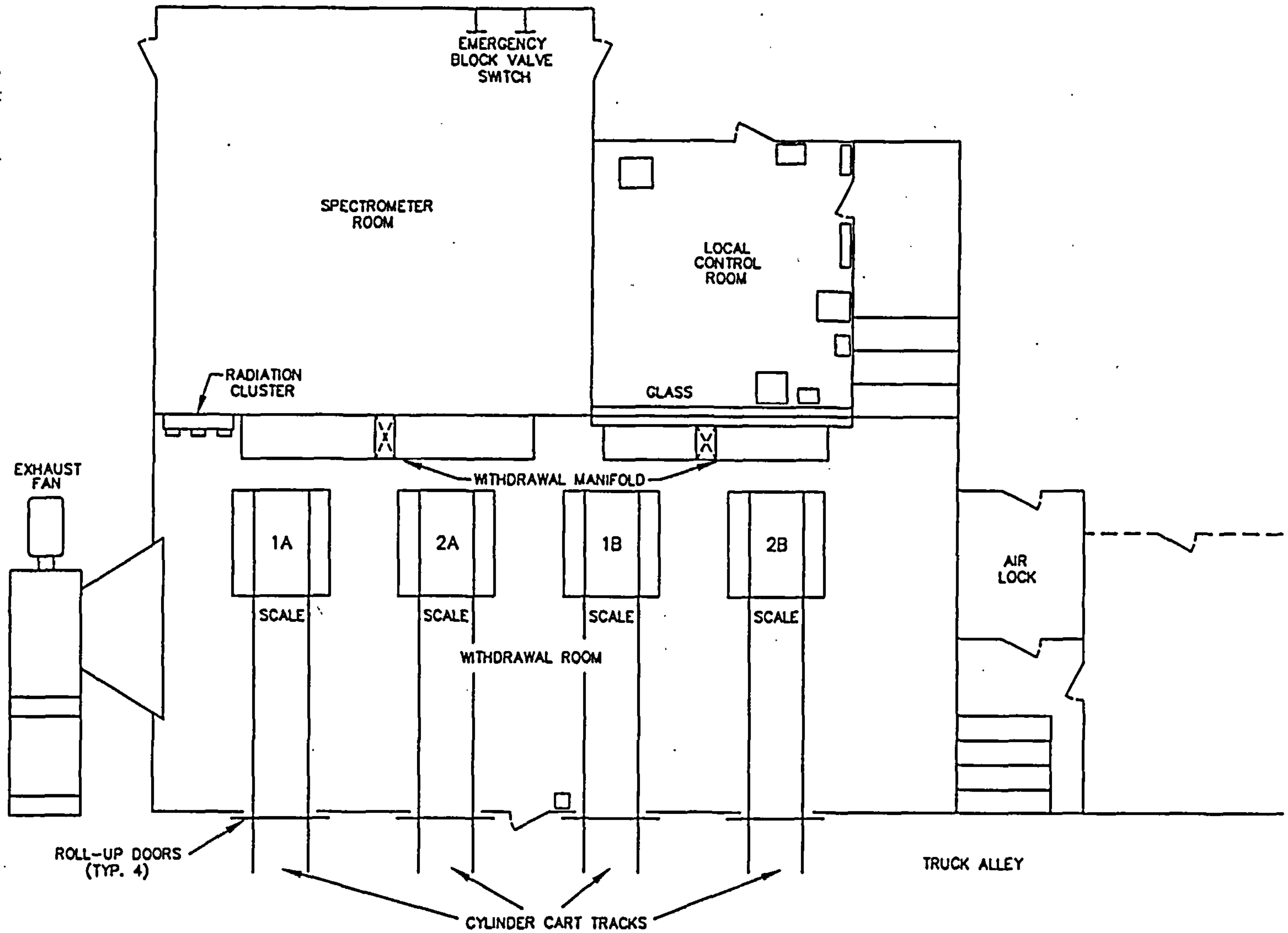

Figure 3.2-13 Low Assay Withdrawal Area.

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3.2-14

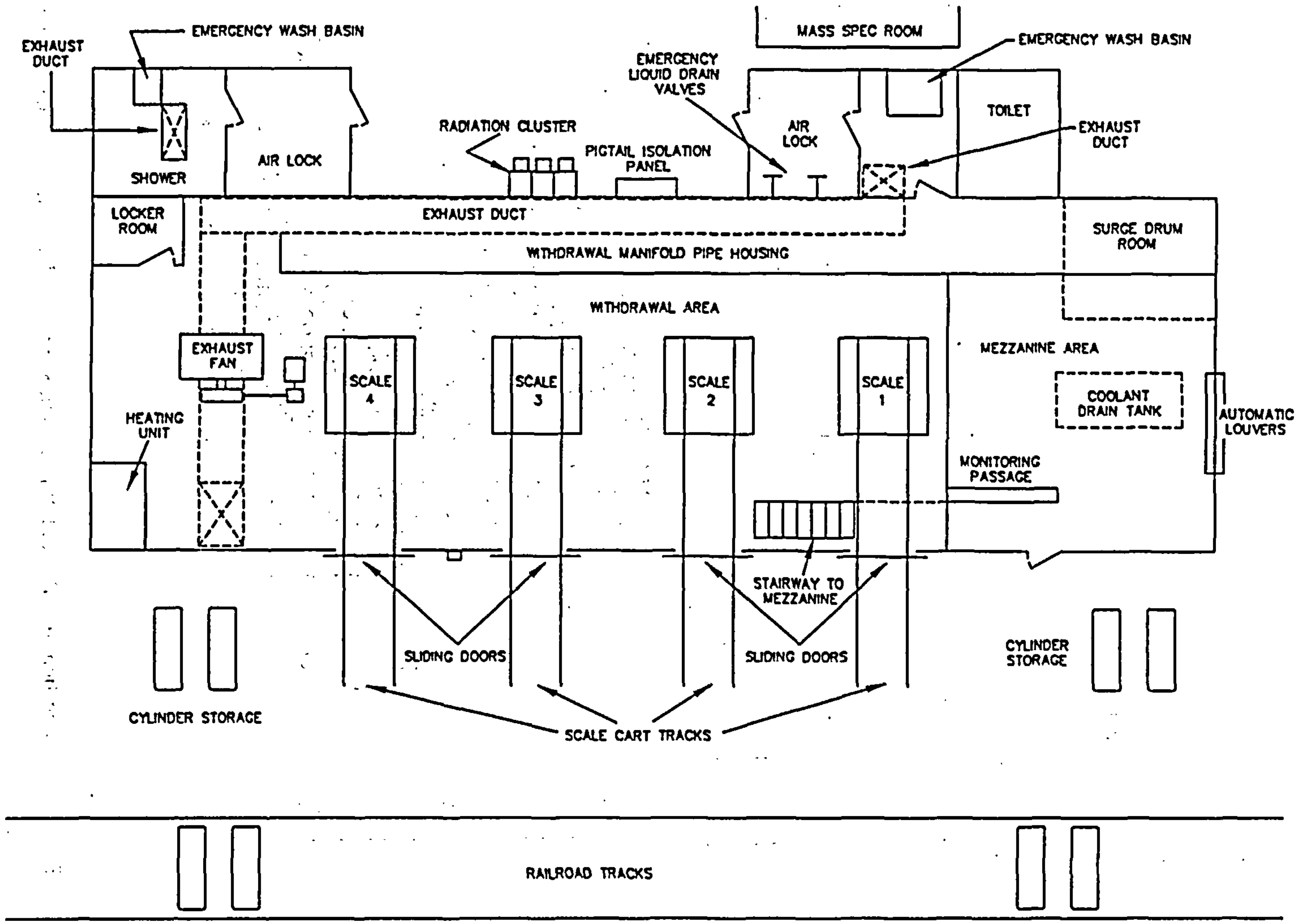
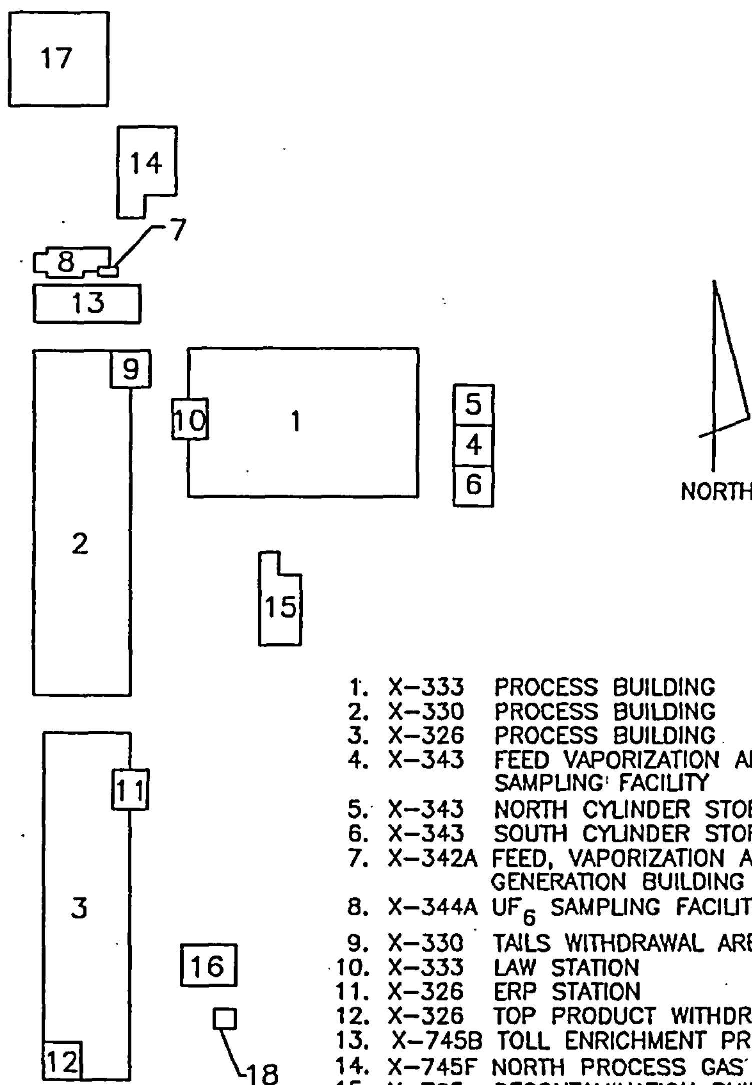


Figure 3.2–14 Tails Withdrawal Area



1. X-333 PROCESS BUILDING
2. X-330 PROCESS BUILDING
3. X-326 PROCESS BUILDING
4. X-343 FEED VAPORIZATION AND SAMPLING FACILITY
5. X-343 NORTH CYLINDER STORAGE LOT
6. X-343 SOUTH CYLINDER STORAGE LOT
7. X-342A FEED, VAPORIZATION AND FLUORINE GENERATION BUILDING
8. X-344A UF_6 SAMPLING FACILITY
9. X-330 TAILS WITHDRAWAL AREA
10. X-333 LAW STATION
11. X-326 ERP STATION
12. X-326 TOP PRODUCT WITHDRAWAL AREA
13. X-745B TOLL ENRICHMENT PROCESS GAS YARD
14. X-745F NORTH PROCESS GAS STOCKPILE YARD
15. X-705 DECONTAMINATION BUILDING
16. X-710 TECHNICAL SERVICES BUILDING
17. X-745G CYLINDER STORAGE YARD
18. X-760 CHEMICAL ENGINEERING BUILDING

Figure 3.2-15 Locations of UF_6 Feed, Withdrawal, Sampling, Handling and Cylinder Storage

3.3 URANIUM RECOVERY AND CHEMICAL SYSTEMS

Uranium recovery and chemical systems include a variety of systems in the X-705, Decontamination Building, the Biodenitrification Pilot Plant and Biodenitrification Plant in the X-700, Converter Shop and Cleaning Building, and various contaminated storage facilities including the XT-847, Waste Management Staging Facility.

3.3.1 X-705 Decontamination Building

Cascade process and support equipment removed from service may need to be decontaminated prior to maintenance or modification. The X-705 contains facilities and equipment necessary for disassembly and decontamination of the equipment. After decontamination, the equipment is transferred to maintenance, returned to service or containerized as scrap.

Uranium from the decontamination solutions with recoverable quantities is reclaimed in the Uranium Recovery System. Uranium from other contaminated sources (e.g., some laboratory wastes and field contamination solutions) is also recovered in the uranium recovery facility. Uranium-bearing solutions are processed to extract uranyl nitrate solutions, which can be calcined to produce uranium oxide (U_3O_8). The recovered U_3O_8 is stored on-site or shipped off-site for further processing and use. Waste streams containing toxic or radioactive contaminants are processed prior to discharge. Wastewater streams are treated to precipitate and filter residual heavy metals. This processed wastewater is discharged to the sanitary sewer or transferred to the Biodenitrification facility for further processing. The filtered solids are packaged for disposal. The waste gas stream from the calciners contains nitrous oxides (NOx) and is passed through a scrubber to remove most of the NOx prior to discharge.

Activities performed in X-705 and X-700 require laboratory analyses to meet nuclear safety requirements and ensure process efficiencies. Analysis is performed in the X-705 process laboratory, the X-710, Technical Services Building, or other appropriate facilities. Nuclear material accountability analyses are also determined at X-710.

Containers of solid contaminated materials and solutions are stored in the area above the abandoned Oxide Conversion Facility. There are several, smaller storage areas throughout the building to store containers of materials that are waiting to be processed.

The X-705 laundry washes the company issued clothing worn by plant personnel. The laundry equipment drains into the sanitary sewer system which discharges to the X-6619, Sewage Treatment Plant.

Fissile material operations in X-705 are performed in accordance with nuclear criticality safety program requirements, as outlined in Section 5.2. Specific fissile material operations and their controls are listed in Section 5.2, Appendix A.

3.3.1.1 Building Services

X-705 is centrally located with respect to the X-326, X-330, and X-333, Process Buildings, X-700, and the X-720, Maintenance and Stores Building. The building is a permanent structure with a concrete slab floor, steel support columns and concrete block and transite walls. Steel trusses support a metal roof deck covered with insulation and built-up roofing. The building structure is important to safety as discussed in Section 3.8, and performs the function of withstanding natural phenomena hazards such as high winds and seismic events.

The X-600, Steam Plant Facility, supplies steam which is reduced to nominally 35 psig and routed throughout the facility for heating and process heat exchangers. A safety relief valve provides necessary pressure relief for the steam piping. Condensed steam flows to X-600 from condensate pumping stations in the building. Steam condensate from the recovery evaporators may be discharged to the storm sewer system provided that condensate conductivity, which could be raised as a result of potential heat exchanger leaks, is within acceptable limits.

Dry air is provided to X-705 from the Plant Air System (Section 3.4.4) for purging and drying operations and to supply dry air for various tools, equipment, and instrumentation. Nitrogen is also supplied to X-705 from the Plant Nitrogen System (Section 3.4.3).

Fluorine produced in the X-342A, Feed, Vaporization & Fluorine Generation Building, enters X-705 through a header. In the event of a fluorine release in the building, the fluorine supply can be valved off outside the building at the main block valve.

Sanitary water is supplied throughout the building to various process systems, laundry and other types of components. Process system water is supplied by the sanitary water system, but it is separated using different water lines and backflow preventers. The sanitary water system also furnishes water to the wet pipe sprinkler system.

Electrical power supply to the X-705 building is from two 13.8 kV underground feeders. Each feeder is connected to a different bus in the X-530A, Switch Yard. Transformers reduce the voltage to 480 V. The power is distributed by motor control centers, power panels, and lighting panels of X-705.

3.3.1.2 X-705 General Operations and Features

Almost all of the uranium-bearing materials removed from equipment that enters X-705 for decontamination or cleaning are ultimately converted into solutions. These solutions normally are processed by one of two overall methods; a series of uranium recovery processes or a microfiltration process. Intermediate processes (e.g., the Oil and Grease Removal Unit [OGRU]) can remove solids from the solutions as they are processed.

The series of uranium recovery processes primarily consists of solvent extraction, calcination, heavy metals precipitation, ion exchange and biodenitrification, and are described in Section 3.3.1.4. All of these processes are contained in X-705, except for biodenitrification, which is located in X-700.

The microfiltration process handles solutions that contain lower uranium concentrations (e.g., rinse solutions) than those handled by the uranium recovery process, and captures precipitated uranium on a series of microfilters as described in Section 3.3.1.5. All of the associated equipment is contained within X-705.

Treated effluent from both the uranium recovery and microfiltration processes is eventually sent to X-6619. The overall flow of solutions through the facility is indicated schematically in Figure 3.3-1.

The treatment systems have a number of safety-significant systems as identified in the process descriptions that follow. In each case, these systems are required for Nuclear Criticality Safety (NCS) concerns and are described with their NCS function in Section 5.2 Appendix A as active engineered features. A more detailed discussion of the NCS analyses is provided in the NCS Approvals and NCS Evaluations for each fissile material operation.

3.3.1.2.1 Radioactive Materials

The two main radioactive materials present in X-705 are uranium and technetium. Detectable concentrations of transuranics and uranium daughter products are also present in the building.

Although process equipment contains residual deposits of uranium hexafluoride (UF_6) and uranyl fluorides, by the time the equipment arrives at X-705 most of the UF_6 has reacted with environmental moisture to form uranyl fluorides and hydrogen fluoride (HF). The uranyl fluorides can be a fine dust and become airborne.

Uranium can be a persistent contamination hazard associated with X-705 operations and radiation protection activities are employed as necessary to control this contamination.

3.3.1.2.2 Handling of Toxic Material

A variety of chemicals and compounds such as nitric acid, sulfuric acid, and sodium hydroxide are typically used or may be present in significant quantities in X-705 or X-700 Biodenitrification Plant. Hazardous chemicals used in X-705 operations are included in the Hazardous Material Control Program on the plant site and are handled per Section 5.6.

3.3.1.2.3 Personal Protection

Sections 5.3 and 5.6 describe the radiation and chemical safety provisions, respectively, that apply to this section.

3.3.1.2.3.1 Safety Equipment

Personal protective equipment (PPE) is worn as specified for radiation protection requirements or for Occupational Safety and Health Administration-regulated hazards.

3.3.1.2.3.2 Access Control

When there can be airborne contamination in an area, signs or physical barriers are erected to limit access of personnel to those wearing appropriate PPE as specified by radiation protection requirements. Posting requirements are specified in Section 5.3.

3.3.1.2.3.3 Building Evacuations

When the nitrogen-operated or electric evacuation horns are actuated, personnel are required to immediately evacuate the building. If evacuation is due to a Criticality Accident Alarm System (CAAS) alarm, radiation warning lights outside of the building will flash, and all personnel immediately proceed to the nearest monitoring station, avoiding buildings with red flashing lights.

In the event of a building fire or a toxic gas release in the high or low bay areas, evacuation horns are manually activated. Personnel are required to immediately and rapidly evacuate the building at the sound of the horns.

3.3.1.2.4 X-705 Facility Drains

X-705 has three independent drain systems for disposing of the various liquid waste streams generated in the building. The three types of drains are the sanitary sewers, the storm sewers, and the contaminated waste drain system.

3.3.1.2.4.1 Sanitary Sewers

Low levels of uranium are discharged from the Wastewater Treatment System and Laundry to X-6619. Effluent from the sewage treatment plant is routinely monitored for uranium as described in Section 5.1.

3.3.1.2.4.2 Storm Sewers

The storm sewers contain rainwater from the roof drains, cooling water from Recovery condensers, and may contain steam condensate from the Recovery evaporators. All storm sewer drains are connected to the "D" sewer. The "D" Sewer empties into the East Drainage Ditch. Effluent from the ditch is sampled at the National Pollutant Discharge Elimination System Outfall 001 monitoring station as described in Section 5.1.

3.3.1.2.4.3 Contaminated Waste Drains

Contaminated waste solutions are collected at various locations in the building and transferred to the Microfiltration Geometrically Safe Storage System as described in Section 3.3.1.5.1.

3.3.1.3 Decontamination Operations

X-705 personnel are responsible for equipment decontamination after the equipment is transferred to X-705. After decontamination, the equipment typically is transferred to either X-720 or X-700 for maintenance, repair, or reassembly. If the equipment is to be scrapped, it is containerized, as appropriate per the disposal facility acceptance criteria, and transferred to await subsequent movement to the disposal facility. Decontaminated equipment that is being moved to various locations is subject to the applicable radiation protection requirements as described in Section 5.3. Decontamination operations performed in the West Annex are under Department of Energy (DOE) jurisdiction in accordance with Portsmouth Gaseous Diffusion Plant (PORTS) Compliance Plan (DOE/ORO-2027/R3), Appendix A.4.

3.3.1.3.1 Large Parts Disassembly and Decontamination

Compressors and other equipment are disassembled and cleaned as necessary in a series of spray booths.

3.3.1.3.1.1 Compressor Disassembly

Large compressors are disassembled at the North Tear Down area and the compressor turnover pit as applicable. Other equipment such as small compressors, rotors, stators, process block valves and control valves are also disassembled in the North Tear Down area. The South Annex is also used for compressor disassembly (Section 3.3.1.3.1.3).

Equipment removed from the cascade may contain deposits of uranium, which can be released to the atmosphere. Care is taken at each step of the disassembly to contain any remaining uranium compounds in the equipment. A geometrically safe vacuum cleaner can be used as needed (Section 3.3.1.3.3).

After large parts disassembly, the parts are transported to the spray booths as required (Section 3.3.1.3.1.4). There, large parts are placed on special carts for the decontamination operation. Smaller parts may be sent to the Small Parts area for hand table decontamination. Compressor seals are placed in seal cans and taken to the Seal Dismantling Room (Section 3.3.1.3.2.6) for disassembly prior to hand table decontamination or placed in storage awaiting processing.

3.3.1.3.1.2 Converter Disassembly

When a converter is removed from the cascade it may be transported to X-700 for cooler flushing.

3.3.1.3.1.3 South Annex Operations

The South Annex is a closed room at the south side of X-705 used to contain contamination during the disassembly of equipment identified with large enriched uranium deposits and for the changing of cylinder valves on cylinders that contain a positive or unknown pressure. The South Annex has its own ventilation system and is isolated from the rest of X-705 during operations. The Annex is also used for handling traps, cutting scrap, handling damaged F-can transfers, and similar activities.

The Annex Fire Protection sprinkler system is isolated and tagged out during operations involving unsafe masses of fissile material to prevent inadvertent moderation from a sprinkler system actuation. If the equipment is classified "Planned Expeditious Handling", and the uranium deposits cannot be removed through normal decontamination methods and a buffer cannot be applied, criticality safety personnel are notified. When a cylinder valve change is scheduled to take place in the Annex, plant site emergency response organizations are notified.

The South Annex exhaust system is set up for High Efficiency Particulate Air (HEPA) filtration and HF removal. A separate HF trap can be installed so that if necessary, the components being dismantled may be purged with plant air or nitrogen bottles.

3.3.1.3.1.4 Spray Booths Operations

Disassembled large equipment decontamination is typically accomplished in the spray booths. Parts are loaded onto stainless steel carts that are pulled through a series of booths. During normal operations, the parts are positioned so liquid will not collect in an unfavorable geometry. In cases where positioning is not possible or practical, special NCS Approvals are obtained. A stainless steel roller chain drive runs between two elevators and pulls the carts into the spray booths. A tunnel basement is provided underneath the spray booths to provide for return of the carts or equipment back to the north end of the tunnel. Elevators are used to lower and raise the carts from the spray booth level and the tunnel basement level.

The facility consists of five serial booths. The first three are recirculating booths where the decontamination solutions drain into storage columns in the tunnel basement and are recirculated until the solids concentration necessitates solution changeout. When solution changeout is required, the contaminated liquid is pumped to basement storage columns for eventual transfer to Uranium Recovery for further processing (Section 3.3.1.4). The fourth booth uses water to rinse components and can be used in a manual mode, recirculating mode, or an automatic mode that utilizes a timer to transfer water when necessary. The spent rinse water from the fourth booth is pumped to the Microfiltration Geometrically Safe Storage System for further processing (Section 3.3.1.5). The fifth booth is a warm air-drying chamber.

Depending on the material construction of the part to be cleaned, any combination or only one of the spray booths may be used to decontaminate the equipment. In addition, hand cleaning is also performed in the individual spray booths. Hot spots or visible deposits may be cleaned by running the part back through the spray booth, or manual methods such as wet/dry decontamination, and buffing.

The tunnel basement contains banks of decontamination solution storage columns for raffinate solutions from the Recovery extractor stripper process, solutions from the spray booths, and measured and unmeasured solutions used as feed to the Recovery System. These storage banks are constructed of five-inch nominal inside diameter (ID) pipe, geometrically favorable columns, separated by paraffin columns that limit neutronic interaction between columns. The tunnel basement also contains a geometrically safe storage system and pump, located directly beneath the rinse booth, to circulate rinse solutions. Other spray booth and storage column pumps are located in the tunnel.

Each of the pumps is set in a pan connected to a scavenger system that has a level alarm. If a pump seal leaks, the solution drains into the pump pan. Any solution that leaks onto the basement floor collects on the floor or in always-safe sumps. Visual inspections are performed in the tunnel basement on a regular basis for leakage since the sumps do not have an alarm.

3.3.1.3.1.5 Truck Alley Cleaning/Oil and Grease Removal Unit

Equipment and parts, such as vacuum pumps and process pipe that cannot be readily cleaned in the spray booths are decontaminated in the Truck Alley. The solutions collected by the Truck Alley drains are processed through the Oil and Grease Removal Unit (OGRU). Field decontamination solutions can also be poured into the truck alley drain for processing in the OGRU or transferred directly into the OGRU. An alkali tank that was used to clean and degrease large process motors in the "Truck Alley" has been abandoned in place.

The truck alley solution is pumped to the geometrically safe, intermediate storage columns. While the storage columns are being filled, a block valve between the storage columns and the OGRU reservoir is closed and locked to prevent unsampled solution from entering the geometrically unfavorable OGRU reservoir.

Chemicals are added to the solution in the OGRU reservoir to break the oil and grease loose from suspension and encapsulate them so the oil and grease can be filtered out. After the chemicals are added, a turbo mixer agitates the solution. The liquid is drained off through filter paper and collected in the filtrate collection tray. The solids collect on the filter paper and are eventually fed through the sludge chute to an approved container for disposal. The permeate of the OGRU is pumped to the Microfiltration Geometrically Safe Storage System for further treatment.

3.3.1.3.2 Small Parts Decontamination

Small parts decontamination includes activities such as cylinder cleaning, cylinder drying, cylinder conditioning, cylinder testing, hand table cleaning, media blasting and seal dismantling.

3.3.1.3.2.1 Thirty and Forty-Eight-Inch Cylinder Cleaning

Large empty UF_6 cylinders may require decontamination before being refilled. The uranium heel must be removed from cylinders scheduled to be hydrostatically tested. Cylinders containing impurities or requiring maintenance work must be cleaned.

Large cylinder cleaning is done on a turning fixture located in the small parts, low bay area. A gulper system may be used to capture local airborne contamination generated while making and breaking connections to the cylinder or cylinder valve. The cylinder transfer sheet is checked for uranium assay and heel weight for verification of nuclear safety.

The cylinder cleaning solution is drawn into six-inch diameter storage columns that are constructed of glass and are not neutron reflected. Of these columns, Column A is not used for contaminated solution because it overflows back to the mixing tank, which is of unsafe geometry for enriched uranium solutions.

After successive washes have reduced the uranium concentration to less than 1000 ppm, the cylinder is rinsed with water. The rinse solution is sampled for uranium concentration. If the sample is below the specified limit of less than 500 ppm, the cylinder cleaning process is complete. The final rinse solution with less than 500 ppm uranium may be transferred to the Microfiltration Geometrically Safe Storage System (Section 3.3.1.5.1) or Uranium Recovery (Section 3.3.1.4).

Once the cylinder is determined to be free of internal visible deposits and foreign material, it is ready for drying (if not already completed), testing, reworking, and release. In addition, the exterior of the cylinder is decontaminated as required.

3.3.1.3.2.2 Eight and Twelve-Inch Cylinder Cleaning

Eight- and twelve-inch cylinders filled under moderation control are decontaminated in the West Annex of X-705. Special handling precautions are taken with these cylinders such as being placed in neutron absorbing cadmium shields and the use of cleaning solutions such as nitric acid/sodium carbonate or other acceptable chemicals. NCS-approved special cases (e.g., oversized cylinders) may be cleaned without being placed in a cadmium shield.

Heel quantities and nonvolatile uranium-bearing materials are removed by cleaning the cylinders with solution. The cylinder to be cleaned is identified and checked for assay, and weight. Due to possible corrosion of the cylinder, an accountability data mass check is not totally reliable. A double check with two non-destructive analysis (NDA) measurements is performed and recorded, since nuclear criticality safety depends on the ^{235}U mass being within the allowed limits and the cylinder construction type being correct. The cleaning solution is drawn into the cylinder by vacuum and removed by vacuum provided by an air jet. The solution is then transferred to a geometrically favorable collection tube and then transferred to columns. Washing and rinsing is repeated until the uranium concentration is below 500 ppm.

Following cleaning, the resulting contaminated cleaning solution is blended as necessary to achieve the ^{235}U enrichment to below 10 weight-% (Section 3.3.1.3.2.9) and eventually either processed in Uranium Recovery (Section 3.3.1.4) or transferred into NCS-approved containers within the West Annex. The solution is transferred by pump to the Recovery area for treatment; for accountability purposes, the transfer line is emptied of solution by air pressure to the B-38 columns. If desired, the solution may be transferred by using NCS-approved containers instead of the transfer line.

A gulper system may be used to capture local airborne contamination generated while making and breaking connections to the cylinder and related systems.

3.3.1.3.2.3 Five-Inch Cylinder Cleaning

Five-inch diameter cylinders are processed in the Small Cylinder Cleaning Unit. The Small Cylinder Cleaning Unit consists of a manifold for up to four 5-inch UF_6 cylinders, and the equipment necessary to circulate the cleaning and rinsing solutions from nominal five-inch ID storage columns through the cylinders. The cleaning solution circulates through the cylinders and back to the storage columns. After the cylinders have been cleaned, the cleaning solution is transferred to columns in the West Annex (Section 3.3.1.3.2.9).

A gulper system may be used to capture local airborne contamination generated while making and breaking connections to the cylinder and related systems.

3.3.1.3.2.4 Cylinder Drying and Testing

All cylinders are periodically inspected and tested throughout their service life at intervals not to exceed 5 years. Exceptions are cylinders that are already filled prior to the five-year expiration date need not be tested until the cylinder has been emptied. Cylinders that have not been inspected and tested within the required five-year period cannot be refilled until they are properly reinspected, retested, and restamped. Both large and small cylinders are inspected, tested, and certified in accordance with American National Standards Institute (ANSI) N14.1, "Uranium Hexafluoride - Packaging for Transport." Cylinder drying is performed consistent with recommendations provided in ANSI N14.1.

If the tests, inspections and drying are completed and approved, the cylinder is ready for refilling with UF_6. If desired, a fluorine treatment may be applied to condition cylinder walls prior to filling with UF_6.

3.3.1.3.2.5 Sodium Fluoride Pellet Conditioning

Sodium fluoride (NaF) pellets used in chemical traps are purchased in the form of sodium bifluoride. Before use as trapping material (in areas such as Cold Recovery, X-344A, UF_6 Sampling Facility transfer autoclaves, etc.), HF gas must be driven off by heat and the pellets hardened. This is done in the NaF pellet treatment system. Treated pellets are placed in a sealed container for storage until used.

3.3.1.3.2.6 Seal Dismantling

Compressor seal assemblies are disassembled inside the Seal Dismantling Room. The Seal Dismantling Room ventilation system contains a HEPA filtration unit that continuously operates during the seal dismantling process. Seal cans are brought into the dismantling room on pallets (the seals are kept in cans for security and health physics reasons). As each can is opened, the interior is inspected to determine if any loose uranium is present. If necessary, the seal parts can be vacuumed using a geometrically safe vacuum cleaner. The seals are dismantled and the various seal parts are stacked on pallets for transport to the hand tables or small parts pit for decontamination, or are classified as scrap material.

3.3.1.3.2.7 Small Parts Handtable Operations

Small parts with visible uranium contaminants are typically precleaned in one of the four small parts handtables. After the visible deposits are removed, final decontamination is normally done in the small parts pit. The cleaning operation may also involve leaching uranium from solid materials. A fifth handtable is a Leaching/Complexing Handtable used to complex and acidify decontamination solutions and leach solids, but is not used to clean parts.

The operator places parts to be cleaned in the decontamination solution (e.g., nitric or citric acid, sodium bisulfate, or sodium carbonate) on the handtable. A stream of decontaminating and cleaning solution is directed at the part. After the parts are cleaned (e.g., with a sponge or wire brush), they are rinsed with water. The parts are then taken to the small parts pit for final decontamination.

When the handtables are used to leach uranium from solids, a screen basket can be used that allows an acid solution to run over the solids to dissolve the uranium. Additional solids can be added to the baskets as the material is dissolved.

When handtable solutions become visibly contaminated and parts are no longer being cleaned, the solution is pumped to Tunnel unmeasured storage columns (Section 3.3.1.3.1.4) or NCS-approved containers. The generated solution is eventually transferred to Uranium Recovery for processing.

3.3.1.3.2.8 Small Parts Pit Operations

Small parts that have no visible contamination are decontaminated in the Small Parts Pit. Ventilation ducts exhaust any fumes generated by the decontamination process. The pit floor is sloped so that any spilled or dumped solutions immediately flow to the floor drains. The floor drains discharge to the suction side of the steam pit effluent pump which pumps to the Microfiltration Geometrically Safe Storage System as described in Section 3.3.1.5.1. After a component has been disassembled, decontaminated at a handtable, and rinsed, it is transferred to the small parts pit. After cleaning and drying, the parts are transferred or scrapped.

3.3.1.3.2.9 BLENDING CYLINDER WASH AND OTHER SOLUTIONS

Uranium bearing solution produced containing material with ^{235}U enrichments equal to or greater than 10% must be blended to obtain a ^{235}U enrichment below 10 wt%. This blending operation is performed in the West Annex of the X-705 Building.

The blend stock used consists of uranyl-nitrate or uranyl fluoride solution with a ^{235}U enrichment of less than 1 wt%. It is stored in an unfavorable geometry 550-gallon cylindrical tank. The tank has a sealed top and a conical bottom and is mounted so its axis is vertical. The tank is located along the north wall of the West Annex.

Blend stock is added to the tank from portable containers, such as 55-gallon drums. Aluminum Nitrate is added to the tank from one or more portable containers. When portable containers of unfavorable geometry, other than UF_6 cylinders, are used in the West Annex, they are marked as to their contents. To avoid possible introduction of uranium bearing material, portable containers of unfavorable geometry, other than UF_6 cylinders and scrap metal drums, are never left unattended in the Annex and their time in the Annex is kept to a minimum. Scrap metal drums will be covered except when adding items to the drum.

The blending and storage columns consist of a 2 x 7 geometrically favorable array of vertical columns. The two rows of 7 columns are used for storage and/or blending.Components include a geometrically favorable recirculation pump, two level indicators, high level alarms, low level alarms, and two 4-inch diameter 8-foot tall glass overflow columns. The columns are constructed of 5-inch schedule 40, 304L stainless steel pipe and are approximately 16-feet tall.

The solution is pumped from the geometrically favorable Unmeasured Storage Columns or the geometrically favorable 8- and 12-inch Intermediate Collection Tank to the storage/blending columns. An audible high level alarm is provided as an administrative aid to avoid accidental overflow of the storage/blending columns during transfer from that area.

The ^{235}U enrichment and concentration of the blend stock and solution are quantified by sampling. Calculations are performed to determine the volumes of solution and blend stock that will be used to obtain a blended solution with a ^{235}U enrichment of 9.5% or lower. The desired volume of blend stock is transferred from its tank, by pump, through an air-gap to the storage/blending column.

As solution is recirculated through the storage/blending columns, the calculated volume of solution is injected by a metering pump into the recirculation pump intake line. The action of the recirculation pump helps geometrically favorable static mixers in its outlet line to provide thorough blending.

The blended solution is sampled to determine what adjustments, if any, are necessary to reach the desired ^{235}U enrichment. The necessary additional blend stock or solution is blended in. The resulting batch of blended solution is sampled to ensure that the enrichment is below 10%. It is then pumped through a 1½ -inch schedule 40 304L stainless steel transfer line, which passes through the Tunnel Basement to the B-38 Columns in the B area. Audible high level alarms are provided the West Annex, along with solenoid valve interlocks, as aids to avoid accidental overflow of the B-38 columns during transfer. The transfer line is emptied of solution by air pressure to the B-38 columns for accountability purposes. Backflow prevention is provided to avoid inadvertent transfer of solution into the plant air system.

If desired, the blended solution may be transferred by using NCS approved polybottles instead of the transfer line. Only one polybottle, or cart containing polybottles, is moved at a time in the West Annex. Two foot edge-to-edge spacing is maintained between bottles and any other item containing uranium-bearing material.

3.3.1.3.2.10 Spray Tank Operations

The spray tank was used for leaching contaminants from alumina (removed from chemical traps) using nitric acid. Occasionally, NaF pellets and magnesium fluoride pellets were processed along with alumina. This equipment has been abandoned in place.

3.3.1.3.2.11 Small Equipment Teardown ("Blue Room")

The "Blue Room" is located just north of the X-705 tunnel spray booths. The room is used for dismantling small valves and pumps, various compressor parts, and other small components. The room is equipped with a flexible duct that provides local ventilation suction to areas and components inside and outside the Blue Room. The Blue Room's exhaust system is set up for HEPA filtration and HF removal.

A separate trap is installed in the Blue Room so that, if necessary, the components being dismantled may be purged of HF. A large portion of the roof is open to allow overhead crane access and coverage by the X-705 fire sprinkler system.

3.3.1.3.2.12 Media Blasting

Contamination sometimes becomes so deeply embedded in metal surfaces that decontamination solutions cannot remove it. Contamination can also be so widely dispersed, or in an accessible position that wire brushing is ineffective at removal. Pieces of equipment can be decontaminated inside X-705 using a media blasting system. The unit is designed to limit the spread of the possibly contaminated dust by containment inside a blast cabinet and exhausting through a HEPA filtration system.

3.3.1.3.3 Always-Safe Vacuum Cleaners

Loose deposits of uranium compounds in cascade equipment can be more conveniently removed dry than wet; however, sweeping up dry contaminated material often generates airborne contamination. This problem is greatly reduced by the always-safe (geometrically safe) vacuum cleaner.

This vacuum cleaner picks up contaminated material for deposit in an NCS-approved container. Pre-filters and HEPA filters remove most contamination from the exhaust airstream, but protective clothing and respiratory protection may be required by radiation protection requirements during vacuum cleaner operation.

3.3.1.4 Uranium Recovery

Decontamination cleaning solutions, from the various X-705 large parts, small parts, and cylinder cleaning operations, and from many field decontaminations, are processed through the Uranium Recovery Facility, to recover uranium and generate an environmentally acceptable effluent. Some uranium-bearing liquids generated in the X-710 process laboratory and field laboratory solutions are also processed in the facility.

The uranium bearing solutions are placed in the B-38 measurement columns. These solutions are either hard-piped from other storages or processed through the recovery handtable to the B-38 measurement columns (Section 3.3.1.4.1). The solutions transported to the columns are recycled and then sampled for uranium and ^{235}U assay. A volume measurement is made for material accountability in the B-38 columns. After the volume measurement is made, the solution is transferred to either the B-1 storage columns or the tunnel measured storage columns. These columns feed the solvent extraction systems (Section 3.3.1.4.2). If solutions have been previously characterized they may not require volume, assay, or concentration sampling in the B-38 columns.

The concentrated uranium stream from the solvent extraction process is further concentrated in the post-evaporators, transferred to the concentrate storage columns, and fed to the calciners. The raffinate, low uranium concentration waste stream from the extraction process, is drained to the tunnel raffinate storage columns. The raffinate is further treated with caustic, filtered, and processed through technetium ion exchange and biodenitrification. See Sections 3.3.1.4.3 for the Heavy Metals Precipitation, 3.3.1.4.4 for Technetium Ion Exchange, and 3.3.1.4.5 for Biodenitrification.

3.3.1.4.1 Recovery Handtable

Uranium-bearing liquids generated on plant site can be processed in the Recovery Handtable to input the NCS-approved container solution into the B-38 measurement columns. These liquids processed by the handtable include solutions such as those generated in cylinder cleaning operations, laboratory wastes, and field decontaminations. Reactants are added to the solution in the handtable, and the resulting uranyl nitrate solutions are processed in the Uranium Recovery solvent extraction loops. The waste gases are processed through a nitrogen oxide scrubber (Section 3.3.1.4.6).

3.3.1.4.2 Uranium Recovery Solvent Extraction Process

There are three uranium recovery solvent extraction loops, A, B, and C, each consisting of pre-evaporators, solvent extraction columns, post evaporators, and condensers associated with the evaporators. The function of the solvent extraction process is to purify and concentrate the uranyl nitrate solutions that are the feed to the calciners.

The A-Loop and B-Loop are fed by the B-1 measured storage columns, and the C-Loop is fed by the tunnel measured storage columns. The columns feed the Loop pre-evaporators, which increase the specific gravity of the feed solution as necessary. The concentrated feed solution is transferred to concentrate storage for processing in the extraction columns.

The solvent extraction process selectively removes the uranyl ion from a mixture of metallic ions and other compounds in the feed solution. This process occurs in two steps and results in an aqueous uranyl nitrate solution and a uranium-depleted raffinate stream.

Each Loop's aqueous uranyl nitrate solution, referred to as T-water, is stored in geometrically favorable columns. The T-water from all the Loops is fed to the post evaporators, which concentrate the solution into geometrically favorable concentrate storage prior to being fed to the calciners.

The uranium depleted raffinate stream is a nitric acid solution containing toxic heavy metals. The raffinate is transferred to tunnel raffinate storage columns for interim storage. Raffinate processing includes heavy metals precipitation, technetium removal in ion exchange columns, and biodenitrification.

Shell-and-tube condensers are utilized in the solution recovery area to condense the process vapors from the pre-evaporators and post-evaporators. The condensers isolate the cooling water from the process condensate, greatly reducing the volume of contaminated effluent. The cooling water is discharged to the storm sewer system for disposal. The process vapors are condensed and transferred to the Microfiltration Geometrically Safe Storage System for final processing and disposal.

The pre-evaporators and post-evaporators use steam as their heat source. Upon transferring heat to the evaporator, the steam condenses and the resultant steam condensate normally is drained to the storm sewer. Conductivity probes/sensors are installed on the steam condensate line from each evaporator. If a tube failure was to occur and/or a high conductivity reading registered, an audible alarm would sound to alert the operator, and automatic control valves would switch the flow from the storm sewer to a geometrically safe storage tank.

3.3.1.4.2.1 B-Area Condensate Drain System

The steam condensate from all the evaporator's collects into a common header containing an additional three conductivity cells in series. This conductivity measurement is part of the B-Area Condensate Drain System that prevents steam condensate from entering the storm sewer if uranium may be present in the condensate (Figures 3.3-1 and 3.3-2). If two of the three conductivity cells exceed preset limits, control valves will automatically divert condensate flow to the geometrically safe storage tank located in the tunnel and cause a local alarm to be generated. This system is important to safety, as described in Section 3.8.

Depending on the uranium concentration, the diverted condensate can be transferred to the microfiltration system for further processing or back through Uranium Recovery for re-processing. If the uranium concentration is at acceptable limits for discharge, the condensate can be discharged to the storm sewer.

Electrical power and Instrument Air are supplied to the B-Area Condensate Drain System. Electrical power is supplied to control components and circuits. A circuit interruption or loss of control power will cause closure of the drain control valves in the line to the storm sewer and opening of the safe storage control valve in the line to the safe storage tank by de-energizing the respective solenoid valves. Instrument Air is supplied to the control valves in the lines to both the storm sewer and the safe storage tank. Interruption of the air supply will cause closure of the fail-close drain control valves in the line to the storm sewer, and opening of the fail-open safe storage control valve in the line to the safe storage tank. Therefore, the B-Area Condensate Drain System is fail safe upon a loss of electrical power or instrument air.

3.3.1.4.3 Heavy Metals Precipitation

The Heavy Metals Precipitation Facility removes the trace amounts of uranium and other heavy metals from raffinate by raising the pH with sodium hydroxide (precipitation) and processing through filter media.

Solutions from the tunnel storage are sampled to determine uranium concentration prior to transfer to the Heavy Metals Precipitation Facility. Allowable uranium concentrations are assured by testing again before the raffinate is drained to the mix/feed tanks. After the pH has been adjusted, the raffinate is pumped through one of two pressure filters. The clear filtrate is pumped to the technetium ion exchange feed tank. The sludge from the filter is stored for future disposal.

3.3.1.4.4 Technetium Ion Exchange

The heavy metals filtrate solutions (raffinate solutions which have been neutralized and processed through heavy metals precipitation) are transferred to the technetium ion exchange feed tank. The solutions are then pumped from the feed tank using a metering pump through ion exchange columns for technetium removal by ion exchange onto the resin. From the last column, the solution flows to a discharge tank. The solution is sampled and eventually pumped to the Biodenitrification Storage Tanks.

3.3.1.4.5 Biodenitrification Facilities

A Biodenitrification Plant (Bio-D Plant) and a Biodenitrification Pilot Plant (Bio-D Pilot Plant) have been installed in the northeast corner of X-700 to lower the nitrate-nitrite levels in the treated raffinate (filtrate) solution from the Heavy Metal Precipitation and Technetium Ion Exchange facilities in X-705 to meet current Environmental Protection Agency guidelines before the liquid is discharged to the environment (see Section 3.5.1.1 for a description of X-700). There are no important to safety structures, systems, or components associated with these facilities.

3.3.1.4.6 Nitrogen Oxide Scrubbers

The Recovery Handtable operations and the calcination of uranyl nitrate to U_3O_8evolve nitrous oxides. A scrubbing system is used to reduce the environmental impact resulting from releasing NOx (Figure 3.3-3). The scrubbers are counterflow extraction systems using water (and dilute nitric acid generated by the extracted NOx) as the extraction fluid. Water in the packed columns overflows to a drain and is then pumped to the Microfiltration Geometrically Safe Storage System. If the drain does not function properly, the water overflows to the floor.

3.3.1.4.7 Continuous Dissolver

The Continuous Dissolver was used for leaching uranium from contaminated solids and also to process Spray Tank solutions. This equipment has been abandoned in place.

3.3.1.4.8 Mixed Acids Precipitation Facility

The Mixed Acids Precipitation Facility has been abandoned in place.

3.3.1.4.9 Neutralization System

The Neutralization System sink has been abandoned in place.

3.3.1.4.10 Calciners

The calciners are electrically heated rotary kilns that expose aqueous uranium solutions to high temperature and air. This results in the removal of water and the conversion of the uranyl nitrate feed solution to solid U_3O_8.

Three calciners are located in X-705. One calciner was normally used for the conversion of uranyl nitrate hexahydrate (UNH) to U_3O_8, but has been abandoned in place. The other two calciners are used for converting uranyl nitrate solutions from the uranium recovery loops (Section 3.3.1.4) to U_3O_8. They can also be fed UNH that is dissolved at the small parts hand table and processed through the Recovery System.

Figure 3.3-3 shows the flow schematic of the calcining system. The calciners are fed through a flow safety block valve and a feed pump. The feed solution passes through several manual valves and into a packed column feed scrubber prior to entering the calciner. Air is pulled countercurrent to the calciner feed by the NOx scrubber blower. As the air moves through the calciner, oxygen reacts with the uranyl nitrate compounds to yield uranyl oxides and NOx gasses. When the exhaust gas (NOx, water vapor, and excess air) leaves the calciner, it is passed through the packed column feed scrubber to preheat the uranyl nitrate feed solutions and remove any finely divided oxide from the exhaust gas. The exhaust gas then passes through separate packed columns to remove NOx and is vented to the atmosphere.

The oxide product exits at the bottom of the calciner through a discharge funnel into an oxide receiving can that sets on a scale directly beneath the funnel. A circular collar around the funnel tube slides down to seal against the top rim of the receiving can. The collar has a gasket that helps seal against the top of the can; the weight of the collar resting on the top of the can makes the seal.

A number of operational alarms and interlocks are provided that will not allow feed operation to begin or continue unless calciner parameters are appropriate for operation. These include the following that are important to safety:

- Level probes in the calciner funnel discharge throat and the oxide receiving can that monitor oxide discharge levels (Calciner Discharge Collector Probe Detector System, Calciner Can Level Probe Detection System),
- Temperature switches to ensure that maximum temperatures are within limits (Calciner High-High Temperature Shutoff System),
- Tube rotation interlocks to ensure that the calciner rotational drive is operating (Calciner Tube Rotation Interlock System).

(Note: These systems actuate a similar set of equipment. As shown in Figure 3.3-3, each calciner has only one feed pump and one flow safety block valve that are involved in the safety system actuations described below.)

3.3.1.4.10.1 Calciner Level Probes

There are two different level probe systems provided for each calciner, the Calciner Discharge Collector Probe Detector System and the Calciner Can Level Probe Detection System.

The Calciner Discharge Collector Probe Detector System includes two probes located in the calciner discharge funnel. These probes are positioned to detect any plugging in the funnel throat, and are necessary as the calciner discharge funnels are not a safe geometric configuration for handling high assay U_3O_8 if filled to maximum capacity. Actuation of either probe will stop solution feed to the calciner via de-energizing the feed pump, closing the flow safety block valve, and causing a local alarm to be generated. This system is important to safety, as described in Section 3.8.

The Calciner Can Level Probe Detection System includes a single probe located in the oxide receiving can. This probe is positioned to prevent the can from overfilling and spilling U_3O_8 on the floor of the unfavorable geometry glove box. Actuation of the probe will stop solution feed to the calciner via de-energizing the feed pump, closing the flow safety block valve, and causing a local alarm to be generated. This system is important to safety, as described in Section 3.8. (Note: The feed pump trip and flow safety block valve closure are the same as actuated by the Calciner Discharge Collector Probe Detector System.)

If the oxide receiving can level probe fails, the U_3O_8 will either back up into the funnel where the discharge collector level probes will sense the condition and stop the feed solution, or, if the collar is not properly sealed against the can, U_3O_8 could overflow and spill into the glove box where it will be visible. Also, the scale on which the oxide receiving can sits has a weight readout at the calciner operating console and will sound an alarm when the can is full.

Electrical power and Instrument Air are supplied to both probe shutdown systems. Electrical power is supplied to control components and circuits, and to the calciner feed pump. A control circuit interruption or loss of control power will cause closure of the flow safety block valve by de-energizing its associated solenoid valve. A loss of electrical power will cause the feed pump to stop operating. Instrument Air is supplied to the flow safety block valve. Interruption of the instrument air supply will cause closure of the fail-close block valve, which has an air volume tank associated with the valve actuator to assure valve closure even if the instrument air supply is unavailable. A valve leak rate test is performed to verify adequacy of the flow safety block valve isolation capability. Therefore, the level probe systems are fail safe upon a loss of electrical power or instrument air.

3.3.1.4.10.2 Calciner Heater Control

The calciners have four furnace control elements. These control elements must be activated and at operating temperatures prior to actuation of the calciner feed pump.

The furnace control elements are each controlled by Temperature Indicator Controllers (TICs). These TICs are set at prescribed operating temperatures and are used to monitor and maintain each calciner furnace zone at the desired operating temperature.

Calciner tube burn-through could result in a criticality risk from the accumulation of uranium in an unsafe geometry or in the release of airborne contamination. The calciners are also equipped with high temperature alarms that are separate from the TICs. These alarms will sound an audible and visual alarm if the furnace section temperature exceeds a maximum temperature.

In addition, a Calciner High-High Temperature Shutoff System is installed on each calciner. This system includes a thermocouple to measure internal calciner temperature and an associated temperature switch. Upon internal temperature reaching the temperature switch setpoint a local alarm is generated, the calciner feed pump de-energizes, the flow safety block valve closes, and power is removed from the calciner heating elements. This system is important to safety, as described in Section 3.8.

Electrical power and Instrument Air are supplied to the High-High Temperature Shutoff System. Electrical power is supplied to control components and circuits, and to the calciner feed pump. A control circuit interruption or loss of control power will cause closure of the flow safety block valve by de-energizing its associated solenoid valve. A loss of electrical power will cause the feed pump to stop operating. Instrument Air is supplied to the flow safety block valve. Interruption of the instrument air supply will cause closure of the fail-close block valve, which has an air volume tank associated with the valve actuator to assure valve closure even if the instrument air supply is unavailable. A valve leak rate test is performed to verify adequacy of the flow safety block valve isolation capability. Therefore, the Calciner High-High Temperature Shutoff System is fail safe upon a loss of electrical power or instrument air.

3.3.1.4.10.3 Calciner Tube Rotation Interlock

During operation, the calciner tube rotates while heat is applied. If the tube would stop rotating for an extended period of time while heating, tube failure could occur due to the uneven application of heat. This could result in a criticality risk from the accumulation of uranium in an unsafe geometry or in the release of airborne contamination.

A Calciner Tube Rotation Interlock System is installed that includes a rotation monitoring switch to detect tube rotation, and a rotation drive motor contactor that detects drive motor energization. If the tube stops rotation or the drive motor de-energizes, power is removed from the calciner heaters, the feed pump de-energizes, the flow safety block valve closes, and a local alarm is generated. This system is important to safety, as described in Section 3.8.

Electrical power and Instrument Air are supplied to the Tube Rotation Interlock System. Electrical power is supplied to control components and circuits, and to the calciner feed pump and calciner heaters. A control circuit interruption or loss of control power will cause closure of the flow safety block valve by de-energizing its associated solenoid valve. A loss of electrical power will cause the feed pump to stop operating and the heaters to shut off. Instrument Air is supplied to the flow safety block valve. Interruption of the instrument air supply will cause closure of the fail-close block valve, which has an air volume tank associated with the valve actuator to assure valve closure even if the instrument air supply is unavailable. A valve leak rate test is performed to verify adequacy of the flow safety block valve isolation capability. Therefore, the Tube Rotation Interlock System is fail-safe upon a loss of electrical power or instrument air.

3.3.1.5 X-705 Waste Water Treatment Microfiltration Facility

The overall Waste Water Treatment Microfiltration System consists of a variety of subsystems that collect, prepare, and process suitable solutions for eventual discharge to X-6619.

3.3.1.5.1 Solution Collection and Storage

A Microfiltration Geometrically Safe Storage System is provided in X-705 to collect the waste water effluents from the areas shown in Figure 3.3-1 and to serve as a buffer volume between these areas and the Microfiltration Treatment System. The solution collected in this storage system is the feed material for the Microfiltration Unit. The storage system consists of overhead pipes that are installed to act as a common volume. Recirculating pumps are installed to recirculate the wastewater to keep any solids in suspension and keep acids mixed in solution.

3.3.1.5.2 X-705 Microfiltration/Pressure Filtration Treatment System

This effluent treatment system is based on microfiltration technology where the effluent stream is pumped through microfilter membranes. Most of the microfiltration system is physically located in the southwest corner of X-705. The overall flow diagram is shown on Figure 3.3-1.

The influent to the microfiltration process drains by gravity from the Microfiltration Geometrically Safe Storage System to the first stage pH adjustment geometrically safe storage columns.

Pumps then move the solution through a two-stage pH adjustment/monitoring system where caustic (sodium hydroxide) or sulfuric acid is added to adjust the pH to approximately 9.0 - 9.8. The pH adjustment systems adjust the pH to the level where the metals will precipitate from solution.

Concentrates that are filtered out of solution by the microfilters are sent to geometrically safe storage tanks and eventually to a filter press. The resultant filter press filtrate is sent back to the Microfiltration Geometrically Safe Storage System, and the resultant filter press sludge is collected in an approved container.

A pH detection system (not important to safety) comprised of a single pH probe and monitoring system is located downstream of the microfilters. If this system detects that the pH has fallen below the required setpoint (higher than that of the separate important to safety pH monitoring system described in Section 3.3.1.5.2.1), an isolation valve will be automatically closed resulting in a microfiltration system shutdown and an alarm generated. This pH detection system is for operational purposes only.

3.3.1.5.2.1 Microfiltration pH Shutdown System

If the adjustment systems should fail to adjust the wastewater solution to the proper pH range, uranium could be carried through the microfilter membranes and into the effluent tank (unsafe geometry) where the amount of ^{235}U might become great enough to cause a criticality.

To mitigate this risk, a Microfiltration pH Shutdown System is installed that has three pH sensors in the common effluent header of the microfilters (Figures 3.3-1 and 3.3-4). This system controls two flow control valves that are located upstream of the effluent tank. If at least two of the three pH sensors indicate that the pH has fallen below the required setpoint, the control valves will be automatically closed resulting in a microfiltration system shutdown and a local alarm generated. The isolation valves are periodically leak-tested to ensure functionality. The pH must be brought back into normal range before the flow to the effluent tank can be restored. This system is important to safety, as described in Section 3.8.

Electrical power and Instrument Air are supplied to the Microfiltration pH Shutdown System. Electrical power is supplied to control components and circuits. A control circuit interruption or loss of control power will cause closure of the flow control valves by de-energizing their respective solenoid valves. Instrument Air is supplied to the flow control valves; interruption of the instrument air supply will cause closure of the fail-close control valves. Therefore, the microfiltration pH shutdown system is fail-safe upon a loss of electrical power or instrument air.

3.3.1.5.2.2 Microfiltration Permeate Effluent Bag Filter System

If a microfiltration membrane failure occurs, solids may be passed through to the unsafe geometry effluent tank. To prevent this, a Microfiltration Permeate Effluent Bag Filter System is installed in the effluent stream that will collect any solids that may be passed through (Figures 3.3-1 and 3.3-4). This plugging will cause a greater differential pressure to exist across the filter. If differential pressure increases to an established level, a pressure differential switch on each bag filter will actuate and cause their associated flow control valve to close and the microfiltration unit to shut down, preventing solids from reaching the unsafe geometry effluent tank. A local alarm will also be generated. The flow control valves that are actuated are the same valves actuated by the Microfiltration pH Shutdown System described in Section 3.3.1.5.2.1. This system is important to safety, as described in Section 3.8.

During normal operations, the permeate from the microfilter is "clean." Any increase in differential pressure indicates that some solids are getting through the membranes and a filter is plugging. The pressure differential switch setting will allow some operating pressure excursions (e.g., pump pulsating pressures) but will still prevent solids entering the effluent tank.

Electrical power and Instrument Air are supplied to the Microfiltration Permeate Effluent Bag Filter System. Electrical power is supplied to control components and circuits. A control circuit interruption or loss of control power will cause closure of the flow control valves by de-energizing their respective solenoid valves. Instrument Air is supplied to the flow control valves; interruption of the instrument air supply will cause closure of the fail-close control valves. Therefore, the Microfiltration Permeate Effluent Bag Filter System is fail-safe upon a loss of electrical power or instrument air.

3.3.1.5.3 Effluent Pumping Station

The effluent pumping station is located in the southwest corner of X-705, near the microfiltration unit. The purpose of the effluent pumping station is to collect the permeate from the microfiltration unit and transfer this permeate to the sanitary sewer line and on to X-6619. Effluents from the X-6619 treatment process are discharged to the Scioto River.

The microfiltration permeate passes through the pH probes described in Section 3.3.1.5.2.1, a pump (with installed spare), two bag filters in series described in Section 3.3.1.5.2.2, two control valves, and enters the effluent pumping station effluent tank.

3.3.1.6 Oxide Conversion

The Oxide Conversion Facility is a non-leased area and has been abandoned in place.

3.3.1.7 Miscellaneous Areas

Several other areas also exist in X-705 that provide a variety of support services. These include maintenance facilities, a process laboratory and laundry facilities.

3.3.1.7.1 Maintenance Shop

The Maintenance Shop contains some of the tools necessary to maintain the mechanical equipment in X-705.

3.3.1.7.2 Process Laboratory

The Process Laboratory performs analytical chemistry for X-705 and other facilities. The laboratory performs analyses of items such as recovery solutions, decontamination solutions and chemical cleaning solutions. Uranium assay analyses are also performed.

3.3.1.7.3 Laundry

The laundry facility services various facilities, and launders most cloth items that are soiled or contaminated on plant site. The laundry contains contamination monitors that can check contaminated items after they have been cleaned. The effluent from the laundry flows to the sanitary sewer and into X-6619.

3.3.1.8 X-705 Facility Utility and Protection Systems

The following systems are controls to monitor or reduce the hazardous and radiological impacts to the personnel and the environment associated with X-705 operations.

3.3.1.8.1 Confinement Systems

Primary containment of hazardous materials within X-705 is provided by containers, cylinders, glove boxes, storage tanks and columns, valves, piping, and other pieces of equipment. As discussed below, certain systems or processes have sufficient potential for dispersion of material that additional measures of confinement have been provided.

Glove boxes include the oxide blending/sampling glove box and the calciner oxide unloading glove boxes. An additional auger/sampling glove box has been abandoned in place. Seal parts dismantling operations that could generate airborne contamination are performed inside the Seal Dismantling Room. The dismantling room does not provide complete containment of airborne contamination as it is not sealed airtight, but does greatly limit the contamination spread. The exhaust fans keep the room at a negative pressure so that air flow is into the room. The exhaust fans are exhausted through a bank of HEPA filters located above the room.

As noted previously, the South Annex is a closed room of X-705 (south side) used to contain contamination during maintenance and disassembly of equipment. It is equipped with a HEPA filtration unit and HF removal capability on the room exhaust (Section 3.3.1.3.1.3).

Dikes are installed around the nitric acid storage tanks located outside of X-705, and the second floor chemical solution storage tanks located inside of X-705. A dike is also located in the Recovery area to contain spills safely without presenting a criticality hazard. Other dikes are located in local areas throughout the building.

3.3.1.8.2 Ventilation Systems

The X-705 ventilation system consists of various exhaust, make-up and ventilation fans. The fans may be either roof mounted or located near the systems that they serve within X-705. Some of the exhaust fans are connected to HEPA filtration systems whose primary function is contamination control.

3.3.1.8.3 Monitoring and Protection Systems

Radiation and airborne contamination monitoring instruments are located throughout X-705. X-705 is equipped with a CAAS. The CAAS is described in Section 3.6.2. Airborne contamination levels are monitored as described in Section 5.3.2.6. Manually operated gas-release alarms are installed in the building to provide an audible signal to evacuate the X-705 work areas.

3.3.1.8.4 Fire Protection

All areas of X-705 are protected by a wet-pipe sprinkler system supplied from the Sanitary and Fire Water System. Sprinkler system operation activates electric alarm bells outside X-705, and is indicated in the X-300, Plant Control Facility, and at the X-1007, Fire Station, fire alarm panels. The sprinkler system has fixed-temperature sprinkler heads installed in accordance with National Fire Protection Association (NFPA)-13. If criticality problems are possible as a result of sprinkler actuation, it is possible to valve-off the South Annex section of the sprinkler system. In addition to the sprinkler system, X-705 is protected by portable fire extinguishers.

3.3.2 Contaminated Storage Facilities

A nuclear facility the size of PORTS is involved with many types of ancillary operations. These operations include equipment maintenance and repair, environmental protection, etc. Many operations generate radionuclide contaminated materials requiring on-site disposal or decontamination procedures, generating in turn, other contaminated wastes. These contaminated wastes must be stored in preparation for further recovery or disposal.

The facilities discussed in this section are:

- XT-847, Waste Management Staging Facility,
- Contaminated Storage Lots,
- UNX and Uranium Oxide Storage Areas in X-330.

3.3.2.1 XT-847 Waste Management Staging Facility

XT-847 is located near the southern end of PORTS. The facility is used to accumulate, repackage, and stage/prepare low-level radioactive waste, Resource Conservation and Recovery Act hazardous and mixed waste (hazardous and radioactive), contaminated metal and equipment, dry active waste (dry/combustible/radioactive material), and non-hazardous recyclable materials prior to shipment off-site or until final waste disposal is secured.

The building is a steel structure with concrete floors and is divided into three major staging areas. The northern and southern sections are separated from the center section of the building by concrete block four-hour rated fire walls and steel fire doors. The building structure is important to safety as discussed in Section 3.8, and performs the function of withstanding natural phenomena hazards such as high winds and seismic events.

The Plant Area Emergency System provides notification for emergencies, evacuations, and other general announcements throughout XT-847. Fissile material operations are performed in accordance with Section 5.2 requirements.

3.3.2.1.1 XT-847 Non-Destructive Analysis Equipment

The NDA Laboratory is located in the northwest corner of XT-847. The NDA equipment is used to characterize waste for radionuclide concentrations for shipping purposes. A box monitor is available for NDA monitoring of B-25 containers.

3.3.2.1.2 Fire Protection System

XT-847 is protected by a sprinkler system, which is supplied water from the high pressure fire water system. Additionally, fire extinguishers are located throughout the building. A fire alarm system provides notification to emergency response personnel.

3.3.2.1.3 Criticality Accident Alarm System

XT-847 is equipped with a CAAS. The CAAS is described in Section 3.6.2.

3.3.2.2 Contaminated Storage Lots

Various outdoor open areas are used for the storage of low-level contaminated equipment and materials. These areas are managed in accordance with Section 5.3. An example of a permanent contaminated storage lot is the west side of XT-847; however, additional areas may be established and disestablished as long as the requirements of Section 5.3 and the Radwaste Management Plan are maintained.

3.3.2.3 UNX and Uranium Oxide Storage Areas in X-330

Areas in the X-330 Facility have been designated for storage of UNX. The crystals are stored in 3 gallon containers. Each container is received in a 55 gallon over-pack. The containers are removed from the over-packs and receipt accountability is performed as described in the FNMCP. The containers are spaced for criticality safety as required per the governing NCSA/NCSE.

Areas in the X-330 Facility have been designated for storage of uranium oxide. The oxide is stored in NCS-approved small diameter containers in fixed holders meeting NCS requirements.

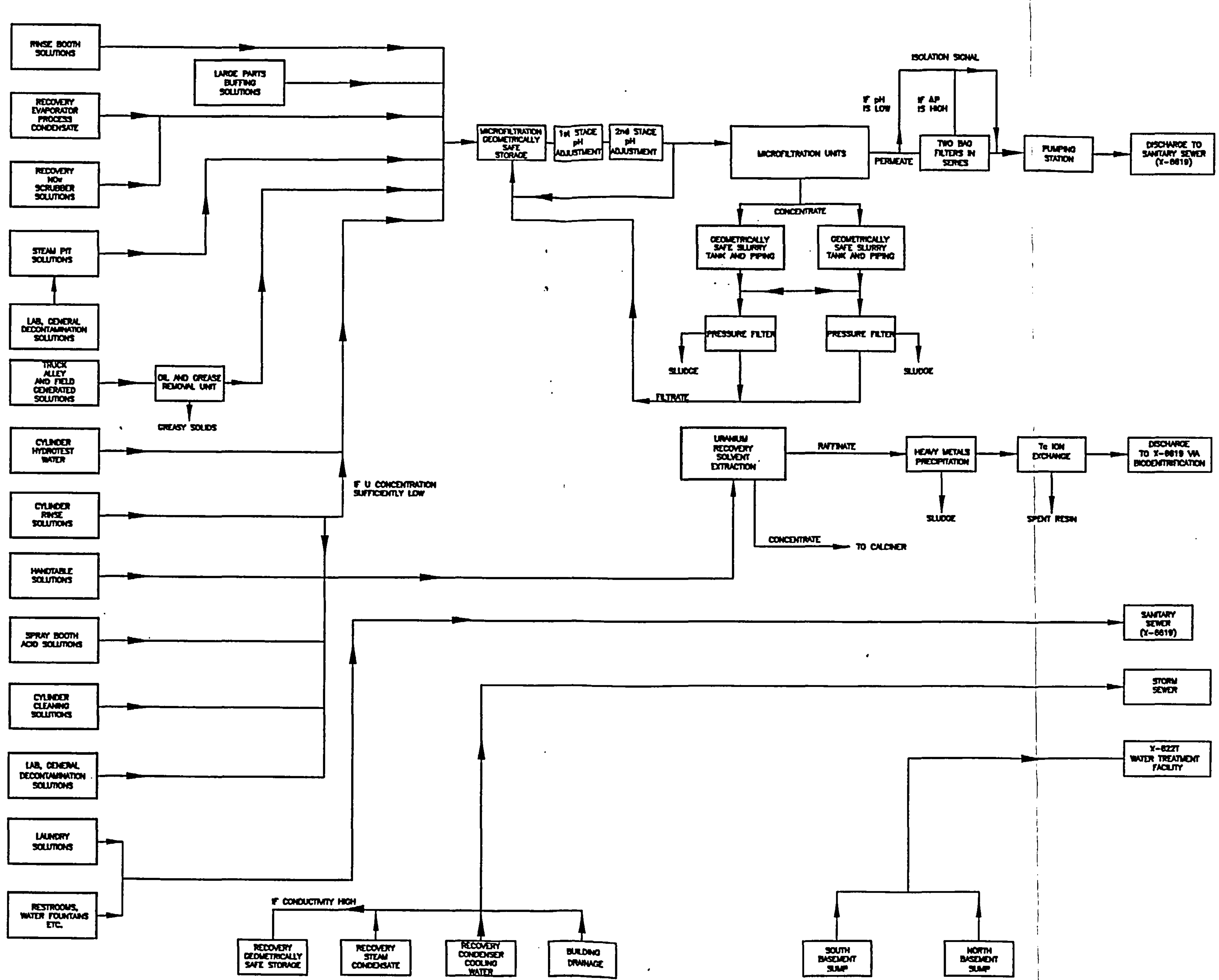


Figure 3.3-1 Diagram of Major X-705 Solution Flow Paths

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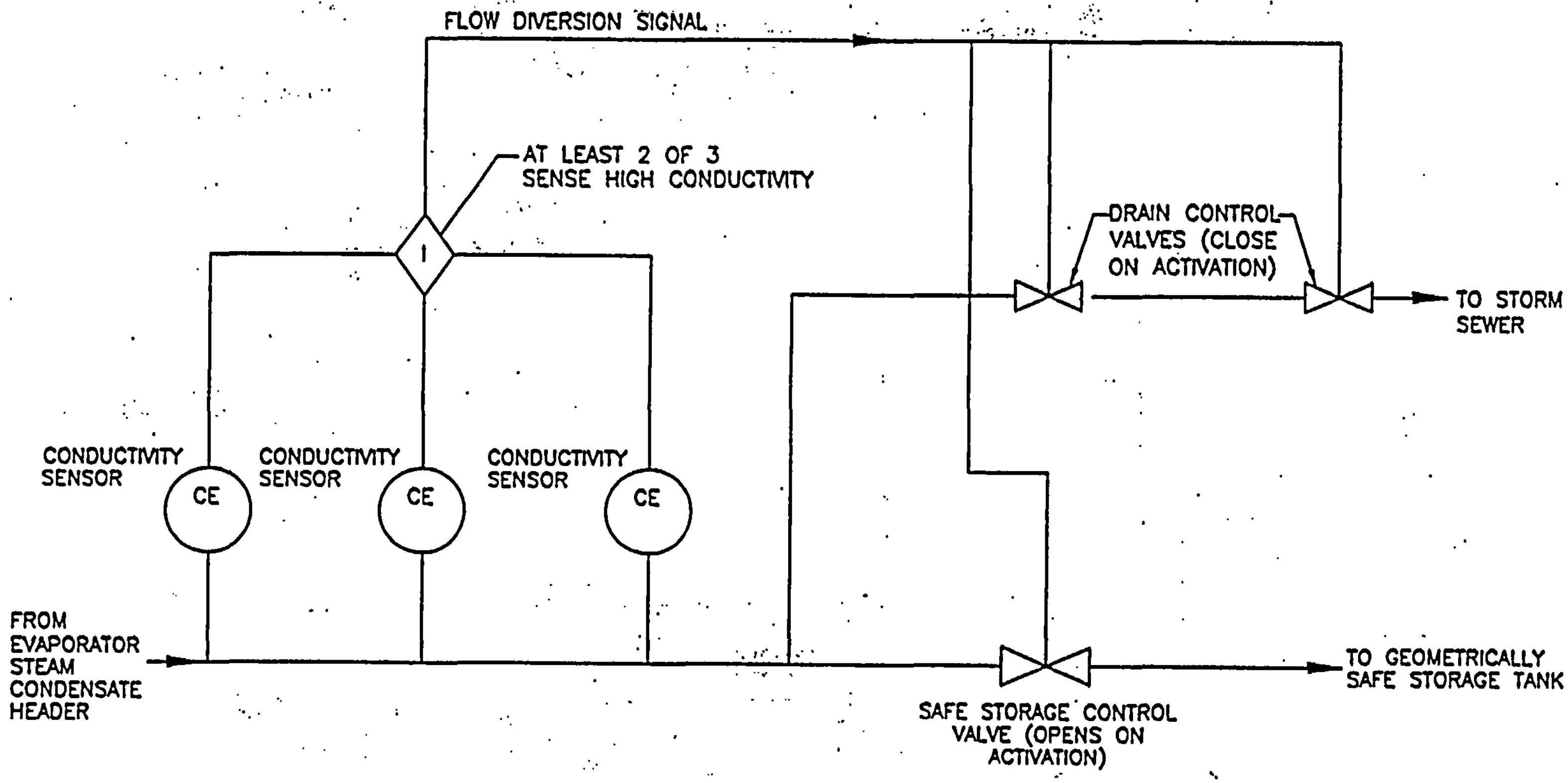

Figure 3.3–2 B–Area Condensate Drain System Schematic.

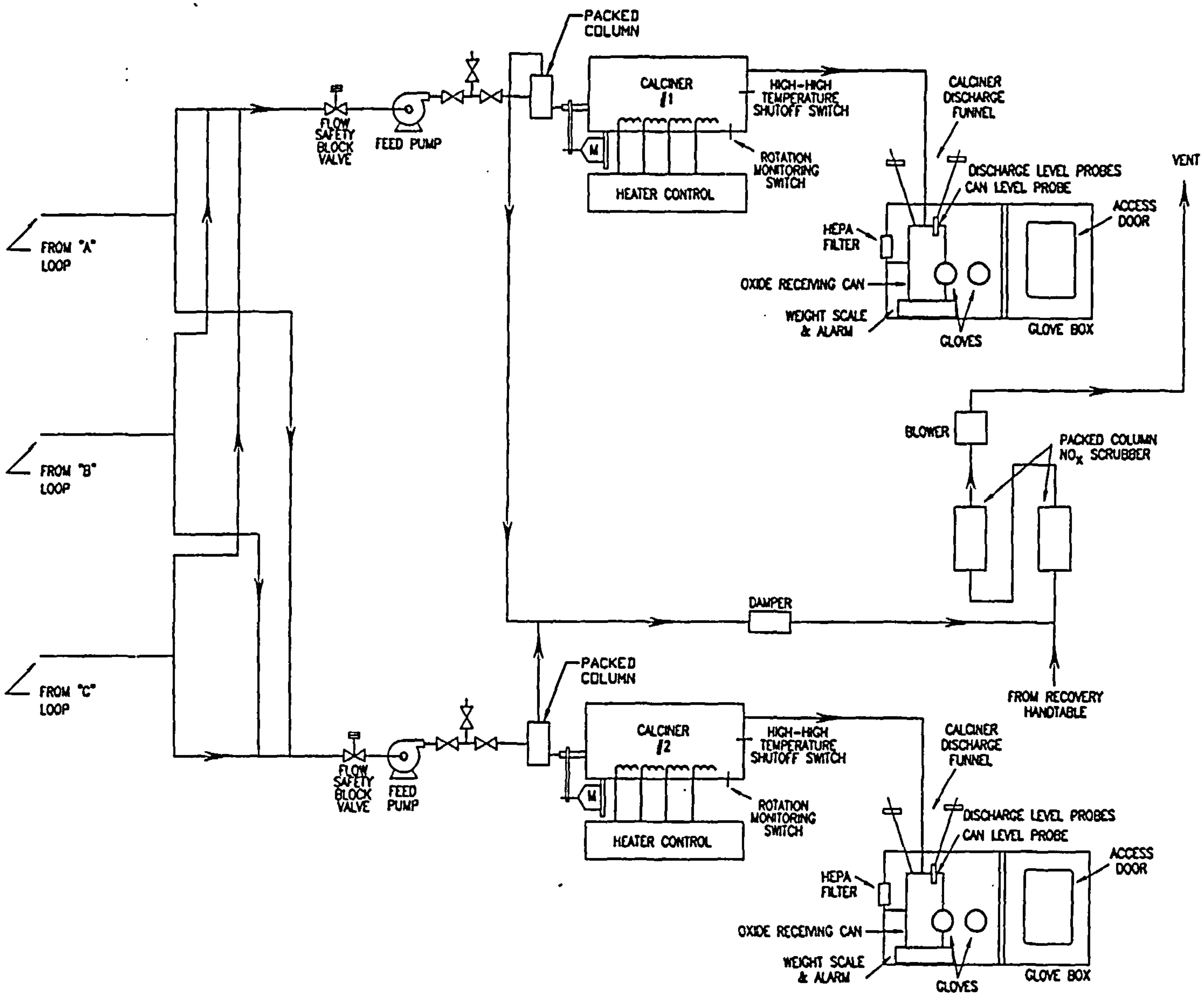

Figure 3.3-3 Calciner Flow Schematic

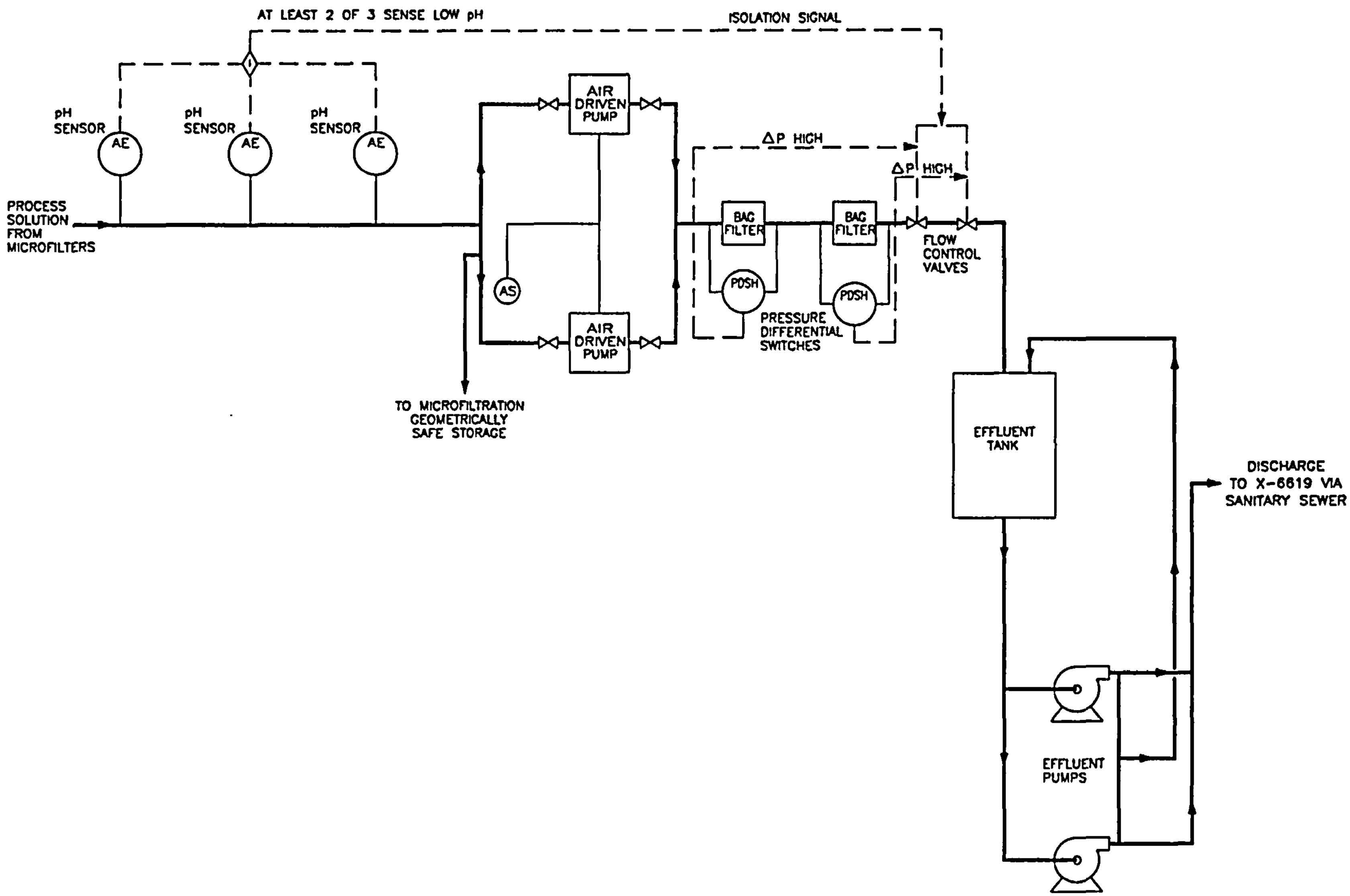

Figure 3.3-4 Microfiltration pH Shutdown & Permeate Effluent Bag Filter Systems Schematic

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3.4 POWER AND UTILITY SYSTEMS

The gaseous diffusion process requires a number of utility or support systems, which are essential for plant operations but are not directly concerned with isotope enrichment. These systems are described in this section.

This section describes the normal operation of the subject systems. These systems can also be operated in other modes, in accordance with approved plant procedures.

3.4.1 Electrical Systems

3.4.1.1 General Description

Electrical power for the Portsmouth Gaseous Diffusion Plant (PORTS) is supplied by commercial power stations to the plant switchyards (the X-530A, Switch Yard, and the X-533A, Switch Yard) at 345 kV. The normal configuration consists of multiple 345 kV transmission lines to each switchyard.

In addition, each switchyard is supplied by a 345 kV line from the Don Marquis Switch Yard. The Don Marquis yard is an "interconnect point" for the East Central Area Region electrical transmission grid. This grid supplies the PORTS area and further enhances the reliability of the plant power supply.

The voltage is reduced to 13.8 kV in the switchyards for distribution to the process and auxiliary substations. At these substations, the voltage is reduced further for operation of plant equipment.

3.4.1.2 Switchyards

X-530A is located west of the X-330, Process Building, and south of the X-630-2B, Cooling Tower. X-533A is located north of the X-333, Process Building, and west of the X-633-2A, Cooling Tower. The layouts of the two switchyards are similar. Each switchyard is enclosed by a perimeter fence on three sides and the attendant control house and two switch houses on the fourth side. Underground tunnels, which contain instrument and control cables, connect the switch houses and the control house.

The control house is located between the switch houses. The control house contains control panels and panels for recording and metering. An operator's console is located centrally on the operating floor. The switch houses distribute the 13.8 kV power to various PORTS substations.

3.4.1.2.1 System Protection

The incoming transmission lines to the switchyards are connected to the main 345 kV buses by means of oil or gas circuit breakers. Disconnect switches provide isolation of the terminals of circuit breakers and other apparatus in the switchyard from the high voltage potential. Protective relays minimize the disturbance created by a short circuit or fault. The switchyard structures and equipment are electrically grounded through a grid system of buried cable and ground rods.

Synchronous condensers in the switchyards correct the power factor and act as voltage regulators under fault conditions by helping to sustain bus voltage and preventing motor instability.

3.4.1.3 Feed Facilities

Power to X-342A, Feed, Vaporization & Fluorine Generation Building, and X-344A, UF_6 Sampling Facility, is supplied by two 13.8 kV lines supplied from different X-530 switchyard buses. The voltage is stepped down to 480 V, three-phase, by transformers at the facilities.

The substation located in X-342A and the two substations in X-344A have double-ended configurations. All three buses are connected on the secondary side through a tie breaker arrangement which allows retention of load capability during any transformer isolation.

Power to the X-343, Feed, Vaporization & Sampling Building, is from two transformers, which are connected on the secondary side by a tiebreaker (normally in the open position). This allows transformer isolation without load interruption. Power to each transformer is supplied from 13.8 kV underground feeders supplied from different transformer buses in the switchyards.

3.4.1.4 X-705 Decontamination Building

The normal feed for the X-705, Decontamination Building, is provided through two 13.8 kV underground feeders from different buses in X-530A. The secondary switchgears of the transformers are connected through a tiebreaker. The normal operating configuration of the double ended substation is to have each transformer operating and supplying its respective bus and for the connecting tiebreaker to be in the open position. Each transformer is sized to allow either transformer to carry the entire facility load during isolation of the other transformer. The internal building power is 480 V, three-phase.

3.4.1.5 Process Facilities

Power for the process buildings includes process power systems, process auxiliary power systems, backup auxiliary power systems and DC power systems. The process power systems provide 2400 or 480 V power to the process stage motors. The process auxiliary power systems supply 480 V power to cascade support equipment. The backup auxiliary power systems provide power upon failure of respective process auxiliary power systems.

3.4.1.5.1 X-326 Process Power Systems

The process power system in the X-326, Process Building, consists of multiple substations. Each substation consists of a transformer, feeder breakers, and the necessary feeder cables to supply power to the process motors (Figures 3.4-1 and 3.4-2). Substations are equipped with overcurrent relays, an undervoltage relay, and a transformer neutral ground relay.

3.4.1.5.2 X-330 Process Power System

The process power system in X-330 consists of multiple substations, each comprised of a transformer, feeder breakers, feeder cables to supply power to the process motors, the necessary relays to protect the equipment, and two banks of capacitors (Figure 3.4-3).

Each of the X-330 process substations is equipped with overcurrent relays on the feeder breakers, an undervoltage relay, transformer differential relays and lockout protection of the feeder.

3.4.1.5.3 X-333 Process Power System

The process power system in X-333 consists of multiple substations. Each substation consists of a transformer, one electrically operated feeder breaker, two banks of capacitors, and the necessary feeder cables to supply power to the process motors (Figure 3.4-4). Each cell in X-333 is supplied by two substations.

Each process substation in X-333 is equipped with an undervoltage relay, overcurrent relays on each stage motor, and a transformer.

3.4.1.5.4 Process Auxiliary Power System

Power for the non-process systems is provided by the 480 V Process Auxiliary Power System. The system provides power to the cascade support equipment. Power from the switchyard flows to the substation where it passes through a manually-operated disconnect switch to a 13.8 kV/480 V transformer and from the transformer secondary breaker to a 480 V bus.

Each 13.8 kV feeder is protected by phase and ground time delay instantaneous overcurrent relays, which trip the feeder breaker. A directional phase time delay overcurrent relay associated with the secondary bus is connected to trip the transformer secondary breaker when reverse currents are detected.

Each process unit in the cascade is served by four auxiliary substations. The substations are broken into transformer pairs, and each pair is supplied by two separate 13.8 kV switchyard buses. Each auxiliary substation, in turn, supplies a separate 480 V bus. In case of an undervoltage situation on one of these buses, the power is supplied from an adjacent substation by means of a solid tie connection (X-330) and/or closure of respective solid bus tiebreakers (X-326 and X-333). If both buses of a pair experience under voltage conditions, in the absence of an electrical fault, the bus tie breaker will close to connect to the remaining pair, re-establishing power on all four 480 V buses. If undervoltage is experienced on all four substations, the backup generators will function as described below.

3.4.1.5.5 Backup Auxiliary Power Systems

There are multiple backup diesel generators in the three process buildings, which provide power to certain loads during a loss of normal power. These units are designed to operate upon the failure of the auxiliary system of a complete unit (i.e. loss of power to all four auxiliary substations). Each diesel generator normally serves two process units and consists of a diesel engine, a generator, an air system for starting the engine, and a fuel system.

During the loss of process auxiliary power to a process unit (i.e. all four auxiliary substations supplying a process unit), the diesel generators in the affected area supply power to process valve control centers, seal exhaust pumps, and certain other systems normally supplied from the Process Auxiliary Power System. The generator(s) start automatically and electrical loads are energized in a predetermined sequence.

3.4.1.5.6 DC Power Supply

Each process unit has its own storage battery room located on the operating floor. The battery banks consist of multiple cells with a nominal output of 250 V. The batteries can also provide 125 V for emergency lighting and backup DC power to the Area Control Rooms (ACRs). Figure 3.4-5 shows a typical DC distribution system diagram.

DC power from the battery room is used for process and auxiliary switchgear breaker operation, protection and control circuitry, breaker indicating lights, emergency lighting, and backup diesel generator control breakers. The batteries also serve as a DC backup system to the ACRs in case of failure of the normal rectifier supply. The ACR system provides DC power, for local equipment alarms, indicating lights, and normal ACR control power. The DC power used to trip the cells in X-333 is supplied by batteries in X-533.

The batteries are connected to a distribution panel, which is connected to a 250 V battery charger. The local battery charger control panel has indicating instruments to monitor the voltage, amperes (charge rate), and ground current. A low charge rate is maintained on the batteries with an equalizing charge administered as needed. In addition, when the battery condition is such that special equalizing is needed, a portable 125 V charger can be applied across the affected batteries. This can be done while the batteries are in service without impairing the operability of the battery system. If at any time a battery (bank) is removed from service, a temporary tie to an adjacent battery (bank) can be installed. Only one adjacent battery (bank) can be connected at any given time.

DC power components associated with the Compressor Motor Manual Trip Systems are important to safety as described in Section 3.8. Pushbuttons/trip-switches in the ACR and the X-300, Plant Control Facility (PCF), provide a means to manually shutdown cell operation. The manual trip switches in X-300 for the enrichment cascade compressor motors are normally powered through a rectifier in X-300 that is fed by the 480 VAC power supply to the building. The rectifier develops the DC voltage needed to drive the compressor motor manual trip-relays. In the event, that the normal 125 VDC supply is lost, an automatic switchover is made to the 125 VDC battery system in X-300. Power to the trip-switches flows from the DC power supply, through associated auxiliary relays, breaker auxiliary contacts, and trip coils to the process cell breaker. Actuation of the pushbutton results in opening the process cell breaker and thereby interrupting power to the compressor motors in the cell. The cell breakers for the X-326 (480V AC) and the cell breakers for the X-330 (2400V AC) are located at the substations in the respective process buildings. The cell breakers for the X-333 cells (13.8 kV ACBs) are located in the X-533; these breakers de-energize both the substations and cell motors. The Compressor Motor Manual Trip Systems for X-326, X-330 and X-333 are illustrated in Figures 3.4-6 and 3.4-7.

The manual pushbuttons/trip-switches in the ACRs (the Local Control Room for the Extended Range Product [ERP] withdrawal station) for the X-326 and X-330 cascade, Tails second-stage compressors, and some of the ERP station second-stage compressor motors are powered by the 250 VDC battery systems in X-326 and X-330, respectively. The pushbuttons/trip-switches in the X-333 ACR are powered by the batteries in X-533. Power to the pushbuttons/trip-switches flows from the batteries, through associated relays and trip coils to control and alarm power circuit breakers and to the DC circuit breakers in the switchgear. Actuation of the pushbuttons results in opening the circuit breakers in the switchgear and thereby interrupting power to the selected compressor motors. The Compressor Motor Manual Trip Systems in the ERP and Low Assay Withdrawal stations that are not supported by the DC power supply are described in Sections 3.2.2.1.2.1.2 and 3.2.2.2.2.1.2, respectively.

3.4.1.6 Administrative and Support Facilities

Power is provided to the administrative and support facilities throughout the plant site via a system of 13.8 kV underground and overhead distribution lines. The distribution voltages are stepped down as necessary, depending on facility requirements. Most facilities are provided with double-ended service, wherein two substations supply power to switchgear separated by a tiebreaker. If one transformer fails or requires servicing, the entire facility load can be transferred to the remaining unit. Normally the two transformers comprising a double-ended unit are fed from different switchyard buses.

Several stationary diesel powered generators are available for backup power. In addition, a portable 480 V generator is available to provide power in the event that normal power sources are lost.

3.4.1.7 Plant Control Facility

3.4.1.7.1 Plant Control Facility Power Supply

Power to X-300 (PCF) is supplied by two separate 13.8 kV feeders feeding a double-ended substation. The two transformers feed the common busload through two secondary breakers and a tiebreaker. Either transformer is capable of carrying the total X-300 load.

The PCF has battery systems that supply nominal 125 V and 48 V power to selected components. The 125 V system provides DC control power and emergency lighting for the facility, and the 48 V system supplies radiation alarm DC power.

Backup power for the PCF includes two uninterruptable power supply systems for selected PCF and Supervisory Control and Data Acquisition (SCADA) loads and two backup diesel generator systems. A diesel generator in the SCADA room in X-300 is the main backup for X-300. A diesel generator in X-326 provides backup for the diesel generator in X-300. The diesel generator in X-300 automatically starts on the loss of both 13.8 kV feeds.

3.4.1.7.2 Supervisory Control and Data Acquisition

The SCADA System provides monitoring and/or control of selected portions of the plant's electrical system. Information provided by the SCADA System 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.

3.4.2 Plant Water System

3.4.2.1 General

The plant water system is made up of the Raw and Makeup Water System, the Sanitary and Fire Water System, the Recirculating Cooling Water (RCW) System, the Recirculating Heating Water (RHW) System, and the High-Pressure Fire Water (HPFW) System (Figure 3.4-8). These systems are described in this section, except the HPFW System, which is described in Section 3.6.1. The plant water system is designed to procure, treat, and distribute water of the desired quality for sanitary, cooling, heating, and fire protection purposes.

3.4.2.2 System and Equipment Description

The plant water system is described in four sections. The first section describes the Raw and Makeup Water System and the supply, treatment, and distribution of raw and makeup water. The second section describes the Sanitary and Fire Water System and the treatment and distribution of water for these purposes. The third section describes the RCW System and the treatment and distribution of RCW. The fourth section describes the RHW System and its distribution.

3.4.2.2.1 Raw and Makeup Water System

The function of the Raw and Makeup Water System is to obtain and treat the water for use on plant site. The primary source is ground water from four well fields, which is pumped to the X-611, Water Treatment Plant. The secondary source is the Scioto River, a surface water source that is used only if the well fields cannot produce an adequate supply of raw water for plant needs. Raw water from the river can be pumped to X-611 using pumps in the X-608, Raw Water Pump House. The third water source is recycled supernatant from the X-611B, Sludge Lagoon. This water can be routed through a recycle line to X-611.

3.4.2.2.1.1 Well Fields (X-605G/H, X-608A, X-608B, X-6609)

Four well fields are located along the Scioto River (Figure 3.4-9). The X-605G field has multiple wells with a total pumping capacity of approximately 3,200 gpm. Water from this well field is used in the Raw and Makeup Water System and as the fire water supply to the X-744W, Surplus and Salvage Building. The X-605H, Booster Pump House & Facility, facilitates the water flow from this well field to X-611. X-605H has multiple pumps with a capacity of approximately 4,300 gpm.

The X-608A and the X-608B, Raw Water Wells, are located near Piketon (Figure 3.4-9). X-608A has multiple wells and a pumping capacity of approximately 4,000 gpm. X-608B, which also has multiple wells, has a pumping capacity of approximately 11,000 gpm. Water from both fields is pumped to X-611.

The X-6609, Raw Water Wells, have a total pumping capacity of approximately 6,000 gpm. Water from X-6609 wells is also pumped to X-611.

3.4.2.2.1.2 Raw Water Pumphouse (X-608)

X-608 houses four pumps with a total capacity of approximately 22,400 gpm that take suction from the Scioto River. The pumphouse is designed for unmanned operation. Inspections are conducted when the pumps are in operation. River water is used when the quantity of the ground water is limited because of well repair or low water table conditions.

3.4.2.2.1.3 Water Treatment Plant (X-611)

The raw water is pumped from its source to X-611 where it is chemically treated (Figure 3.4-10). A portion of the softened water is also routed to the Sanitary and Fire Water System. X-611 has a design capacity of 40 million gpd.

The raw water normally enters a primary rapid mix basin where it is mixed with a lime slurry solution and polymer fed from the X-611 chemical building. After mixing, the water flows into a slow mix basin for flocculation before entering a primary settling basin. There are two primary systems at X-611, which can be run independently.

Settled water from the primary settling basins and raw water, if it has been allowed to bypass the primary system, flow into the secondary rapid mix basin. There is only one secondary rapid mix basin, which is arranged to permit flow to either or both secondary slow mix basins. The water then flows into any one, all, or a combination of the four secondary settling basins.

Treated water flows to a basin which provides the makeup water supply to the RCW and HPFW Systems and to the carbon basin, which is where the Sanitary and Fire Water System begins.

Sludge produced in the softening process is pumped to the X-611 lime sludge division box then to a waste sludge box. The sludge is then pumped to X-611B. Pumping stations X-611B1 and X-611B3 pump the supernatant liquid from the lagoon back to X-611.

3.4.2.2.1.4 Distribution System (Raw and Makeup Water)

From X-611, makeup water is fed to the four RCW pumphouses, the X-640-1, Fire Water Pump House, and the X-600, Steam Plant Facility (Figure 3.4-8).

3.4.2.2.1.5 Protection Systems (Raw and Makeup Water Facilities)

Fire protection for X-608 is provided by a wet pipe sprinkler system in part of the pumphouse; the water is supplied by the raw water pipeline. Fire protection at X-611 includes plant fire protection and evacuation alarm systems.

Overpressure protection for the raw water pipeline, the piping of the makeup water distribution system, and other associated piping is provided by surge relief valves or air relief valves.

3.4.2.2.1.6 Control Systems (Raw and Makeup Water Facilities)

Starting and stopping the pumps in X-605G wells and at X-605H is initiated locally. The controls for X-605G are located in X-605G, and the controls for the booster station are located in X-605H.

The starting and stopping of pumps in the X-608A and X-608B wells, X-608, and the X-6609 wells can be initiated locally or remotely from the control room in X-611. However, because the raw water pumps at X-608 must be primed before starting, they are always started locally.

A supervisory panel and control system located at X-611 shows the operating status of critical equipment and is provided with alarms to alert operating personnel of possible problems. Operating personnel are alerted by either local alarms when they are in the vicinity, or by a remote dial-up notification in the X-300 PCF during the times when X-611 is unmanned. In the event of remote dial-up notification in X-300, operating personnel are contacted through the PCF. The control system also allows the remote operation of the X-608A, X-608B, and X-6609 well pumps.

Controls for the operation of the chemical feed systems at X-611 are located in the chemical building at X-611, the X-611C, Filter Building, the X-611D, Recarbonization Instrument Building, or the X-611E, Clearwell & Chlorine Building, depending on chemical feed system.

The starting and stopping of the pumps in X-611B3 and X-611B1 is initiated locally.

3.4.2.2.2 Sanitary and Fire Water System

The function of the Sanitary and Fire Water System is to supply potable water to most of the buildings on plant site. The system also supplies cooling water for various plant equipment. In addition, the system supplies water for the fire sprinkler systems in the support buildings, the switchyards, and for most of the fire hydrants in the Gaseous Diffusion Plant (GDP) area.

The system receives its water supply from the Raw and Makeup Water System (Figure 3.4-8). The portion of the treated water from the Raw and Makeup Water System that is allocated for sanitary usage flows into the X-611 carbon basin, where the water is treated with carbon dioxide (Figure 3.4-10).

3.4.2.2.2.1 Recarbonation System

As water flows through the carbon basin, carbonic acid (carbon dioxide and water) is added to reduce the pH and for scale inhibition (Figure 3.4-10). The main components of the recarbonation system are a bulk carbon dioxide storage tank, distribution piping, pumps, and automatic feed equipment.

3.4.2.2.2.2 Filter Building (X-611C) and Clearwell and Chlorine Building (X-611E)

After recarbonation, the water is routed to the filter system to remove suspended solids (Figure 3.4-10). The filtered water exits X-611C and enters the X-611E clearwells. The water exits the clearwells into a header and returns to the X-611C storage basin (X-611C wetwell). The interconnecting piping between X-611C and X-611E is arranged to permit pumping of the filtered and treated water from either, or both, clearwells or wetwells. The water is then pumped into the Sanitary and Fire Water distribution system as detailed in Section 3.4.2.2.2.3.

Chlorination of the sanitary water provides microbiological control. The primary components of the X-611E Chlorine System are chlorine containers, a feed manifold, chlorinators, chlorine injectors, and chlorine leak detectors and associated alarms. The Chlorine System is a nonradiological chemical system that is important to safety as described in Section 3.8.

Chlorine for use in X-611E is delivered to the site in containers, each with a maximum capacity of 2,000 lb of chlorine. The containers comply with the appropriate Department of Transportation (DOT) specification. The quantity of chlorine used for water treatment and the storage locations for the containers are described in Section 5.6.

A feed manifold connects the chlorine containers to the chlorinating equipment. The system is designed to operate with gaseous chlorine at below atmospheric pressure. The system has two container feed positions that are equipped with automatic switchover vacuum regulators so that as one container empties, the system automatically switches to the full container. The vacuum regulators also control the gas flow to the manifold. Any leak in the system that reduces the vacuum (increases the system pressure) to the regulator, setpoint would result in isolation of the feed container by the vacuum regulator.

The chlorinators are metering instruments that control the rate of chlorine flow to the injectors. Flow indicators in the chlorine feed line are an integral part of each chlorinator. Multiple chlorinators are available to provide operating flexibility.

The metered chlorine gas supply mixes with a process water stream in the injector to produce the desired chlorine concentration. The resulting chlorine solution is routed to the point where it is injected into the process water system. Multiple injectors can introduce the chlorine solution at different points in the water treatment process.

Instrumentation monitors the chlorine content of the sanitary water to ensure that the necessary concentration is maintained. Routine monitoring is also conducted using portable monitoring equipment.

Instrumentation, controls, and alarms designed to monitor the Chlorine System's confinement integrity include chlorine leak detectors in the X-611E chlorine storage and chlorine feed rooms that initiate audible and visual alarms locally at X-611E and in the X-611 control room. In addition to alarming locally and in X-611, chlorine alarms are also brought to the attention of operating personnel via a remote dial-up notification in the X-300 PCF. The system also has a pressure sensor in the line from the chlorine containers to the chlorinators that senses low pressure (high vacuum), which indicates an empty container and/or failure of the automatic cylinder switchover mechanism. This pressure condition results in an alarm in the control room in X-611. Gauges at each injector indicate the pressure in the chlorine feed line.

3.4.2.2.2.3 Distribution System (Sanitary and Fire Water)

From the wetwells/clearwells in X-611C/X-611E, the filtered, chlorinated water is pumped into the distribution headers. Sanitary water can also be stored in a two-million gallon tank for reserve. Pumps in the X-6644, Fire Water Pump House, can feed water from the tank into the sanitary distribution headers.

The distribution system connects X-611C and X-6644 with the 250,000-gallon X-612, Elevated Water Tank (Figure 3.4-8). The water tank level is maintained by the sanitary water pumps located in X-611C. The water tank is a reservoir which "floats" on the sanitary water loop distribution system, filling when the system demand is below the X-611C sanitary water pump(s) output. The distribution system loop pressure is controlled by the sanitary water pump discharge and storage tank level/pressure relationships.

The distribution system supplies the plant site with sanitary water, and it supplies the sanitary Fire Water System.

3.4.2.2.2.4 Protection Systems (Sanitary and Fire Water Facilities)

A sprinkler system is located in X-611C for fire protection. The filterhouse is also protected by the plant fire protection and evacuation alarm system.

Two of the sanitary water pumps in X-611C are dual powered (electric motors and diesel engines). The diesel engines are used as back-ups in the event of a power failure.

3.4.2.2.2.5 System Controls (Sanitary and Fire Water Facilities)

Controls for feeding carbonic acid into the carbon basin at X-611 are located in X-611D. Controls for feeding chlorine are located in X-611E. Controls for feeding the polyphosphate are located in X-611C.

Each of the filters in X-611C is equipped with a control console which allows filter and backwash cycles to be performed. The clearwell is equipped with instrumentation to indicate water levels.

The sanitary pumps in X-611C can be started and stopped locally, at the filterhouse. The emergency diesels are set to start automatically on loss of normal voltage to the electric motor starters.

3.4.2.2.3 Recirculating Cooling Water System

The function of the RCW System is to supply cooling water to the process buildings and some auxiliary buildings. The heat of compression of the process gas (PG) is transferred through the coolant systems to the cooling water and then to the atmosphere.

In the plant RCW System, there is one subsystem for each process building—the X-626 RCW System, the X-630 RCW System, and the X-633 RCW System—and the X-6000,GCEP Cooling Tower Pump House. Each subsystem consists of a pumphouse, cooling tower system and associated piping.

The RCW System is supplied with water from the Raw and Makeup Water System. Makeup water is fed into the RCW Systems at the pumphouses where it is chemically treated along with RCW that has been returned from the cooling towers. The chemical treatment is accomplished in the pumphouse wetwell from which the water is pumped into the process buildings header systems. A double header system consisting of two banks of pumps and two headers per system provides cooling water to the process equipment. The heated water from the process equipment cooling system is returned via the return headers, return piping and risers to the distribution headers in the cooling towers. A portion of the returned RCW is lost through evaporation when passing through the cooling towers while the remainder accumulates in the cooling tower basins. The cooled water flows from the tower basins, back to the pumphouse well to again be treated and circulated as cooling water.

RCW instruments, at the RCW pumphouses, that monitor the temperature of the RCW supplied to the Evacuation Booster Stations in X-330 and X-333 are nuclear criticality safety components (see Section 5.2, Appendix A)—however, they are not active engineered features (see Section 3.8.10). These instruments consist of temperature indicators that are located in the RCW pump rooms.

Some of the heated water from X-630 is pumped through the RHW System prior to its return to the cooling towers. The RHW System is described in Section 3.4.2.2.4.

3.4.2.2.3.1 Recirculating Cooling Water Pumphouses (X-626-1, X-630-1, X-633-1, X-6000)

The RCW pumphouses act as control centers for the four RCW subsystems. In addition to the recirculating pumps and equipment, chemical feeders, pumps, motors, valves, switchgear, and recorders are located in the pumphouses.

Recirculating Cooling Water Pumps and Motors

The X-626-1, Recirculating Water Pump House, contains six RCW pumps each powered by an electric motor. The X-630-1, Recirculating Water Pump House, contains eight pumps. Each pump is driven by an electric motor. X-633-1 contains 14 RCW pumps, which are powered by electric motors. At X-6000, there are four pumps each driven by an electric motor.

Recirculating Cooling Water Chemical Feed Systems

Each pumphouse is equipped with a chemical feed system. The systems include equipment for the dispensing of biocide, sulfuric acid, mild steel corrosion inhibitor, copper corrosion inhibitor (except for X-6000), and a dispersant polymer.

A biocide is used at all four pumphouses for microbiological control.

At X-626-1, X-630-1 and X-633-1, sulfuric acid is fed directly into the pumphouse wet well from a storage tank located outside the pumphouse. The acid storage tanks at X-626-1, X-630-1, and X-633-1 are permanent units with capacities of 5,000, 10,000, and 10,000 gallons, respectively. Acid is dispensed at X-6000 from portable shuttles as needed.

Chemicals for the phosphate-based corrosion control systems are fed from bulk storage tanks or portable shuttles into the pumphouse wetwell. The chemicals used are part of a phosphate-based program.

3.4.2.2.3.2 Cooling Towers

There are eight cooling towers in the RCW System: one at X-626-1, two at X-630-1, four at X-633-1, and one at X-6000. In all of the towers, the heated air is discharged at the top of the tower and the cooled water is collected in a basin located under the tower.

RCW flows from the process heat exchange equipment into the return header, through the risers to the top of the tower, and into the tower distribution system. The water is evenly distributed in the top portion of the cells, and is cooled as it falls through the tower cells. A riser bypass line (except X-626-2 Tower) allows RCW return water to be routed directly into the cooling tower basin. To enhance cooling, a fill material is placed in each cell. The fill is constructed so that the water falling through it breaks into small droplets, enhancing heat transfer.

3.4.2.2.3.3 Recirculating Cooling Water Distribution Piping

RCW distribution piping consists of supply and return headers, bypass and blend lines, and blowdown lines.

<u>Recirculating Cooling Water Supply and Return Headers</u>

Two headers from each pumphouse supply water to opposite sides of their respective process building. At X-630-1 and X-633-1, there is a crossover line between the supply headers just outside each pumphouse. At X-626-1 and X-6000, the supply headers are tied together inside the pumphouse. There are also two return headers from the process building to the cooling tower(s). The X-630 and X-633 headers are tied together before reaching the cooling towers, while the X-626 and X-6000 headers are tied together at the cooling tower. The crossover piping allows any part of the building supply line or return line to be shut down for cleaning or repairs. All outside piping is underground, except for the risers on the return line to the cooling towers and the blend lines.

<u>Recirculating Cooling Water Bypass and Blend Lines</u>

The function of the RCW (hot water) bypass is to help control the temperature of the RCW supplied to the process buildings. This is done by allowing a portion of the hot return water to flow directly into the mixing flume from the return headers, bypassing the cooling tower(s). The bypass is used as needed to aid in keeping the supply water at the desired temperature for process cooling.

To prevent damage to the cooling towers, the blend lines are used to mix cool water with hot return water from X-330 and X-333 to control the temperature of the return water.

<u>Recirculating Cooling Water Blowdown Lines</u>

The function of the blowdown lines is to provide a means of lowering the dissolved and suspended solids concentrations in the systems. The blowdown from the X-626 system is used as partial makeup for the X-630 system. The blowdown from the X-6000 system is used as a partial makeup for the X-626 system. Likewise, blowdown from the X-630 system is used as partial makeup for the X-633 system. A blowdown line runs from the X-633 supply header to the Scioto River.

3.4.2.2.3.4 Protection Systems (Recirculating Cooling Water Facilities)

Due to the large quantity of water flowing through the RCW Systems, the equipment must be protected from pressure changes which result from the starting or stopping of a pump or the sudden closing of a valve. Surge protection is provided by surge relief valves or cone valves, which will open and allow water to return to the wetwell if high pressure occurs in the system. Check valves or cone valves on the pump discharge lines protect from backflow through the pumps.

The cooling tower fans are equipped with vibration switches, which will shut down the fan if excessive vibration occurs.

Fire protection in the RCW pumphouses is provided by Sanitary and Fire Water System sprinklers and fire hydrants, except in X-6000, which is protected by the HPFW System. The fire protection for the RCW cooling towers is provided by HPFW System sprinklers. All four RCW pumphouses are protected by the plant fire protection and evacuation alarm system.

3.4.2.2.3.5 Control Systems (Recirculating Cooling Water Facilities)

RCW pumps in three of the RCW Systems (X-626, X-630, and X-633) can be started and stopped locally or remotely. Local controls are positioned on control panels in each respective pumphouse. Remote controls are located in X-300. The X-6000 RCW pumps are started and stopped from X-6000.

Similarly, the RCW cooling tower fans in the X-626, X-630, X-633, and X-6000 RCW Systems can be started or stopped locally or remotely. Local controls are mounted on the cooling towers next to each cooling tower cell. Remote controls are located on the control panels in each respective pumphouse.

3.4.2.2.4 Recirculating Heating Water System

The RHW System consists of the necessary piping and equipment to circulate hot RCW return water from X-330 to the X-700, Converter Shop & Cleaning Building, X-705, the X-720, Maintenance & Stores Building, the X-623, North Groundwater Treatment Building, and the Gas Centrifuge Enrichment Plant (GCEP). The system provides a source of building heat. The RHW system is currently in cold standby condition; the buildings listed above are heated by other means when the RHW system is in cold standby.

The primary pumping station in X-330 is equipped with pumps, filters, flow controls and piping. RCW return water is taken from one or more of four return headers and is pumped into the distribution piping to flow to the various building heating systems. Each building serviced by the system has a pumping system to circulate water through the building heat exchange units and into the RHW return line.

3.4.3 Plant Nitrogen System

3.4.3.1 System Description

The Plant Nitrogen System consists of a nitrogen plant, nitrogen storage facilities, vaporization facilities and a distribution system. The system is designed to generate and distribute nitrogen gas used in the cascade for seal feed, buffer systems, and servicing equipment when dry gas is required. Nitrogen gas is also distributed to various process auxiliary buildings. The principal nitrogen production and storage equipment is located in X-330 and just south of X-330.

The nitrogen plant consists primarily of a separation column in which the nitrogen is produced. From the separation column, the nitrogen can be routed as a gas to a distribution header or a bank of storage cylinders. It can also be supplied as a liquid to a low-pressure liquid nitrogen storage tank. The tank is normally filled from a truck. Additional liquid nitrogen storage capacity is provided by a high-pressure storage tank that is filled from a tank truck.

When needed, liquid nitrogen from the low pressure storage tank or the high pressure storage tank may be transferred to a cold converter and vaporizing unit where it is converted to gaseous nitrogen. Gas from the cylinder storage bank can be transferred to the distribution header as a supplementary source of nitrogen.

3.4.3.2 Nitrogen Distribution System

A distribution header that typically operates at approximately 55 psig furnishes nitrogen to various plant buildings. Nitrogen is provided to the distribution header from three main sources:

- Nitrogen from the air separation column is furnished directly to the distribution header at a rate of up to 100 scfm.
- Nitrogen is supplied from the liquid storage tanks through the cold converter and vaporizing unit at the rate of up to 7,100 scfm. (Nitrogen is also vented from the high-pressure gas storage tank into the distribution header. However, this is not considered a major source of nitrogen.)
- If the nitrogen demand exceeds column production and cold converter capacity, the high-pressure storage cylinders are used to meet the demand. Nitrogen can be transferred at the rate of up to 1,000 scfm from that source.

Pressure reducing stations in each process building are located on the operating floor beneath the X-25-7, X-31-5, and X-33-1 units. These stations reduce nitrogen pressure for building needs. A vent line from the low-pressure liquid storage tank furnishes additional flow to the header in X-326 and can supplement the header in X-330. The distribution systems in the process buildings are protected by pressure relief valves.

The plant distribution header supplies nitrogen to auxiliary and service buildings where maintenance, testing, or plant service activities are conducted. Each of these buildings contains a station where nitrogen pressure is reduced to operating pressure.

X-333 and X-330 are interconnected by a nitrogen line to ensure a nitrogen supply in the event of a process building pressure reducing station failure. In addition, an automatic air-to-nitrogen crossover is provided in each process building for emergency use of dry air in place of nitrogen.

3.4.3.3 Protection Systems

The nitrogen system contains multiple relief valves and rupture discs, which are provided to prevent over-pressurization of various components of the system. These are designed and sized to comply with ASME standards for the pressure vessels on which they are placed.

In addition to internal safety devices, the area around the generation facility is protected by the building fire protection and evacuation alarm systems.

3.4.4 Plant Air System

3.4.4.1 General Description

The Plant Air System supplies dry compressed air to the process buildings and the auxiliary buildings, except some buildings outside the perimeter fence. The Plant Air System consists of equipment to compress, dry, and distribute air to the use points. System design capacity is more than 47,000 scfm. Typical uses for Plant Air include purging process equipment; as a backup for the nitrogen system; to operate instruments, controls, air ejectors, and alarms; to provide air for the plant datum systems; to provide process system buffers; to provide air for compressor seal operation; and to provide air for general maintenance and laboratory operations. The principal system components are located in

NOTE: This page has not been submitted to the NRC for review.

X-326, X-330, X-333 and X-6000. Dry air is produced with a dew point of at least -60 °F, measured at atmospheric pressure.

3.4.4.2 Description of the Air Plants

The dry air plants are typical industrial units consisting of compressors, receivers, oil adsorbers and dryers. Multiple compressors, including diesel-powered backup units, are available to meet varying site air demands. Typical site usage is approximately 15,000 scfm. Normally, four compressors can meet the demand. However, additional compressors will start automatically to augment system capacity, as needed. The diesel-driven units are normally in standby. They automatically start when the air pressure drops to a predetermined level. Package air compressor units can be installed to augment the capability of the equipment installed in the air plants.

Sanitary water and RCW are used for cooling the equipment at the X-326, X-330 and X-333 air stations.

Controls are built into air plant equipment to improve the overall safety of the system. All compressors have shutdown interlocks for low lube oil pressure and high air temperature. The centrifugal compressors also have vibration monitors. The diesel-driven compressors have overspeed cutoffs. Instrumentation is provided to monitor and record the moisture content of the air in the system. Alarms are provided to alert operators to conditions of low pressure or high moisture content.

3.4.4.3 Air Distribution System

The main air distribution line for the GDP is arranged as a loop. The cascade portion of the loop can be isolated from the auxiliary portion in the event of air pressure reduction, thereby maintaining the air for the enrichment cascade. The auxiliary portion of the distribution loop supplies those facilities where continuous air service is not required. Such facilities include those involved in maintenance, testing, administration and storage. The distribution system also provides the means for isolating portions of the system for maintenance or operational reasons, while maintaining service to unaffected areas.

Dry air also serves as a backup to Plant Nitrogen Systems. In the event of a nitrogen system failure, dry air is automatically supplied to each process building nitrogen system through crossover connections.

3.4.4.4 Air System Safety Systems, Design Features, and Administrative Controls

Plant Air System instruments, fixed or portable, that are relied upon to monitor the dew point temperature are nuclear criticality safety features (Section 5.2, Appendix A)—however, they are not active engineered features (Section 3.8.10).

3.4.5 Plant Steam and Condensate Systems

3.4.5.1 General Description

X-600 is a standard industrial facility with typical systems such as water treatment, steam generation, coal and ash handling, steam distribution, and condensate return. Radioactive materials are not routinely handled in this facility, although the boilers are radiologically controlled due to contamination.

X-600 is located near the south end of PORTS, east of X-326. The Steam Plant produces saturated steam that is used for general plant heating and to provide heat for process operations. Three coal-fired boilers are used in conjunction with necessary auxiliary equipment to generate the required quantity of steam. Each boiler is rated for continuous operation at 125,000 lb of steam per hour at approximately 125 psig and a saturated steam temperature of 353 °F. Package steam boiler units can be installed to augment the steam generating capability of X-600.

3.4.5.2 Steam and Condensate Return Systems

The steam pressure developed in the boilers is reduced within X-600 and other end user buildings through pressure reducing stations. The steam is distributed through two lines referred to as the east and west loops. The condensate is returned to the condensate tank at X-600.

3.4.5.3 Coal and Ash Handling Systems

Coal is trucked into the plant and delivered to the coal storage yard or placed directly into the coal conveyor system. The coal yard has a capacity of approximately 50,000 tons. Normal storage is less than 15,000 tons; however, storage stockpile quantities vary. The coal pile runoff treatment facility is described in Section 3.6.3.1.

Coal dumped into the coal chute is fed onto a system of large belt conveyors that transports it to the coal bunker room. From there, a conveyor distributes it to the three coal bunkers. Coal from the bunkers slides through baffles down four chutes into stokers that feed the boiler. The fly ash is removed by mechanical dust collectors and electrostatic precipitators before the gases are released to the atmosphere through the boiler stacks. The stack particulate emissions to the atmosphere are controlled by electrostatic precipitators.

Ash is removed from the boilers by a vacuum conveying system. The ash is stored in silos and is periodically hauled to an off-site landfill. Particulate from the ash handling systems is either filter-pressed or bag-filtered. The solids are disposed of in an approved offsite landfill.

3.4.6 Plant Waste Systems and Facilities

This section describes waste systems and facilities not discussed in other sections of the Safety Analysis Report.

3.4.6.1 X-230C Storm Sewer System

3.4.6.1.1 General

The storm sewer systems that serve the GDP receive precipitation run-off and some also receive discharges from plant facilities. Generally, each storm sewer system discharges into a ditch that runs to a holding pond, drainage ditch or larger stream. The storm sewer discharges are monitored as described in Section 5.1.

3.4.6.1.2 Nuclear Criticality Safety

The potential for discharging uranium solutions to the storm sewer systems is discussed in Nuclear Criticality Safety evaluations and approvals examining facilities that contain fissionable materials.

3.4.6.2 Sewage Treatment

3.4.6.2.1 General

The X-6619, Sewage Treatment Plant, services the GDP, GCEP, and the Ohio Valley Electric Corporation (OVEC) facilities. In addition, several septic/leach fields are maintained for remote facilities.

Sewage from the GDP, GCEP, and OVEC facilities is fed into a series of underground sanitary sewers. The GDP sanitary sewers feed into one of the lift stations located around the plant site or directly to the X-614A, Sewage Pumping Station. From X-614A, the sewage is routed to the X-6614E, Sewage Lift Station, and then to X-6619. Sewage from GCEP flows into lift stations where it is pumped to X-6614E, and then to the treatment plant. Sewage from OVEC is routed directly to X-6614E.

3.4.6.2.1.1 Sewage Treatment Plant

X-6619 is an activated-sludge facility utilizing the plug flow process, aerobic digestion, secondary clarification, and granular-media filtration for effluent polishing (tertiary treatment). Post-chlorination followed by de-chlorination with sulfur dioxide is used to meet National Pollutant Discharge Elimination System (NPDES) effluent standards. The treated effluent is discharged to the Scioto River.

3.4.6.2.1.2 Septic Tanks

Septic tank/leach bed systems are provided for locations not serviced by the Plant Sanitary Sewage System, including X-633, X-611, X-608, X-744W, and the X-735A, Landfill Utility Building. The effluent from the leach bed at X-608 discharges into the Scioto River. The effluent from the other facilities discharges to Little Beaver Creek.

3.4.6.2.2 Hazardous Materials

Chlorine is used to disinfect the water prior to its discharge to the Scioto River. The quantity of chlorine available for use in sewage treatment is maintained below the Occupational Safety and Health Administration, Title 29 Code of Federal Regulations, Part 1910.119 threshold quantity. Sulfur dioxide is used to neutralize the chlorine residual in the effluent water. Standard industrial safety procedures are used to manage these materials.

3.4.6.2.3 Monitoring and Protection Systems

Gas feed controllers, monitoring instrumentation, and administrative procedures are used to control the sewage treatment plant operations. The amount of chlorine and sulfur dioxide injected into the waste stream to treat the plant effluent water is regulated by gas feed control units (chlorinators and sulfonators) based on the effluent flow rate. Analyzers/recorders continuously monitor the chlorine residual and sulfite residual of the effluent.

Administrative controls and procedures ensure that the proper chlorine and sulfite residuals have been achieved for the required effluent disinfection and chlorine neutralization. The effluent stream is monitored to verify compliance with the plant NPDES permit.

3.4.6.2.4 Ventilation Systems

The chlorine and sulfur dioxide feed room is equipped with a ventilation system for handling and storage of these hazardous materials.

3.4.6.2.5 Nuclear Criticality Safety

Plant facilities and processes that handle fissionable material and discharge waste to the sewage treatment system have equipment and operating controls that limit the carryover of fissionable material to the sewage system. There are trace amounts of uranium and other radioactive materials in the water discharged to X-6619; the majority comes from laundry operations in the X-705. The concentration of uranium is sufficiently small that the probability of the accumulation of enough uranium to sustain a critical nuclear reaction is very remote. It is extremely unlikely that significant amounts of uranium could be discharged to the sanitary sewer system and X-6619 in an accident.

3.4.6.2.6 Fire Protection System

X-6619 is equipped with a sprinkler system that automatically notifies the fire station when the sprinkler system activates. There is a manual fire alarm pull box at this facility also.

3.4.6.2.7 Waste Disposal System

The sludge generated in the sewage treatment process is placed in drums or other appropriate containers for disposition.

3.4.7 Fluorine Generation System

Fluorine (F_2) gas is produced in the Fluorine Generation System using hydrogen fluoride (HF) as the feed material. Anhydrous HF is delivered to the Plant as a liquid. The HF cylinders are stored and the F_2 generating equipment is housed in X-342A. F_2 generated in the system is stored in tanks in X-342B, Fluorine Storage Building. From the storage tanks, the F_2 is piped throughout the cascade and other support facilities.

X-342A occupies the southeast portion of the X-344A/342A complex. X-342A is equipped with ventilation systems, including separate, dedicated systems in the Fluorine Generation Room and the sodium fluoride (NaF) trap room. HF detectors and F_2 detectors with automatic alarms, as well as manually operated gas release alarms, are located in the F_2 generation areas. In addition to the F_2 system, uranium hexafluoride (UF_6) cylinder sampling equipment is located in X-342A. A separate high-bay part of the building contains autoclaves and other associated UF_6 feed and sampling equipment. The F_2 process areas are separated from the UF_6 areas by concrete block walls. The HF feed header from the HF cylinders to the generator room is routed through the UF_6 high bay, and the HF cylinders are moved through the high bay area en route to the HF storage room. No other interactions occur between the two systems.

X-342B houses the F_2 storage tanks and associated piping and valves. The building is equipped with HF vapor detectors.

3.4.7.1 System Description

The primary components of the Fluorine Generation System are DOT-approved HF cylinders, a heated cabinet, F_2 generators, a surge drum, NaF traps, sintered metal filters, F_2 compressors, F_2 storage tanks, and associated control valves and piping (Figure 3.4-11). The Fluorine Generation System is a nonradiological chemical system that is important to safety as described in Section 3.8.

HF cylinders are received by Shipping and Receiving. The cylinders are each designed to hold 1000 lb of HF, but are limited by procedure to 850 lb per cylinder. Each cylinder has two valves—one for filling the HF as a liquid, and one for feeding the HF as a gas. Up to four cylinders at a time are moved to X-342A, where they are inspected and moved to the HF storage room. The storage room is equipped to store up to 12 full cylinders.

HF cylinders are moved from the storage room to the heated cabinet, where the HF is fed into the system. The heated cabinet accommodates two HF cylinders. The heated cabinet is equipped with an HF detector and an air exhaust line. An air jet is provided to purge the cabinet prior to opening the access doors. Gas purged from the cabinet is exhausted outside the building through an elevated stack.

Multiple F_2 generators are located in the generator room. The primary components of the generators are the steel outer cell body, the Monel inner body, the electrolyte, the electrodes, the hydrogen (H_2) collector and the F_2 collector (Figure 3.4-12). Steam or cooling water can be circulated in the space between the inner and outer cell bodies to heat or cool the electrolyte solution, as necessary. HF is fed to the generators from the feed cylinder. The generators produce F_2 by applying a DC current through the electrolyte. A gas separator skirt between the electrodes prevents mixing of the H_2 and F_2 gases.

PORTS uses medium-temperature generators with a potassium fluoride (KF)-2HF electrolyte solution. The electrical conductivity increases with increasing temperature and HF concentrations. The specific gravity decreases with increasing HF concentration. Since the fluoride and potassium ions are present in the solution, the following simplified equations illustrate the electrode reactions:

(1) Anode Reaction: $2F^- \rightarrow F_2 + 2e^-$.

(2) Cathode Reaction: $K^+ + e^- \rightarrow K$.

The potassium, not being able to exist in the presence of HF, immediately reacts with it as follows:

(3) $2K + 2HF \rightarrow H_2 + 2KF$

The net result is the decomposition of HF to produce free F_2 at the anode and free H_2 at the cathode. The H_2 gas produced in the process is routed through a flame arrestor and discharged to the atmosphere through an elevated stack. Two selenium diode rectifiers provide DC power to the F_2 generators.

From the generators, the F_2 flows to a 110 ft^3 surge drum in the generator room. The surge drum is designed for a maximum operating pressure of 5 psig and an operating temperature of 80 – 180 °F.

From the surge drum, F_2 flows first through NaF traps and then through sintered metal filters located in the trap room. The traps and the filters are provided to remove residual HF and particulate, respectively, from the product stream.

From the sintered metal filters, the F_2 flows to the multi-diaphragm compressors, which pump the gas to the storage tanks in X-342B. The compressor diaphragms provide multiple barriers between the F_2 gas and the pump oil to prevent mixing of the F_2 with pump oil. Leakage of F_2 or oil through any diaphragm is detected and annunciated by audible and visual alarms in the F_2 control room in X-342A.

In the event that high pressure develops in the system, F_2 can be manually vented to the atmosphere through an elevated stack.

From X-342A, the F_2 is pumped into any of three nominal 1,000 ft^3 capacity storage tanks located in X-342B. At a nominal operating pressure of 45 psig and 80 °F, the contents of each tank is calculated as 430 lb of F_2. The tanks have a maximum allowable working pressure of 194 psig and a maximum operating temperature of 250 °F. Each tank is equipped with a relief device consisting of a pair of rupture discs with a nitrogen buffer in the piping between the discs. The piping between the discs is instrumented to detect and annunciate pressure changes. In the event that both discs rupture, excess system pressure is vented outside the building through an elevated stack. Valves in X-342B are equipped with extension rods that extend through the wall so the valves can be operated from outside the building. Instrumentation for this portion of the system is also mounted on the outside wall of the building.

From the storage tanks, F_2 is distributed to plant buildings through a black-iron header or the PG return header. A metering station in X-342A monitors the flow of F_2 to the PG return header. Operations personnel in the F_2 control room in X-342A are notified when F_2 will be used in another facility so that the drop in F_2 header pressure and the resulting low pressure alarm will be expected. A low header pressure alarm when F_2 flow is not scheduled requires Operations to verify that the alarm is valid and, if so, isolate the header in accordance with approved procedures.

Valve alignment changes in the Fluorine Generation primary system are controlled by procedures. Where block valves are installed for isolation, double valves are typically provided.

Piping and equipment for use in F_2 service is cleaned prior to installation to remove organic contaminants. Personnel working on piping or equipment in F_2 service wear gloves to prevent contaminating surfaces with organic materials. F_2 system primary piping is purged and evacuated prior to being opened to prevent personnel exposure to F_2 and potential fires. Replacement equipment that will be used in F_2 service is preconditioned before it is placed in service to reduce the likelihood of primary system failure due to reaction of the material with F_2. Plant programs and plans that address the F_2 system are listed in Section 5.6.

3.4.7.2 Process Instrumentation and Alarm Systems

The Fluorine Generation System contains the following key instruments, controls, and alarms:

- The Fluorine Generation System is equipped with the means for emergency shutdown to protect the F2 generating equipment by interrupting power to the F2 generators and isolating the piping and the storage tanks. The shutdown functions may be activated automatically or by either of two manual pushbuttons—one on the control panel and one on the outside west wall of the Fluorine Generator Room. Activation of the shutdown function is initiated by the following indications:
    - High H_2 or F_2 cell pressure,
    - High differential pressure in an H_2 or F_2 cell header,
    - High differential pressure between F_2 and H_2,
    - Rectifier power overload,

- Rectifier cooling water pump failure,
- Rectifier cooling fan failure,
- Rectifier high temperature,
- F_2 compressor shutdown (high F_2 discharge pressure).

- A temperature controller maintains the internal setpoint temperature in the HF cylinder heated cabinet. The controller actuates audible and visual alarms in the F_2 control room in X-342A and shuts off the heaters if the internal cabinet temperature exceeds the high temperature setpoint or if the pressure in the system exceeds the high-pressure setpoint.
- High or low pressure in the HF header that exceeds the setpoint causes a signal to be transmitted to the Fluorine Generator Room and actuates an audible alarm and a light in the F_2 control room in X-342A.
- High or low pressure in the F_2 header that exceeds the setpoint causes a signal to be transmitted to the Fluorine Generator Room and actuates an audible alarm and a light in the F_2 control room in X-342A. Low pressure can result when F_2 is used in the GDP process or if a breach occurs in the F_2 system.
- In the event that pressure in the F_2 header exceeds the setpoint, a control valve located upstream of the NaF traps automatically closes. A second control valve located downstream of the F_2 compressors closes on compressor shutdown to prevent distribution system pressure from reaching the F_2 generating equipment.
- Each of the cylinder pigtail connections and the main HF feed line are monitored by a digital pressure readout in the F_2 control room in X-342A that actuates an alarm if the high or low pressure setpoints are exceeded.
- The nitrogen buffer in the piping between the rupture discs on the F_2 storage tanks is monitored so that an alarm is actuated on high or low pressure. High pressure would indicate leakage through the inboard rupture disc. Low pressure would indicate leakage of the nitrogen buffer or the outboard rupture disc. The alarm is actuated in the F_2 control room in X-342A.
- F_2 or H_2 header pressure that exceeds the setpoint activates visual and audible alarms in the F_2 control room in X-342A.
- Leakage of F_2 or oil through any diaphragm of the F_2 compressors is detected and annunciated by audible and visual alarms in the F_2 control room in X-342A.
- Actuation of a HF or F_2 leak detector in X-342A or X-342B results in an alarm locally and in the F_2 control room in X-342A.

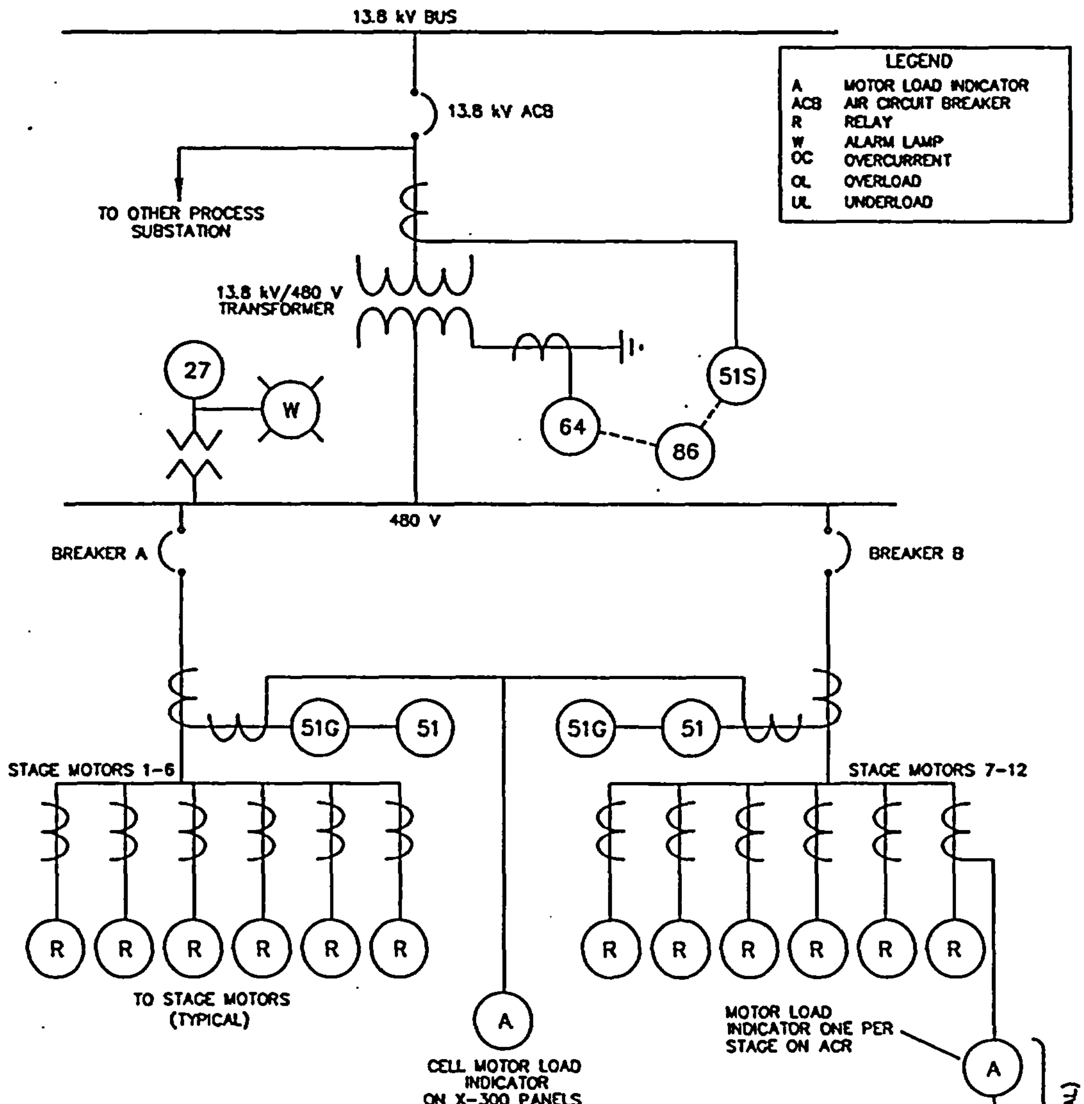
Activation of manual gas leak alarms located throughout X-342A and X-344A will sound the building evacuation sirens simultaneously in both buildings.

3.4.7.3 Leak Detection

HF or F_2 leak detectors in X-342A are located in the HF storage room, above the heated cabinet, inside the heated cabinet, in the NaF trap room, in the generator room, and in the high bay area. HF detectors are also located above each of the F_2 storage tanks in X-342B. Actuation of the detectors results in audible and visual alarms in the F_2 control room in X-342A.

3.4.7.4 Materials of Construction

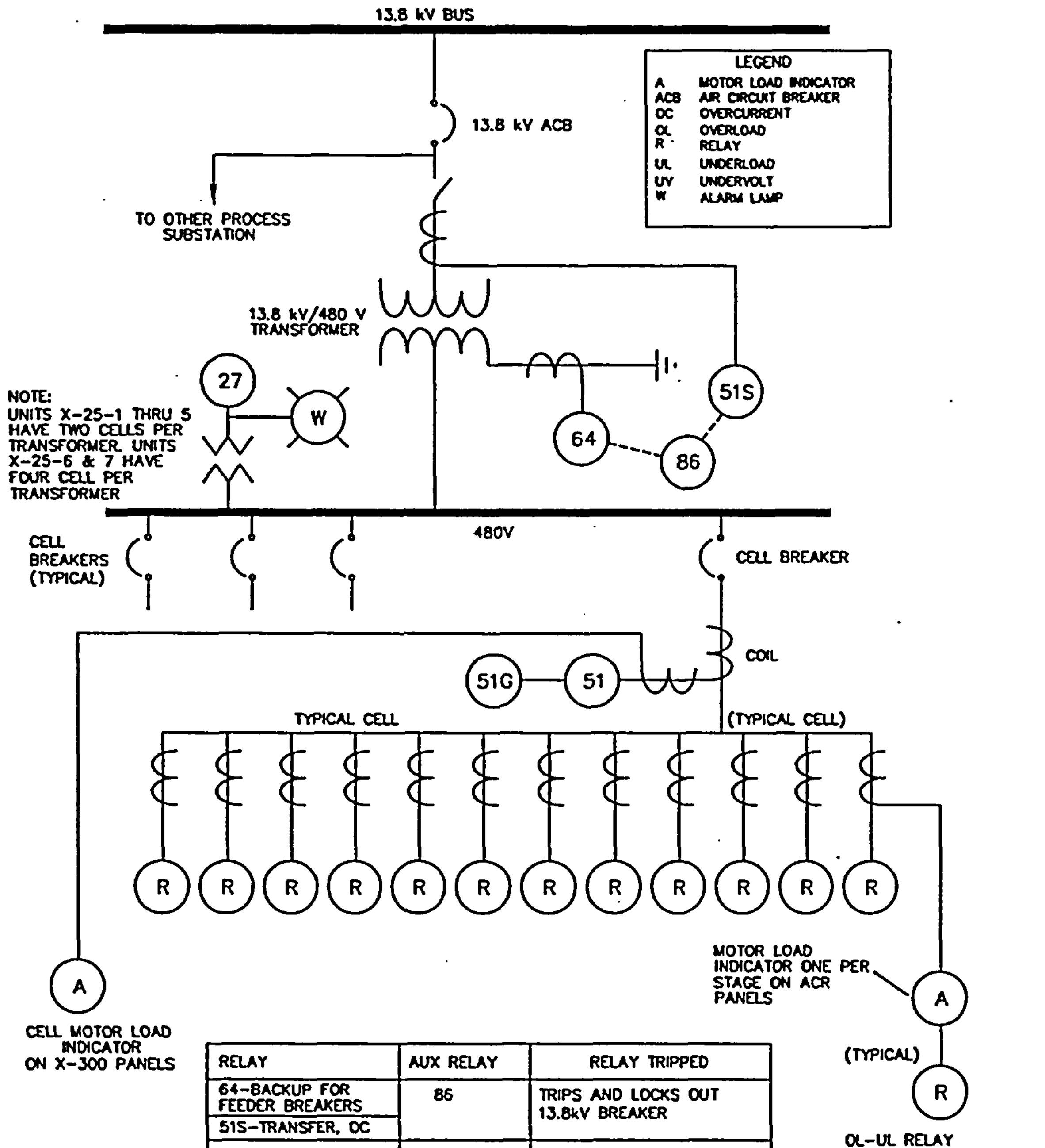
Materials of construction are specified for the intended service on the basis of PORTS and industry experience. Carbon steel, black iron, stainless steel, brass, copper and aluminum may be used for ambient temperature applications when no moisture is present. Nickel and Monel may be used for higher temperature applications or when higher corrosion resistance is desired.



RELAY	AUX RELAY	RELAY TRIPPED
64-BACKUP FOR FEEDER BREAKERS 51S-TRANSFER, OC	86	TRIPS AND LOCKS OUT 13.8kV BREAKER
51 & 51G FEEDER OC STAGE OC	-	BOTH FEEDER BREAKERS
27-BUS UNDER VOLT	-	BOTH FEEDER BREAKERS
OVERLOAD-UNDERLOAD	-	ALARMS ONLY

Figure 3.4-1 X-326 Process Power Distribution One-line Diagram (Units X-27-1 through X-27-3)

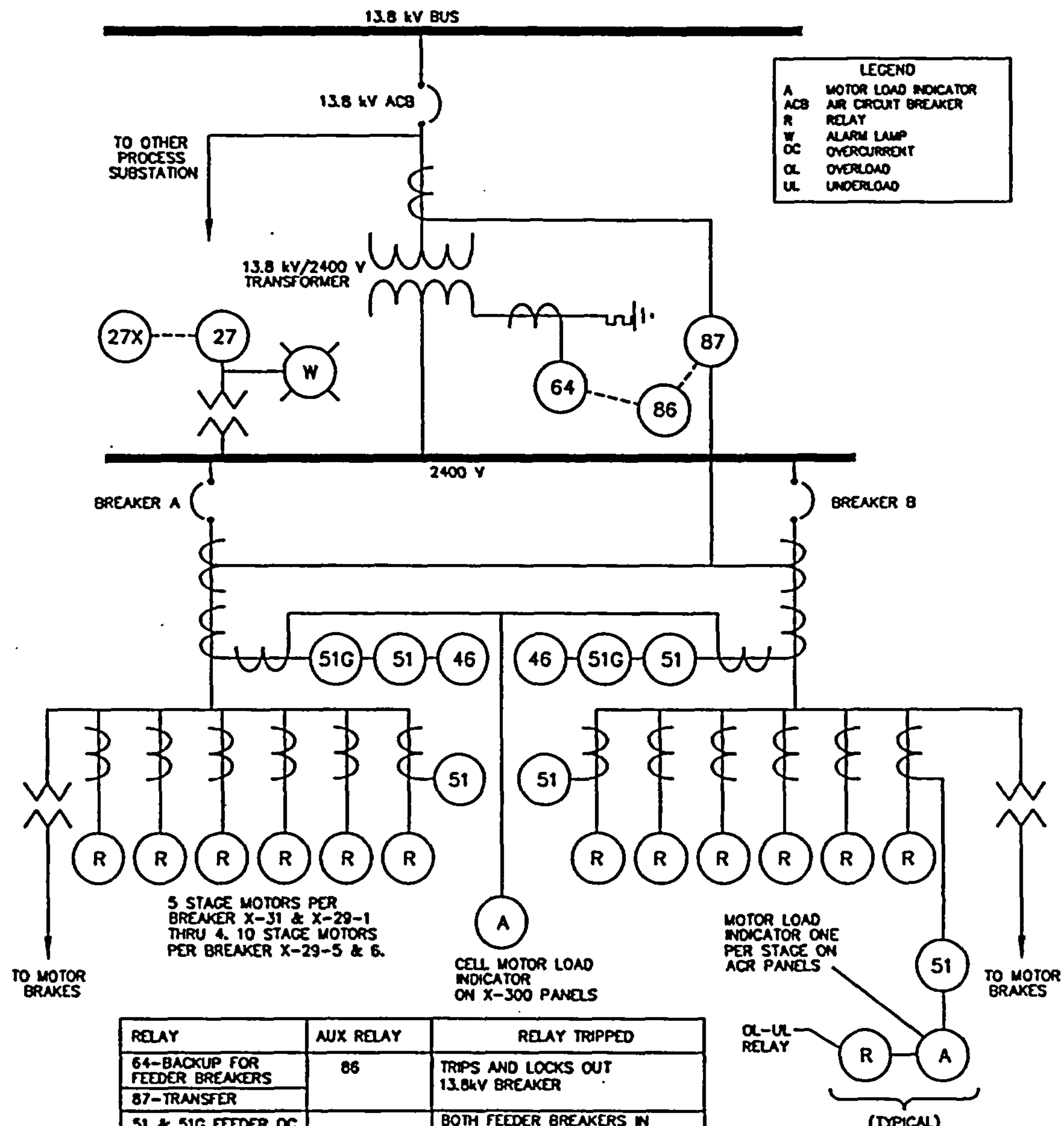
AUTOCAD/CSD
8/21/03
figure 3.4-1 page 3.4-22



RELAY	AUX RELAY	RELAY TRIPPED
64-BACKUP FOR FEEDER BREAKERS 51S-TRANSFER, OC	86	TRIPS AND LOCKS OUT 13.8kV BREAKER
51 & 51G FEEDER OC STAGE OC	–	INDIVIDUAL CELL BREAKER
27-BUS UNDER VOLT	–	ALL CELL BREAKERS
OVERLOAD-UNDERLOAD	–	ALARMS ONLY

Figure 3.4-2 X-326 Process Power Distribution One-line Diagram (Units X-25-1 through X-25-7)

AUTOCAD/CSD
8/21/03
figure 3.4-2 page 3.4-22



RELAY	AUX RELAY	RELAY TRIPPED
64-BACKUP FOR FEEDER BREAKERS	86	TRIPS AND LOCKS OUT 13.8kV BREAKER
87-TRANSFER		
51 & 51G FEEDER OC CAPACITOR OC STAGE OC	-	BOTH FEEDER BREAKERS IN X-31 & X-29-1 THRU 4, RESPECTIVELY FEEDER BREAKER IN X-29-5 &6
27-BUS UNDER VOLT	27X IN UNITS X-29-5 & 6	BOTH FEEDER BREAKERS
46-PHASE BALANCE	-	CELL BREAKERS
OVERLOAD-UNDERLOAD	-	ALARMS ONLY

Figure 3.4-3 X-330 Process Power Distribution One-line Diagram

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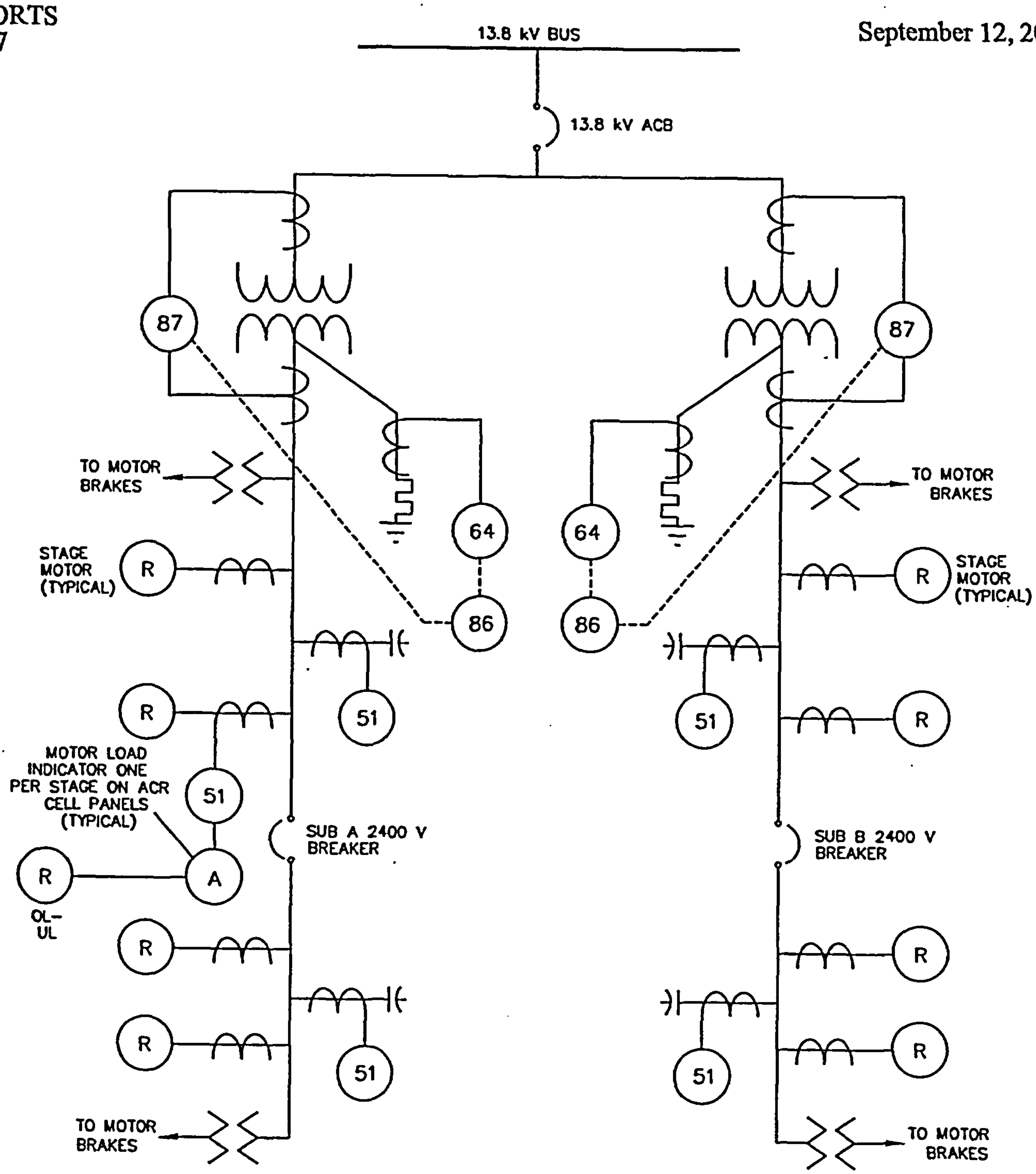
Figure 3.4-3 page 3.4-24



RELAY	AUX RELAY	RELAY TRIPPED
64-BACKUP FOR FEEDER BREAKERS 87-TRANSFER	86	TRIPS AND LOCKS OUT 13.8kV BREAKER
51 & 51G FEEDER OC CAPACITOR OC	-	13.8kV BREAKER
OVERLOAD-UNDERLOAD	-	ALARMS ONLY

LEGEND	
A	MOTOR LOAD INDICATOR
ACB	AIR CIRCUIT BREAKER
OC	OVERCURRENT
OL	OVERLOAD
R	RELAY
UL	UNDERLOAD

Figure 3.4-4 X-333 Process Power Distribution One-line Diagram

AUTOCAD/GSD
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figure 3.4-4 page 3.4-25

AUTOCAD/CSD
8/21/03
figure 3.4-5 page 3.4-26

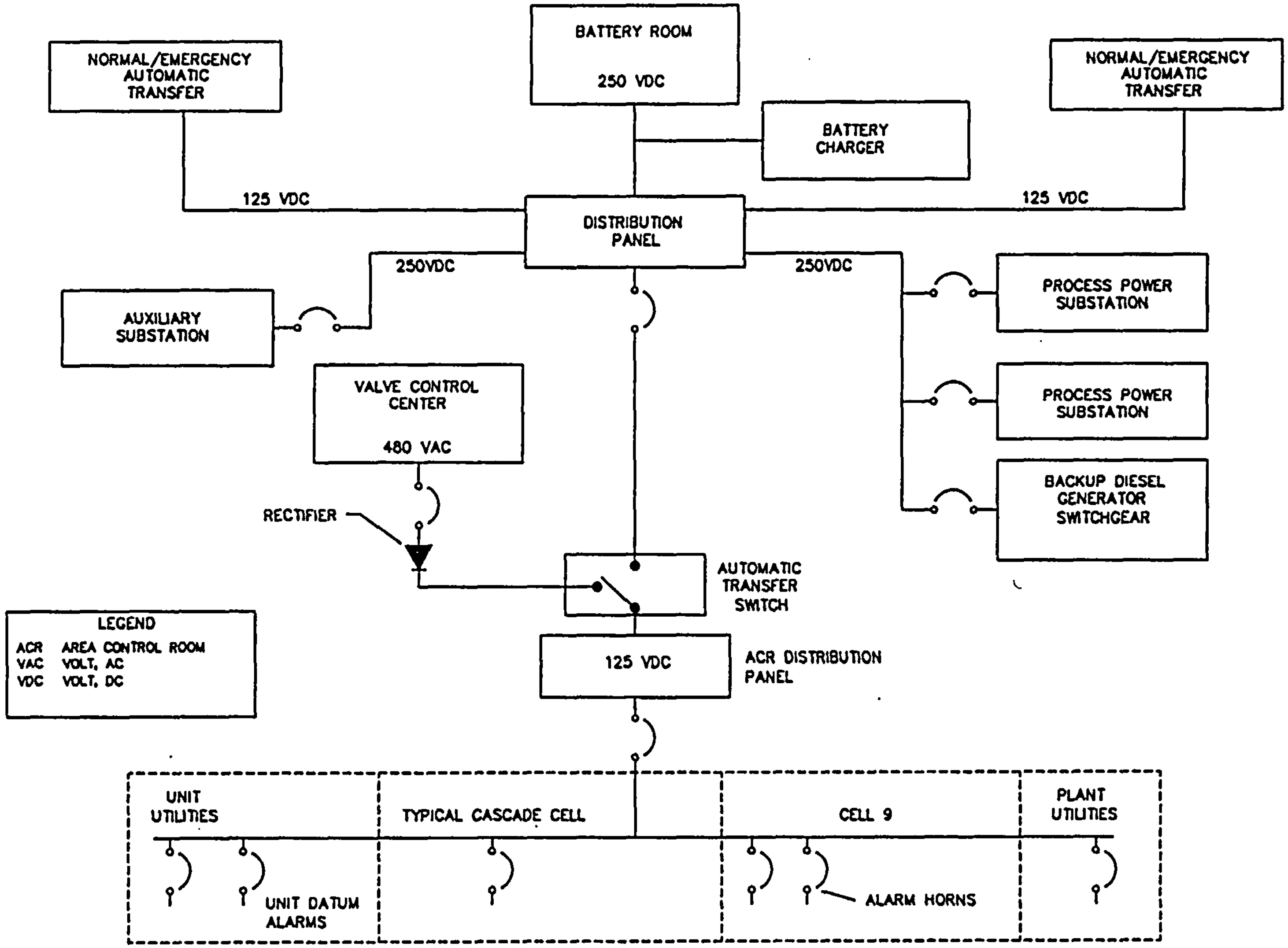

Figure 3.4-5 Simplified Diagram Showing the Principal Components of a Typical DC Power Distribution System in the Cascade

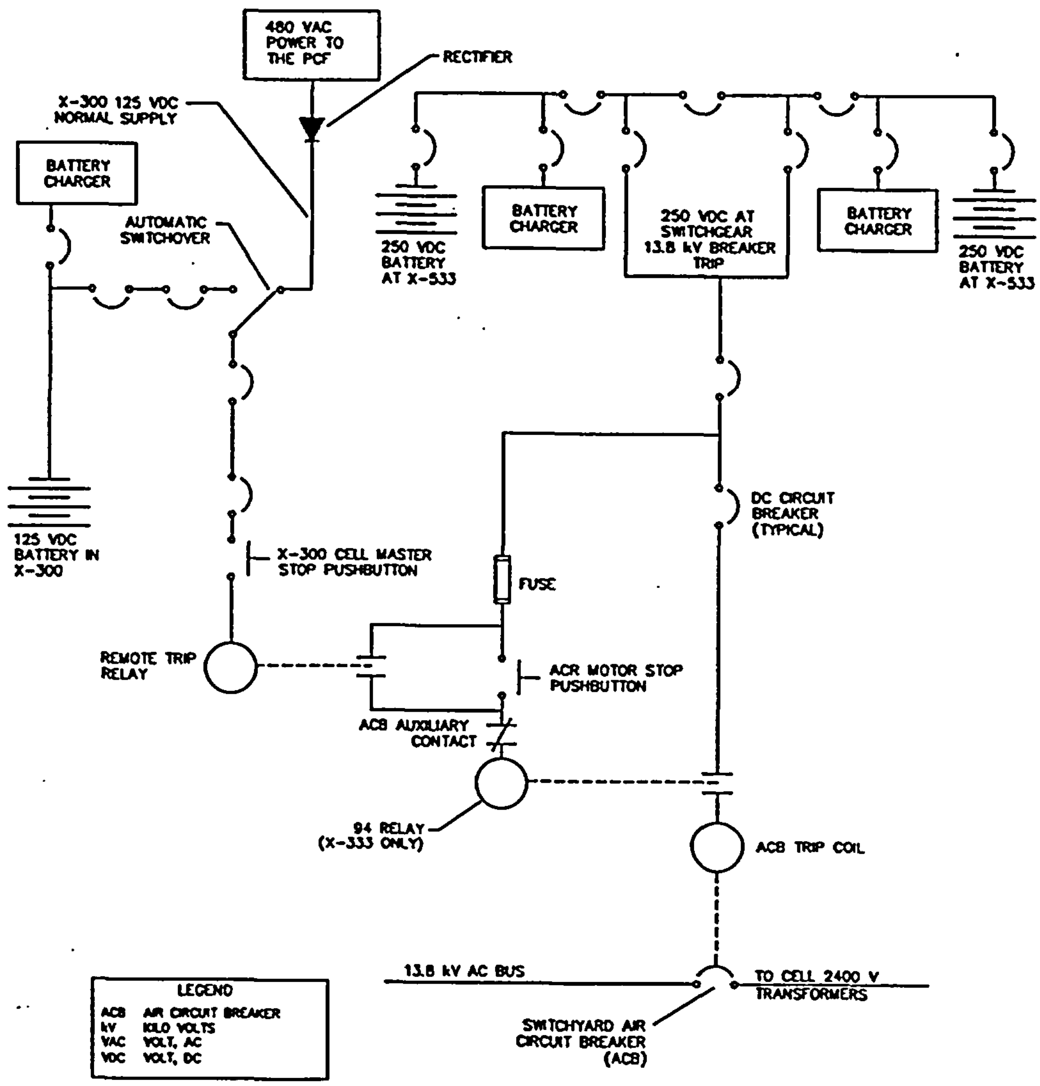

Figure 3.4-6 Simplified Diagram Showing the DC Power Supply to the Compressor Motor Manual Trip System for a Cell in X-333

AUTOCAD/GSD
8/21/03
figure 3.4-6 page 3.4-27

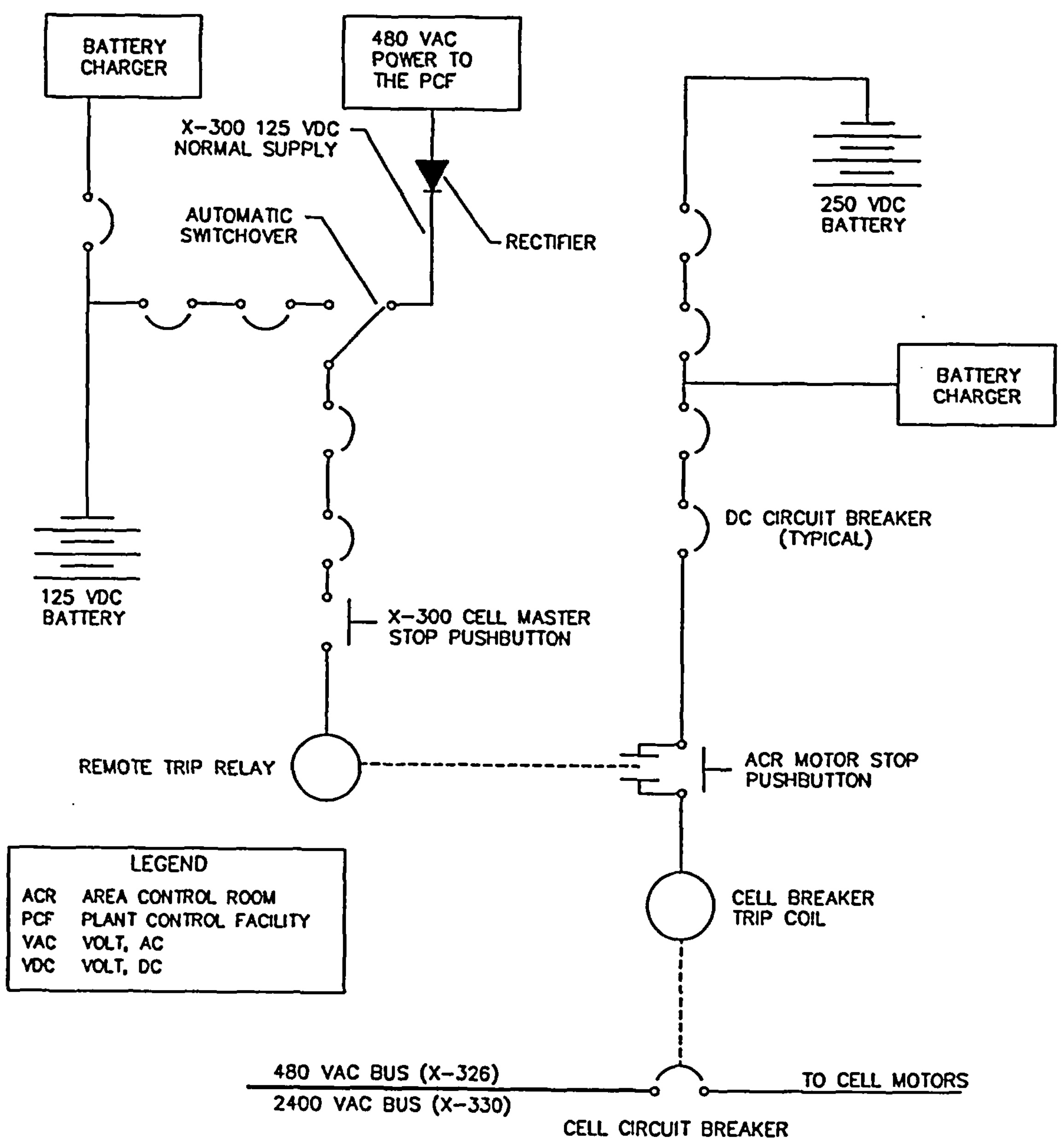

Figure 3.4-7 Simplified Diagram Showing the DC Power Supply to the Compressor Motor Manual Trip System for a Cell in X-326 or X-330

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figure 3.4-7 page 3.4-28

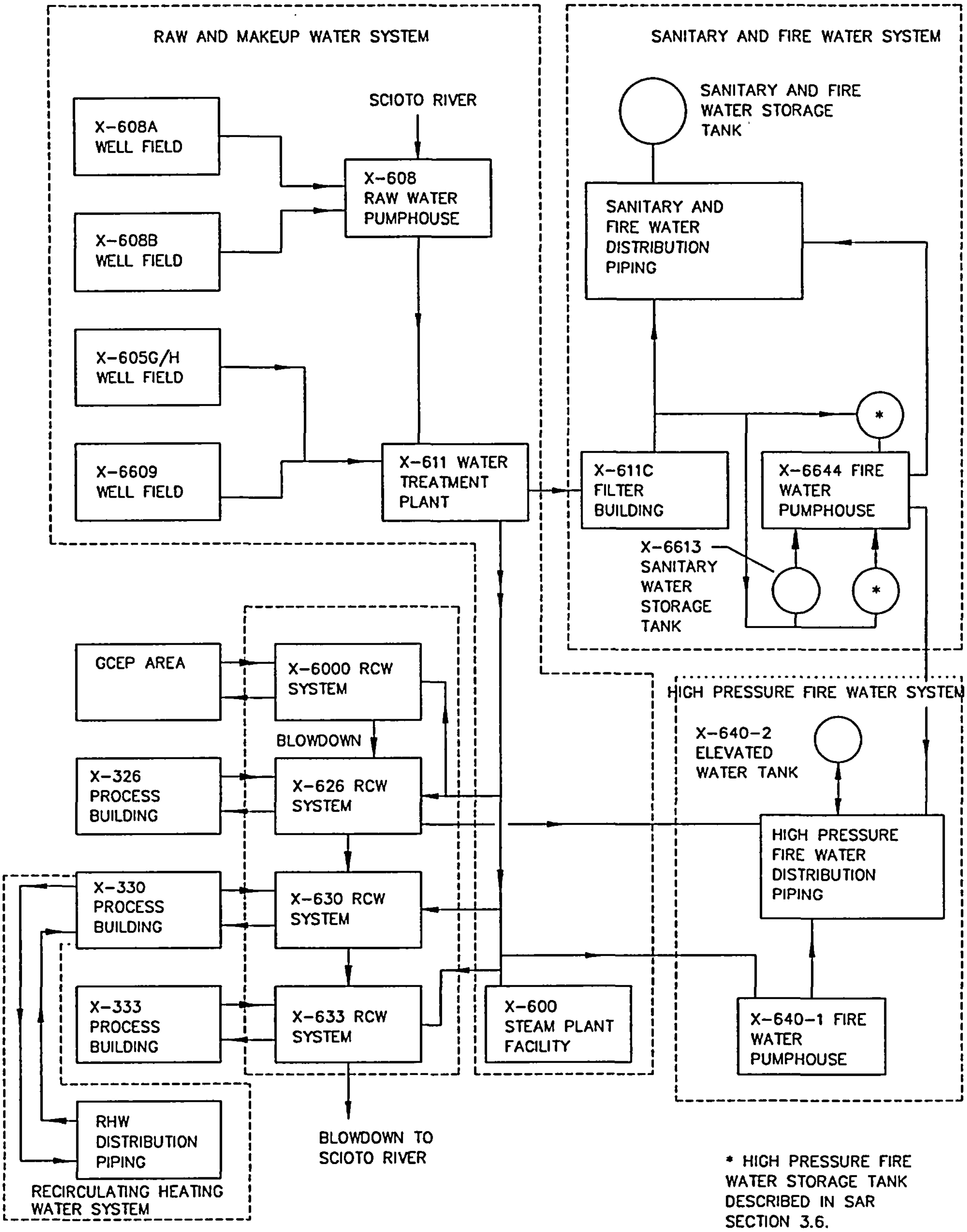

Figure 3.4-8 Block Diagram Showing Plant Water System Interconnections

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figure 3.4-8 page 3.4-29

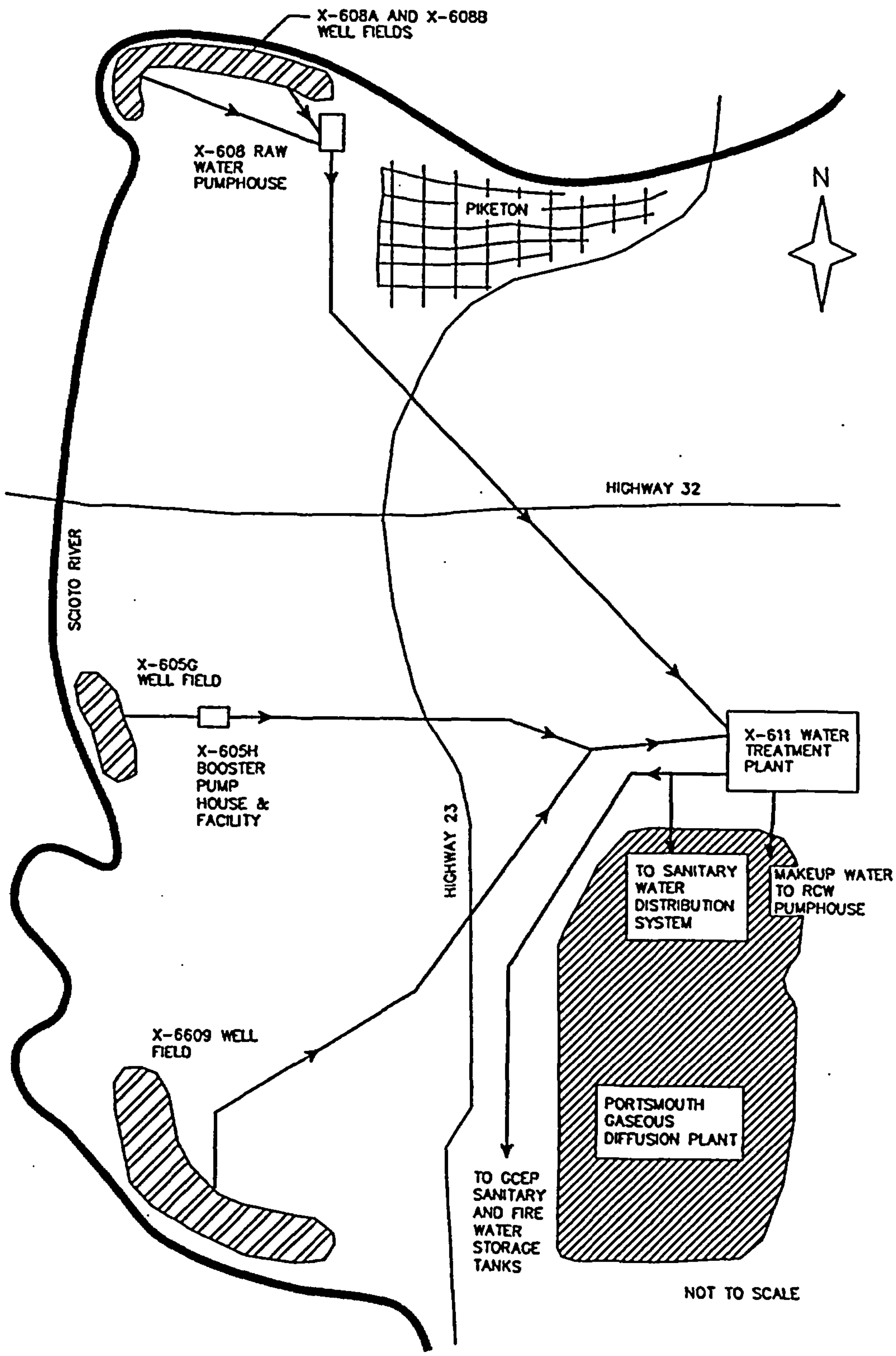

Figure 3.4-9 Portsmouth Plant Water Supply

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figure 3.4-9 page 3.4-30

AUTOCAD/CSD
8/21/03
figure 3.4-10 page 3.4-31

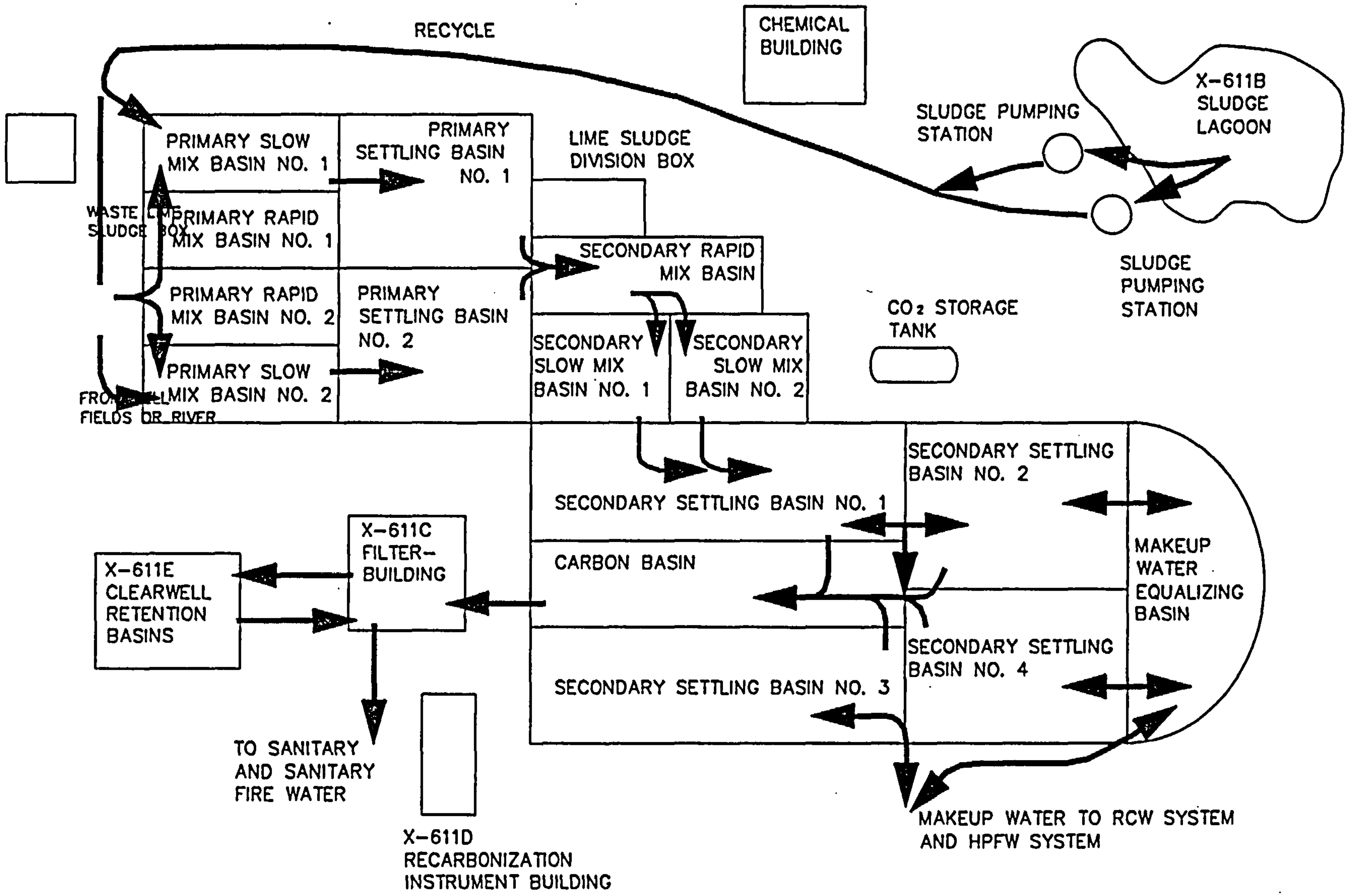

Figure 3.4-10 Simplified Diagram Showing the Principal X-611 Water Treatment Plant Components and a Typical Process Flow Path

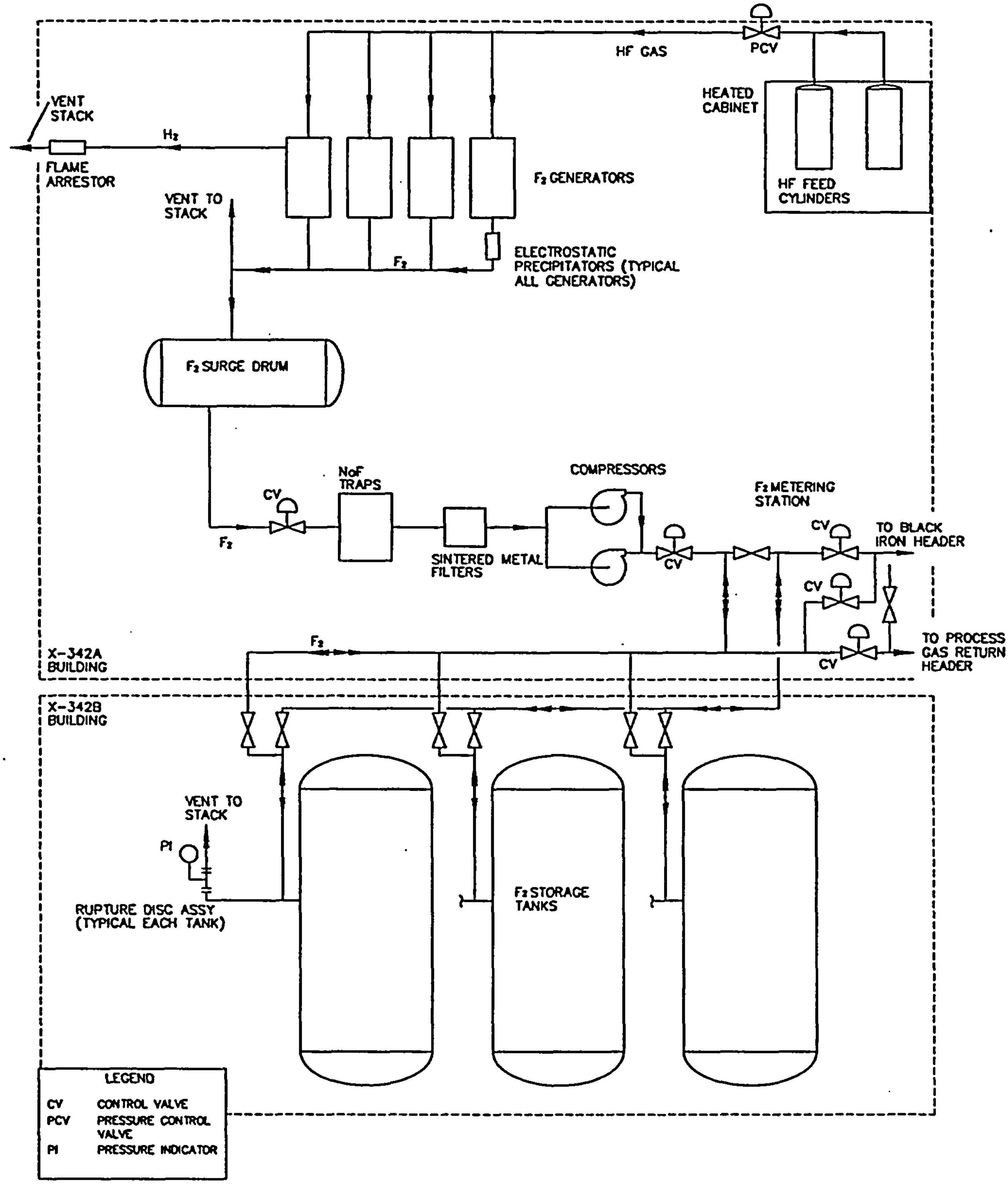

Figure 3.4-11 Simplified Diagram Showing the Principal Components of the Flourine Generation System

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8/21/03
figure 3.4-11page 3.4-32

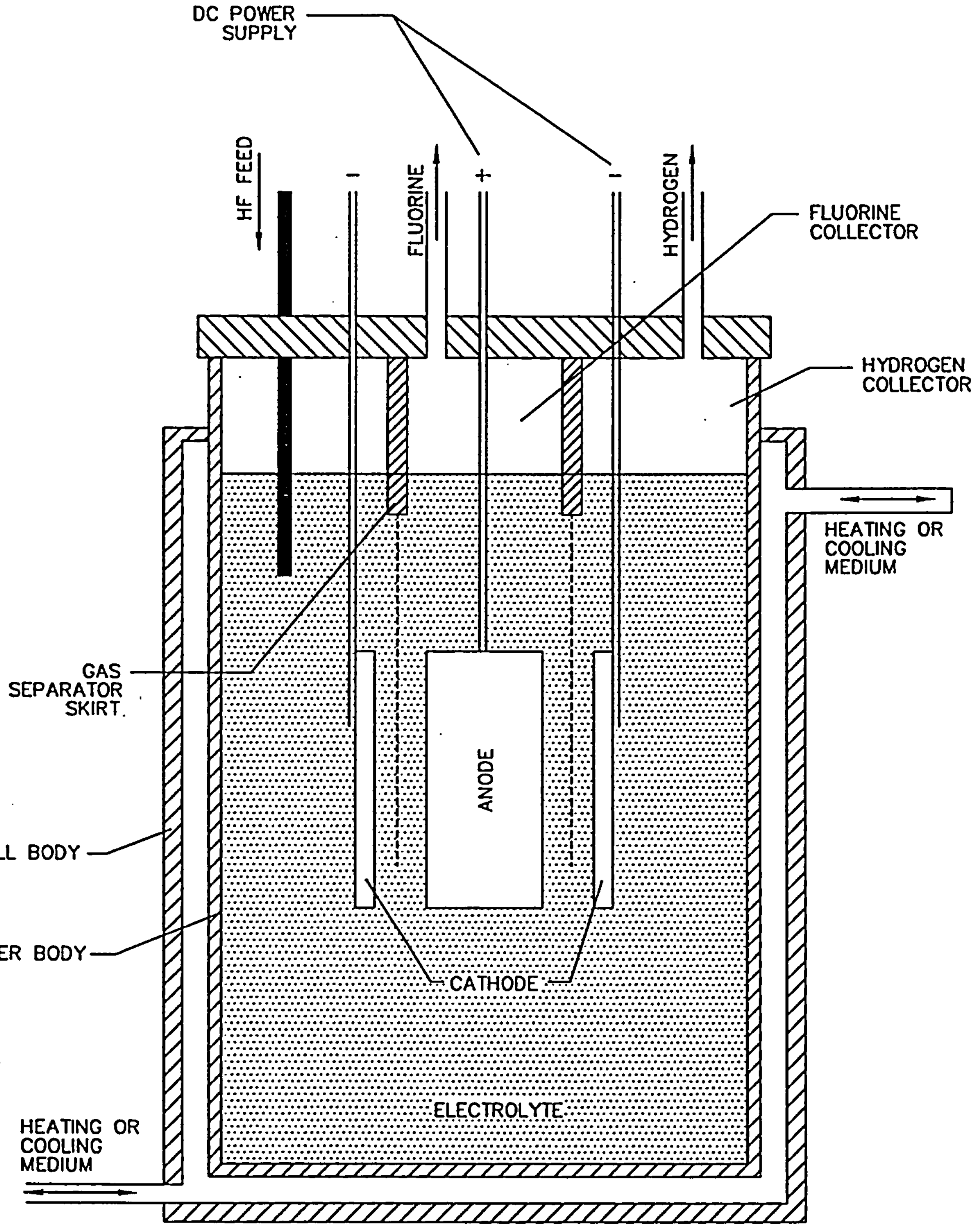

Figure 3.4-12 Primary Components of a Fluorine Generator

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8/21/03
figure 3.4-12 page 3.4-33

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3.5 GENERAL SUPPORT FACILITIES AND SYSTEMS

The Portsmouth Gaseous Diffusion Plant (PORTS) site has a variety of facilities that provide for maintenance services, laboratories, materials receiving and storage, communications and data processing, administrative services, and health protection services.

3.5.1 Maintenance Facilities

The PORTS maintenance facilities consist of sections of the X-700, Converter Shop & Cleaning Building, the X-720, Maintenance & Stores Building, all of the X-750, Mobile Equipment Maintenance Garage, and some of the X-7721, Maintenance, Stores & Training Building. In addition, maintenance shops are found in the X-333, X-330, X-326 Process Buildings, X-600B (Steam Plant Shop), and the X-342A, Feed, Vaporization & Fluorine Generation Building, / X-344A, UF_6 Sampling Facility, building complex. The locations of these maintenance facilities are shown in the plantsite map, Figure 2.1-4.

3.5.1.1 X-700 Maintenance Facility

X-700 is a permanent structure located north of X-720 and east of the X-705, Decontamination Building. The building is divided into two main sections. The east section is an equipment and parts cleaning area, and also contains the Biodenitrification facilities described in Section 3.3.1.4.5. The west section houses the Converter/Weld Shop and the X-721, Radiation Instrument Calibration (RADCAL) Facility.

The work activities involved within this facility have the potential to deal with radioactive contaminated materials and process related equipment. The requirements for working with radioactive contaminated material in all facilities are established in Section 5.3.

The Cleaning Area in X-700 is used for cleaning parts in support of maintenance activities. Cleaning activities, such as rust removal and removing hard water deposits, are performed on parts and equipment requiring maintenance. The facility contains cleaning tanks (normally not all are in service and one is designated for converter flushing only), and a sandblast cabinet. The cleaning tanks in service contain vent exhausts at the tank top lip. The exhaust system has motorized exhaust fans that discharge through a common stack. The cleaning tanks are serviced by overhead cranes. Equipment cleaning may be facilitated by dipping the equipment into the cleaning tanks.

The X-700 Barrier Shop Area is used for general maintenance activities such as cooler repair. The X-700 Stabilization Stand Facility is no longer in service.

The X-700 Converter/Weld Shop is capable of various welding techniques and cutting of metals. The Converter/Weld Shop works on materials such as tool steel, stainless steel, monel, inconel, aluminum, and nickel.

X-700 is provided fire protection by fire alarm systems and automatic wet pipe sprinkler systems. The facility is also equipped with a Criticality Accident Alarm System (CAAS). CAAS details are contained in Section 3.6.2. Compressed gas cylinders are stored in accordance with site industrial safety requirements and have protective valve caps.

3.5.1.1.1 Radiation Instrument Calibration (RADCAL) Facility

The RADCAL Facility is used to test and evaluate radiation instruments and equipment and to certify plant radiation standards.

The north and west walls of the RADCAL Facility are concrete and are shared in common with X-700. The remaining walls are stud walls and the roof is made of steel decking. A portion of the facility is located outside X-700 and has a beam room. Walls and others features of the beam room are discussed in Section 3.5.1.1.1.2. The laboratory and training room walls are steel-reinforced block with all voids filled with concrete grout. The control room and the storage room share walls in common with other rooms. These walls either are made of concrete block or are solid concrete.

The Cleaning Room located inside X-700 is used to disassemble and clean incoming instruments. The low level contamination from the cleaning solutions presents no safety hazard. Protective equipment, approved operating procedures, and adequate ventilation mitigate any toxic hazards of the chemicals used.

A radiation hazard does exist in the beam room. As such, each RADCAL area has written procedures that govern the safe operation of that area. All personnel assigned to the RADCAL Facility are required to wear personnel dosimeters as required by the radiation protection program. Supplemental instrumentation is employed for non-routine or special work as defined in the applicable work requirements document. All personnel assigned to the facility are trained in accordance with approved training materials.

The utilities furnished to the RADCAL Facility are supplied from X-700 and the X-700A, Air Conditioning Equipment Building. Fire protection is provided by an extension of the sprinkler system used in X-700.

3.5.1.1.1.1 RADCAL Facility Radiation Shielding Assessment

The RADCAL Facility houses several high intensity radiation sources which are either intrinsically safe or are used remotely inside a shielded irradiation room. This facility has been designed to meet the calibration requirements given in the American National Standards Institute (ANSI) standard N323-1978, Radiation Protection Instrumentation Test and Calibration. In addition, the beam room has been designed to meet safety requirements stated in the following documents:

- DOE/EV 1830-T5, "Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable," April, 1980,
- ANSI/ANS 6.4-1977, "Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants," 1977,
- GAT-T-3193, "Proposed Corporate Radiation Instrument Maintenance and Calibration Facility," May 5, 1983,
- Y-1754, "X-ray and Nuclear Radiation Facility, Personnel Safety Features," October 1986.

A gamma irradiator (Unit 1) and one filtered 320 kV constant potential (CP) X-ray unit are located in the "beam room" at fixed positions. The multiple source gamma irradiator focuses its radiation field through a 20 degree beam port against the North wall of the beam room 48 ft. away. The unit is pneumatically controlled with additional passive mechanical fail-safe source storage control devices. Dose rates from the irradiator are less than 5 mRad/hr at 1 ft. (30 cm) from the shield surface when each unit is deactivated (i.e. lowered into its storage position).

A neutron irradiator is also located in this facility. The source is positioned pneumatically with mechanical or gravity-based fail-safe storage mechanisms. Neutron dose rates are below 5 mRem/hr at 1 ft. (30 cm) from shield surfaces when these devices are deactivated. Dose rates from the largest gamma irradiator will produce maximum radiation fields of less than 500 Rad/hr at 1 meter. Maximum dose rates for neutrons occur with unmoderated ^{252}Cf. This area can also be used for irradiations with low intensity gamma ray standards such as ^{226}Ra and ^{241}Am.

Distance and shielding are employed to assure that external exposures to personnel outside of the beam room are kept below plant limits. For all irradiators, their position is fixed either by size and weight constraints or by their physical installation. Both computer analysis and actual field results verify gamma exposure rates outside of the beam room are less than 0.1 mRad/hr at 1 ft. (30 cm) for measurements in the direct path of the radiation. Scattered radiation levels on the roof will be less than 4 mRad/hr at 1 ft. (30 cm) from either gamma irradiator. Scattered and penetrating neutron radiation fields on the roof will be less than 100 mRem/hr. Therefore, access to this area is physically restricted and is governed by radiological work limits. Appropriate radiological posting and boundary markers are in place should personnel require access to this area. Sky-shine effects in uncontrolled laboratory and outside areas are less than those that would require controlled access to these areas due to radiation levels.

The source storage room is located inside X-700 in the northeast corner of the RADCAL Facility. This area is used both for storage of tertiary and working level alpha and beta particle emission sources as well as a box-type irradiator and other small gamma or neutron sources used in the bench-top calibration or response checks of radiological survey instruments. All radioactive materials stored in this area are kept in special containers provided by the source manufacturer or are kept in lockable storage cabinets. Access to this room is controlled and all activities are controlled by active radiological work controls or direct surveillance.

The radiation protection development laboratory area, which is an integral part of the RADCAL Facility, is located in the southwest corner of this facility outside of the X-700 high-bay area. This laboratory can contain additional alpha and beta particle emission reference standards and miscellaneous low level standard reference materials provided by the National Institute of Standards and Technology. All radioactive materials stored in this area will be kept in special containers provided by the source manufacturer or are kept in lockable storage cabinets. Access to this room is controlled.

3.5.1.1.1.2 Monitoring and Protection Systems in the RADCAL Facility

The design of the facility, the safety devices, and the procedures meet the applicable ANSI and PORTS requirements. The RADCAL Facility is equipped with a number of operational alarms and interlocks that provide protection from the radiation hazard that exists. These include the following features that are part of the RADCAL Facility interlocks, which are important to safety as discussed in Section 3.8:

- Closure switches on the entrance doors and the beam room sliding radiation shielding doors. These composite lead, steel, and concrete doors are normally opened by key access. All irradiators must be de-energized for a door to open without generating a source scram alarm and an immediate return of the source to its storage position.
- Interior motion detectors. No source can be energized if motion is detected in the beam room.
- Neutron and gamma detectors. Separate detectors are interlocked so that no source can be energized if an area monitor is in a high alarm state. All sources will retract if a high alarm

state is actuated after a source is energized. Alert alarm states do not control source operations.

- Manual scram pushbuttons. Scram pushbuttons are located in the control room, beam room, and other convenient locations. Exposure will immediately terminate when the pushbuttons are actuated.
- Source rod assembly. The assembly requires electrical power to position the source during exposure.
- Control relays and solenoid valves for the above listed components.

A horn alarm is located on the control room operator's console that sounds if a scram pushbutton or a detector alarm is actuated.

Electrical power is supplied to the switches, control relays, solenoid valves, and control circuits for the above listed components. The electrical control components are configured such that any open circuit, switch failure, or interruption of power deenergizes the source rod assembly. The source rod assembly is a spring-loaded component that retracts the radiation source if power is interrupted. Therefore, the RADCAL Facility interlocks are fail-safe upon a loss of electrical power.

In addition to the above, the beam room walls and sliding radiation shielding doors are also important to safety as described in Section 3.8. The beam room north, east, and west walls are made of reinforced concrete. The south wall is made of reinforced concrete and contains two equivalent composite shield doors. Each shield door contains steel, boron loaded polyethylene, and lead in equivalent proportions to equal the concrete walls on the south side. No support systems are applicable to the beam room walls and sliding radiation shielding doors.

Although not classified as important to safety, the floor in the beam room has a special covering of concrete mixed with boron frits. Part of the floor in the beam room is below the main floor level.

Fire protection for the RADCAL Facility is provided by an extension of the sprinkler system used in the X-700 Building. The system was installed in accordance with the National Fire Protection Association Standard 13 (NFPA-13).

3.5.1.2 X-720 Maintenance and Stores Building

X-720 contains several types of maintenance shops. The south side of the building contains the Main Stores Area, and a Toxic Materials Storage Area. The building and its facilities are necessary to provide services for maintenance of the plant.

Hazardous materials and spills in the building are handled in accordance with the requirements of Section 5.6.

Specially constructed storage lockers to house toxic materials are located at the east end of the Stores Area. These lockers are equipped with diked doorways and are locked to minimize access to the material.

The work activities involved within this facility have the potential of dealing with radioactive contaminated materials and process related equipment. The requirements for working with radioactive contaminated material are established by the plant's radiation protection procedures, as described in Section 5.3.

The X-720 maintenance facility is equipped with fire alarm systems and automatic sprinkler systems. Various portable fire extinguishers are located throughout the building. Ventilation in the shops is provided by large ceiling exhaust fans.

The facility is equipped with a CAAS. CAAS details are contained in Section 3.6.2.

The X-720 building structure is important to safety (Section 3.8) and performs the function of withstanding natural phenomena hazards such as high winds and seismic events. As described in Section 3.8, the X-720 building is capable of withstanding the evaluated events.

3.5.1.2.1 X-720 Shop Areas

The X-720 Machine Shop contains tools capable of performing drilling, turning, broaching, grinding, threading, boring, shaping, milling, and sawing on metal parts or stock. The shop balances assembled compressor rotors. The shop also operates a tool room for sharpening drills, reamers, cutting dies, taps, etc. The Machine Shop is also equipped with a brush plating system (Section 3.5.1.2.2). Small quantities of non-hazardous cutting oil and cleaning fluids are used throughout the shop.

The X-720 Compressor Shop reblades and assembles component parts of axial compressors. Centrifugal compressors are also assembled and tested in this area. All compressor assembly is under stringent cleanliness conditions. This shop utilizes many fixtures and jigs in the assembly of compressors. All compressor parts are checked per radiation protection requirements before entering the X-720 Shop.

The X-720 Sheet Metal Shop is equipped for repair and fabrication of metal parts from metal stock. The shop is also equipped for the layout and fabrication of small models of new or experimental machinery.

The X-720 Carpenter Shop is equipped for various types of carpentry work. In addition to wood, the shop is able to work with such materials as masonite, and plastics. The hazardous and volatile materials stored in the Carpenter Shop include items such as paints, thinners, glues, wood preservatives, and solvents.

The X-720 Paint Shop is located adjacent to the Carpenter Shop. The Paint Shop is equipped to apply paints, varnish, and other coatings required on plantsite. This shop includes a spray booth equipped with filtered ventilation, storage space for paints and lacquers, and a drying oven that has its own exhaust system.

The paint mixing and cleaning room is used for storage of small amounts of paint. This cleaning area contains solvent and is ventilated by a hood and exhaust fan. The doorways are diked to contain spills. A locker approved for storage of toxic and flammable materials is used to store thinners and toxic paints and is equipped with a ventilation system, diked doorway, and an eye bath. A vent system is provided for a darkroom that is located in this area.

The X-720 mechanical maintenance area is separated into several small shops. The equipment available in these shops may include items such as hand chain hoists, an oil recovery unit, an oil filter unit, assorted carts, winches, sewer pipe cleaners, telescoping platforms, electric agitators, portable generators, centrifugal pumps, and air compressors.

Shop facilities for repair of electrical equipment and instruments are provided in X-720. The X-720 Electrical Maintenance Shop contains equipment such as volt-ohmmeters, oscillographs, oscilloscopes, and electronic amplifiers.

Instruments are repaired or rebuilt in the X-720 Instrument Shop. The following hazards and hazardous materials can exist in these areas:

- Storage of flammable and toxic chemical cleaning materials,
- Mercury exposure resulting from small mercury spills,
- Plating solution spills,
- Leaks from Nuclear Criticality Safety (NCS)-approved containers containing contaminated cleaning solutions.

These hazards are minimized by the following safeguards:

- Automatic sprinkler systems and fire extinguishers at strategic locations,
- Approved and separate storage containers for toxic chemicals and flammable materials,
- Availability of mercury control kits designed to contain mercury spills,
- Plating solutions spills are cleaned up and the collected liquid is placed in approved containers for disposal,
- Varying assays of ^{235}U can be found on contaminated instruments; therefore, all contents of NCS-approved containers are handled in accordance with applicable NCS requirements.

Several hazardous materials such as acids and nickel plating solutions are used for cleaning and plating instrument parts. These chemicals are stored and used in accordance with Section 5.6.

3.5.1.2.2 X-720 Metal Spray and Plating Areas

Several areas in X-720 are involved with metal plating.

The Metal Spray Facility provides an area for the restoration of worn parts and for the application of protective coatings. The hazardous materials encountered at the Metal Spray Facility include airborne metal dusts (principally steel, iron, and nickel), cylinders of oxygen (under pressure), and acetylene (explosive/flammable).

Brush plating (or selective plating) is the electrodeposition of plating metal upon selected areas of a work piece. The Brush Plating System is used in an open shop area; industrial safety and building protective systems for this area are the same as those that protect the Machine Shop area (Section 3.5.1.2.1).

The Cleaning and Plating Facility is located in the northeast section of X-720. Electroless nickel metal plating is performed in this facility. Some low level decontamination occurs at this facility and is done in accordance with applicable NCS Approvals (NCSAs). Several acid and detergent solutions are used for the cleaning operations that are performed in accordance with applicable NCSAs. The parts to be cleaned can either be assembled or disassembled, and can be solution dipped or wiped.

Electroless nickel plating deposits metal out of solution onto the base metal for the purpose of improving the corrosion resistance, or wear qualities of the base metal. Chemical hazards at the Cleaning and Plating Facility include the nickel metal plating solutions, alcohols, and acids. Exhaust fans are provided for the removal of chemical fumes. Eye wash and a deluge shower are provided in the event of a solution spill on operating personnel.

3.5.1.2.3 X-720C Flammable Materials Storage

The X-720C Paint and Oil Storage Building is located near the northwest corner of X-720. Materials such as paint, paint thinner, acetone, solvents and oil are stored in this building. X-720C is equipped with diked doorways, fire protection (wet pipe sprinkler and fire extinguishers), and a ventilation system. X-720C also houses a diked liquid hazardous waste storage area. Personal Protection Equipment/spill response equipment is available.

3.5.1.3 X-750 Mobile Equipment Maintenance Garage

X-750 houses maintenance facilities for all types of mobile equipment used at the GDP and provides space for checking safety features of all vehicles.

3.5.1.4 X-333 Maintenance Shop

The X-333 Maintenance Shop is located on the west-central portion of the process building operating floor. This maintenance shop provides a work and storage area for personnel. Routine maintenance for X-333 process and auxiliary equipment is performed in the shop area.

The X-333 Maintenance Shop is protected from fire by fire alarm systems, wet pipe sprinkler system, and portable fire extinguishers. This area is provided coverage by the X-333 CAAS. CAAS details are contained in Section 3.6.2.

All gas bottles are stored in accordance with site industrial safety requirements. The shop area is equipped with a ventilation system.

3.5.1.5 X-330 Maintenance Shop

The X-330 Maintenance Shop is located in the center of the X-330 Process Building operating floor. Personnel that work out of this shop provide maintenance for X-330 process and auxiliary equipment.

The X-330 Maintenance Shop is protected from fire by fire alarm systems, wet pipe sprinkler system, and portable fire extinguishers. This area is provided coverage by the X-330 CAAS. CAAS details are contained in Section 3.6.2.

All gas bottles are stored in accordance with site industrial safety requirements. The shop area is provided with ventilation.

Cleaning solvents are used in the shops for small parts cleaning. A limited quantity is used and in the event of a spill, the solvent would be contained and absorbed.

3.5.1.6 X-326 Maintenance Shop and Radiographic Facility

The X-326 Maintenance Shop is located in the center of the X-326 Process Building on the operating floor. Personnel perform routine maintenance for X-326 process equipment.

The X-326 Maintenance Shop is protected from fire by fire alarm systems, wet pipe sprinkler system, and portable fire extinguishers. This area is provided coverage by the X-326 CAAS. CAAS details are contained in Section 3.6.2.

All gas bottles are stored in accordance with site industrial safety requirements. The shop area is equipped with a ventilation system. The shop is equipped with a contaminated equipment storage area.

The X-326 Radiographic Facility is located in the southeast corner of the X-326 operating floor. This X-ray facility is used to radiograph components for quality control and assurance, and consists of an X-ray vault housing an industrial X-ray machine. A frame structure is attached to the vault that is divided into two rooms, one of which is the control room. The other is the darkroom for the processing of film. The control room houses the operating console for the X-ray machine.

Toxic chemicals are used in the processing of radiographs. Protective equipment, approved operating procedures, and adequate ventilation mitigate the toxic hazards of photographic chemicals.

Uranium hexafluoride (UF_6) solids are present in some of the equipment to be radiographed. Process equipment is delivered with contamination controls in place and facility operations are performed in accordance with radiological work requirements. If the equipment "smokes" due to UF_6 interacting with air, adequate facility exits are provided for egress.

3.5.1.6.1 Radiographic Facility X-Ray Shielding

The Radiographic facility has been designed to meet ANSI Standard N543-1974 (external exposure average level less than 2 mr/hr) and to comply with Y-1754 Rev. 1. Assuming the beam is always directed at the control room, the worst case weekly exposure is approximately 20 mR.

3.5.1.6.2 Radiographic Facility Monitoring and Protection Systems

Radiograph equipment is found in many industries and is not unique to a uranium enrichment facility. Typical protective features are installed to provide protection to personnel operating this equipment. Field radiography is performed utilizing mobile equipment consisting of a constant potential X-ray system with an X-ray tube. The field operations are controlled under the radiation protection requirements of Section 5.3.

Some of the items radiographed at the facility contain limited amounts of fissile material. Any fissile material brought into the X-ray facility is handled in accordance with applicable NCSAs. X-326, which houses the Radiographic Facility, contains fissile materials and has a CAAS (Section 3.6.2).

Fire protection for the X-326 Radiographic Facility is provided by the existing wet pipe sprinkler system installed in X-326 (Section 3.6.1).

3.5.1.7 X-600B Steam Plant Shop

X-600B is provided at the X-600, Steam Plant Facility, to provide maintenance services primarily for steam plant equipment. The facility is equipped with CAAS slave components (CAAS details are described in Section 3.6.2). Any work involving potentially radioactive contaminated material is managed in accordance with the requirements of Section 5.3.

3.5.1.8 X-342A/X-344A Complex Maintenance Shop

The X-342A/X-344A Complex Maintenance Shop is located in the central portion of the X-342A/X-344A complex. The shop provides a planning and work area for electrical, instrument, mechanical and welding support for maintenance of systems in the X-342A/X-344A complex.

The maintenance shop is protected from fire by fire alarm systems, sprinkler system, and portable fire extinguishers. This area is covered by the X-344A CAAS. CAAS details are contained in Section 3.6.2. Evacuation alarms from the X-342A/X-344A complex provide coverage to the shop. All gas bottles are stored in accordance with site industrial safety requirements.

3.5.1.9 Maintenance, Stores, and Training Building (X-7721)

X-7721 is a multi-use facility and is used by several plant organizations.

X-7721 is provided fire protection by the alarm system and the automatic wet pipe and dry pipe sprinkler systems. Various portable fire extinguishers are located throughout the building.

The work activities involved within this facility have the potential to deal with radioactive contaminated materials and process related equipment. The requirements for working with radioactive contaminated material are established in accordance with Section 5.3.

3.5.1.9.1 X-7721 Shops

The X-7721 Scale Shop area is used for the maintenance, calibration, and repair of the various scales used on the plant site.

The Roads and Grounds Shop is used to store site supplies and materials. Lockable hazardous storage lockers that have separate air supply fans and exhaust vents are provided in this area. Flammable storage lockers are provided for the storage of materials such as gasoline, motor oils, and paints.

The Rigging Shop is used to house and fabricate various slings and lifting fixtures utilized to conduct hoisting and rigging operations around the plant site. Flammable storage lockers are provided for the storage of materials such as gasoline, motor oils, penetrating oils, and paints.

The X-7721 low bay area includes a small restricted area to maintain potentially radioactive contaminated equipment. The local area paging system is connected to the plant public address system to provide emergency communications. Small quantities of flammable liquids such as alcohol and flux remover are stored in flammable liquids safety storage cabinets.

3.5.2 Laboratories and Support Facilities

The X-710, Technical Services Building, laboratory serves as the location for a variety of production analytical support services (Section 5.7). The building is a two-story, reinforced concrete frame, concrete-block structure with a two-story insulated steel frame and metal siding addition on the south end of the original structure. The building location is indicated in Figure 2.1-4.

The building structure is important to safety (Section 3.8) and performs the function of withstanding natural phenomena hazards such as high winds and seismic events. As described in Section 3.8, the X-710 building is capable of withstanding the evaluated events.

In addition to the laboratory facilities in X-710, PORTS is equipped with the X-760, Chemical Engineering Building. The location of this facility is shown in Figure 2.1-4.

3.5.2.1 X-710 Building Utilities

Power is supplied to X-710 by two 13.8 kV feeders serving four substations. Each substation is operated at less than 50% capacity to allow for automatic (208/120V) or manual (480V) load transfer between substations in the event of inadvertent loss of either feed, and for substation maintenance.

The X-710 building is air-conditioned to provide the required environment for analytical laboratory instrumentation. The laboratories in X-710 are serviced by fume hoods and general exhaust fans.

X-710 is supplied with compressed air, steam, nitrogen, recirculating cooling water, and sanitary water by plant utility systems. The building is supplied with oxygen, liquid propane gas, hydrogen, and acetylene from the X-710A, Technical Services Gas Manifold Shed, directly west of the building. Fluorine (F_2) gas is provided to select areas from a F_2 supply cabinet also located directly west of X-710. Deionized water is processed from the building sanitary water through an ion exchange system.

3.5.2.1.1 X-710 Building Special Utility Hazards

The F_2 and acetylene supply and distribution systems present hazards to X-710 personnel. These materials are controlled in accordance with the chemical safety requirements of Section 5.6.

F_2 is delivered to X-710 from a supply cabinet located on the west side of the building as described in Section 3.5.2.1. F_2 is distributed to various rooms of X-710, and each room and the supply cabinet have double block valves on the distribution header to guard against a release in the event of a single valve failure.

3.5.2.2 X-710 Building Monitoring and Protection Systems

The original part of X-710 is equipped with an in-line rate-of-rise fire detection system in the laboratory areas and mechanical equipment rooms. The fire alarm annunciator panel is in the X-710 lobby and is tied into the plant fire alarm system.

The waste management storage area and flammable liquid storage vault are protected by a temperature rate-of-rise fire alarm detector, and sanitary water supplied sprinkler system. Activation of any of these systems is transmitted to the plant fire alarm system. The south addition of X-710 has a sprinkler system, and has smoke detectors installed in various locations.

X-710 is equipped with CAAS clusters. A detailed description of the CAAS is contained in Section 3.6.2.

3.5.2.3 X-710 Building Support Facilities

The X-710 building support facilities consist of X-710A, the X-710B, Explosion Test Facility, and X-760. These facilities provide X-710 with specialized utilities and house potentially dangerous experiments.

3.5.2.3.1 X-710A Technical Services Gas Manifold Shed

X-710A is an open air structure that houses high pressure gas manifolds and cylinders for the specialized gas utilities used in the laboratory areas of X-710. A portable fire extinguisher is installed at this facility to provide first response fire protection.

3.5.2.3.2 X-710B Explosion Test Facility (inactive)

X-710B was built to provide an area to perform hazardous experiments. The building is constructed of reinforced concrete and contains a cylindrical explosion chamber equipped with explosion vents. The explosion vents are directed toward an unoccupied controlled access area to mitigate any consequences of an explosion in the facility.

Utilities to the explosion test facility include those normal to any laboratory. In addition, the facility is equipped with a 42-ft^3 F_2 pig to supply F_2 gas independently of the main plant F_2 supply for X-710.

3.5.2.3.3 X-760 Chemical Engineering Building

X-760 is located between X-710 and the X-770, Mechanical Test Building. X-760 can be used for a variety of chemical and production support operations, and is equipped with a CAAS cluster. CAAS details are contained in Section 3.6.2.

3.5.2.4 Laboratory Special Hazards

Aside from hazards such as chemical reagents, toxic, flammable, and explosive materials, etc., that will be present in any laboratory facility, the only unique hazards involve uranium, technetium, and other radioactive materials in X-710.

These hazards exist in laboratories that routinely perform uranium analysis of cascade samples of all assays, where large numbers of the sample containers can accumulate. Although the individual sample quantities are negligible, the collective quantity of fissile material may be great enough to require an NCSA and periodic inspections in accordance with Section 5.2 requirements.

The locations in X-710 where the greatest amount of fissile material can be present are the uranium sampling and uranium analysis areas. At these locations the contents of uranium sample containers are collected in safe geometry containers and either returned to the cascade or disposed of as waste.

3.5.3 Receiving and Storage Facilities

An industrial facility the size of PORTS is involved with many types of operations and facilities. This broad range of activities necessitates the use of large quantities and numerous types of materials and equipment. Numerous storage yards and warehouses are required to accommodate these materials.

Many of these facilities are used to store materials that in some cases have been in contact with PG and could be considered hazardous under certain conditions. These materials are handled and stored in accordance with the chemical safety requirements of Section 5.6, and, if applicable, the radiation protection requirements of Section 5.3.

As indicated in Table 3.5-1, there are generally no monitoring and protection systems involved in the operation of the receiving and storage facilities. However, some of the facilities have evacuation alarms slaved to criticality alarms in nearby facilities, and the X-720 stores area is covered by a CAAS cluster (see Section 3.6.2 for CAAS details). Several facilities are protected by sprinkler systems; however, many of the outlying facilities have no fire protection systems other than fire extinguishers.

A listing and brief description of the facilities examined in this assessment are presented in Table 3.5-1.

3.5.3.1 Shipping and Receiving/Stores

The Shipping and Receiving area in the X-7721 Building is the general receiving area for the majority of the shipments of material for the GDP. The shipments are received, checked, and logged by personnel. If inspection is required, this is principally handled by a quality control group. The material is then moved to its designated location. UF_6 cylinder receiving is discussed in Section 3.2.4.

3.5.3.2 Aboveground Flammable/Combustible Storage Tanks

There are several aboveground tanks containing diesel fuel oil, gasoline or methanol located inside and outside of United States Enrichment Corporation-leased buildings. Information on these tanks and their locations is presented in Table 3.5-2. The diesel fuel oil tanks support operation of backup diesel generators in the process buildings, air compressors and sanitary water pumps. The gasoline tanks are used as satellite refueling stations for forklifts and other equipment used in the associated plant buildings. The methanol tank at X-700 provides a carbon source for the bacteria used in the biodenitrification process.

3.5.4 Communications and Data Processing

The X-112, Data Processing Building, provides facilities for equipment and personnel to support site-wide activities. The Automatic Data Processing areas are segregated from the balance of the facility and access is limited only to authorized personnel.

3.5.5 Administration Facilities

A variety of facilities are present on site that provide space for administrative functions. Building locations are shown in Figure 2.1-4.

The X-100, Administration Building, provides the offices for plant administration, support personnel, and the Nuclear Regulatory Commission.

The X-103, Auxiliary Office Building, is located north of the X-300, Plant Control Facility, and provides facilities for site support personnel.

The X-102, Cafeteria, is located just west of X-100 and north of the X-101, Health Services, building and provides facilities for food preparation, storage, and dining. X-102 has evacuation alarms slaved to the CAAS (Section 3.6.2).

The X-1000, Administration Building, is an administrative and technical building that provides facilities for plant administration and site support personnel. Included may be radiation protection equipment that utilizes small radiological sources for analytical purposes. The sources are controlled in accordance with the requirements of Section 5.3.

3.5.6 Health Protection Facilities

The health protection program provides services for individuals to meet Plant regulatory requirements and to maintain a high level of employee health.

X-101 is located immediately west of X-100, as shown in Figure 2.1-4. The facility is staffed with medical personnel to provide medical services for routine and emergency conditions.

The X-1007, Fire Station, contains a first aid room and provides ambulance service.

Table 3.5-1. Listing and Brief Description of Material Storage Facilities

FACILITY NUMBER AND TITLE	X-344B Maintenance Storage Building	X-720 (Stores Area) Maintenance and Stores Building
TYPICAL MATERIALS STORED IN THE FACILITY	X-340 & utilities maintenance equipment	General stores material
MONITORING AND PROTECTION SYSTEMS	Evacuation alarm slaved to criticality alarms in the X-344A	CAAS Cluster and evacuation alarms tied to building system.
CONFINEMENT SYSTEMS	NONE	NONE
VENTILATION SYSTEMS	Roof vents	Building ventilation system services the Stores Area.
CRITICALITY CONTROL SYSTEMS	NONE	NONE
FIRE PROTECTION SYSTEMS	Sprinkler system	Sprinkler system
WASTE DISPOSAL SYSTEMS	NONE	Utilities building drains and sewer
SAFETY SYSTEMS REMARKS	CAAS	CAAS

Table 3.5-1. Listing and Brief Description of Material Storage Facilities (Continued)

FACILITY NUMBER AND TITLE	X-720C Paint and Oil Storage Building	X-741 Oil Drum Storage Facility	X-742 Gas Cylinder Storage Facility	X-743 Lumber Storage Shed
TYPICAL MATERIALS STORED IN THE FACILITY	–Paint, paint thinners, oils, and greases	Oil	Compressed gas cylinders	Miscellaneous stores material, empty gas cylinders
MONITORING AND PROTECTION SYSTEMS	Evacuation alarm slaved to criticality alarms in X-720	NONE	NONE	NONE
CONFINEMENT SYSTEMS	Containment dike formed by the foundation	NONE	NONE	NONE
VENTILATION SYSTEMS	Power ventilators and air intake louvers	NONE (open area)	NONE (open area)	NONE (open area)
CRITICALITY CONTROL SYSTEMS	NONE	NONE	NONE	NONE
FIRE PROTECTION SYSTEMS	Sprinkler system	NONE	NONE	Sprinkler system
WASTE DISPOSAL SYSTEMS	NONE	NONE	NONE	NONE
SAFETY SYSTEMS	CAAS	NONE	NONE	NONE
REMARKS	The electrical power and lighting fixtures are explosion proof. There are also grounding buses with pintails for grounding explosive liquid containers.	The electrical power and lighting fixtures are explosion proof. There are also grounding buses with pintails for grounding explosive liquid containers.	The electrical power and lighting fixtures are explosion proof. There are also grounding buses with pintails for grounding explosive liquid containers.	

Table 3.5-1. Listing and Brief Description of Material Storage Facilities (Continued)

FACILITY NUMBER AND TITLE	X-744B Salt Storage Shed	X-744H & J Bulk Storage Building	X-744L Stores and Maintenance Building	X-744W Surplus and Salvage Building
TYPICAL MATERIALS STORED IN THE FACILITY	Salt	General stores material	General stores material, utilities materials, compressor hardware	Surplus materials and equipment
MONITORING AND PROTECTION SYSTEMS	NONE	NONE	Evacuation alarm slaved to criticality alarms in X-720	NONE
CONFINEMENT SYSTEMS	NONE	NONE	NONE	NONE
VENTILATION SYSTEMS	NONE (one open side)	Roof vents	Roof vents	Roof vents
CRITICALITY CONTROL SYSTEMS	NONE	NONE	NONE	NONE
FIRE PROTECTION SYSTEMS	NONE	Sprinkler system	Sprinkler system	Sprinkler system
WASTE DISPOSAL SYSTEMS	NONE	NONE	NONE	NONE
SAFETY SYSTEMS	NONE	NONE	CAAS	NONE
REMARKS		Material which has been in contact with process gas has been decontaminated (some residual contamination may remain)		

Table 3.5-1. Listing and Brief Description of Material Storage Facilities (Continued)

FACILITY NUMBER AND TITLE	X-747A Material Storage Yard	X-747B Material Storage Yard	X-747C Material Storage Yard	X-747D Material Storage Yard
TYPICAL MATERIALS STORED IN THE FACILITY	General stores material (primarily large metal objects)	Repair parts for engine towers, converters on wagons, miscellaneous maintenance equipment	Piping, valves, compressor motors, cable, etc.	Materials and equipment used in or requiring work by the weld, paint and carpenter shops
MONITORING AND PROTECTION SYSTEMS	NONE	NONE	NONE	NONE
CONFINEMENT SYSTEMS	NONE	NONE	NONE	NONE
VENTILATION SYSTEMS	NONE	NONE (open area)	NONE (one open side)	NONE (open yard)
CRITICALITY CONTROL SYSTEMS	NONE	NONE	NONE	NONE
FIRE PROTECTION SYSTEMS	NONE	NONE	NONE	NONE
WASTE DISPOSAL SYSTEMS	NONE	NONE	NONE	NONE
SAFETY SYSTEMS	NONE	NONE	NONE	NONE
REMARKS		Material which has been in contact with process gas has been decontaminated (some residual contamination may remain)	Material which has been in contact with process gas has been decontaminated (some residual contamination may remain)	Material which has been in contact with process gas has been decontaminated (some residual contamination may remain)

Table 3.5-1. Listing and Brief Description of Material Storage Facilities (Continued)

FACILITY NUMBER AND TITLE	X-747E Material Storage Yard
TYPICAL MATERIALS STORED IN THE FACILITY	Compressor parts
MONITORING AND PROTECTION SYSTEMS	NONE
CONFINEMENT SYSTEMS	NONE
VENTILATION SYSTEMS	NONE (open yard)
CRITICALITY CONTROL SYSTEMS	NONE
FIRE PROTECTION SYSTEMS	NONE
WASTE DISPOSAL SYSTEMS	NONE
SAFETY SYSTEMS	NONE
REMARKS	Material which has been in contact with process gas has been decontaminated (some residual contamination may remain)

Table 3.5-2. Aboveground Flammable/Combustible Storage Tanks

Tank Location	No. of Tanks	Nominal Capacity in Gallons	Product	Fire Protection Criteria
X-104	1	250	Diesel	UL listed 2-hour fire protection.
X-326	4	250	Diesel	UL listed 2-hour fire protection.
X-326	1	1,500	Diesel	Separation of 20 feet from buildings.
X-330	1	300	Gasoline	Separation of 50 feet from buildings and portable fire extinguisher.
X-330	5	250	Diesel	UL listed 2-hour fire protection.
X-330	1	1,500	Diesel	Separation of 20 feet from buildings.
X-333	4	250	Diesel	UL listed 2-hour fire protection.
X-333	1	300	Gasoline	Separation of 50 feet from buildings and portable fire extinguisher.
X-344 B	1	300	Gasoline	Separation of 25 feet from buildings and portable fire extinguisher.
X-344 B	1	300	Diesel	Separation of 25 feet from buildings and portable fire extinguisher.
X-611	1	500	Diesel	UL listed 2-hour fire protection.
X-611 C	1	500	Diesel	UL listed 2-hour fire protection.
X-640-1	1*	550	Diesel	Sprinkler Protection
X-700	1	7,800	Methanol	Separation of 50 feet from buildings.
X-705	1	300	Gasoline	Separation of 50 feet from buildings.
X-710	1	300	Diesel	UL listed 2-hour fire protection
X-720	1	300	Gasoline	Separation of 50 feet from buildings and portable fire extinguisher.
X-1007	1	300	Diesel	UL listed 2-hour fire protection
X-6000	3*	275	Diesel	Sprinkler Protection.
X-6644	2*	250/550	Diesel	Sprinkler Protection.

Aboveground storage tanks having UL listed 2-hour fire protection ratings were installed by licensed certified contractors and approved by the Ohio State Fire Marshal's Office. Installation of these tanks was in accordance with National Fire Protection Association (NFPA) Code 30, "Flammable and Combustible Liquids Code."

* Located inside building

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3.6 FIRE PROTECTION, RADIATION ALARM SYSTEMS, ENVIRONMENTAL PROTECTION FACILITIES, AND WARNING SYSTEMS

This section describes protection and warning systems that either serve large areas of the plantsite or provide some safety function to the offsite public. Section 3.6.1 describes the plant-wide fire protection systems provided for the prevention and mitigation of large fires in plant facilities. The water supply systems, sprinkler systems, and other fire protection provisions and support facilities are discussed. Section 3.6.2 describes the systems which are in place to detect a nuclear criticality and to provide warnings to plant personnel to evacuate areas affected by a nuclear criticality. Section 3.6.3 describes those facilities which are dedicated to protecting the environment. Section 3.6.4 describes the system provided to notify the public surrounding the plantsite of incidents which may require sheltering or evacuation. Section 3.6.5 describes those systems that are used to provide notifications or evacuation instructions of an incident requiring sheltering or evacuation of plant personnel.

3.6.1 Fire Protection Systems

This section describes the various fire protection systems installed at the Portsmouth Gaseous Diffusion Plant (PORTS). The sprinkler systems in the X-326, Process Building, the X-330, Process Building, the X-333, Process Building, and the X-343, Feed, Vaporization & Sampling Building, are relied upon to prevent and to mitigate a large fire. These sprinkler systems and components of the high-pressure fire water system are covered in more depth than are the fire protection systems that protect only against property damage and monetary loss.

3.6.1.1 Water Supply Systems

The system, which supplies water to the plant, is described in Section 3.4.2. There are two water systems, which distribute water for fire protection systems. These systems are (1) the Sanitary and Fire Water (SFW) System and (2) the High-Pressure Fire Water (HPFW) System.

3.6.1.1.1 Sanitary and Fire Water System

The SFW System supplies potable water as well as water for various processes on plant site. It also supplies water for the sprinkler systems in some buildings and switchyards, and for nearly all of the fire hydrants in the gaseous diffusion plant (GDP) Area. Some fire hydrants are served by the HPFW System, as noted in Section 3.6.1.1.2. Typically, there are separate water piping systems in each building for sanitary purposes and for the fire protection sprinkler systems.

3.6.1.1.2 High-Pressure Fire Water System

The function of the HPFW System is to supply water to the fire protection sprinkler systems in X-326, X-330, and X-333, the cooling towers on the GDP plant site, the X-343, Feed, Vaporization, & Sampling Building, and in the Gas Centrifuge Enrichment Plant (GCEP) site. The HPFW System is important to safety as described in Section 3.8.

The HPFW System components are as follows:

- X-640-1, Fire Water Pump House,
- X-6644, Fire Water Pump House,

- Fire Water Storage (tanks and basins),
- Distribution system,
- Sprinkler systems in X-326, X-330, X-333, X-343, and GCEP Buildings,
- Sprinkler systems on cooling towers,
- Associated underground piping, valves, and fire hydrants (those not served by the SFW System).

3.6.1.1.2.1 X-640-1, Fire Water Pump House

X-640-1 is located northeast of X-333. It houses two electric motor driven fire water pumps, a jockey pump, and a diesel-powered emergency fire water pump. The electric pumps start and stop automatically at specified water levels in the X-640-2, Elevated Water Tank. The jockey pump is used to maintain the X-640-2 tank level. The diesel emergency fire pump is a manual start pump only. A diesel fuel oil tank provides fuel for approximately 15 hours of operation.

The electric pumps are normally automatically started based upon the water level in X-640-2. If X-640-2 is out of service the X-640-1 pumps can be operated manually. The X-640-1 pumps and the X-6644 pumps (described in the next section) can be used in combinations to meet the fire water demand.

All of the X-640-1 pumps can be started from either X-640-1 or remotely from the X-300, Plant Control Facility (PCF).

The electric fire pumps require AC electrical power in order to perform their required function. Therefore, the AC electrical power source back to and including the breaker is a required support system, as discussed in Section 3.8. In the event that AC electrical power fails, the diesel emergency fire pump can be manually started to meet fire water demand.

3.6.1.1.2.2 X-6644, Fire Water Pump House

X-6644 is located west of X-3001, GCEP Process Building Number One. X-6644 contains two electric motor-driven fire pumps and a diesel-powered emergency fire pump. The electric pumps start and stop automatically at specified water levels in X-640-2.

The diesel emergency fire pump is a manual start pump only. A diesel fuel tank provides fuel for approximately 15 hours of operation. These pumps can be used in combinations to meet the fire water demand.

The electric pumps are normally automatically started based upon the water level in X-640-2. If the tank is out of service, a pump at X-6644 can be arranged to start automatically on system pressure drop or the pumps can be operated manually.

All of the X-6644 fire pumps can be started from either X-6644 or remotely from the X-300 PCF.

The electric fire pumps require AC electrical power in order to perform their required function. Therefore, the AC electrical power source back to and including the breaker is a required support system, as discussed in Section 3.8. In the event that AC electrical power fails, the diesel emergency fire pump can be manually started to meet fire water demand.

3.6.1.1.2.3 Fire Water Storage (Tanks and Basins)

X-640-2 is a 300,000-gallon storage tank located between X-330 and the X-720, Maintenance and Stores Building. It provides constant system pressure. At the bottom of the storage tank is a series of pressure switches that sequentially start the fire water pumps at X-640-1 and X-6644 (refer to Sections 3.6.1.1.2.1 and 3.6.1.1.2.2). The water for the X-6644 pumps is supplied from two 2-million gallon storage tanks (X-6643-1, Fire Water Storage Tank Number One, and X-6643-2, Fire Water Storage Tank Number Two) located adjacent to X-6644. The basins in the X-611, Water Treatment Plant, are primarily used for makeup water for the RCW system. However, the X-611 basin is also used to supply the water to the pumps in X-640-1 when they are activated.

3.6.1.1.2.4 Distribution System

The underground piping for the HPFW System is basically a loop system (Figure 3.6-1) around the process buildings, cooling towers and GCEP site. It supplies water to the sprinkler systems in those facilities.

All underground pipe was installed using the requirements of the National Fire Protection Association (NFPA) Standard 24, Private Fire Service Mains, as guidance.

Sectional control valves are typically located such that, if an underground break in a pipe occurs, only a portion of the system will be out of service. Each sprinkler system has a shutoff valve.

The HPFW distribution system is equipped with surge relief valves to dampen surges in the system.

3.6.1.1.2.5 GCEP Plantsite Expansion

In 1983, the HPFW System was expanded to provide fire protection (sprinkler protection and fire hydrants) to the GCEP plantsite by making three tie-ins to the water lines near the southwest corner of X-326. Each tie-in is separated by a sectional valve on the GDP system and has its own sectional valve near the original GDP water lines.

3.6.1.2 Sprinkler Systems

The three major types of sprinkler systems are wet-pipe, dry-pipe, and deluge systems.

3.6.1.2.1 Process Building and X-343 Wet-Pipe Sprinkler Systems

The automatic sprinkler systems providing interior protection to X-326, X-330, X333 and X-343 are wet-pipe systems. These systems are the same type found throughout industry and consist of a system of water-filled pipes with standard upright, pendant, or sidewall sprinkler heads installed on the pipes.

The size of the process buildings dictates that more than one system be used in each building. Most systems are installed in areas where temperatures are maintained to prevent freezing; in areas subject to freezing (e.g., filter rooms), an antifreeze solution is maintained in the piping antifreeze loop. This solution meets NFPA standards. All systems were installed using the requirements of the NFPA Standard 13, Sprinkler Systems, as guidance.

3.6.1.2.1.1 Water Supply and Underground Components

Water is supplied to the process building sprinkler systems by the distribution system for the HPFW System described in Section 3.6.1.1.2.4.

Lead-in lines carry fire water from the distribution piping to each sprinkler system riser. All lead-ins run underground.

A shutoff valve is provided for each sprinkler system.

3.6.1.2.1.2 Inside Components

The water riser enters through the building floor to an alarm check valve. The alarm check valve is essentially a free-swinging clapper valve, which reseats automatically. This valve serves as an alarm valve that indicates when a sprinkler head has operated and as a check valve that prevents backflow from the sprinkler system.

Bolted on the upper side of the alarm check valve is a pipe called a bulk main. This pipe supplies water to the cross mains, which, in turn, supply water to the branch lines with sprinkler heads. The system piping progressively decreases in size, in proportion to the number of sprinklers, from the source of water supply to the most remote sprinklers.

Upright, pendant, and sidewall sprinkler heads are used. The temperature range of the heads is 250°F to 300°F, typically 280°F or 286°F, for the cell floor ceiling systems; 175°F to 225°F, typically 212°F for the rest of the industrial areas of the process buildings; and 135°F to 170°F, typically 165°F in the administrative areas.

An inspector's test pipe and valve is provided to allow testing of the system.

3.6.1.2.1.3 System Operation

Water under pressure is maintained in the process building sprinkler system. Under normal conditions, the clapper of the alarm check valve remains closed.

When a fire occurs and the resultant temperature at a sprinkler head reaches the sprinkler head's temperature rating, the fusible link operates. Water immediately flows from the head's orifice and strikes the deflector, which results in a spray. This water flow causes the water pressure on the supply side of the alarm valve clapper to exceed that on the system side. Consequently, the clapper opens and water flows from the supply main, through the lead-in piping, up the supply riser, through the alarm check valve, and through the system piping to the open sprinkler heads.

The opening of the clapper simultaneously allows water to flow through the alarm line to the alarm switch, thus, causing an alarm to actuate in the area control room of the affected building as well as the X-1007, Fire Station, and the X-300 PCF. The water flow continues until it is shut off manually at the control valve.

3.6.1.2.2 Other Wet-Pipe Sprinkler Systems

In addition to the process building sprinkler systems, there are wet-pipe systems located in other buildings that are supplied by the SFW System. These systems are functionally similar to the process building systems and are inspected by Fire Services as described in Section 5.4.

3.6.1.2.3 Dry-Pipe Sprinkler Systems

The dry-pipe sprinkler systems have automatic sprinkler heads attached to piping, which contains air under pressure. When a sprinkler head is actuated by heat, such as from a fire, the air pressure is reduced, and a "dry-pipe valve" is opened by the unequal pressure between the air and the water. Water from the SFW System or HPFW System then flows out of any actuated sprinkler head. Dry-pipe systems are provided when needed to protect buildings or areas subject to freezing.

3.6.1.2.4 Deluge Sprinkler Systems

The deluge system sprinkler heads are open at all times. A heat-actuated mechanism opens a valve permitting the water to flow into or through the pipe. The water is then discharged through all the sprinkler heads at once. Deluge systems are provided, where needed, to protect special hazards (e.g., cooling towers and some exterior oil filled transformers). The SFW System or HPFW System supplies the deluge sprinkler systems.

3.6.1.2.5 Pre-action Sprinkler Systems

The pre-action sprinkler system is similar to the deluge system except that the sprinkler heads are closed and operate independently of the water supply valve that opens when a heat-sensing device is actuated. This system is supplied by the SFW System.

3.6.1.3 Other Fire Extinguishing Systems

Portable fire extinguishers are located throughout the plant site. Various types of portable extinguishers are used depending on the hazard, and are inspected by Fire Services in accordance with Section 5.4.

There are fixed carbon dioxide (CO_2) systems on plantsite. When a system is activated, CO_2 stored as a liquid at high-pressure in cylinders is discharged in the form of a gas. The CO_2 gas floods the designated area and extinguishes the fire.

There are fixed Halon 1301 systems on plantsite. When a system is activated, Halon 1301, stored in high-pressure cylinders, discharges and extinguishes the fire by breaking the chemical reaction of the fire.

Standpipe systems are designed for fire department use to provide quick and convenient means of obtaining effective water streams on the upper stories of high buildings. The only standpipe system on plantsite is installed to provide protection to the coal bunkers of the X-600, Steam Plant Facility.

Fire hydrants are located throughout plant site and are supplied by either the SFW System or by the HPFW System. The hydrants are of standard type and are inspected by Fire Services in accordance with Section 5.4.

3.6.1.4 Fire Services Facilities

X-1007 houses the Fire Service's mobile equipment, alarm room, and Fire Station offices. The X-106C, New Fire Training Building, is located 300 ft. east of the X-616, Liquid Effluent Control Facility.

3.6.1.5 Fire Alarm Systems

The fire alarm system consists of water flow indication, supervisory alarms, manual pull stations, and other alarms as needed. These alarms are received in X-1007, with selected alarms mimicked in the X-300 PCF. The telephone and radio communication systems are used as alternate systems to report fires or other emergencies.

3.6.2 Radiation Alarm Systems

3.6.2.1 General

The primary radiation alarm system is the Criticality Accident Alarm System (CAAS) designed to detect a nuclear criticality and provide audible and visual alarms that will alert personnel to evacuate the immediate area.

3.6.2.2 Criticality Accident Alarm Systems

The CAAS is designed to detect neutron radiation levels that would result from the minimum criticality accident of concern as defined by American National Standard Institute (ANSI)/ANS 8.3 and to provide an audible evacuation alarm. A secondary function is to activate the building evacuation horns and radiation warning lights and alarms at X-300 and the X-104, Guard Headquarters. This system is important to safety as described in Section 3.8.

The CAAS is primarily divided into four parts: the local alarm system, the building alarm system, the X-300 alarms and controls, and the X-104 alarms and controls. The local alarm system includes the radiation detection instrument referred to as a "cluster" and local evacuation horn. The building alarm system includes the evacuation horns and radiation warning lights for a "clustered" facility and for those buildings designated as "slaved" facilities.

Operations involving fissile material are evaluated for Nuclear Criticality Safety (NCS) considerations 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 Nuclear Criticality Safety Evaluation. Current cluster and slave locations are listed in Table 3.6-1. Additional details describing the NCS evaluation of the need for CAAS coverage are provided in Section 5.2.2.5.

When a cluster reaches a Radiation Alarm state, it activates both visual and audible alarms in the affected area(s). The following alarms would be activated:

- A local evacuation horn,
- Building evacuation horns,
- Radiation warning lights located on the outside of buildings,

- Audible and visible alarms at the X-300 master control console and at the X-104 alternate master control panel.

The local and building horns produce a distinct sound and are used as an emergency signal for immediate evacuation of all personnel from the building or area. The subsystems and components that comprise the CAAS are described in the following subsections.

3.6.2.2.1 Local Evacuation Alarm System

The local evacuation alarm system is described in the following paragraphs.

3.6.2.2.1.1 Radiation Alarm Cluster

Each radiation alarm cluster comprises three neutron-sensitive radiation detection units, related cluster and channel electronics, power supply, and battery packs. Clusters are designed to detect and alarm on a minimum credible criticality accident of concern, defined as producing an integrated total dose of 20 Rads in one minute at two meters from the reacting material (ANSI/ANS 8.3-1986). Radiation alarm clusters are installed such that an alarm will be actuated within 0.5 seconds after activation by a minimum credible criticality accident of concern. If one of the three radiation detection units detects a radiation level that exceeds the cluster calibration set point of 5 mRad/hr in air neutron, a Radiation Alert state is generated for that cluster and maintained until reset. If any two of the three radiation detection units are in a Radiation Alert state, a Radiation Alarm state is generated for that cluster. After thirty seconds, all clusters, which are in a Radiation Alarm state will be reset automatically. A single "red" lamp on the front of the cluster is used to show the alarm state of the cluster. It is illuminated only if the cluster is in alarm. A logic diagram of the cluster alarm and alert functions is provided in Figure 3.6-2. A simplified schematic of the CAAS is shown in Figure 3.6-3.

The clusters are normally powered by a 120 VAC electrical power source. A series of three nickel-cadmium battery power packs served by an AC to DC power supply is used to supply reserve DC power to the radiation detection units, the channel electronics, and the cluster logic boards if the cluster AC power source is lost. Because they are provided with reserve power via the battery packs, the radiation detection units are fail-safe on loss of the AC power source.

3.6.2.2.1.2 Cluster Alert/Alarm States

Two sets of electronic circuitry are used to determine the total cluster logic state and to issue the appropriate alarm signal as needed. Any combination of two separate Radiation Alert or Trouble Alert conditions generated within a cluster are sufficient to produce a cluster Radiation Alarm state. A Radiation Alert state occurs when one unit of a cluster detects a high neutron level or an electrical malfunction occurs. A Trouble Alert state occurs upon failure of a single unit within a cluster. A cluster failure not associated with an individual unit, such as loss of AC power to the cluster or low nitrogen supply pressure for the local evacuation horn, results in a Trouble Condition. To provide a more reliable system, a combination of a Trouble Condition and a single Radiation Alert or Trouble Alert state generated within the cluster will not generate a cluster Radiation Alarm.

3.6.2.2.1.3 Local Evacuation Horns

Local evacuation horns (also called Nitrogen Strombos horns) are located at each cluster installation. Each local evacuation horn is powered by a dedicated nitrogen cylinder with a supply pressure of at least 900 psig. The audible evacuation signal from a criticality alarm is a horn or set of horns that operates on a regulated nitrogen supply. The system is activated when a Radiation Alarm signal from a cluster triggers a solenoid activation valve in an associated nitrogen horn cabinet, releasing nitrogen from the supply cylinder through the local evacuation horn(s). Once actuated, the local evacuation horn continues to blow until the nitrogen cylinder is depleted (a minimum of two minutes).

The solenoid activation valves are provided with 24 VDC power by their associated clusters. Upon loss of AC power, the clusters rely upon DC reserve power from the battery packs to operate as required, including providing power to the solenoid valves in the event of a Radiation Alarm condition. Therefore, this system is failsafe upon loss of AC power.

3.6.2.2.2 Building Alarm System

The building alarm components are described in the following paragraphs.

3.6.2.2.2.1 Building Evacuation Horns

Building evacuation horns serve as a secondary audible alarm signal to the local evacuation horn. The building evacuation horns in X-326, X-330, and X-333 are air horns supplied by the plant air system. All other clustered facilities use electric building evacuation horns. The slaved buildings use either nitrogen-operated or electric building evacuation horns. Slaved facilities that have audibility provided by a local evacuation horn in an adjacent clustered facility do not require their own building evacuation horns. Once activated, the process building evacuation horns and the electric horns in the tunnels and the X-111A, Data Processing Building, slave will continue to sound until silenced from the master control console in the PCF. All other clustered and slaved facility building evacuation horns will sound for approximately five minutes unless stopped sooner from the master control console in the PCF. Once actuated, the slaved facility nitrogen-operated building evacuation horns will continue to blow until the nitrogen cylinder is depleted (a minimum of two minutes).

The building evacuation horns for X-326, X-330 and X-333 also serve as the Cascade Building Evacuation System portion of the Onsite Warning/Evacuation Systems. Refer to Section 3.6.5 for further discussion of the Onsite Warning/Evacuation Systems.

The air solenoid valves for the X-326, X-330, and X-333 building evacuation horns are powered by an AC electrical power source. For the X-326, X-330 and X-333 building evacuation horns only, the electrical power source back to and including the automatic DC transfer switch to the air solenoid valves is a required support system, as discussed in Section 3.8. Upon loss of AC electrical power, actuation of the DC transfer switch will allow DC power to operate the air solenoid valves of the X-326, X-330 and X-333 building evacuation horns so that the horns can carry out the system alarm function. For the X-326, X-330 and X-333 building evacuation horns, the plant air supply from the air horns and back to, but not including, the main air supply header is considered to be a required support system, as discussed in Section 3.8. Air is required for the X-326, X-330 and X-333 building evacuation horns to fulfill their design function.

3.6.2.2.2.2 Radiation Warning Lights

Radiation warning lights are installed on the outside of the affected buildings at locations visible from all approaches to the building. A sign is placed adjacent to each radiation warning light to identify the purpose of the warning light. The lights are activated by a signal sent from the cluster that is in alarm.

The radiation warning lights are powered by an AC electrical power source. The power supplied to the evacuation relay cabinet relay used to activate the radiation warning lights is monitored. A trouble alarm is initiated in X-300 upon loss of power to the evacuation relay cabinet.

3.6.2.2.2.3 Slaved Buildings

Site buildings, except for X-300, which are located within 200 ft of a clustered building and either not equipped with criticality alarms of their own or provided with alarm coverage from an adjacent alarmed building, are provided with evacuation horns and radiation warning lights slaved to the clustered building. When a cluster enters a Radiation Alarm state, the building evacuation horns and radiation warning lights slaved to that cluster are activated. For slave facilities, the AC electrical power supplied to the evacuation relay cabinet relays used to activate the individual building evacuation horns and radiation warning lights is monitored. A trouble alarm is initiated in X-300 upon loss of AC power to the evacuation relay cabinet. Slaved buildings are listed in Table 3.6-1.

3.6.2.2.3 X-300 and Alarms and Controls

The master control console is located in the X-300 PCF. It is equipped with alarm indicating lights for all clusters. Controls for resetting the alarm clusters and devices for remote activation or deactivation of the building evacuation horns and radiation warning lights are provided. In addition, a plant-wide evacuation may be started by sounding the evacuation horns in all buildings covered by the CAAS. The clusters themselves cannot be activated from the master control console; only the warning devices may be activated. The master control relay circuitry operates from a 52 VDC battery equipped with a 208 VAC battery charger. The X-300 alarm/trouble indicators are normally powered by a 26 VDC battery, which is powered by the 120 V AC electrical system. The alarm/trouble indicators are provided with battery backup from the 52 VDC battery in the event of a loss of AC power to the 26 VDC battery. Failure of normal power will result in a switch from the 26-VDC battery and its AC power supply to the 52 VDC backup battery to maintain power to the X-300 alarm/trouble indicators. The electrical power source back to and including the automatic DC transfer switch is a required support system for the alarm/trouble indicator function only, as discussed in Section 3.8.

3.6.2.2.4 X-104 Alarms and Controls

X-104 is provided with an alternate master control panel. It can be used if it becomes necessary to evacuate X-300. The alternate master control panel does not provide individual cluster indication, but provides indication by building whenever an alarm condition exists. Controls for plant-wide evacuation are also provided. The X-104 alarm/trouble indicators are powered by the AC electrical system.

3.6.2.2.5 Instrumentation, Controls, and Alarms

A Trouble Alert may result from any of the following:

- Indication of radiation detection by only one radiation detection unit,
- Loss of AC power,
- Failure of either of the two cluster logic boards,
- Loss of signal from any one radiation detection unit,
- Disconnected cable to local evacuation horn,

- Disconnected lines or "opens" in the trouble circuit,
- Low gas pressure on the "supply side" of the nitrogen regulator, which is set to trigger or "open" before the nitrogen gas pressure drops below 900 psig in the cylinder,
- Low gas pressure on the output side of the nitrogen regulator, which is set to trigger or "open" if the nitrogen gas pressure at the output of the regulator drops below 90 psig,
- High gas pressure on the output side of the nitrogen regulator, which is set to trigger or "open" if the gas pressure exceeds 150 psig.

As the Trouble Alert and Radiation Alert states are distinguishable at the master console located in X-300, appropriate action can be taken with knowledge of the hazards involved. Prompt attention to Trouble Alert conditions is initiated to avoid needless evacuation of personnel. The cause of the trouble alert cannot be identified at the master console in X-300. Therefore, in the event of a trouble alert, personnel respond to the area to investigate the cause of the alert.

3.6.2.2.6 Maintenance and Testing Requirements

As part of scheduled preventive maintenance, clusters are tested and checked for physical and electrical damage. The units are calibrated and the unit's response to a known neutron source at a given distance is checked.

The master control panel controls with the exception of the plantwide evacuation buttons (X-300 and X-104 consoles) and the cluster reset buttons (only X-104 console) and the local and building evacuation horns and radiation warning lights on all clustered and slaved buildings are tested as part of scheduled preventive maintenance. At the beginning of each shift, all trouble lights on the master console are tested to ensure that they illuminate. System testing and calibrating of the clusters is done according to approved maintenance procedures.

During maintenance activities, a facility may be placed into TEST in order to prevent inadvertent activation of the building evacuation horns and radiation warning lights. Controls for placing a facility into TEST are located on the X-300 master control panel. Placing a facility in TEST prevents the building evacuation horns and radiation warning lights from being activated should a cluster radiation alarm condition occur. It does not however prevent the activation of the local evacuation horn as long as the nitrogen cylinder has not been valved off. If a radiation alarm condition should occur while a facility is in TEST, by removing the facility from TEST the building evacuation horns and radiation warning lights are activated automatically.

3.6.3 Environmental Protection Facilities

The facilities, which are dedicated to environmental protection, are noted in this section. Management of radiological environmental protection is described in Section 5.1. Thirteen separate, numbered facilities and numerous unnumbered air sampling stations have been identified as the fixed facilities associated with PORTS operations to protect the environment. No safety systems, design features, or administrative controls that are important to safety have been identified for these environmental protection facilities.

The environmental protection facilities comprise the following:

- X-621, Coal Pile Runoff Treatment Facility,

- X-230K, South Holding Pond,
- X-617, South Holding Pond & pH Control Facility,
- X-230L, North Holding Pond,
- X-618, North Holding Pond Storage Building,
- X-230J-5, West Holding Pond,
- X-230J-6, Northeast Holding Pond,
- X-230J-7, East Holding Pond,
- X-611B, Sludge Lagoon,
- X-6619, Sewage Treatment Facility,
- X-120H, New Weather Station,
- X-230J-7, X-230J-5, X-230J-6 and X-230J-2, Monitoring Stations,
- Air Sampling Stations.

3.6.3.1 X-621, Coal Pile Runoff Treatment Facility

X-621 provides a lagoon for collection and equalization of coal pile runoff and steam plant bearing cooling water. At this facility, the collected water is pH adjusted, suspended solids are removed, and sludge is dewatered.

3.6.3.2 X-230K, South Holding Pond

X-230K collects discharges from F, G and H storm sewers. Major contributions to X-230K are discharges from the X-100, Administration Building, air-conditioning system, drainage from the southeast quadrant of X-326 from the X-626 facilities, and liquid wastes from X-600 and the coal storage pile.

3.6.3.3 X-617, South Holding Pond & pH Control Facility

X-617 receives discharges from the X-100 air-conditioning system, drainage from the southeast quadrant of X-326, liquid wastes from X-600, and treated runoff from the coal storage pile. X-617 maintains the effluent pH.

3.6.3.4 X-230L, North Holding Pond

X-230L collects discharges from storm sewers K, C and M. The primary purpose of the pond is to retain accidental spills of oil or other material until it may be treated or removed and disposed of properly.

3.6.3.5 X-618, North Holding Pond Storage Building

X-618 is a small storage building on a concrete pad located near the North Holding Pond. This building houses electric sampling equipment, pH and flow instrumentation, and other equipment associated with the operation of the North Holding Pond.

3.6.3.6 X-230J-5, West Holding Pond

X-230J-5 is used in the settling of suspended solids, pH adjustment, and oil diversion and containment. A unique feature of this drainage sector is the ability to manually control/contain all water upstream of the X-230J-5.

3.6.3.7 X-230J-6, Northeast Holding Pond

X-230J-6 is used in the settling of suspended solids, pH adjustment, and oil diversion and containment.

3.6.3.8 X-230J-7, East Holding Pond

X-230J-7 receives once-through cooling water and runoff. Drains from X-343 are also routed to the pond. This pond is used in the settling of suspended solids, pH adjustment, and oil diversion and containment.

3.6.3.9 X-611B, Sludge Lagoon

X-611B provides a quiescent zone for settling lime sludge used in the water-softening process. X-611B also receives some water from rainfall runoff.

3.6.3.10 X-6619, Sewage Treatment Plant

X-6619 is used to treat domestic sewage, biodenitrification effluent from:

- The X-700, Converter Shop & Cleaning Building, Biodenitrification Facility,
- Microfiltration effluent from the X-705, Decontamination Building, microfiltration facility,
- Treated groundwater from the X-623, North Groundwater Treatment Building,
- Effluent from the X-700 air stripper (currently not in operation),
- Treated groundwater from the X-622, South Groundwater Treatment Building,
- Effluent from the X-622T, Carbon Filtration Facility,
- Miscellaneous waste streams (the X-710, Technical Services Building, waste, the X-102, Cafeteria, food wastes, and the X-101, Health Services, medicinal wastes, office chemicals, miscellaneous chemicals, laundry wastewater, and floor wash water),
- Infiltration/inflow of ground water.

3.6.3.11 X-120H, New Weather Station

The site maintains a meteorological tower which measures air temperature, wind speed, wind direction, relative humidity, solar radiation, barometric pressure, precipitation, and soil temperature.

3.6.3.12 X-230J7, J5, J6, and J2 Monitoring Stations

The X-230J7, J5, J6 and J2 monitoring facilities are used for storage and water sampling.

3.6.4 Public Warning System

The Public Warning System is used to provide notification to the public within a two-mile radius of the plant in the event of an incident requiring evacuation or sheltering of the public. The Public Warning System is important to safety, and is further discussed in Section 3.8. The system comprises sirens on poles/towers, siren control stations necessary to operate the system (one located at each siren tower), and electronic siren controllers at the X-300 PCF, the X-1020, Emergency Operations Center, and the Pike County Sheriff's Department. The system relies on AC power for normal operations. Battery backup is provided for the control of each siren on loss of normal power. Backup power supplies are also provided for each of the three electronic siren controllers. The sirens are subjected to an inaudible test on a monthly basis, and an audible test is conducted semiannually.

3.6.5 Onsite Warning/Evacuation Systems

The Onsite Warning/Evacuation Systems are used to provide evacuation instructions or notification in the event of an incident requiring evacuation or sheltering of plant personnel. The Onsite Warning/Evacuation Systems comprise the Public Address System and the Cascade Building Evacuation Alarm System. The Onsite Warning/Evacuation Systems are important to safety, and are further discussed in Section 3.8. These two systems are described in the following subsections.

3.6.5.1 Public Address System

A Public Address (PA) System is in place to provide evacuation instructions or notification in the event of an incident requiring evacuation or sheltering of plant personnel. The PA System comprises speakers, microphones at X-300 and X-1020, associated power amplifiers, mixer/preamplifiers, and tone generators, Lo-signal relays, distributed process controller and associated software, and wiring/fiber optic links. The X-300/X-1020 control console is provided with AC power, and is provided with backup power via a diesel generator. The X-300/X-1020 control console receives a feedback signal from each facility via the Lo-signal relays to indicate whether a message was received or not. Failure to receive a Lo-signal feedback from a facility may indicate a failure of that facility's PA System.

The X-300/X-1020 control console is continuously manned. During emergencies, the PA System is not used for routine traffic. The PA System serves most occupied site buildings. Alternate methods are used to communicate with individuals in buildings that are not covered by the PA System or for facilities where there is an indication that the PA System has failed. The PA System is tested daily.

3.6.5.2 Cascade Building Evacuation Alarm System

The Cascade Building Evacuation Alarm System comprises the Building Evacuation Horns in X-326, X-330, and X-333. Horns are used to alert personnel in areas within these buildings where the PA System is not effective due to ambient noise levels. These horns can be actuated from either X-104 or X-300. The Building Evacuation Horns are described in Section 3.6.2.2.2.1.

Table 3.6-1 CAAS Buildings and Slaves

Clustered Buildings	Number of Clusters	Associated Slaved Buildings	
X-333	12	**X-334, (X-700A)**	
X-330	17	X-614A	
X-326	18	X-111A, X-111B	
X-343	1	None	
X-344A/X-342A	2	X-342B, X-344B, X-344H	
X-345	5	None	
X-700	1	X-700A, X-701D	
X-705	2	(X-700A), X-705D	
X-710	4	**X-102**, X-710B	
X-720	2	X-720C, **X-744L**	
X-744G	2	**X-623**	
X-760	1	None	
X-770	1	X-600B, X-600D	
*X-7725/X-7725R	6	X-6614J, X-7727H, X7726	
XT-847	2	**X-1107AV**	

Slaved buildings in **bold type** have slave lights and controls on the X-300 CAAS control console.

Clustered buildings with radiation warning lights and evacuation horns extended to other buildings:

- X-326 radiation warning lights and evacuation horns are extended to the X-111A portal.
- X-326 radiation warning lights are extended to the X-111B portal.
- X-330 radiation warning lights are extended to X-614A.
- X-344A radiation warning lights and evacuation horns are extended to X-342B, X-344B, and X-344H.
- X-700 radiation warning lights and evacuation horns are extended to X-701D.
- X-705 radiation warning lights and evacuation horns are extended to X-705D.
- X-710 radiation warning lights and evacuation horns are extended to X-710B.
- X-720 radiation warning lights and evacuation horns are extended to X-720C.
- X-770 radiation warning lights and evacuation horns are extended to X-600D and X-600B.
- X-7725 radiation warning lights and evacuation horns are extended to X-6614J, X-7727H, and X-7726.

* X-7725 clusters provide coverage for X-7745R. X-7745R has no evacuation horns or warning lights. Notification to be provided by Plantsite radio communications. X-7725 and X-7745R are not leased facilities.

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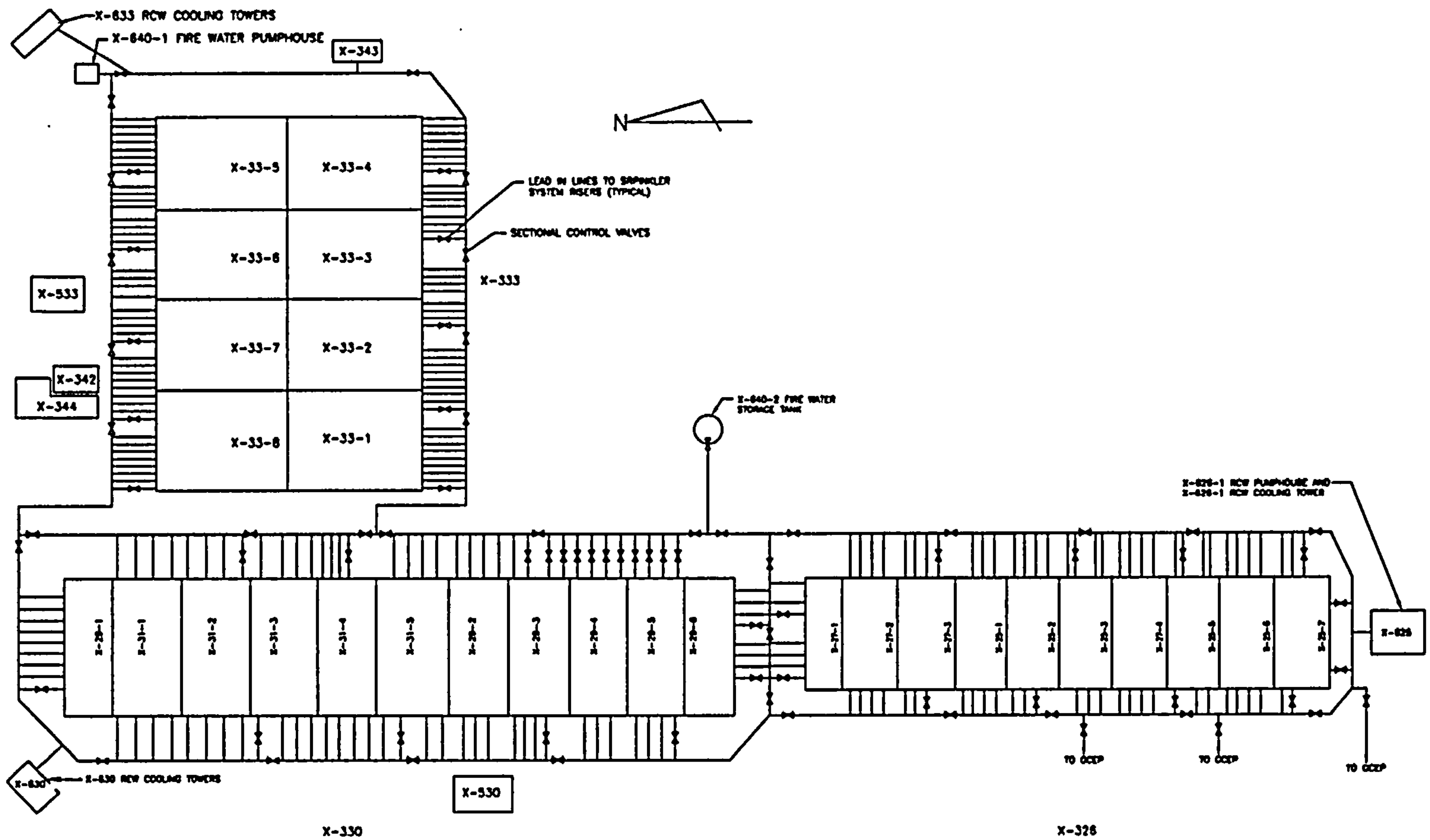

Figure 3.6-1 High Pressure Fire Water System Distribution Piping and Identification

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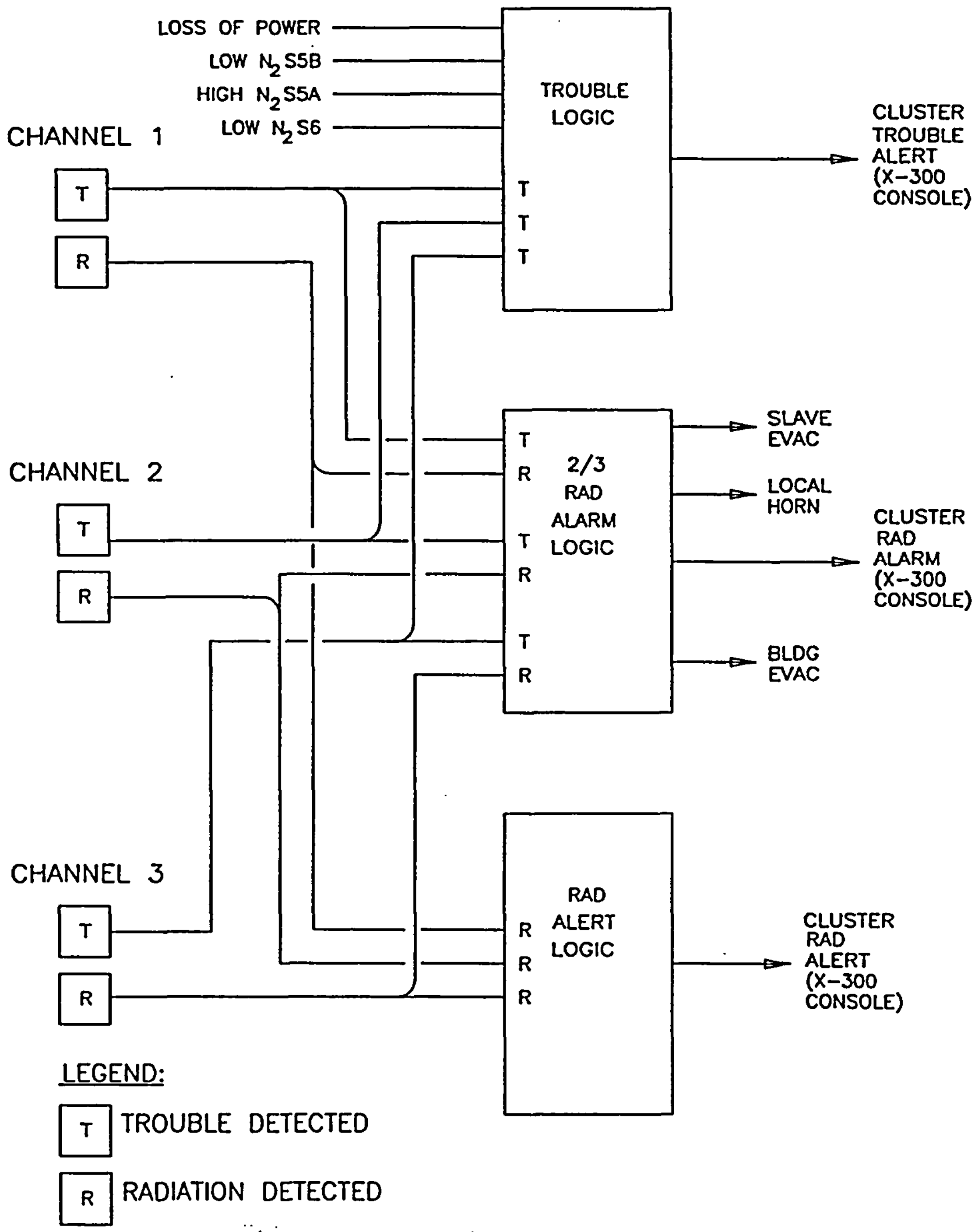

Figure 3.6-2 Logic Diagram of Cluster Alarm and Alert Functions

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3.6-2

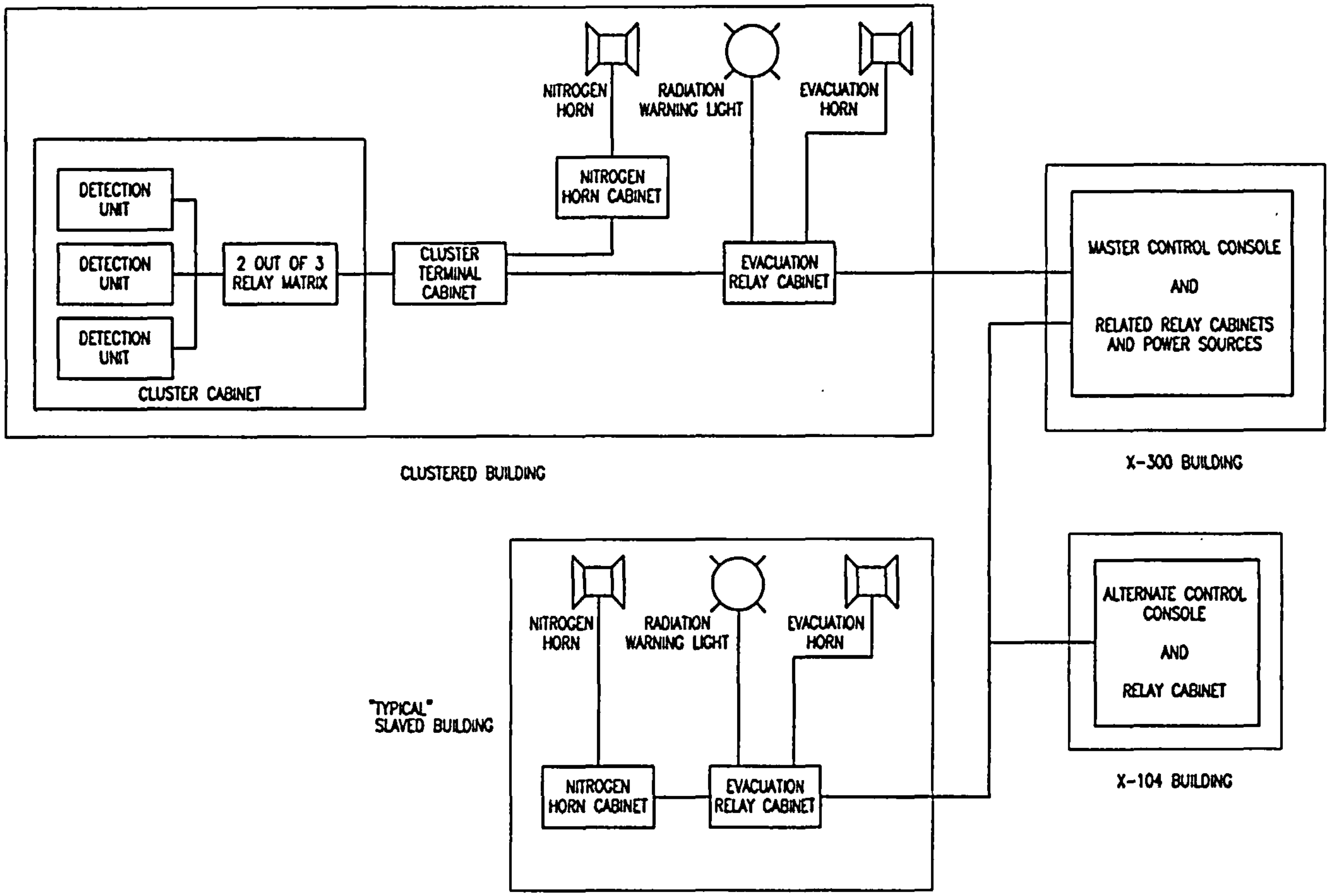

Figure 3.6–3 Simplified Schematic of the CAAS

3.7 HEU AND MEU ACTIVITIES

3.7.1 Description

The Regulatory Approach for Post NRC Certification of Gaseous Diffusion Plants (JW Parks to GP Rifakes, October 11, 1995), DOE will retain regulatory authority over HEU, except for residual HEU that is held up in equipment subsequent to DOE HEU cleanout performed as part of the HEU suspension project and Category III quantities (or less) of other HEU (these small quantities of HEU may be handled incidental to general enrichment activities).

The Fundamental Nuclear Materials Control Plan, submitted as part of this SAR and the associated programs and plans, describes the accounting methods for HEU activities.

As a part of the normal operation of the gaseous diffusion process, cells are treated with oxidant gases to remove deposits of uranyl fluoride and other compounds from the cascade equipment surfaces in a manner described in Section 3.1.1.12. Generally, these treatments liberate a few hundred to several thousand grams of uranium from deposits. The treatment gases, including any uranium liberated from deposits as UF_6, are evacuated to surge drums and then returned to the enrichment cascade at a point near its origin.

Cell treatment may result in the liberation of small quantities of residual HEU that was left in USEC process equipment following completion of the DOE cleanup process. This may occur at any point during the remaining operational life of the enrichment cascade. The liberated HEU material will mix with the LEU material in the process equipment and surge drums and the treatment gases will be returned to the cascade, where it will be mixed with the much larger quantities of uranium present in the interstage flow at LEU enrichments. This process ensures that the blended stream remains within the ^{235}U possession limits defined in Table 1-3. Analysis of uranium enrichment is not performed prior to returning the mixtures to the cascade. Any changes in uranium inventory due to "recovery" of the relatively small amounts of HEU would be reflected in USEC's enrichment cascade Inventory Difference (ID) during periodic inventories.

In addition to the HEU downblending activities, there may be occasions when equipment or components removed from the LEU cascade, X-705 Building or other leased areas contain uranium greater than USEC's possession limits due to the presence of material left from previous DOE operations. This includes equipment or components in the X-326 facility that need to be removed for maintenance or other operational purposes and contain retained inventory of UF_6 plated out on the inside surfaces (includes both shutdown and operating equipment in the X-326 facility); material and equipment such as alumina traps, seal exhaust oil and GP containers from always-safe vacuums that are generated as part of ongoing operations in X-326, or equipment in X-705 that needs to be removed for maintenance purposes. On those occasions when material is discovered in uninstalled equipment in any USEC-leased and NRC-certified area of the PORTS plant that exceeds USEC's possession limits, the PORTS NRC Resident Inspector will be notified of the situation; and the equipment, components, or items will be moved to a DMSA within seven days after removal for storage or further processing. Equipment and components may subsequently be disassembled and decontaminated in an area in the X-705 Building which is placed temporarily under DOE regulation with appropriate safeguards in place (see the description of the process in Section 3.7.2). Material removed which exceeds USEC's possession limits will be retained by DOE or will be blended with LEU solution until the overall enrichment is less than USEC's possession limits. DOE regulation and associated safeguards will cease to be applied when material equal to or greater than USEC's possession limits is no longer present. The blended-down solution would be processed through uranium recovery as described above. While the X-705 area is temporarily converted to DOE regulation, access to the DOE regulated areas is controlled in accordance with the DOE Regulatory Oversight Agreement (ROA).

3.7.2 Temporary Conversion of Leased Areas of the X-705 Facility from NRC to DOE Regulation

Temporary conversion of leased areas of the X-705 facility from NRC regulation to DOE regulation will be accomplished as follows:

1. USEC will send a written request to NRC and DOE to temporarily convert an area of X-705 to DOE regulation for a specific activity in order to remain in compliance with USEC's possession limits. This notification will include a description of the work planned to be done, why USEC's possession limits may be exceeded if the work was done under NRC regulation, anticipated start and end dates for the temporary conversion, and a justification that NRC regulated activities will not be impacted by the temporary conversion.

2. USEC will receive written approval from NRC and DOE to proceed with temporary conversion to DOE ROA regulation prior to beginning the work activity, along with the approved start and end dates.

3. USEC will complete the subject activity (or suspend the activity if an unacceptable impact on other NRC activities have been identified) and then perform a static special inventory and a security sweep of the specific area to provide a high degree of assurance that materials are not present that would cause USEC to exceed its possession limits after conversion to NRC regulation.

4. USEC will notify NRC and DOE in writing that the activity is complete (or has been suspended if an unacceptable impact on other NRC regulated activities has been identified), that USEC requests conversion to NRC regulation, and that converting the area to NRC regulation will not result in USEC exceeding it possession limits.

5. DOE will notify NRC and USEC in writing of any open findings or issues related to the subject area of the facility to NRC, and that DOE agrees with the conversion to NRC regulation.

6. DOE and NRC will agree to a date when all regulatory authority will convert from DOE regulation to NRC regulation, and NRC will notify USEC and DOE of this date in writing.

7. The area will convert to NRC regulation on the date specified by NRC.

3.7.3 Organization and Responsibilities

When HEU quantities greater than Category III are eliminated from PORTS (other than residual holdup that may be encountered during cell treatment and equipment removal described in Section 3.7.1 above), NRC will be the regulator for the entire USEC operated site and the DOE Regulatory Oversight Agreement (ROA) will expire. However, should remaining quantities of HEU or MEU greater than Category III be physically removed from USEC equipment subsequent to expiration of the DOE ROA, the material will be the responsibility of DOE.

The DOE ROA will cease to apply to all facilities or activities for which NRC assumes regulatory authority. This may occur on the entire site or on a facility, area, or activity basis. The DOE ROA will continue to be used for regulation after NRC certification for leased uncertified facilities, areas or activities after NRC assumes regulatory oversight. Such activities include the movement of HEU along USEC leased roadways.

The boundaries between DOE and NRC regulation will not coincide with the USEC/DOE lease during the transition period (HEU activities after NRC certification) from DOE to NRC oversight. The boundaries where the DOE ROA will apply after initial NRC certification of PORTS are described in the SAR and the associated programs and plans and the DOE Compliance Plan.

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