Tables

This page intentionally left blank.

Table 11.3-1. Inventory of Radionuclides for the Decanning Unit

Table 11.3-2. Inventory of Radionuclides for the Milling Unit

Table 11.3-3. Inventory of Radionuclides for the Recanning Unit

Table 11.3-4. Inventory of Radionuclides for the Dissolution Unit during PDCF Operations

Table 11.3-4 (continued). Inventory of Radionuclides for the Dissolution Unit during AFS Operations

Table 11.3-5. Inventory of Chemicals for the Dissolution Unit during PDCF Operations

Table 11.3-5 (continued). Inventory of Chemicals for the Dissolution Unit during AFS Operations

Table 11.3-6. Inventory of Radionuclides for the Dechlorination and Dissolution Unit during PDCF Operations

Table 11.3-6 (continued). Inventory of Radionuclides for the Dechlorination and Dissolution Unit during AFS Operations

Table 11.3-7. Inventory of Chemicals for the Dechlorination and Dissolution Unit during PDCF Operations

Table 11.3-7 (continued). Inventory of Chemicals for the Dechlorination and Dissolution Unit during AFS Operations

Table 11.3-8. Inventory of Radionuclides for the Purification Cycle when 0.73 g/L of U at Process Inlet (case 1)

Table 11.3-8 continued). Inventory of Radionuclides for the Purification Cycle when 0.73 g/L of U at Process Inlet (case 1)

Table 11.3-8 (continued). Inventory of Radionuclides for the Purification Cycle when 5 g/L of U with 30% of Enriched

(Case 2)

Table 11.3-8 (continued). Inventory of Radionuclides for the Purification Cycle when 5 g/L of U with 30% of Enriched

(Case 2)

Table 11.3-8 (continued). Inventory of Radionuclides for the Purification Cycle when 34 g/L of U with 5% of Enriched Uranium at Process Inlet (case 3)

Table 11.3-8 (continued). Inventory of Radionuclides for the Purification Cycle when 34 g/L of U with 5% of Enriched Uranium at Process Inlet (Cease 3)

Table 11.3-9. Inventory of Chemicals for the Purification Cycle when 0.73 g/L at Process Inlet (case 1)

Table 11.3-9 (continued). Inventory of Chemicals for the Purification Cycle when 0.73 g/L at Process Inlet (case 1)

Table 11.3-9 (continued). Inventory of Chemicals for the Purification Cycle when 5 g U/L (30% enriched U) at KPA inlet (case 2)

Table 11.3-9 (continued). Inventory of Chemicals for the Purification Cycle when 5 g U/L (30% enriched U) at KPA inlet (case 2)

Table 11.3-9 (continued). Inventory of Chemicals for the Purification Cycle when 34 g U/L (5% enriched U) at KPA inlet (case 3)

Table 11.3-9 (continued). Inventory of Chemicals for the Purification Cycle when 34 g U/L (5% enriched U) at KPA inlet (case 3)

Table 11.3-10. Process Flows – Purification Cycle

Table 11.3-11. Inventory of Radionuclides for the Solvent Recovery Cycle

Table 11.3-12. Inventory of Chemicals for the Solvent Recovery Cycle

Table 11.3-13. Process Flows – Solvent Recovery Cycle

Table 11.3-14. Inventory of Radionuclides for the Oxalic Precipitation and Oxidation Unit

Table 11.3-15. Inventory of Chemicals for the Oxalic Precipitation and Oxidation Unit

Table 11.3-16. Process Flows – Oxalic Precipitation and Oxidation Unit

Table 11.3-17. Inventory of Radionuclides for the Homogenization Unit

Table 11.3-18. Inventory of Radionuclides for the Canning Unit

Table 11.3-19. Inventory of Radionuclides for the Oxalic Mother Liquor Recovery Unit

Table 11.3-20. Inventory of Chemicals for the Oxalic Mother Liquor Recovery Unit

Table 11.3-21. Process Flows – Oxalic Mother Liquor Recovery Unit

Table 11.3-22. Inventory of Radionuclides for the Acid Recovery Unit during PDCF Operations

(Evaporator EV2000 Concentration Factor: 78)

Table 11.3-22 (continued). Inventory of Radionuclides for the Acid Recovery Unit during AFS Operations

(Evaporator EV2000 Concentration Factor: 50)

Table 11.3-23. Inventory of Chemicals for the Acid Recovery Unit during PDCF Operations

(Evaporator EV2000 Concentration Factor: 78)

Table 11.3-23 (continued). Inventory of Chemicals for the Acid Recovery Unit during AFS Operations

(Evaporator EV2000 Concentration Factor: 50)

Table 11.3-24. Process Flows – Acid Recovery Unit

Table 11.3-25. Inventory of Radionuclides for the Offgas Treatment Unit

Table 11.3-26. Inventory of Chemicals for the Offgas Treatment Unit

[

]

Table 11.3-27. Process Flows – Offgas Treatment Unit

Table 11.3-28. Inventory of Radionuclides for the Liquid Waste Reception Unit during PDCF Operations

Table 11.3-28 (continued). Inventory of Radionuclides for the Liquid Waste Reception Unit during PDCF Operations

Table 11.3-28 (continued). Inventory of Radionuclides for the Liquid Waste Reception Unit during AFS Operations

Table 11.3-28 (continued). Inventory of Radionuclides for the Liquid Waste Reception Unit during AFS Operations

Table 11.3-29. Inventory of Chemicals for the Waste Disposal Unit – Stripped Uranium Liquid Waste

Note 1: The number of moles is not specified.

Table 11.3-29 (continued). Inventory of Chemicals for the Waste Disposal Unit – High-Alpha Liquid Waste

Note: 1. The number of moles is not specified.

Table 11.3-29 (continued). Inventory of Chemicals for the Waste Disposal Unit – Low Low Level Liquid Waste – Drip Trays / Floor Drains

Table 11.3-29 (continued). Inventory of Chemicals for the Waste Disposal Unit – Low Low Level Liquid Waste

Table 11.3-30. Process Flows – Liquid Waste Reception

High Alpha Waste Stream

	~~5~~	
	~~63~~	

Stripped Uranium Waste Stream

Low Level Solvent Waste Stream

Low Low Level Liquid Waste Stream

(1) Waste is produced only when processing AFS with chlorides. Volume based on diluting the chloride waste with rinsing water and distillate to less than 0.15 g/l chloride to meet ETF WAC.

(2) Based on 80% of maximum quantity.

Table 11.3-31. Inventory of Radionuclides for the Uranium Oxide Dissolution Unit

Table 11.3-32. Inventory of Chemicals for the Uranium Oxide Dissolution Unit

Table 11.3-33. Process Flows – Uranium Oxide Dissolution Unit

Table 11.3-34. Sampling System Classification

Table 11.3-35. Chemical Impurities of Plutonium Oxide Feed Material

(PDCF type)

Chemical Component	Maximum Content (µg/g Pu)	Maximum Exceptional Content (µg/g Pu)	Chemical Component	Maximum Content (µg/g Pu)	Maximum Exceptional Content (µg/g Pu)
Ag	NA	10,000	Nb	100	3,500
Al	150	10,000	Ni	200	2,500
B	100	1,000	P	200	1,000
Be	100	2,500	Pb	200	1,000
Bi	100	1,000	S	250	1,000
C	500	1,500	Si	200	200
Ca	500	10,000	Sm	2	1,000
Cd	10	1,000	Sn	100	2,500
Cl	(+ F < 250)	500	Ti	100	2,500
Co	100	10,000	Th	100	100
Cr	100	500	V	300	2,500
Cu	100	500	W	200	2,500
Dy	1	1,000	Zn	100	1,000
Eu	1	1,000	Zr	50	1,000
F	(+ Cl < 250)	350	Boron Equivalent	Not applicable	
Fe	500	2,500	Total Impurities	18,837	
Ga	12.000	12,500			
Gd	3	250			
In	20	1,000			
K	150	10,000			
Li	400	10,000			
Mg	500	10,000			
Mn	100	1,000			
Mo	100	1,000			
N	400	400			
Na	300	10,000			

Table 11.3-36. Chemical Impurities of Plutonium Oxide Feed Material

(AFS)

Chemical Component	Maximum Content for most (~75%) of Items (μg/g Pu)	Maximum Content exceeded only by 2% of Items (μg/g Pu)	Chemical Component	Maximum Content for most (~75%) of Items (μg/g Pu)	Maximum Content exceeded only by 2% of Items (μg/g Pu)
Ag	NA	10,000	I	NA	100
Al	4,000	15,000	In	20	2,500
Am	7,000 (100% ^{241}Am)	7,000 (100% ^{241}Am)	K	220,000	(Ca + K +Mg + Na) ≤ 40% Net weight
As	NA	100	La	NA	5,000
Au	NA	100	Li	5,000	10,000
B	100	1,000	Mg	70,000	(Ca + K +Mg + Na) ≤ 40% Net weight
Ba	5,000	10,000	Mn	1,000	2,000
Be	100	5,000	Mo	100	(Mo + Zr) < 5,000
Bi	1,000	1,000	N	400	5,000
C	2,000	10,000	NO_3	NA	5,000
Ca	120,000	(Ca + K +Mg + Na) ≤ 40% Net weight	Na	130,000	(Ca + K +Mg + Na) ≤ 40% Net weight
Cd	1,000	1,000	Nb	100	3,500
Ce	NA	500	Ni	5,000	15,000
Cl	200,000	330,000	Np	500	1,000
Co	5,000	10,000	P	1,000	(P + S) ≤ 10,000
Cr	3,000	8,000	Pb	200	5,000
Cu	500	3,000	Pd	NA	100
Dy	NA	NA	Pt	NA	100
Er	NA	500	Rb	100	5,000
Eu	NA	NA	S	330	(P + S) ≤ 10,000
F	1,000	7,000	SO_4	1,000	(P + S) ≤ 10,000
Fe	5,000	18,000	Sb	NA	100
Ga	12,000	15,000	Si	5,000	10,000
Gd	250	250	Sm	NA	NA
Ge	NA	100	Sn	1,000	10,000
Hf	50	1,000	Sr	5,000	10,000
Hg	NA	100	Ta	4,000	10,000

Table 11.3-36. (continued) Chemical Impurities of Plutonium Oxide Feed Material (AFS)

Chemical Component	Maximum Content for most (~75%) of Items (µg/g Pu)	Maximum Content exceeded only by 2% of Items (µg/g Pu)	Chemical Component	Maximum Content for most (~75%) of Items (µg/g Pu)	Maximum Content exceeded only by 2% of Items (µg/g Pu)
Ti	100	3,000	V	300	1,000
Th	100	300	W	4,000	10,000
Tl	NA	100	Y	200	10,000
Enriched U (EU)	EU ≤ 30% Net weight	EU ≤ 30% Net weight Annual max. value: 50 kg (^{235}U: 93.2%)	Zn	1,000	10,000
Depleted U (DU), Natural U (NU)	[TBD]	500,000	Zr	50	(Mo + Zr) ≤ 5,000

Table 11.3-37. Radionuclide Impurities of Plutonium Oxide Feed Material

PDCF Type

Impurity	Isotope	Maximum content µg/g Pu
Americium	^{241}Am: 100 %	7,000 µg/g Pu
Uranium	^{235}U: 93.2 %	Standard value: 5,000 µg/g Pu Maximum value: 20,000 µg/g Pu for 10 % of the delivered cans during one year Annual maximum value: 17 kg

AFS Type

Impurity	Isotope	Maximum content
Americium	^{241}Am: 100 %	11,000 µg/g Pu
Enriched Uranium	^{235}U: 93.2 %	Maximum value: 30% of can net weight Annual maximum value: 50 kg
Depleted Uranium and Natural Uranium	^{235}U: 93.2 %	Maximum value: 42% of can net weight (with 5% of Enriched Uranium)

Figures

This page intentionally left blank.

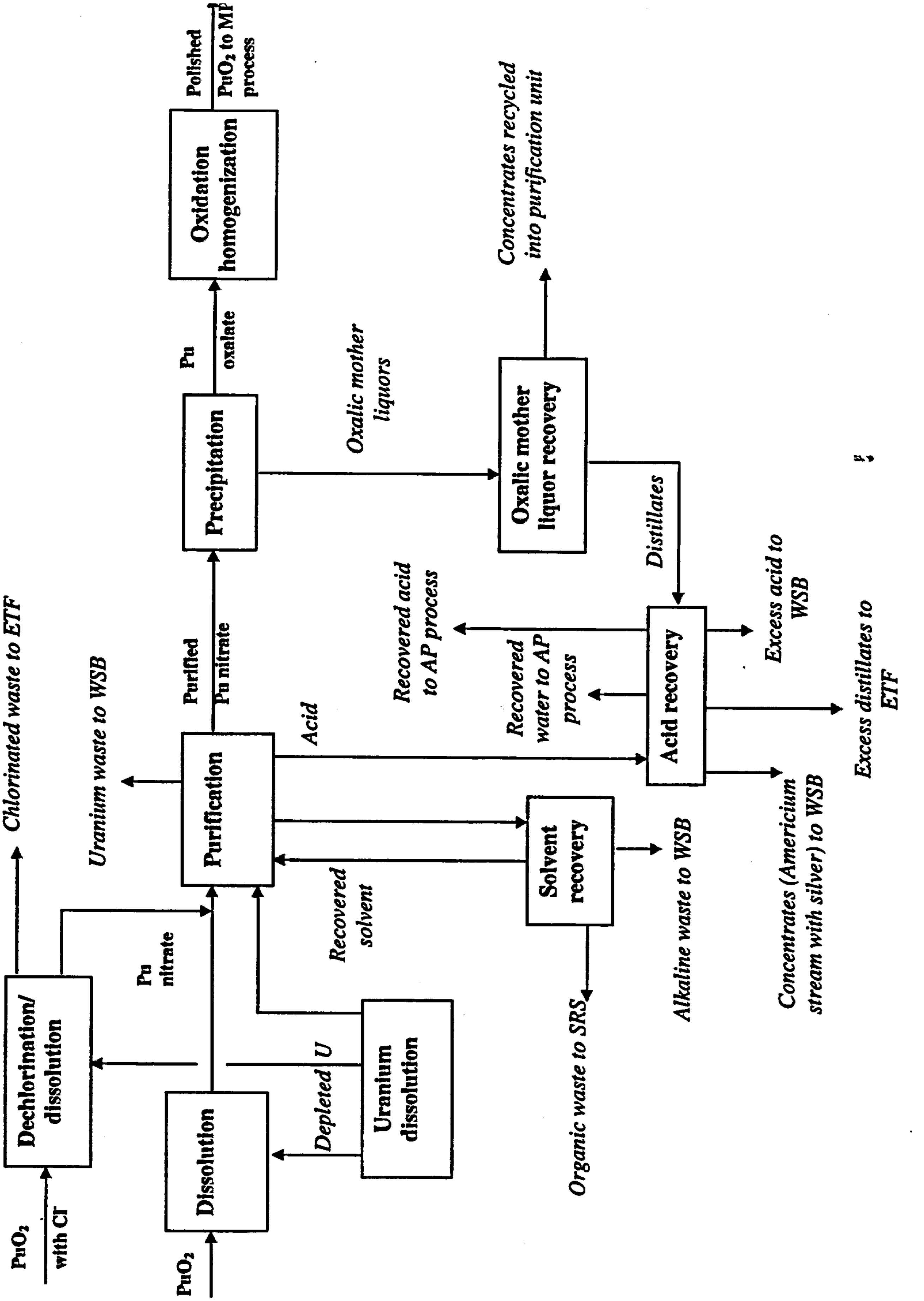

Figure 11.3-1. AP Process Overview

This page intentionally left blank.

Figure 11.3-2. General Flow Diagram

This page intentionally left blank.

Figure 11.3-3. Schematic of the Decanning Unit

This page intentionally left blank.

Figure 11.3-4. Schematic of the Milling Unit

This page intentionally left blank.

Figure 11.3-5. Schematic of the Recanning Unit

This page intentionally left blank.

Figure 11.3-6. Schematic of the Dissolution Unit

This page intentionally left blank.

Figure 11.3-6. Schematic of the Dissolution Unit (continued)

This page intentionally left blank.

Figure 11.3-7. Drawing of the Electrolyzer

This page intentionally left blank.

Figure 11.3-8. Schematic of the Dechlorination and Dissolution Unit

This page intentionally left blank.

Figure 11.3-8. Schematic of the Dechlorination and Dissolution Unit (continued)

This page intentionally left blank.

Figure 11.3-9. Purification Cycle Unit

This page intentionally left blank.

Figure 11.3-9. Purification Cycle Unit (continued)

This page intentionally left blank.

Figure 11.3-10. Pulsed Column

This page intentionally left blank.

Figure 11.3-11. Solvent Recovery Cycle

This page intentionally left blank.

Figure 11.3-11. Solvent Recovery (continued)

This page intentionally left blank.

Figure 11.3-12. Mixer-Settler

This page intentionally left blank.

Figure 11.3-13. Oxalic Precipitation Unit

This page intentionally left blank.

Figure 11.3-13. Oxalic Precipitation Unit (continued)

This page intentionally left blank.

Figure 11.3-14. Precipitator

This page intentionally left blank.

Figure 11.3-15. Rotating filter

This page intentionally left blank.

Figure 11.3-16. Furnace

This page intentionally left blank.

Figure 11.3-17. Homogenization Unit

This page intentionally left blank.

Figure 11.3-17. Homogenization Unit (continued)

This page intentionally left blank.

Figure 11.3-18. Separating Hopper

This page intentionally left blank.

Figure 11.3-19. Canning Unit

This page intentionally left blank.

Figure 11.3-20. Oxalic Mother Liquor Recovery Unit

This page intentionally left blank.

Figure 11.3-20. Oxalic Mother Liquor Recovery Unit (continued)

This page intentionally left blank.

Figure 11.3-21. Evaporator

This page intentionally left blank.

Figure 11.3-22. Acid Recovery Unit

This page intentionally left blank.

Figure 11.3-22. Acid Recovery Unit (continued)

This page intentionally left blank.

Figure 11.3-23. Off-gas Treatment Unit

This page intentionally left blank.

Figure 11.3-23. Off-gas Treatment Unit (continued)

This page intentionally left blank.

Figure 11.3-24. Liquid Waste Reception Unit - High Alpha Wastes

This page intentionally left blank.

Figure 11.3-25. Liquid Waste Reception Unit - Low Level Wastes

This page intentionally left blank.

Figure 11.3-26. Liquid Waste Reception Unit – Stripped Uranium Wastes

This page intentionally left blank.

Figure 11.3-27. Uranium Dissolution Unit

This page intentionally left blank.

Figure 11.3-27. Uranium Dissolution Unit (continued)

This page intentionally left blank.

11.4 HVAC SYSTEMS AND CONFINEMENT

The MFFF HVAC systems and confinement principles are discussed in this section. The MFFF HVAC systems are designed to maintain radioactive material within process units and process enclosures, preventing the dispersal of radioactive material. In addition, these systems maintain required design temperatures during normal operations and design basis events.

Confinement of radioactive material is provided by the use of static barriers, generally in conjunction with dynamic systems. Gloveboxes and process enclosures provide static confinement barriers while the HVAC systems provide dynamic confinement. The static and dynamic systems are closely integrated to provide multiple layers of protection against the release of radioactive material.

The safety functions of the principal SSCs associated with these systems are discussed in Chapter 5. The design of the HVAC systems and confinement for the MFFF is consistent with the criteria and design guidance provided in Regulatory Guide 3.12, *General Design Guide for the Ventilation System of Plutonium Processing and Fuel Preparation Plants*. One noted exception to this Regulatory Guide is that there are no adsorbers in the filter lines therefore the heaters and water mist spray for fire protection of final HEPA filters are not required.

The following subjects are discussed in this section:

- Confinement principles
- MOX Fuel Fabrication Building HVAC systems
- Emergency Generator Building HVAC systems
- Standby Generator Building HVAC systems
- Safe Haven HVAC systems
- Reagent Processing Building HVAC systems
- Static barriers
- Fire protection and confinement
- Final filtration units and analysis
- Design basis for non-principal SSCs
- Design basis for principal SSCs.

11.4.1 Confinement Principles

This section provides a general description of the confinement principles used in the MOX Fuel Fabrication Building.

11.4.1.1 Function

The function of MFFF confinement and related systems is to control and prevent the dispersal of radioactive material.

11.4.1.2 Description

Confinement of radioactive material is provided by dividing the MOX Fuel Fabrication Building into multiple zones, with each zone based on different potentials for contamination. Confinement of radioactive material is provided by combining various static confinement barriers (e.g., vessels, gloveboxes, fuel rod cladding, and process rooms with dynamic confinement through the corresponding HVAC system). Static barriers effectively preclude leakage out of a confinement boundary. The associated dynamic confinement maintains a negative pressure with respect to the adjacent areas such that leakage air flows from zones of the lowest contamination risk to zones of increasing contamination risk. In those cases in which dynamic confinement is not utilized in conjunction with static confinement, confinement barriers are provided by sealed systems (e.g., 3013 containers and fuel rods). Confinement is the principal protection against the dispersal of radioactive material.

The MOX Fuel Fabrication Building uses three confinement levels to provide confinement of nuclear material: primary, secondary, and tertiary confinement. Each confinement level consists of static barriers and dynamic HVAC systems. The multiple levels of confinement are the basis for the division of the MOX Fuel Fabrication Building into confinement zones (i.e., C1, C2, C3, and C4 or process cells). Pressure gradients between zones ensure that leakage air flows from the zones of lowest contamination risk to zones of increasing contamination risk. For example, the contamination risk in C3 zones is higher than in C2 zones. Figures 11.4-1 and 11.4-2 provide graphical representations of the confinement philosophy for the MP and AP Areas, respectively.

Primary confinement mainly consists of process equipment, gloveboxes, and vessels containing radioactive material, rods, and 3013 canisters. The interior of these enclosures is classified as a C4 zone. Primary confinement SSCs are installed immediately around the radioactive material (see Table 11.4-1) and are intended to prevent dispersal of nuclear material into working areas and the environment. This design allows personnel to move and perform tasks without wearing respiratory protection. Primary confinement includes at least one static confinement barrier. In most cases, primary confinement also includes a corresponding HVAC system (normally the Very High Depressurization Exhaust System) with the exception being welded equipment.

Secondary confinement consists of process rooms, which are designated C3 zones and C2 zones. Secondary confinement SSCs (see Table 11.4-1) provide defense in depth to primary confinement. They provide additional assurance in protecting the environment and the public against an uncontrolled release of radioactive material. Secondary confinement includes static barriers (e.g., walls, floors, and roofs surrounding gloveboxes and process cells), waste drum storage, and the associated HVAC system (normally the High Depressurization Exhaust System).

In the case of welded SSCs (e.g., fuel rods, fuel assemblies, 3013 containers, and process vessels), secondary confinement is not necessary since primary confinement is provided by a sealed and welded barrier. In the case of the fuel rods, the sintered pellets are inserted into the cladding and the seal is welded. Furthermore, the fuel rods and assemblies are the "normal" forms of radioactive material transported to reactor facilities for use. In the case of plutonium oxide, the powder is received in DOE Standard 3013 containers, which consist of a convenience can, a welded inner can, and a welded outer can. The 3013 container provides primary and secondary confinement of the nuclear material.

Tertiary confinement SSCs consist of rooms designated as C2 zones. Tertiary confinement (see Table 11.4-1) includes static barriers (e.g., the walls, floors, and roofs surrounding the remaining portions of the MP and AP Areas) and their associated HVAC systems (normally the Medium Depressurization Exhaust System). Tertiary confinement static barriers provide defense in depth to primary and secondary confinement by minimizing dispersal of radioactive material. Tertiary dynamic confinement provides an additional protection feature for protecting the environment and public.

11.4.1.2.1 Confinement Zones

The MFFF equipment and facility boundaries provide static barriers and are classified into the following confinement zones as shown in Figures 11.4-3 through 11.4-10:

- Process vessels and equipment containing radioactive materials (includes fuel rods and 3013 containers)
- C4 zones, where contamination is inherent to the process (e.g., gloveboxes)
- C3 zones, further subdivided into two subzones:
  - C3b, where contamination risk is moderate (e.g., process rooms containing gloveboxes)
  - C3a, where contamination risk is low (e.g., airlocks to process rooms, rooms containing C3b exhaust HVAC filters)
- Process cells, where the likelihood of contamination is very low (e.g., process rooms containing process vessels)
- C2 zones, where contamination risk is very low (e.g., process rooms containing rods or assemblies, corridors around C3 areas)
- C1 zones, where contamination risk is virtually zero (e.g., areas with an opening to the outside).

11.4.1.2.2 Dynamic Systems

The HVAC systems work with the static confinement barriers by maintaining a negative pressure gradient from the zones of lowest risk toward the zones of increasing risk. The HVAC systems also ensure suitable air filtration prior to atmospheric release.

In the AP and MP Areas, dynamic confinement of C4 confinement enclosures is ensured by the Very High Depressurization Exhaust System. In the AP Area, dynamic confinement of process cells within tertiary confinement is provided by the Process Cell Exhaust System. In the AP and MP Areas, dynamic confinement of C3a and C3b rooms within secondary confinement is provided by the High Depressurization Exhaust System. In the AP and MP Areas, dynamic confinement of C2 rooms within tertiary confinement is provided by the Medium Depressurization Exhaust System. For the AP process cells, the typical cascading sequence of pressure gradients between neighboring zones is as follows:

C1 → C2 → process cells → process vessel

For the AP and MP Areas with gloveboxes containing dispersible material, the typical sequence is as follows:

C1 → C2 → C3a → C3b → C4

In both examples, leakage airflow is from high pressure to low pressure.

11.4.1.2.3 Confinement Zone Interfaces

Static confinement barriers include supplemental provisions around openings (e.g., personnel or equipment access, HVAC ducts) to reduce the risk of contamination leaks. The major interfaces and their supplemental confinement features are as follows:

- **Airlocks** – Airlocks are used for personnel and equipment access from one confinement zone to another. The airlock consists of a minimum-leakage door and is ventilated by the highest adjacent confinement zone.
- **Penetrations for HVAC ducts** – Penetrations have at least one high-efficiency particulate air (HEPA) filter installed at each penetration between C4 and C3 zones or between C3 and C2 zones.
- **Equipment access to gloveboxes** – Equipment is moved into gloveboxes usually via a bag port or an airlock.

11.4.1.3 Major Components

MFFF confinement includes the following dynamic and static SSCs:

- Offgas Treatment Unit (Section 11.3)
- Very High Depressurization Exhaust System (Section 11.4.2.2)
- High Depressurization Exhaust System (Section 11.4.2.3)
- Process Cell Exhaust System (Section 11.4.2.4)
- Medium Depressurization Exhaust System (Section 11.4.2.5)
- Gloveboxes (Section 11.4.7.1)
- DOE Standard 3013 Canisters and Transport Casks (Section 11.4.7.2)
- Fuel rod cladding (Section 11.4.7.6)
- Process vessels, equipment, cells, and rooms (Section 11.3)
- Process equipment (e.g., sintering furnace, inflatable seal) (Section 11.2)
- MOX Fuel Fabrication Building (Section 11.1).

11.4.1.4 Control Concepts

Control concepts are discussed for each of the major components within their respective sections (listed above).

11.4.1.5 System Interfaces

In general, MFFF confinement systems and components (indicated above) interface with each other, with instrumentation and controls, and with normal, standby, and emergency power.

11.4.2 MOX Fuel Fabrication Building HVAC Systems

The MOX Fuel Fabrication Building HVAC systems are shown in Figures 11.4-11 and 11.4-12. The MOX Fuel Fabrication Building HVAC systems maintain differential pressures between confinement zones and maintain an environment suitable for personnel and process operations.

The MOX Fuel Fabrication Building HVAC systems discussed in this section are as follows:

- Offgas Treatment Unit
- Very High Depressurization Exhaust System
- High Depressurization Exhaust System
- Process Cell Exhaust System
- Medium Depressurization Exhaust System
- Supply Air System
- Emergency Control Room Air-Conditioning System
- Truck Bay Ventilation System
- Shipping and Receiving Area Air-Conditioning System.

11.4.2.1 Offgas Treatment Unit

The functions, description, major components, control concepts, and interfaces of the Offgas Treatment Unit are described in Section 11.3.1.13.

11.4.2.2 Very High Depressurization Exhaust System

11.4.2.2.1 Function

The functions of the Very High Depressurization (VHD) Exhaust System are as follows:

- Maintain a negative pressure differential between the C4 (glovebox) and C3 (process room) confinement zones
- Filter contaminants from glovebox exhaust gases/air prior to discharge through the exhaust stack
- Maintain an environment suitable for the manufacturing process.

See Chapter 5 for a list of safety functions.

11.4.2.2.2 Description

The VHD Exhaust System is depicted schematically on Figure 11.4-11. The VHD Exhaust System provides confinement of radioactive materials within the glovebox by maintaining a continuous negative differential pressure between the C4 and C3 confinement zones under normal operating conditions.

During a tornado, the HDE, MDE, POE and HSA systems are shut down during the period when the tornado dampers are closed. The VHD system continues to run against the closed tornado dampers. The HDE, MDE, POE and HSA systems are re-started after the tornado passes.

The glove box atmosphere is exhausted through two stages of HEPA filters at the glovebox boundary, one stage of HEPA filters at the C3 boundary, and two stages of final HEPA filters prior to being discharged to the atmosphere through the MFFF stack, which is continuously monitored. Air or gases supplied to the gloveboxes are supplied through two stages of HEPA filters. The filters on the supply and exhaust of each glovebox are provided to confine radioactive materials within the glovebox as close to the point of origin as practical.

At least one stage of the glove box inlet or exhaust HEPA filtration is testable. The filter design for the glove boxes includes one bag-out type filter housing on the inlet and exhaust with in place testing ports, on the filter housing, to check for proper seating of the filter. This filter housing is on the external stages only. The HEPA filter stage on the inside of the glove box are not tested. All intermediate HEPA filters at the C3 boundaries have the same provisions, as above, for testing. Exhaust flow is maintained by one of four 100%-capacity exhaust fans located downstream of two 100%-capacity final filtration units. The exhaust fans discharge to the MOX Fuel Fabrication Building stack.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air (and gas as applicable) through each glovebox. Fire-rated protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the Very High Depressurization Exhaust System can be tested periodically for operability and required functional performance. Airflow can periodically be measured in the exhaust ducts and at gloveboxes. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

The glovebox exhaust is conveyed through either the normal exhaust duct or the high-capacity exhaust duct to the fans and final filters of the VHD Exhaust System based on the operating mode. The normal exhaust path is used to maintain the environmental requirements of the equipment contained within the glovebox, remove heat, and maintain the operating differential pressure.

A second parallel exhaust duct is used during operation of the high-capacity exhaust flow. It is provided to handle the much higher exhaust flows from a glovebox, if a maximum postulated breach were to occur (one bag port, at 24 in [61 cm] in diameter). Flow in this exhaust duct would occur primarily in the event of a breach of confinement and is initiated by the opening of automatic dump valves. This exhaust path carries the gas flows associated with maintaining a velocity of 125 ft/min (38.1 m/min) through the maximum postulated breach.

The VHD Exhaust System also exhausts the intermittent flows from the discharge of the pneumatic transfer operations in the transfer gloveboxes. This flow is discharged into the high-capacity exhaust duct.

11.4.2.2.3 Major Components

The VHD Exhaust System contains the following major components:

- Four 100%-capacity, variable-speed, centrifugal fans with direct-drive motors.
- Two 100%-capacity final filtration units. The filter trains are described in more detail in Section 11.4.9.1.
- Single-stage intermediate HEPA filters. Filters not located in gloveboxes are installed in stainless bag-in/bag-out housing with differential pressure indicators.

The ductwork upstream of the intermediate HEPA filters for the VHD Exhaust System is welded stainless steel pipe with flanged joints where the ductwork connects to equipment and in-line components. The ductwork downstream of the intermediate filters is welded stainless steel.

11.4.2.2.4 Control Concepts

The variable-speed exhaust fans maintain constant pressure at the inlet to the final filters with respect to atmosphere. The system is designed so that one fan is capable of meeting normal and abnormal flow requirements. The other fans are in standby. The standby fans automatically start upon a trip of the lead exhaust fan or the failure of the system to maintain adequate differential pressure at the inlet to the final HEPA filter units. Pressure-regulating valves at each glovebox maintain the required differential pressure in the glovebox at approximately -1.4 in WG to -2.0 in WG (-298 to -498 Pa). Over- and under-pressure protection is provided at the glovebox. The over- and under-pressure protection is set at approximately -0.8 in WG (-200 Pa) and -3.0 in WG (-746 Pa), respectively ("over-pressure" refers to insufficient depressurization).

The control circuits for the VHD Exhaust System are normally interlocked with the control circuits of the High Depressurization (HD) Exhaust System, Medium Depressurization (MD) Exhaust System, Supply Air System and Process Cell Exhaust System to prevent operation of the ventilation systems unless a VHD Exhaust fan is operating and the system is maintaining adequate differential pressure at the inlet to the VHD final HEPA filter units. This design ensures that the pressure differentials in the gloveboxes and process rooms comprising the C4 and C3 confinement zones maintain a pressure gradient such that C4 zones are maintained more negative than C3 zones.

Differential pressure-indicating switches are provided for each final filter unit and pressure differential indicators are provided for each intermediate filter and glove box filter to provide pressure differential data to operations and maintenance personnel so that filters can be changed out at appropriate times. Flow instrumentation is provided to monitor the system flow rates.

Temperature detectors are provided at the inlet of each final filtration unit to provide a temperature indication and alarm in the event of high temperature in the ductwork.

Nitrogen or dry air is supplied to a glovebox at a constant rate. Nitrogen or dry-air supply is automatically terminated at the over-pressure set point of the glovebox.

Pressure controls are provided to vary the operating fan speed to maintain a constant pressure differential in the glovebox, nominally -1.4 to -2.0 in WG (-298 to -498 Pa) with respect to the process room.

11.4.2.2.5 System Interfaces

Each of the four 100%-capacity exhaust fans is powered from the normal, standby, emergency, and uninterruptible power supplies. The VHD system interfaces with the HD Exhaust System, the MD Exhaust System, the process cell exhaust system and the supply air system to control the differential pressure between the C3 (process room) and C4 (glovebox) confinement zones. The VHD Exhaust System also interfaces with the Nitrogen System, the Instrument Air System (dry air) for glove box ventilation and air operated valves. The pneumatic transfer system, sintering furnace off gas system and the precipitator-calcination unit exhaust discharge into the VHD exhaust duct. The radiation monitoring system (CAMs) sample the VHD exhaust at multiple points within the AP and MP buildings.

11.4.2.3 High Depressurization Exhaust System

11.4.2.3.1 Function

The functions of the HD Exhaust System are as follows:

- Maintain a negative pressure differential between the C3 (process room) confinement zone and the C2 confinement zone
- Ventilate the 3013 can storage area in the C2 confinement zone
- Ventilate the emergency power supply rooms serving the VHD Exhaust System fans and the HD Exhaust System fans in the C2 confinement zone
- Filter contaminants from the exhausted air prior to discharge through the MOX Fuel Fabrication Building exhaust stack
- Maintain an environment suitable for operating personnel.

11.4.2.3.2 Description

The HD Exhaust System is depicted schematically on Figure 11.4-11. The HD Exhaust System provides confinement of radioactive materials within the process rooms by maintaining a continuous negative differential pressure between the C3 and C2 confinement zones. The rooms in the C3 confinement zone consist largely of process rooms containing gloveboxes.

The process room air is exhausted through one stage of HEPA filters as close to the C3 boundary as practical and two stages of final HEPA filters prior to being discharged to the atmosphere through the MFFF stack. Air is supplied to the process rooms through one stage of HEPA filters. The filters on the supply and exhaust of the process rooms are provided to confine radioactive materials within the process room as close to the point of origin as practicable.

Exhaust flow is maintained by one of two 100%-capacity exhaust fans located downstream of two 100%-capacity final filtration units. The exhaust fans discharge to the MOX Fuel Fabrication Building exhaust stack.

All HEPA filters at the C3 boundaries have in place testing ports, on the filter housing, to check for proper seating of the filter.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air through each room. Fire-rated protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the HD Exhaust System can be tested periodically for operability and required functional performance. Airflow can periodically be measured in the exhaust ducts and at gloveboxes. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

The system provides sufficient exhaust air, when operated with the emergency air supply of the Supply Air System, to maintain the temperature in the 3013 can storage areas and the emergency power supply rooms at or below the maximum design temperature.

Air is supplied uniformly, as high in the room as practicable, to provide a low velocity flow over the glovebox. The air is exhausted near the floor through grilles or registers. This flow pattern sweeps contaminants from the areas surrounding the operator's access points, minimizing possible contamination.

Battery rooms served by this system are ventilated to prevent the build up of explosive levels of hydrogen. The ventilation rate is a minimum of two air changes per hour in accordance with NFPA -111 and limit hydrogen accumulation to less than 2% of the room volume in accordance with IEEE 484. A standby exhaust fan is provided for all battery rooms.

The ventilation system and gloveboxes ensure that the airborne concentration in occupied operation areas remains well below the limits of 10 CFR Part 20. Continuous air monitors (CAMs) are placed in radiation areas to monitor potential airborne radioactive contaminants and to warn workers by alarming in the event of unsafe conditions. Personnel located at workstations where there is an increased inhalation risk are continuously monitored with mobile CAM heads, as appropriate, while coverage of general workplaces is provided by general area CAMs. Chapter 9 provides more details concerning the radiation protection program.

11.4.2.3.3 Major Components

The HD Exhaust System contains the following major components:

- Two 100%-capacity, variable-speed, centrifugal fans with direct-drive motors.
- Two 100%-capacity final filtration units. The filter trains are described in more detail in Section 11.4.9.1.
- Single-stage intermediate HEPA filters. Filters are located in stainless bag-in/bag-out housing with differential pressure indicators.

The ductwork upstream of the final HEPA filter units is welded stainless steel with flanged joints where the ductwork connects to equipment and in-line components. Ductwork downstream of the final HEPA filter units is welded galvanized steel.

11.4.2.3.4 Control Concepts

The variable-speed exhaust fans maintain constant pressure at the inlet to the final filters with respect to the atmosphere. The system is designed so that one fan is capable of meeting normal and abnormal flow requirements. The other fan is in standby. The standby fan automatically starts upon loss of negative pressure at the final filter housing

The control circuits for the HD Exhaust System are normally interlocked with the control circuits of the VHD Exhaust System, MD Exhaust System, and Supply Air System to prevent operation of the ventilation systems unless the VHD Exhaust System is operating. This design ensures that the C4, C3, and C2 confinement zones maintain a pressure gradient from the highest to lowest pressure such that the C4 zone is maintained more negative than the C3 confinement zone, which is maintained more negative than the C2 confinement zone.

Flow instrumentation is provided downstream of each exhaust fan to monitor the system flow rates. Temperature detectors are provided in the ductwork upstream of each final filtration unit to provide an alarm in the event of high temperature in the ductwork. Pressure controls are provided to vary the operating fan speed to maintain a constant pressure differential in the process rooms, nominally -0.6 to -0.75 in WG (-124 to -180 Pa), with respect to the atmosphere.

11.4.2.3.5 System Interfaces

The HD exhaust fans are powered from the normal, standby, and emergency power supplies. The system interfaces with the VHD Exhaust System, the MD Exhaust System and the Supply Air System.

11.4.2.4 Process Cell Exhaust System

11.4.2.4.1 Function

The functions of the Process Cell Exhaust System are as follows:

- Maintain a negative pressure differential between the process cell confinement zone and the C2 confinement zone
- Filter contaminants from process cell exhaust air prior to discharge through the exhaust stack
- Maintain an environment suitable for the manufacturing process.

11.4.2.4.2 Description

The Process Cell Exhaust System is depicted schematically on Figure 11.4-11. The Process Cell Exhaust System provides confinement of radioactive materials within the process cell by maintaining a continuous negative differential pressure between the process cell and the C2 confinement zones.

The system exhausts air from the process cells in the AP Area, rooms that are not normally accessible and contain welded process equipment (all welded fittings). Air is supplied near the ceiling and removed near the floor (above the level of potential liquid spills).

Exhaust flow is maintained by one of two 100%-capacity exhaust fans located downstream of two 100%-capacity final filtration units. The exhaust fans discharge to the MOX Fuel Fabrication Building exhaust stack.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air through each cell. Fire-rated isolation dampers or other protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the Process Cell Exhaust System can be tested periodically for operability and required functional performance. Airflow can periodically be measured in the exhaust ducts. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

11.4.2.4.3 Major Components

The Process Cell Exhaust System contains the following major components:

- Two 100%-capacity, variable-speed, centrifugal fans with direct-drive motors.
- Two 100%-capacity final filtration units. The filter trains are described in more detail in Section 11.4.9.1.

The ductwork in the Process Cell Exhaust System upstream of the final HEPA filter units is welded stainless steel. The ductwork downstream of the final HEPA filter housings is welded galvanized steel.

11.4.2.4.4 Control Concepts

The variable-speed exhaust fans maintain constant pressure at the inlet to the final filters with respect to the atmosphere. The system is designed so that one fan is capable of meeting normal and abnormal flow requirements. The other fan is in standby. The standby fan automatically starts upon loss of negative pressure at the final filter housing.

The control circuits for the Process Cell Exhaust System are normally interlocked with the control circuits of the VHD Exhaust System to allow a permissive start. Failure of the Process Cell Exhaust System stops the Supply Air System to prevent reverse flow conditions. Failure of the Process Cell Exhaust System does not result in a condition adversely effecting safety.

Flow instrumentation is provided downstream of each exhaust fan to monitor the system flow rates. Temperature detectors are provided in the ductwork upstream of each final filtration unit to provide an alarm in the event of high temperature in the ductwork. Pressure controls are provided to vary the operating fan speed to maintain a constant pressure differential in the process cells, nominally -0.72 to -0.88 in WG (-180 to -220 Pa), with respect to the atmosphere.

11.4.2.4.5 System Interfaces

The process cell exhaust fans are powered from the normal and standby power supplies. The system interfaces with the VHD Exhaust System.

11.4.2.5 Medium Depressurization Exhaust System

11.4.2.5.1 Function

The functions of the MD Exhaust System are as follows:

- Maintain a negative pressure differential between the C3 (process room) and C2 confinement zone
- Filter contaminants from the exhaust air prior to discharge through the exhaust stack
- Maintain an environment suitable for operating personnel
- Provide a common exhaust stack for discharge of process vents and ventilation exhaust.

11.4.2.5.2 Description

The MD Exhaust System is depicted schematically on Figure 11.4-11. The MD Exhaust System provides confinement of radioactive materials within the MOX Fuel Fabrication Building by maintaining a continuous negative differential pressure between the C2 and C1 (environment) confinement zones.

The system exhausts air from rooms in the MOX Fuel Fabrication Building designated as C2 confinement areas, except those rooms requiring cooling during emergency operation. The rooms in the C2 confinement zone consist largely of process unit control rooms, electrical rooms, and manufacturing process rooms for operations associated with the following: 3013 container receiving, unpacking, and nondestructive assay activities; rod storage and inspection; assembly mounting, inspection, and storage; and fuel cask loading.

Exhaust flow is maintained by one of two 100%-capacity exhaust fans located downstream of the final filtration units. Sufficient spare filtration units are provided to permit removal of one unit for service and testing while maintaining 100% flow capacity. The exhaust fans discharge to the MOX Fuel Fabrication Building exhaust stack.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air through each glovebox. Fire-rated isolation dampers or other protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the MD Exhaust System can be tested periodically for operability and required functional performance. Airflow can periodically be measured in the exhaust ducts. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

Exhaust flows from the process vent systems and the VHD Exhaust System, HD Exhaust System, and Process Cell Exhaust System are combined and discharge through a common exhaust stack. The stack effluent is monitored. Chapter 10 describes the stack monitoring systems.

11.4.2.5.3 Major Components

The MD Exhaust System contains the following major components:

- Two 100%-capacity, variable-speed, centrifugal fans with direct-drive motors.
- Multiple final filtration units. The filter trains are described in more detail in Section 11.4.9.1.

The ductwork upstream of the final HEPA filter units is welded stainless steel with flanged joints where the ductwork connects to equipment and in-line components. The ductwork downstream of the final HEPA filter units is welded galvanized steel.

11.4.2.5.4 Control Concepts

The variable-speed exhaust fans maintain constant pressure at the inlet to the final filters with respect to the atmosphere. The system is designed so that one fan is capable of meeting normal and abnormal flow requirements. The other fan is in standby. The standby fan automatically starts upon loss of negative pressure at the final filter housing.

The control circuits for the MD Exhaust System are normally interlocked with the control circuits of the HD Exhaust System and Supply Air System to prevent operation of the ventilation systems unless the HD Exhaust System is operating. This design ensures that the pressure differentials in the process rooms and rooms comprising the C3, C2, and C1 confinement zones maintain a pressure gradient from the highest to lowest pressure such that the C3 confinement zone is more negative than the C2 confinement zone and the C2 confinement zone is more negative than the C1 confinement zone.

Flow instrumentation is provided downstream of each exhaust fan to monitor the system flow rates. Temperature detectors are provided in the ductwork upstream of each final filtration unit to provide an alarm in the event of high temperature in the ductwork. Pressure controls are provided to vary the operating fan speed to maintain a constant pressure differential in the process rooms, nominally -0.2 to -0.4 in WG (-50 to -100 Pa), with respect to the atmosphere.

11.4.2.5.5 System Interfaces

The MD exhaust fans are powered from the normal and standby power supplies. The system interfaces with the HD Exhaust System and the Supply Air System.

11.4.2.6 Supply Air System

11.4.2.6.1 Function

The functions of the Supply Air System are as follows:

- Maintain a pressure differential between the C4 (gloveboxes), C3 (process rooms), process cells, and C2 (rooms) confinement zones
- Provide a source of unconditioned air for emergency cooling of the 3013 storage vault and emergency electrical rooms
- Maintain an environment suitable for operating personnel
- Maintain an environment suitable for the process, manufacturing, electrical, and laboratory equipment.

11.4.2.6.2 Description

The Supply Air System is depicted schematically on Figure 11.4-11. The Supply Air System supplies conditioned outside air to rooms and spaces designated as C2, process cell, and C3 confinement zones in the MOX Fuel Fabrication Building. The supply air fans draw air from the outside, through two sets of filters, heaters, and cooling coils, to condition the air for distribution in the MOX Fuel Fabrication Building. The supply air filter housing also contains freeze protection to permit continued operation of the emergency air supply in cold weather. Supply airflow is maintained by one of two 100%-capacity fans.

Rooms in C2 areas with high heat loads, principally electronics rooms, are provided with unit coolers to supplement cooling capability of the supply air. Additionally, duct-mounted cooling coils are provided where necessary to further cool the supply to meet ambient temperature criteria.

The ductwork incorporates manual and automatic dampers and controls to distribute and regulate the movement of air to each room. Fire-rated isolation dampers or other protective features are provided when ductwork passes through a fire barrier into another fire area.

Components of the Supply Air System can be tested periodically for operability and required functional performance. Airflow can be measured in the supply ducts. The operating sequence that would bring the spare components into service and transfer to alternate power sources can be tested periodically.

11.4.2.6.3 Major Components

The Supply Air System contains the following major components:

- Two 100%-capacity, variable-speed, centrifugal fans with direct-drive motors
- One set of multi-stage electric heating coils
- One set of multi-bank cooling coils and multiple supplemental cooling coils
- One prefilter bank (atmospheric dust filters)

- One HEPA filter bank
- Chilled water unit coolers.

The ductwork in the Air Supply System is galvanized steel.

11.4.2.6.4 Control Concepts

The variable-speed supply fans maintain constant flow to the MOX Fuel Fabrication Building. The system is designed so that one fan is capable of meeting normal and abnormal flow requirements. The other fan is in standby. The standby fan automatically starts upon loss of flow in the supply air duct.

The control circuits for the Supply Air System are normally interlocked with the control circuits of the VHD Exhaust System, Process Cell Exhaust System, HD Exhaust System, and the MD Exhaust System to prevent operation of the Supply Air System unless these systems are operating. This design ensures that the pressure differentials in the process cells and rooms comprising the C3, process cell, C2, and C1 confinement zones maintain a pressure gradient from the highest to lowest pressure such that the process cell is maintained more negative than the C3 confinement zone, the C3 confinement zone is maintained more negative than the C2 confinement zone, and the C2 confinement zone is maintained more negative than the C1 confinement zone.

Flow instrumentation is provided to monitor the system flow rates. Temperature detectors are provided in the ductwork to provide an alarm in the event of high temperature. Temperature controls are provided to heat or cool the supply air temperature as necessary. Room temperature controls are provided to control the temperature of rooms provided with supplemental unit coolers. The emergency air supply inlet dampers open automatically upon loss of the normal and standby power supplies.

11.4.2.6.5 System Interfaces

The supply air fans are powered from the normal and standby power supplies. The electric heating coils are powered from the normal power supply. The system interfaces with the VHD Exhaust System, HD Exhaust System, MD Exhaust System, and Process Cell Exhaust System. The HVAC Chilled Water System supplies chilled water to the cooling coils.

11.4.2.7 Emergency Control Room Air-Conditioning System

11.4.2.7.1 Function

The functions of the Emergency Control Room Air-Conditioning System are as follows:

- Maintain a habitable environment in each of the two emergency control rooms for facility personnel
- Provide cooling to the emergency electrical rooms.

11.4.2.7.2 Description

The Emergency Control Room Air-Conditioning System is depicted schematically on Figure 11.4-12. The Emergency Control Room Air-Conditioning System maintains a habitable environment for facility personnel in each of the two emergency control rooms. The HVAC system is of sufficient capacity to maintain the rooms within acceptable temperature ranges and maintain a positive pressure of 0.125 in. WG. with respect to surrounding areas.

Fresh air inlets are located where it is most unlikely for contaminants to be present in order to reduce the possibility of contaminants being introduced into the control rooms as required by NFPA 801, Section 3-9.7.13.48. The fresh air inlets are furnished with tornado missile protection hoods.

The Emergency Control Room HVAC System is designed to operate at all times to maintain temperature, ventilation, and pressure control.

Each independent outside air intake is capable of supplying air to each of the emergency control rooms and is provided with gas-tight isolation capability. Outside air and recirculated inside air passes through the filtration units; each filter housing contains a hazardous gas removal cartridge and/or an organic vapor cartridge and HEPA filter cartridges, as determined by the ISA. The system also maintains appropriate temperature limits for human occupancy by recirculating air through heating and cooling elements. The system also provides cooling to maintain appropriate temperature limits for emergency electrical equipment. Each emergency control room intake is monitored for radiological and hazardous chemicals. Each emergency control room is equipped with breathing air outlets and sufficient quantities of self-contained breathing apparatuses.

Battery rooms, served by this system are ventilated to prevent the build up of explosive levels of hydrogen. The ventilation rate is a minimum of two air changes per hour in accordance with NFPA -111 and limit hydrogen accumulation to less than 2% of the room volume in accordance with IEEE 484. A standby exhaust fan is provided for all battery rooms.

11.4.2.7.3 Major Components

The Emergency Control Room Air-Conditioning System contains the following major components:

- Four 100%-capacity, self contained, air-conditioning units, one for each emergency control rooms and emergency electronics rooms for the A & B trains and one unit for the emergency electrical rooms and emergency battery rooms for the A & B trains. Each unit consists of a filter, a direct-expansion cooling coil with an associated refrigeration system, and condenser.
- Two 100%-capacity air filter trains, one for each emergency control room. Each unit consists of a filtration unit and a booster fan for each intake. The filter housings are stainless steel. Each filter housing contains a hazardous gas removal cartridge and/or an organic vapor cartridge and HEPA filter cartridges.
- Three, duct mounted, electric heaters for train A & B.

- Two 100% capacity exhaust fans for each of the emergency battery rooms (A & B).

The ductwork is galvanized steel.

11.4.2.7.4 Control Concepts

The air-conditioning unit for each emergency control room operates automatically to maintain the set temperature for the emergency control room and associated electrical rooms.

Each emergency control room air intake is continuously monitored for hazardous chemicals. Upon detection of a hazardous chemical above allowable limits, the intake is automatically isolated and switched to the recirculation mode using a filtration unit with HEPA filtration and hazardous gas removal elements. An alarm sounds in the facility if hazardous chemical concentrations are above allowable limits are detected at both intakes which alerts operators to don emergency self-contained breathing apparatuses.

11.4.2.7.5 System Interfaces

The Emergency Control Room Air-Conditioning System receives power from the normal, standby, and emergency power supplies.

11.4.2.8 Truck Bay Ventilation System

The function of the Truck Bay Ventilation System is to remove heat and exhaust fumes during truck operation. The Truck Bay Ventilation System is depicted schematically on Figure 11.4-12. The Truck Bay Ventilation System provides ventilation for the truck bay areas using two 50% supply and two 50% exhaust fans. These rooms are designated as a C1 confinement zone. These fans are powered from the normal power supply.

11.4.2.9 Shipping and Receiving Area Air-Conditioning System

The function of the Shipping and Receiving Area Air-Conditioning System is to maintain a suitable environment for operating personnel. This system is depicted schematically on Figure 11.4-12. The Shipping and Receiving Area Air-Conditioning System is a conventional quality heating and cooling system supplying the offices and electrical rooms in this area. These rooms are designated as a C1 confinement zone. This system comprises one or more self-contained air-conditioning units and one or more exhaust fans. This equipment is powered from the normal power supply.

11.4.3 Emergency Generator Building HVAC Systems

11.4.3.1 Function

The functions of the Emergency Generator Building HVAC systems are as follows:

- Ventilate the engine rooms when the engine is not operating
- Provide combustion air to the operating engine
- Ventilate and cool the emergency switchgear room.

11.4.3.2 Description

The Emergency Generator Building HVAC systems are depicted schematically on Figure 11.4-12. The ventilation system for each emergency generator room ventilates the engine room when the engine is not in operation to maintain room temperature parameters within design limits and to provide combustion air to support engine operation.

During engine operation, outside air is pulled into the generator room by the engine air intake system and by the engine-driven radiator fan. After passing through the radiator, the air is discharged to the outside environment.

Electrical switchgear rooms are maintained at design conditions by separate air-conditioning units.

The generator rooms, served by this system are ventilated to prevent the build up of explosive levels of hydrogen from the unit's batteries. The ventilation rate is a minimum of two air changes per hour in accordance with NFPA -111 and limit hydrogen accumulation to less than 2% of the room volume in accordance with IEEE 484. The generator room is maintained at a minimum temperature of 60° F to assure the reliability of the batteries.

11.4.3.3 Major Components

The Emergency Generator Building HVAC systems contain the following major components:

- One multi-speed, powered ventilator for ventilation of the engine room
- Two 50%-capacity, self-contained, air-cooled, direct-expansion air-conditioning unit for air-conditioning of the switchgear room.
- One electric unit heater.

11.4.3.4 Control Concepts

Room temperature-indicating controllers modulate an air-conditioning unit to maintain the required design temperature in the associated switchgear rooms. The generator roof ventilator is controlled by a local thermostat and is interlocked with the generator. When the generator starts, the fan shuts off.

Dampers are interlocked with the generator. When the generator starts, they open to provide a flow path for combustion and cooling air for the generator.

11.4.3.5 System Interfaces

The fans and air-conditioning units are powered from the normal, standby, and emergency power supplies.

11.4.4 Standby Generator Building HVAC Systems

11.4.4.1 Function

The functions of the Standby Generator Building HVAC systems are as follows:

- Ventilate the engine rooms when the engine is not operating
- Provide combustion air to the operating engine
- Ventilate and cool the switchgear room.

11.4.4.2 Description

The Standby Generator Building HVAC systems are depicted schematically on Figure 11.4-12.

The ventilation system for each standby generator room ventilates the engine room when the engine is not in operation to maintain room temperature parameters within design limits and to provide combustion air to support engine operation.

During engine operation, outside air is pulled into the generator room by the engine air intake system and by the engine-driven radiator fan. After passing through the radiator, the air is discharged to the outside environment.

The electrical switchgear rooms are maintained at design conditions by separate air-conditioning units.

The generator rooms, served by this system are ventilated to prevent the build up of explosive levels of hydrogen from the unit's batteries. The ventilation rate is a minimum of two air changes per hour in accordance with NFPA -111 and limit hydrogen accumulation to less than 2% of the room volume in accordance with IEEE 484. The generator room temperature is maintained at a minimum temperature of 60° F to assure reliability of the batteries.

11.4.4.3 Major Components

The Standby Generator Building HVAC systems contain the following major components:

- One multi-speed powered roof ventilator for ventilation of the engine room
- One 100%-capacity, self-contained, air-cooled, direct-expansion air-conditioning unit for air-conditioning of the switchgear room.
- One electric unit heater.

11.4.4.4 Control Concepts

Room temperature-indicating controllers modulate the air-conditioning unit to maintain the required design temperature in the associated switchgear rooms. The generator roof ventilators are controlled by local thermostats and are interlocked with the generator. When the generator starts, the fans shut off.

Dampers are interlocked with the generator. When the generator starts, they open to provide a flow path for combustion and cooling air for the generator.

11.4.4.5 System Interfaces

The fans and air-conditioning units are powered from the normal and standby power supplies.

11.4.5 Safe Haven HVAC Systems

The function of the Safe Haven HVAC systems is to provide a habitable environment in the safe haven rooms for facility personnel in the event of evacuation (e.g., as a result of a fire, certain security events, etc.) in the MOX Fuel Fabrication Building. The Safe Haven HVAC systems are depicted schematically on Figure 11.4-12.

The Safe Haven HVAC systems, using outside air, provide habitable environments for facility personnel in safe haven rooms in case of a fire. The safe havens are slightly pressurized when the doors are closed. The outside air is not heated or cooled. The safe havens are connected to the MOX Fuel Fabrication Building and are classified as a C1 confinement zone.

The Safe Haven HVAC systems consist of centrifugal, direct-drive supply fans through filter housings, containing two stages of HEPA filters and a hazardous gas removal cartridge, to the safe haven rooms. The Safe Haven HVAC systems are controlled manually from within the safe haven. These fans are powered from the normal and standby power supplies.

11.4.6 Reagent Processing Building HVAC Systems

The function of the Reagent Processing Building HVAC systems is to provide a supply of conditioned fresh air to the electronics/electrical rooms and changing rooms as well as to provide heating and ventilation of chemical storage areas. The Reagent Processing Building HVAC systems are depicted schematically on Figure 11.4-12.

The Reagents Processing Building HVAC System consists of a single, roof mounted, air handling supply package, supplying conditioned air to the Electronics /Electrical rooms and change rooms. Powered roof exhausters are provided for exhausting air from the reagents storage area, laboratory and tank rooms to remove heat and dilute gases in accordance with NFPA 30. Storage areas is provided with electric unit heaters for winter heating. Wall mounted, outdoor louvers with electrically operated dampers is provided for fresh air inlet to the reagents storage areas and tank rooms.

The Reagents Processing Building HVAC systems are powered from the normal power supply.

11.4.7 Static Barriers

Static barriers restrict leakage of radioactive material out of a confinement boundary. Static barriers include gloveboxes, process vessels, process cells, rooms, fuel rod cladding, 3013 canisters, filters, piping, tanks, exhaust ductwork, MOX shipping casks, MOX Fuel Fabrication Building, and waste containers. The following items are discussed in this section:

- Gloveboxes
- DOE Standard 3013 canisters and transport casks
- Waste containers
- Transfer containers
- MOX fuel shipping casks
- Fuel rods
- Specific process equipment
- Vessels.

11.4.7.1 Gloveboxes

11.4.7.1.1 Function

Gloveboxes perform two fundamental functions in the MFFF:

- The glovebox provides a static confinement barrier to maintain confinement of hazardous materials.
- The glovebox and the internal supporting systems provide a seismic structure to maintain equipment integrity and process component geometry.

11.4.7.1.2 Description

Gloveboxes are single or multiple enclosures grouped together, which house process equipment and utility systems in order to maintain confinement of radioactive or toxic materials, while providing access to the equipment for operations and maintenance activities.

Gloveboxes serve as part of the primary confinement boundary for handling dispersible nuclear materials (e.g., powder, pellets, and liquids) outside of qualified containers. They perform this function by providing a static confinement barrier to the dispersion of materials and by working in concert with the MOX Fuel Fabrication Building HVAC systems to maintain a differential pressure between the internal and external atmospheres of the glovebox. This differential pressure ensures that leakage across the glovebox confinement boundary is inward, from areas of lesser contamination potential to areas of greater contamination potential.

Gloveboxes provide physical and visual access to internal equipment to conduct process and manufacturing operations, transfer material into and out of the glovebox, and perform maintenance activities. Process and manufacturing operations are linked together through material-handling operations located in gloveboxes. Transfer gloveboxes that pass through a fire barrier are equipped with a fire door.

Physical access to process and manufacturing operations, as well as equipment maintenance, is provided through glove ports installed in the box exterior shell or window panels. Visual access is provided through window panels, viewing ports, or via video cameras located inside or outside of the glovebox. Light fixtures, which are generally installed outside the gloveboxes, provide illumination for interior spaces through windows located primarily in the glovebox ceilings. Material is transferred into or out of the glovebox using bag-out operations through bag rings, or double-door transfer containers may be used that dock with ports that can be resealed, installed in the glovebox shell. Process and utility services required to conduct operations inside the gloveboxes (including HVAC, process fluids and gases, electrical power and instrument signals, and mechanical drives) are provided via various standardized styles of pass-through connectors installed in the glovebox shells. The pass-through connectors are designed and tested to ensure that the glovebox pressure boundary integrity remains within maximum leakage criteria.

The glovebox leak rate criteria are provided not only for confinement but also for the quality of the fuel produced. Many of the fuel fabrication process operations are conducted within an inert atmosphere to eliminate the adverse effects of atmospheric oxygen on the process or fuel. Each glovebox is leak-tested after installation or major maintenance.

The VHD Exhaust System provides the HVAC flow required to remove excess heat generated by the process, maintains inert or special atmospheres required by the process, and provides confinement airflow through postulated breaches. The VHD Exhaust System also controls the effects of system pressure transients on glovebox confinement boundary integrity to maintain pressure inside the glovebox suitable for working in gloves and to prevent over-pressurization (positive and negative) of the glovebox.

To ensure that atmospheric differential pressures remain within design limits, each glovebox or its associated HVAC system is equipped with devices that control the pressure and additional devices that automatically actuate to relieve both positive and negative excess differential pressure. The instrumentation for the glovebox HVAC system includes devices to indicate the differential pressure between the glovebox and the surrounding area, the HVAC filter resistance, and the exhaust flow rate from the glovebox. Gloveboxes are designed and tested to meet volumetric leakage criteria for specific values of differential pressure between internal and external atmospheres.

11.4.7.1.3 Major Components

The typical glovebox is a large, stainless steel enclosure mounted on a structural stainless steel stand anchored to the floor and/or ceiling. The box may be stand-alone or interconnected with other gloveboxes, depending on the configuration of the process. Flexible metal bellows are used to structurally isolate interconnected gloveboxes where required. Glovebox shells are welded.

Glovebox windows consist of rectangular polycarbonate panels that fit into frames in the glovebox walls and ceiling. The window panels clamp between channel-shaped, resilient gaskets to prevent leakage. Lead-impregnated polymer sheets or lead glass panels overlay windows where radiation shielding is required to reduce operator exposures. Glove ports installed in the glovebox walls or directly in the window panels accommodate push-through style gloves that can be changed without breaching confinement. The effects of temperature, radiation and aging on the material creep properties of glovebox polycarbonate panels is being evaluated as part of final design. Results of this evaluation will be reported in the MFFF ISA.

Penetrations that communicate with the glovebox atmosphere are equipped with filters or seals that permit electrical signals or fluids to cross the confinement boundary. Electrical penetrations utilize sealed bulkhead-type fittings to transfer signals. Fluid penetrations are equipped with isolation valves located outside the glovebox.

11.4.7.1.4 Control Concepts

Gloveboxes are static devices that do not require active control. However, gloveboxes are equipped with relief devices to protect against excessive negative and positive pressure. Other glovebox instrumentation provided includes a differential pressure-indicating switch to indicate the differential pressure between the glovebox and the surrounding work area, differential pressure gages to indicate the pressure differential between the supply and exhaust filter resistance, and a flow indicator to indicate the exhaust flow rate. The differential pressure-indicating switch alarms locally and in the main control room in the event of abnormal pressure in a glovebox (see Figure 11.4-13 for typical glovebox instrumentation). The control of process equipment inside the gloveboxes is described in Sections 11.2 and 11.3.

11.4.7.1.5 System Interfaces

Gloveboxes interface both functionally and physically with a large number of systems in the MOX Fuel Fabrication Building. The primary functional interface occurs with the glovebox supply and exhaust HVAC systems that help maintain confinement of airborne radioactive materials. These systems provide the HVAC flow required to remove excess heat generated by the process or product, inert or special atmospheres required by the process, and confinement airflow through breaches in the event of an accident. HVAC system controls also mitigate the effects of system pressure transients on glovebox confinement boundary integrity and maintain pressure inside the glovebox suitable for working in gloves. Double filters at the supply and exhaust HVAC connections to the glovebox prevent migration of contamination outside of the glovebox confinement boundary.

Gloveboxes share physical interfaces with a variety of structural, process, utility, and monitoring systems as a consequence of their role in isolating process equipment from the plant environment. The physical interfaces occur primarily at points where the interfacing system penetrates the glovebox pressure boundary. Penetrations are equipped with filters or seals that permit signals or fluids to cross the glovebox confinement boundary but minimize, to the maximum extent practical, the transfer of contamination across the boundary. Electrical penetrations utilize sealed bulkhead-type fittings to transfer signals. Fluid penetrations are equipped with manual isolation valves located outside the glovebox to isolate the glovebox as conditions warrant. Filters and isolation valves at the glovebox penetration boundaries are not credited in the normal or accident dose analysis and are thus not considered to be principal SSCs.

Gloveboxes structurally interface with the main building structure at embedment points, with adjacent gloveboxes and process equipment, and with adjacent utility systems and equipment supported off of the glovebox shell. Mechanical interfaces occur at pass-throughs where motion from actuators or motors located outside the glovebox is transferred to equipment inside. Mechanical seals maintain the confinement boundary at the pass-through.

Fluid systems that penetrate the glovebox confinement boundary include compressed nitrogen, process helium, argon and hydrogen for the sintering furnaces, process demineralized water, and chilled water. Provisions for introducing carbon dioxide to the glovebox interior for fire suppression are also included.

Electrical systems that interface with the gloveboxes include power for process equipment, convenience receptacles, lighting, and a wide variety of signals for process and utility control and monitoring. The primary utility monitoring systems are the smoke and thermal fire detection systems located in each glovebox.

11.4.7.2 DOE Standard 3013 Canisters and Transport Casks

DOE Standard 3013 containers provide primary and secondary confinement for plutonium received at the facility. As described in Section 11.3, all de-canning operations are carried out within glove boxes. The design basis of the Decanning Unit is to prevent the spread of radioactive material during 3013 canister opening operations. The container is qualified for a 30-ft (9.1-m) drop, which is not exceeded in handling operations. The 3013 Transport casks are designed to meet the applicable requirements of 10 CFR Part 71.

11.4.7.3 Waste Containers

MOX transuranic wastes are packaged in waste containers, which meet U.S. Department of Transportation (DOT) Type A, Specification 7A requirements. The waste drums and waste transfer containers provide primary and secondary confinement. Wastes in these containers are bagged, and the drum is closed and sealed with a gasketed cover. Drums are provided with filters to prevent pressurization.

11.4.7.4 Transfer Containers

Transfer containers are used to manually transport waste and samples inside the C2 confinement boundary. These containers are designed for applicable events identified in the ISA.

11.4.7.5 MOX Fuel Shipping Casks

The MOX fuel shipping cask contains fuel assemblies for shipment. The new fuel cask is designed to meet the specifications of 10 CFR Part 71.

11.4.7.6 Fuel Rods

As described in Section 11.2, sintered pellets are inserted into zircaloy cladding within a glovebox. After insertion of the spring and plug, the rod is pressurized with helium and the seal is welded. The rod is decontaminated prior to removal from the glovebox.

11.4.7.7 Specific Process Equipment

The two sintering furnaces are described in Section 11.2.2.16. These furnaces are contained within a welded steel jacket under a slight positive pressure to prevent oxygen from entering the furnaces. The gas leaving the furnace is cooled and filtered prior to being extracted by the VHD Exhaust System. The furnaces are monitored for internal pressure, oxygen, and temperature.

After power to the furnace is tripped, no safety systems are required to maintain primary confinement.

11.4.7.8 Vessels

Vessels provided in the AP systems that provide a primary confinement function are welded construction and are vented by the Offgas Treatment System. Vessels that may require access are located in gloveboxes, which provide primary confinement.

11.4.8 Fire Protection and Confinement

In the event of a fire, nuclear materials must be confined. Fire and nuclear material confinement barriers generally include a group of rooms, constituting a volume capable of containing the radioactive products that may be released by a fire within the area. Figure 11.4-14 provides an overview of the fire and nuclear material confinement barriers for process rooms.

The fire areas are surrounded by fire-rated barriers. Access to rooms is via a confinement airlock with a separate HVAC exhaust duct. Fire dampers capable of operating at high temperatures are placed on the room HVAC inlet and exhaust. Exhaust system components are designed with the proper temperature rating so that they can perform their required function under the conditions that may exist in the event of a fire. Air stream dilution is used to protect the final filter stage before the stack. The dilution factor depends on the temperature of the fire, the flow rate, and the flow of dilution air. Fire detection and suppression are described in Chapter 7.

For areas with no dispersible nuclear material, fire dampers are provided on the inlet and exhaust that are closed automatically upon sensing high temperature or upon activation of the gas suppression system.

For areas with dispersible nuclear material and without gloveboxes (e.g., waste storage and polishing cells), the main objective is to maintain differential pressure between the room and the surrounding areas. In case of fire, the fire damper on the HVAC inlet is automatically closed in order to limit air supply to the fire. The exhaust fire damper is manually closed if set thresholds (e.g., temperature of exhaust, temperature at the last filtration level before the stack, pressure drop at the last filtration level and low flow rate at the stack) are exceeded.

For areas with gloveboxes, a change in the HVAC configuration could impair the pressure gradient between gloveboxes and the room. No modification in the HVAC configuration is expected in the case of an incipient fire that can be suppressed immediately. For the case of a larger fire, the main confinement principle is to maintain differential pressure between the room and the surrounding areas. The fire damper on the room HVAC inlet is manually or automatically closed, subject to detailed design. The fire dampers on the glovebox HVAC inlet and exhaust are manually or automatically closed. The exhaust fire damper is manually closed if set thresholds (e.g., temperature on exhaust, temperature at the last filtration level before the stack, pressure drop at the last filtration level, low flow rate at the stack) are exceeded.

11.4.9 Final Filtration Units

The final filtration units provide the last stages of HEPA filtration prior to the air being discharged to the stack. These units are installed in the VHD Exhaust System, HD Exhaust System, Process Cell Exhaust System, MD Exhaust System, and Offgas Treatment System. The final filters are capable of operating during a fire in rooms that are exhausted through the filters and to safely handle products of combustion.

Each of the final filtration units consists of a filter assembly housing, a two stage spark arrester, a pre-filter, and two stages of HEPA filters. The final filter housings are stainless steel, bag-in/bag-out type and are equipped with necessary test ports to permit in-place testing of HEPA filter stages with dioctyl phthalate (DOP) to monitor system efficiency. Dampers are provided so that filter housings can be completely isolated from the HVAC system during filter replacement.

The first stage spark arrester is made of a stainless steel wire mesh. The second stage spark arrester is made of a stainless steel mesh with interwoven fiberglass designed to remove particles greater than 1 micron. The complete spark arrester assemblies are designed and fabricated to the same temperature ratings as the exhaust pipe/duct in which they are installed. Frames are metallic construction. The spark arresters are fabricated of noncombustible materials and are designed to pass design flow rates under fully loaded conditions without structural failure.

Pre-filters are fiberglass media filters with metallic frames and nominal efficiencies between 60% and 85%. Continuous filter temperature rating is nominally 400°F (204.5°C).

HEPA filters are fabricated of glass media with metallic frames and silicone gaskets. The filters are at least 99.97% efficient and can operate in continuous service at 450°F (232°C). The filters can withstand a differential pressure of 10 in WG (2488 Pa) without failure.

The final filtration units, exhaust plenums, exhaust fans, and associated control devices are located as far as practicable from a postulated fire, where they are not exposed to the fire's direct effects. Redundant trains are located in separate fire areas. The integrity of the final filtration units is not degraded by fire and smoke.

Analyses based on final design are in progress to demonstrate that the HEPA filters are protected from fire and other operating conditions and to demonstrate that the ventilation systems LPF is 10^{-4} or better. See Section 5.4.4.4 for information on operating conditions that will damage HEPA filters.

11.4.10 Design Basis for Non-Principal SSCs

The design of the ventilation and air-conditioning systems is in accordance with the applicable standards and guidelines published by the following organizations:

- Air Moving and Conditioning Association
  - AMCA-1999, *Standards Handbook*
- American Conference of Governmental Industrial Hygienists

  - *Industrial Ventilation A Manual of Recommended Practice*, 23rd Edition
- American Society of Heating Refrigeration and Air-Conditioning Engineers
  - ASHRAE 62-1999, *Ventilation for Acceptable Air Quality*
  - ASHRAE 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- National Fire Protection Association
  - NFPA 45-1996, *Standard on Fire Protection for Laboratories Using Hazardous Chemicals*
  - NFPA 90A-1999, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*
- Sheet Metal and Air-Conditioning Contractors National Association
  - SMACNA-1980, *Rectangular Industrial Duct Construction Standards*
  - SMACNA-1999, *Round Industrial Duct Construction Standards.*

Outdoor design temperatures for use in sizing HVAC systems are based on weather data, in accordance with ASHRAE, *1997 Handbook of Fundamentals*, as follows:

• Summer; dry bulb	96°F (.4%); 94°F (1%)
• Summer; mean coincident wet bulb	76°F; 75°F
• Summer, maximum wet bulb	79°F (1%)
• Summer, daily range	20.2°F
• Winter; dry bulb	21°F (99%); 25°F (99.6%).

11.4.11 Design Basis for Principal SSCs

The following sections provide the design bases for the confinement and ventilation systems that are designated as principal SSCs in Chapter 5. The ventilation systems, gloveboxes, process vessels, and other containers used to store and transport plutonium are designed to ensure the confinement of hazardous materials. These systems are designed to limit the release of radioactive material to the environment (including plant operating areas) and to meet the performance requirements of 10 CFR §70.61 for protection of the public and workers.

The principal SSCs associated with the confinement and ventilations systems are as follows

<u>Ventilation and Air Conditioning Systems</u>

- C2 Confinement System Passive Barrier
- C3 Confinement System
- C4 Confinement System
- Emergency Control Room Air Conditioning System

- Emergency Generator Ventilation System
- High Depressurization Exhaust System
- Process Cell Ventilation System Passive Barrier
- Supply Air System
- MFFF Tornado Dampers
- Offgas Treatment System

Confinements

- 3013 Canister
- 3013 Transport Cask
- Glovebox and Glovebox Pressure Controls (Including Process Safety Control Sub-System pressure alarm function)
- Transfer Containers
- Waste Containers
- Sintering Furnace Confinement Boundary

11.4.11.1 Ventilation and Air-Conditioning Systems

The following ventilation and air-conditioning systems are principal SSCs or have individual components that are principal SSCs:

- VHD Exhaust System
- HD Exhaust System
- Emergency Control Room Air-Conditioning System
- Emergency Generator Building HVAC systems
- Process Cell Exhaust System components:
  - Final filters
  - Pressure boundary
  - Tornado dampers
- MD Exhaust System components:
  - Final filters
  - Pressure boundary downstream of the final filters
  - Tornado dampers

- Supply Air System components:
  - Emergency air duct
  - Inlet filters
  - Pressure boundary upstream of the inlet filters
  - Tornado dampers
- Offgas Treatment Unit (Scrubbing function is not credited in the accident analysis)
  - Pressure boundary
  - Final filters
  - Exhaust Fans

11.4.11.1.1 Design Basis Standards

The design of the HVAC systems and confinement for the MFFF is consistent with the criteria and design guidance provided in Regulatory Guide 3.12, *General Design Guide for the Ventilation System of Plutonium Processing and Fuel Preparation Plants*. One noted exception to this Regulatory Guide is that there are no adsorbers in the filter lines, therefore the heaters and water mist spray for fire protection of final HEPA filters are not required.

The design of the principal ventilation SSCs is developed in accordance with the following codes and standards (as applicable to each SSC):

- Energy Research and Development Administration
  - ERDA 76-21 *Nuclear Air Cleaning Handbook*, 2nd edition
- American Society of Mechanical Engineers
  - AG-1-1997, *Code on Nuclear Air and Gas Treatment*
  - B31.3- 1996, *Process Piping, including 1998 Addenda*
  - N509-1996, *Nuclear Power Plant Air-Cleaning Units and Components*
  - N510-1995, *Testing of Nuclear Air-Treatment Systems*
- National Fire Protection Association
  - NFPA 801-1998, *Fire Protection for Facilities Handling Radioactive Materials.*

11.4.11.1.2 C2 Confinement System Passive Barrier

Additional design basis associated with this PSSC is as follows:

- Two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors and prefilters in each final filtration assembly;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Fire-rated dampers between designated fire areas;
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;

- Final filters and downstream ductwork remain structurally intact during and after design basis earthquakes and withstand the effects of tornadoes.

11.4.11.1.3 C3 Confinement System

Additional design basis associated with this PSSC is as follows:

- C3 zone pressure is maintained at a negative pressure relative to atmosphere during normal and transient operation;
- Designed to maintain system exhaust safety function assuming single active component failure;
- Redundant 100 percent capacity final filter assemblies with two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors and prefilters in each final filter assembly upstream of the HEPA filters;
- Two 100 percent capacity fans in C3 exhaust system;
- Fire-rated dampers between designated fire areas;
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Provide emergency cooling capability for selected areas;
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency power supplies (PSSC);
- Remains operational after facility fires and design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.4 C4 Confinement System

Additional design basis associated with this PSSC is as follows:

- C4 zone pressure maintained at negative pressure with respect to C3 process room during normal operation and transients;
- Designed to maintain system exhaust safety function assuming single active component failure;
- Redundant 100 percent capacity final filter assemblies with two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors and prefilters in each final filter assembly upstream of the HEPA filters;
- Four 100 percent capacity fans in C4 exhaust system;
- Manual actuated fire isolation valves between designated fire areas;
- VHD Exhaust system is designed to maintain a 125-ft/min (38.1-m/min) face velocity across a design basis glovebox breach. The design basis breach is equal to the larger area of either two 8-in (20.3-cm) glove ports or the maximum credible glovebox breach;
- In –place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);

- Fans are UPS powered from normal (non-PSSC), standby (non-PSSC), and emergency power supplies (PSSC)

11.4.11.1.5 Emergency Generator Ventilation System

Additional design basis associated with this PSSC is as follows:

- One 100 percent capacity air conditioning unit for each switchgear room;
- One 100 percent capacity roof ventilator for engine room cooling during standby (engine fan cools room during operation);
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies;
- Remains operational after facility fires and design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.6 Emergency Control Room Air Conditioning System

- Maintain habitable environment in emergency control room
- Dual emergency control room air intakes with continuous monitoring for hazardous chemicals
- Maintain a positive pressure with respect to surrounding areas
- One 100 percent capacity (per control room) filtration assembly (using pre-filter, two HEPA filter stages, and chemical filters) for control room air supply
- In-place HEPA filter testing capability for HEPA filter assemblies in accordance with ANSI-N510;
- One 100 percent capacity (per control room) air handling unit;
- One 100 percent capacity exhaust fan and one 100 percent capacity booster fan;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent
- Fans are powered from normal (non-PSSC), standby (non-PSSC), and emergency (PSSC) supplies;
- Remains operational during and after facility fires and after design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.7 High Depressurization Exhaust System

See C3 Confinement System above for additional design basis associated with this PSSC.

11.4.11.1.8 Process Cell Ventilation System Passive Barrier

Additional design basis associated with this PSSC is as follows:

- Two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors and prefilters in each final filtration assembly;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Fire-rated dampers between designated fire areas;

- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Final filters and ductwork remain structurally intact during and after design basis earthquakes and withstand the effects of tornadoes

11.4.11.1.9 Supply Air System

Additional design basis associated with this PSSC is as follows:

- Provide supply air for emergency cooling;
- HEPA filter stages for building air supply for static confinement;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);

11.4.11.1.10 MFFF Tornado Dampers

Additional design basis associated with this PSSC is as follows:

- Withstand the effects of design basis tornadoes;
- Remains operational after facility fires and design basis earthquakes

11.4.11.1.11 Offgas Treatment System

Additional design basis associated with this PSSC is as follows:

- Two stages of HEPA filters prior to discharge to the atmosphere;
- Spark arrestors and prefilters in each final filtration assembly;
- Each HEPA stage shall be field tested to have an efficiency of 99.95 percent (1E-4 analytical assumption);
- Fire-rated dampers between designated fire areas;
- In-place HEPA filter testing capability in accordance with ASME N510 for the final filtration assemblies;
- Final filters and ductwork remain structurally intact during and after design basis earthquakes and withstand the effects of tornadoes

11.4.11.2 Gloveboxes and Glovebox Pressure Controls

Gloveboxes are designed to provide a confinement barrier for hazardous material. They are designed to remain functional during and after a design basis earthquake.

Design provisions that minimize the potential for a breach of confinement resulting from dropped loads include the following:

- Use of highly automated processes with complementary hard-wired logic for safe material handling within the glovebox, which precludes human handling incidents

- Use of impact-resistant materials for window panels
- Design of the glovebox floor to withstand the impact of potential load drops
- Use of barriers or guides to prevent the fall of containers and other equipment inside the glovebox and to protect windows from external impact.

Gloveboxes and their principal SSCs are designed and fabricated in accordance with the following codes and standards:

- ANSI N690-1994, *Specification for the Design, Fabrication and Erection of Safety Related Steel Structures for Nuclear Facilities*
- AWS D1.1-2000, *Structural Welding Code*

Gloveboxes are designed with pressure/vacuum-relief devices that prevent over-pressurizing gloveboxes and excessive negative pressures.

The glovebox ventilation will provide sufficient flow to compensate for in-leakage rate of 0.25 percent of the glovebox volume per hour at -4.0 in WG (-1000 Pa).

Redundant pressure sensors monitor differential pressure with respect to the process room and alert the operators to upset conditions. The instruments remain operational following facility fires in unaffected areas, tornadoes, and design basis earthquakes.

11.4.11.3 3013 Canisters

The 3013 inner and outer canisters are designed according to the specifications in DOE-STD-3013-2000, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials.*

11.4.11.4 3013 Transport Casks

The 3013 Transport casks are designed for applicable requirements of 10 CFR Part 71.

11.4.11.5 MOX Fuel Transport Cask

The MOX fuel transport casks are designed and certified separately in accordance with 10 CFR Part 71.

11.4.11.6 Waste Containers

MOX transuranic wastes are packaged in waste containers designed to DOT Type A Specification 7A and are vented and filtered, as appropriate.

11.4.11.7 Transfer Containers

Transfer containers are designed to withstand applicable events. These events will be identified in the ISA.

11.4.11.8 Sintering Furnace Confinement Boundary

The sintering furnace provides a primary confinement boundary function. The design basis for the sintering furnace is as follows:

The seals for the sintering furnace are designed for peak temperature of 316°C. The furnace is shutdown with no damage to the confinement barrier if overheating or low cooling flow conditions exist.

The furnace shell and airlocks are designed to withstand an over pressure of 2.5 bar (36.3 psi). The furnace shell leak tightness is specified at 5E-5 leaked vol/hr at 2.2 psi. To prevent furnace overpressure conditions, the following controls are implemented:

- High humidifier water level isolates the humidifier water feed line to prevent excessive moisture carryover to the furnace and subsequent over pressure due to rapid steam generation.
- Hydrogen hazards are prevented as discussed in Section 8.5 and 8.7
- The furnace is designed to operate at a slight overpressure. Pressure control and overpressure protection are provided by redundant pressures controls.
- The furnace is designed to maintain its confinement function during the design basis earthquake.

11.4.11.9 Process Cell

Process cell leak confinement is performed by drip trays. The drip tray design basis is to contain the maximum inventory of the largest vessel in the cell. Drip trays are fully welded and designed to withstand a design basis earthquake.

This page intentionally left blank.

This page intentionally left blank.

Tables

This page intentionally left blank.

Table 11.4-1. MFFF Confinement Systems for Each Change in Confinement Zones

Process Steps	Physical State of PuO_2	Primary Confinement		Secondary Confinement		Tertiary Confinement	
		Confinement Boundary	Dynamic Exhaust System	Confinement Boundary	Dynamic Exhaust System	Confinement Boundary	Dynamic Exhaust System
Powder Receipt and Storage	Powder	Inner 3013 Can	None	Outer 3013 Can	None	BMF[1]	Medium Depress
Decanning	Powder	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Dissolution	Powder, Solution	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Purification, Conversion	Solution	Process Equip (All Welded Fittings)	Offgas Treatment Unit	Drip Tray	None	Process Cell Room	Process Cell
Oxidation, Homogenization, Canning	Solution, Powder	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Buffer Storage	Powder	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Primary Dosing, Ball Milling, Final Dosing, Homogenization, Pelletizing	Powder, Pellets	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Sintering[2]	Pellets	Sintering Furnace	None	Process Room	High Depress	BMF	Medium Depress
Grinding, Sorting, Rod Clad	Pellets	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Rod Inspection	Pellets	Rod Clad	None	None	None	BMF	Medium Depress
Rod Storage	Pellets	Rod Clad	None	None	None	BMF	Medium Depress
Assembly Mounting, Assembly Inspection	Pellets	Rod Clad	None	None	None	BMF	Medium Depress
Assembly Storage	Pellets	Rod Clad	None	None	None	BMF	Medium Depress
Scrap Recovery	Pellets	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Laboratory Operations with Significant Plutonium	Powder, Pellets, Solution	Glovebox	Very High Depress	Process Room	High Depress	BMF	Medium Depress
Assembly Loading into Transport Container	Pellets	Rod Clad	None	None	None	BMF	Medium Depress

---

[1] BMF refers to the MOX Fuel Fabrication Building.
[2] Sintering furnaces are under slight positive pressure.

This page intentionally left blank.

Figures

This page intentionally left blank.

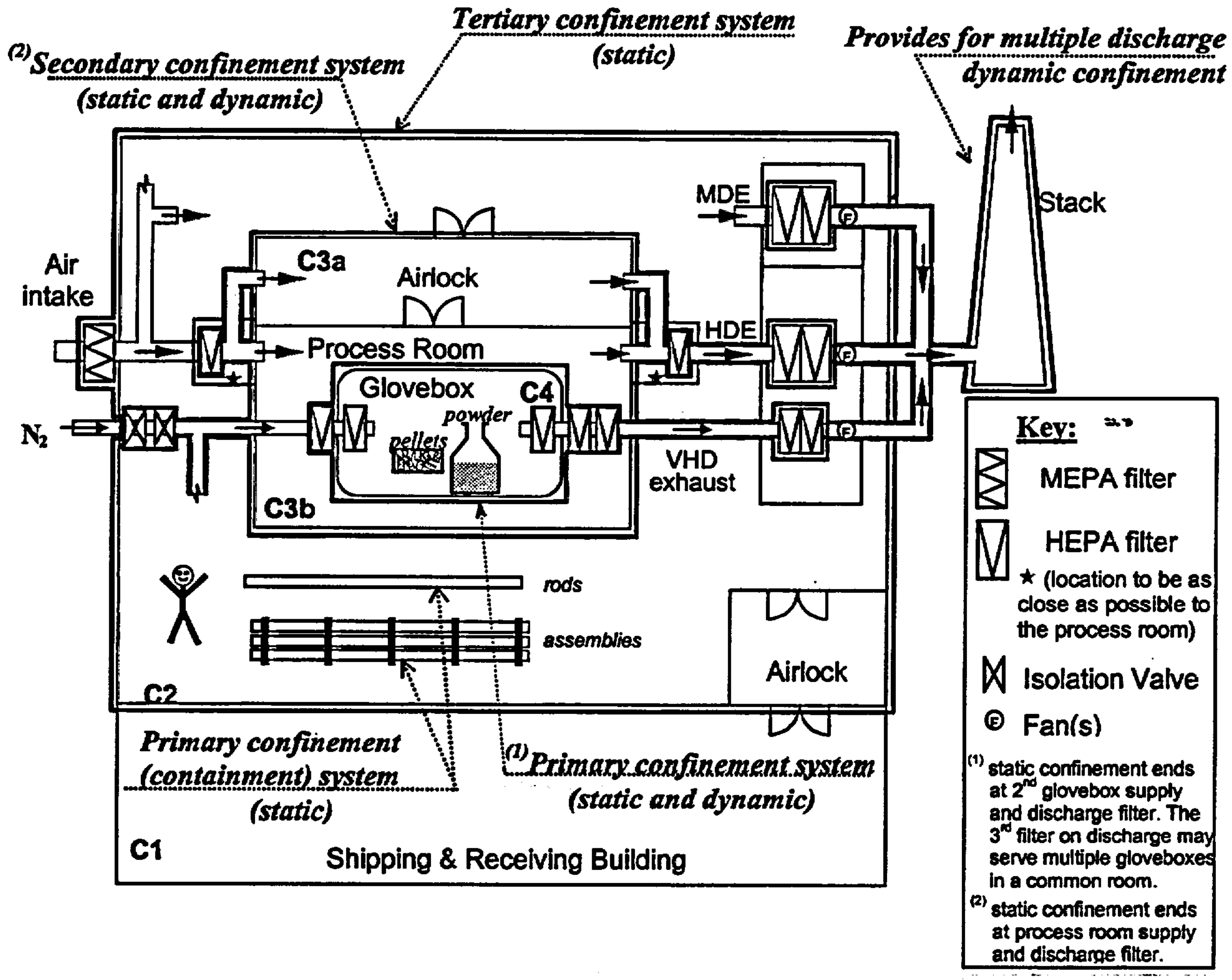

Figure 11.4-1. Example of MP Confinement

This page intentionally left blank.

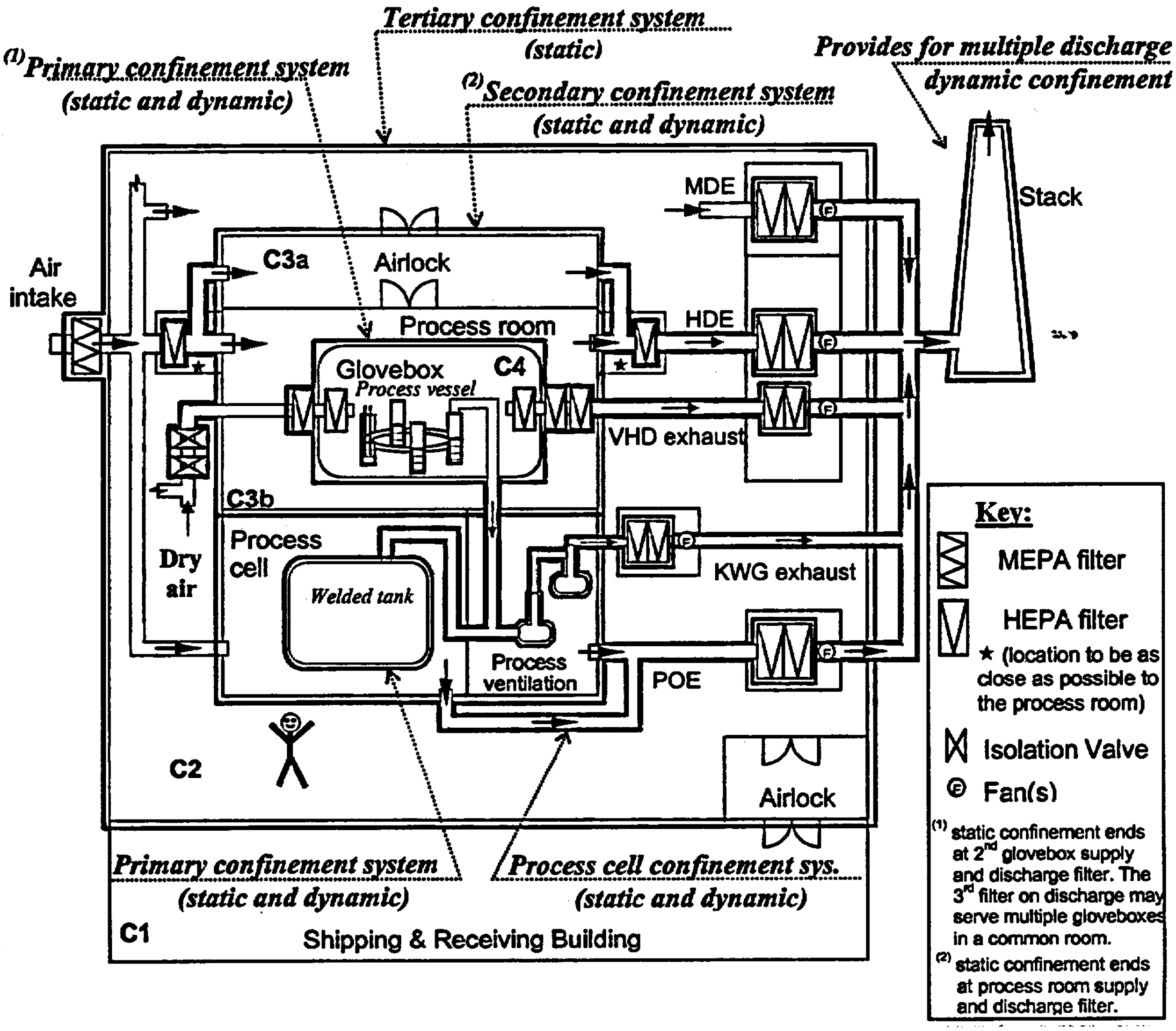

Figure 11.4-2. Example of AP Confinement

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.

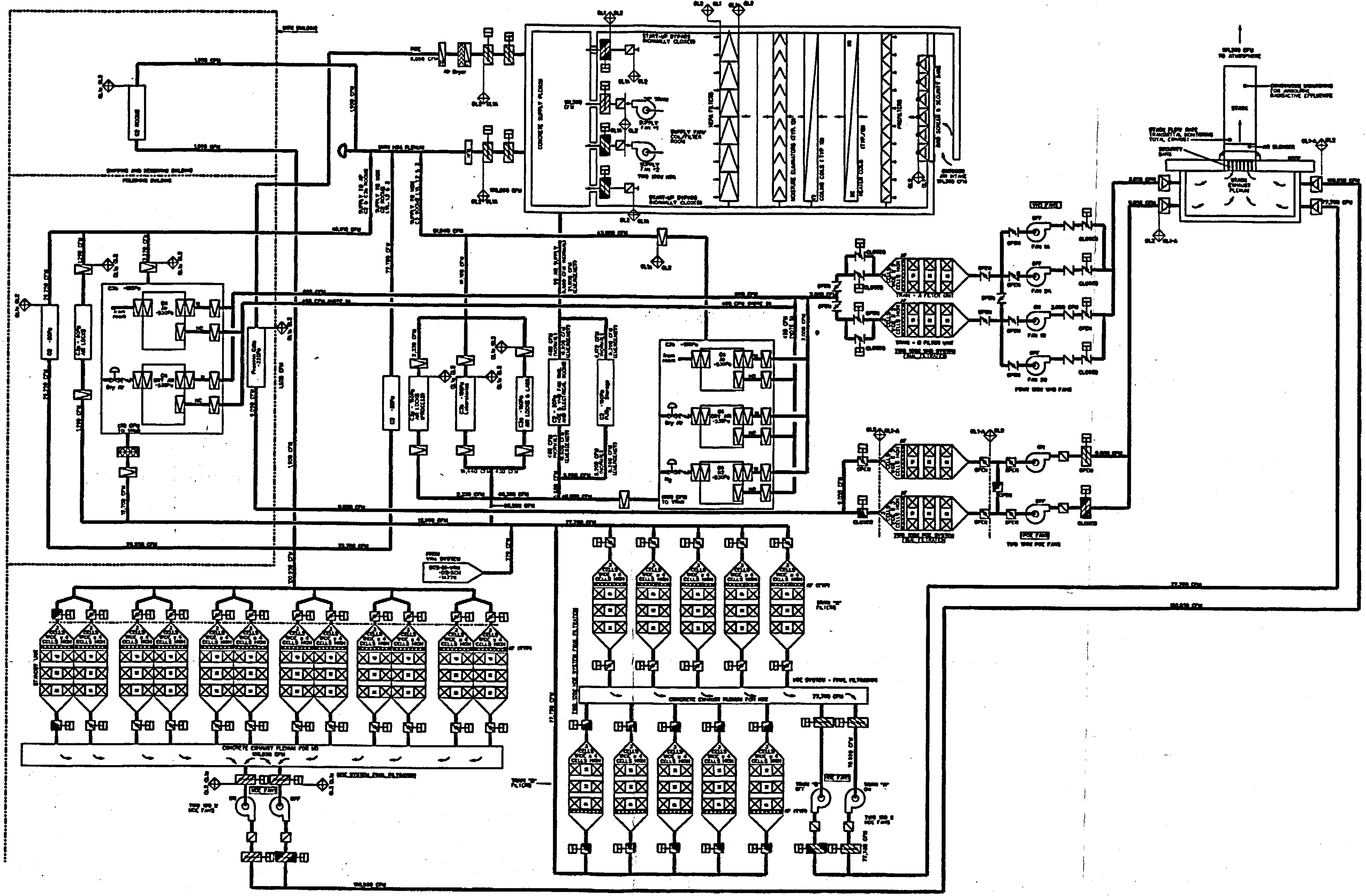

Figure 11.4-11. Schematic Flow Diagram, HVAC Systems, MOX Processing and Aqueous Polishing Buildings

This page intentionally left blank.

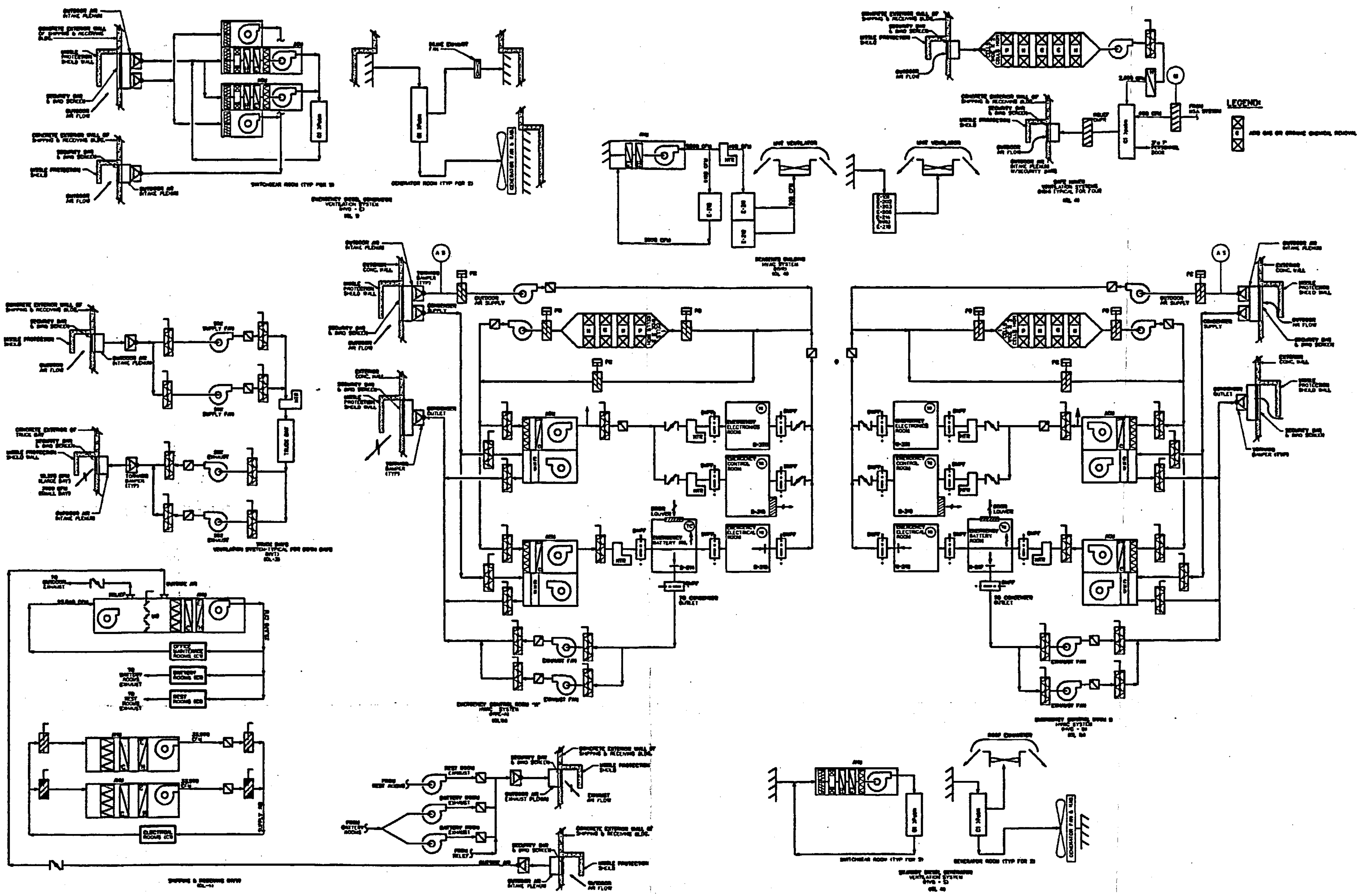

Figure 11.4-12. Schematic Flow Diagram, HVAC Systems – Emergency and Standby Diesel, Shipping and Receiving, Safe Haven, Emergency Control Room and Reagent Processing Bldg. HVAC Systems

This page intentionally left blank.

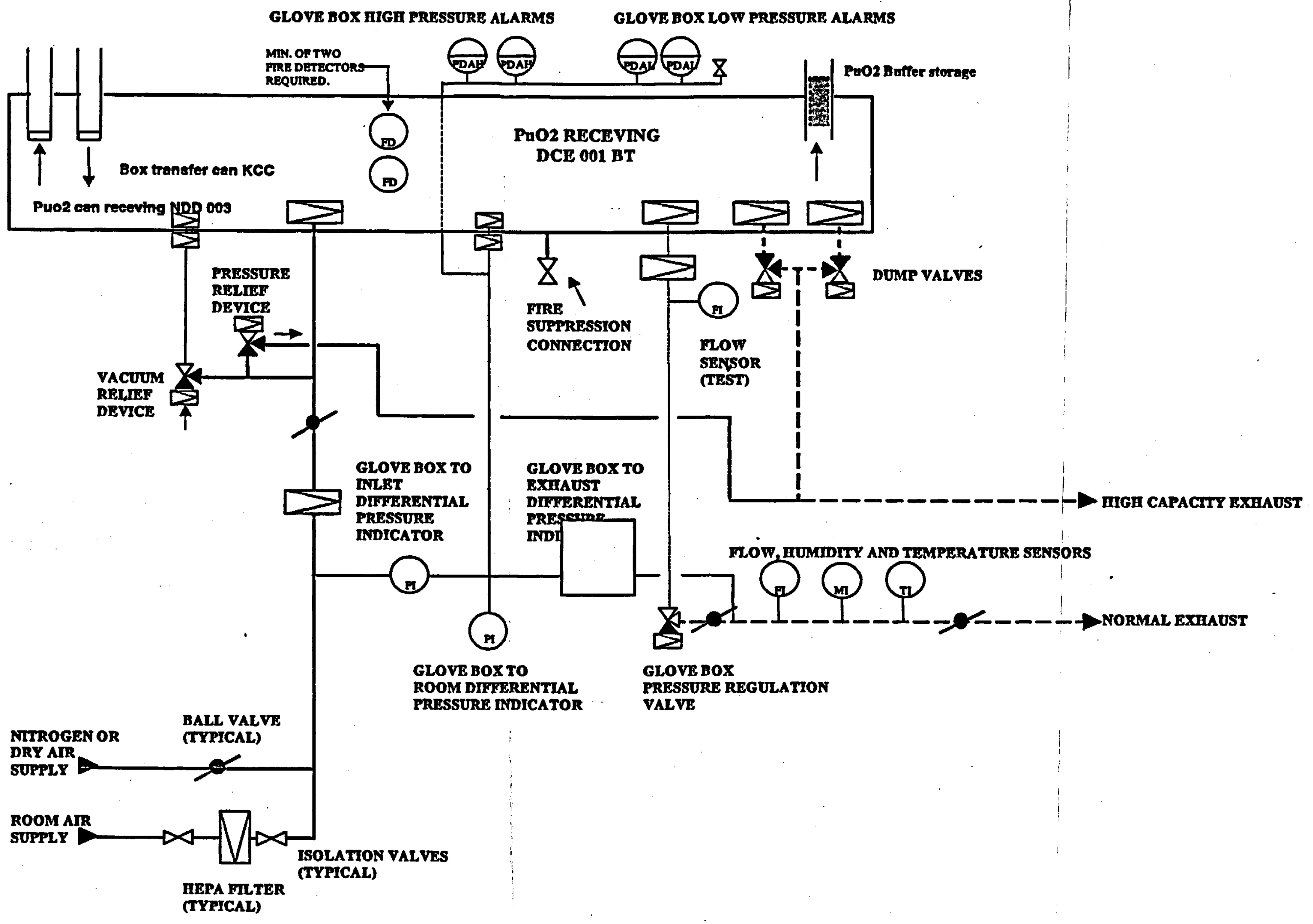

Figure 11.4-13. Typical Glovebox HVAC Schematic Diagram

This page intentionally left blank.

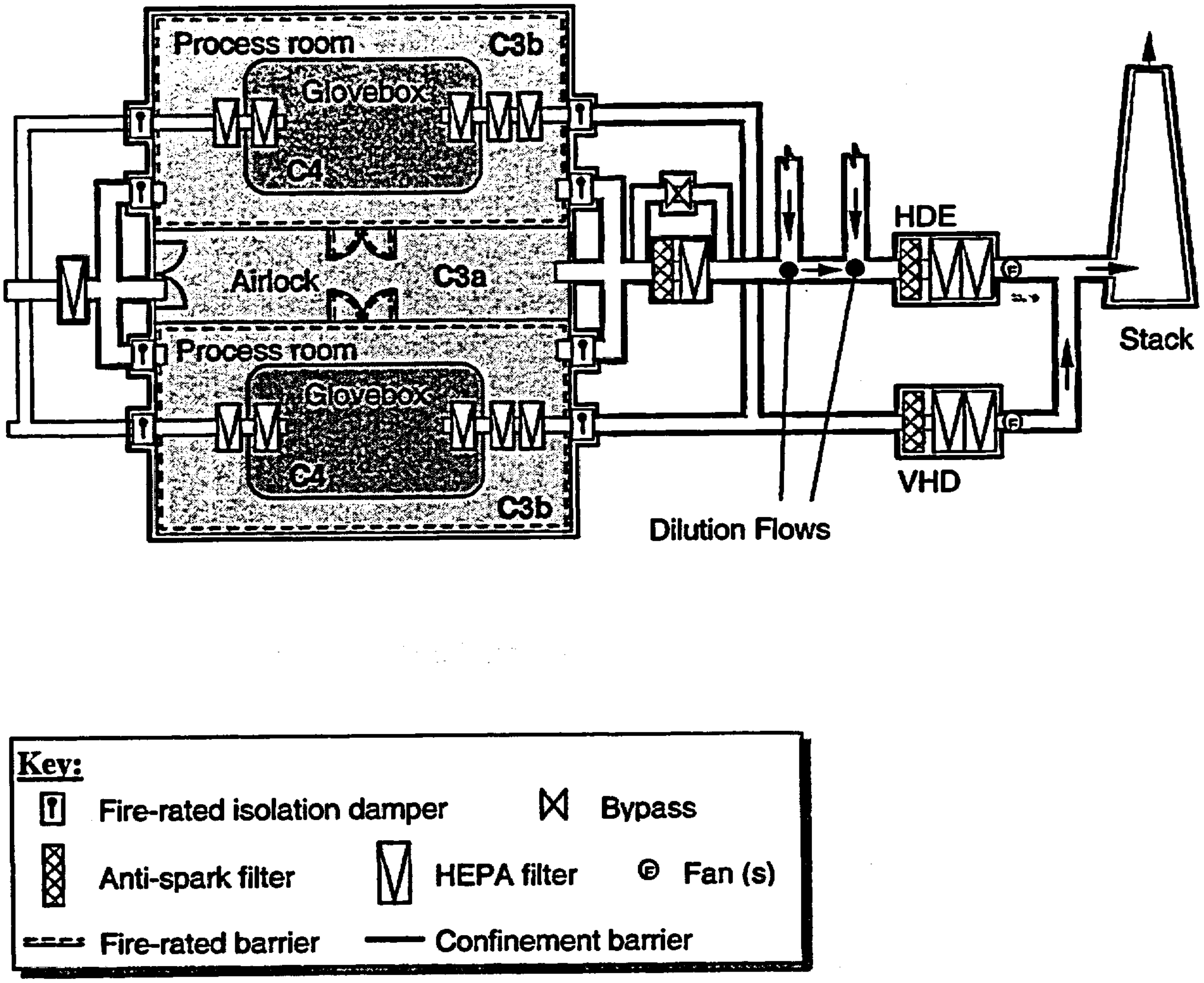

Figure 11.4-14. Example of Fire and Confinement Areas

This page intentionally left blank.

[THIS PAGE INTENTIONALLY LEFT BLANK.]

This page intentionally left blank.