

TABLES

Table 3.4-1 UF₆ Feed System Design Basis
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Equipment Requirements			
Component	Quantity Per		
	Cascade Hall	Separations Building Module	Plant Total
Solid Feed Station and Associated Valve Hot Box	6	12	36
Feed Purification Low Temperature Take-off Station and Associated Valve Hot Box	2	4	12
Feed Purification UF ₆ Cold Trap	2	4	12
Feed Purification Vacuum Pump/ Chemical Trap Set	2	4	12

Flow	Per Cascade Hall	Number Cascades
Continuous Minimum – kg/hr (lb/hr)	13.5 (29.8)	1
Continuous Maximum – kg/hr (lb/hr)	187 (412)	8

Solid Feed Station	
Number per Cascade Hall	6
On-line	3
Standby or Preparation	2
Spare (Standby, Prep, Maintenance)	1
Cylinder Type	48 X or 48Y
Capacity UF ₆ , kg (lb)	9,539 or 12,501 (21,033 or 27,565)
Heating Requirements	Air, via dedicated heater
Temperature, °C (°F)	61 (142)

Table 3.4-1 UF₆ Feed System Design Basis
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Solid Feed Station Weighing System	
Type	Load Cell
Capacity, kg (lb)	16,000 (35,300)

Feed Purification Low Temperature Take-off Station	
Number per Cascade Hall	2
Available, On-line	1
Spare (Standby, Prep, Maintenance)	1
Cylinder Type	48 X or 48Y
Capacity UF ₆ , kg (lb)	9,539 or 12,501 (21,033 or 27,565)
Cooling	
Medium	Air, via dedicated chiller
Temperature, °C (°F)	-25 (-13)
Heating	
Heating Requirements	Cylinder Valve Hot Air Blower
Temperature, °C (°F)	63 (145)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	16,000 (35,300)

Table 3.4-1 UF₆ Feed System Design Basis
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Feed Purification UF ₆ Cold Trap	
Number per Cascade Hall	2
Available, On-line	1
Spare (Standby, Prep, Maintenance)	1
Capacity, kg (lb) UF ₆	50 (110)
Cool Down / Desubliming	
Operating Temperature, °C (°F)	-60 (-76)
Heat Up / Subliming	
Operating Temperature, °C (°F)	20 (68)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	To be determined at final design.

Feed Purification Vacuum Pump/Chemical Trap Set				
Number per Cascade Hall			2	
Available, On-line			1	
Spare (Standby, Prep, Maintenance)			1	
Vacuum Pump				
Capacity, m ³ /hr (gpm)			40 (176)	
Chemical Traps (Note 1)				
Type	Chemical	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	HF Removal	Oil Removal	Oil Removal
Count	One	One	One	One
Media	Activated Carbon	Aluminum Oxide (Al ₂ O ₃)	Al ₂ O ₃	Activated Carbon

Note 1: Each Vacuum Pump/Chemical Trap Set has the above chemical traps.

Table 3.4-1 UF₆ Feed System Design Basis
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Hot Boxes, Pipe Heat Tracing	
Media	Electric
Temperature, °C (°F)	56 to 64 (133 to 147)

Nitrogen Purge	
Operating Pressure, mbar (psia)	<1,000 (14.5)
Gas Usage	Intermittent flow in small quantities.

Table 3.4-2 UF₆ Feed System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the UF ₆ Feed System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the UF ₆ Feed System.
Material handling equipment is designed in accordance with the appropriate industry codes and standards and the requirements of the Occupational Safety and Health Administration. There is no QA Level 1 material handling equipment in the UF ₆ Feed System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the UF ₆ Feed System.
All process piping in the UF ₆ Feed System shall meet or exceed the requirements of the American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail design.
All 48-in cylinders used in the UF ₆ Feed System comply with the requirements of ANSI N14.1, Uranium Hexafluoride Packaging for Transport, version in effect at the time of cylinder manufacture.

Table 3.4-3 Cascade System Codes and Standards

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The Centrifuge Machine Passive Isolation Devices is designed, constructed, tested, and maintained to QA Level 1.
Rotating equipment is designed in accordance with the appropriate industry codes and standards.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards.
All process piping in the Cascade System shall meet or exceed the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail engineering.
The design of electrical systems and components in the Cascade System is in conformance with the requirements of the National Electrical Safety Code, IEEE C2, current edition in effect at detail design, and the National Fire Protection Association, National Electrical Code, NFPA 70, current edition in effect at detail engineering, and appropriate industry codes and standards.

Table 3.4-4 Product Take-off System Design Basis

Page 1 of 5

Equipment Requirements			
Component	Quantity Per		
	Cascade Hall	Separations Building Module	Plant Total
Product Pumping Trains	2	4	12
Product Pumps (2 Pumps in series per Train)	4	8	24
Product Low Temperature Take-off Stations	5	10	30
UF ₆ cold traps	2	4	12
Vacuum Pump/Chemical Trap Sets	2	4	12

Flow – kg/hr (lb/hr)	Per Cascade Hall
Maximum	18.4 (40.6)

First Pump, Product Pumping Train	
Nominal Pump Capacity, m ³ /hr (cfm)	2,000 (1,177)
Inlet Pressure, mbar (in. H ₂ O)	2 (0.803)

Second Pump, Product Pumping Train	
Nominal Pump Capacity, m ³ /hr (cfm)	500 (294)
Maximum Outlet Pressure, mbar (in. H ₂ O)	80 (32.1)

Table 3.4-4 Product Take-off System Design Basis
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Product Low Temperature Take-off Station	
Number Per Cascade Hall	5
On-line	2
Standby	2
Preparation/Maintenance	1
Cylinder Type	30B or 48Y
Capacity UF ₆ , kg (lb)	2,277 or 12,501 (5,021 or 27,565)
Heating	
Heating Requirements	Cylinder Valve Hot Air Blower
Temperature, °C (°F)	63 (145)
Cooling	
Medium	Air, via dedicated chiller
Media Temperature, °C (°F)	-25 (-13)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	16,000 (35,300)

Table 3.4-4 Product Take-off System Design Basis
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Product Vent UF ₆ Cold Trap	
Number Per Cascade Hall	2
Available, On-line	1
Spare (Standby, Prep, Maintenance)	1
Capacity, kg (lb) UF ₆	25 (55.1)
Cool Down / Desubliming	
Operating Temperature, °C (°F)	-60 (-76)
Heat Up / Subliming	
Operating Temperature, °C (°F)	20 (68)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	To be determined at final design.

Table 3.4-4 Product Take-off System Design Basis

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Product Vent Vacuum Pump/Chemical Trap Set				
Number Per Cascade Hall			2	
Available, On-line			1	
Spare (Standby, Prep, Maintenance)			1	
Vacuum Pump				
Capacity, m ³ /hr (cfm)			40 (23.5)	
Chemical Traps (Note 1)				
Type	Chemical	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	HF Removal	Oil Removal	Oil Removal
Count	One	One	One	One
Media	Activated Carbon	Aluminum Oxide (Al ₂ O ₃)	Al ₂ O ₃	Activated Carbon

Note 1: Each Vacuum Pump/Chemical Trap Set has the above chemical traps.

Nitrogen Purge	
Operating Pressure, mbar (psia)	<1,000 (14.5)
Gas Usage	Intermittent flow in small quantities.

Table 3.4-4 Product Take-off System Design Basis
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Assay Sampling Pump/Chemical Trap Set			
Number Per Cascade Hall		1	
Vacuum Pump			
Capacity, m ³ /hr (cfm)		40 (23.5)	
Chemical Traps			
Type	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	Oil Removal	Oil Removal
Count	One	One	One
Media	Activated Carbon	Al ₂ O ₃	Activated Carbon

Table 3.4-5 Product Take-off System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the Product Take-off System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the Product Take-off System.
Material handling equipment is designed in accordance with the appropriate industry codes and standards and the requirements of the Occupational Safety and Health Administration. There is no QA Level 1 material handling equipment in the Product Take-off System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the Product Take-off System.
All process piping in the Product Take-off System shall meet or exceed the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail design.
All 30-in and 48-in cylinders used in the Product Take-off System comply with the requirements of ANSI N14.1, Uranium Hexafluoride Packaging for Transport, version in effect at the time of cylinder manufacture.

Table 3.4-6 Tails Take-off System Design Basis

Page 1 of 3

Equipment Requirements			
Component	Quantity Per		
	Cascade Hall	Separations Building Module	Plant Total
Tails Pumping Trains	16	32	96
Tails Pumps (Two Pumps in series per Train)	32	64	192
Tails Low Temperature Take-off Stations	10	20	60
Tails Evacuation Pump/Chemical Trap Sets	1	2	6

Flow – kg/hr (lb/hr)	Per Cascade Hall
Maximum	168 (370)
Dump Peak	256 (564)

First Pump, Tails Pumping Train	
Nominal Pump Capacity, m ³ /hr (cfm)	2,000 (1,177)
Inlet Pressure, mbar (in. H ₂ O)	2 (0.80)

Second Pump, Tails Pumping Train	
Nominal Pump Capacity, m ³ /hr (cfm)	500 (294)
Maximum Outlet Pressure, mbar (in. H ₂ O)	55 (22.1)

Table 3.4-6 Tails Take-off System Design Basis
Page 2 of 3

Tails Low Temperature Take-off Station	
Number Per Cascade Hall	10
On-line	7
Standby	1
Preparation/Maintenance	2
Cylinder Type	48Y
Capacity UF ₆ , kg (lb)	12,501 (27,565)
Heating	
Heating Requirements	Cylinder Valve Hot Air Blower
Temperature, °C (°F)	63 (145)
Cooling	
Medium	Air, via dedicated chiller
Media Temperature, °C (°F)	-25 (-13)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	16,000 (35,300)

Table 3.4-6 Tails Take-off System Design Basis
Page 3 of 3

Tails Evacuation Pump/Chemical Trap Set				
Number Per Cascade Hall			1	
Vacuum Pump				
Capacity, m ³ /hr (cfm)			40 (23.5)	
Chemical Traps				
Type	Chemical	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	HF Removal	Oil Removal	Oil Removal
Count	One	One	One	One
Media	Activated Carbon	Aluminum Oxide (Al ₂ O ₃)	Al ₂ O ₃	Activated Carbon

Nitrogen Purge	
Operating Pressure, mbar (psia)	<1,000 (14.5)
Gas Usage	Intermittent flow in small quantities.

Table 3.4-7 Tails Take-off System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the Tails Take-off System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the Tails Take-off System.
Material handling equipment is designed in accordance with the appropriate industry codes and standards and the requirements of the Occupational Safety and Health Administration. There is no QA Level 1 material handling equipment in the Tails Take-off System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the Tails Take-off System.
All process piping in the Tails Take-off System shall meet or exceed the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail design.
All 48-in cylinders used in the Tails Take-off System comply with the requirements of ANSI N14.1, Uranium Hexafluoride Packaging for Transport, version in effect at the time of cylinder manufacture.

Table 3.4-8 Product Blending System Design Basis

Page 1 of 3

Equipment Requirements	
Component	Number Required (Plant Total)
Blending Donor Stations and Associated Valve Hot Boxes	2
Blending Receiver Stations and Associated Valve Hot Boxes	4
Blending and Sampling Vent Subsystem UF ₆ cold traps	1
Blending and Sampling Vent Subsystem Pump/Chemical Trap Sets	1

Blending Donor Stations	
Number per Plant (Total)	2
On-line	1 or 2
Standby, Preparation, Maintenance	1 or 2
Heating Requirements	Air, via dedicated heater
Cylinder Type	30B or 48Y
Capacity UF ₆ , kg (lb)	2,277 or 12,501 (5,021 or 27,565)
Temperature, °C (°F)	61 (142)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	16,000 (35,300)

Table 3.4-8 Product Blending System Design Basis
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Blending Receiver Stations	
Number per Plant (Total)	4
On-line	1 to 4
Standby, Preparation, Maintenance	1 to 4
Cylinder Type	30B
Capacity UF ₆ , kg (lb)	2,277 (5,021)
Cooling	
Medium	Air, via dedicated chiller
Temperature, °C (°F)	-25 (-13)
Heating	
Heating Requirements	Cylinder Valve Hot Air Blower
Temperature, °C (°F)	63 (145)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	4,000 (8,820)

Donor and Receiver Station Valve Hot Boxes		
Heating Media	Donor	Receiver
Media	Electrical Trace	Electrical Trace
Temperature, °C (°F)	60 (140)	60 (140)

Table 3.4-8 Product Blending System Design Basis
Page 3 of 3

Blending and Sampling Vent UF ₆ Cold Trap	
Number per Plant (Total)	1
Capacity, kg (lb) UF ₆	25 (55.1)
Cool Down/Desubliming	
Operating Temperature, °C (°F)	-60 (-76)
Heat Up/Subliming	
Operating Temperature, °C (°F)	20 (68)
Weighing System	
Type	Load Cell
Capacity, kg (lb)	To be determined in final design.

Blending and Sampling Vent Vacuum Pump/Chemical Trap Set				
Number per Plant (Total)			1	
Vacuum Pump				
Nominal Capacity, m ³ /hr (cfm)			40 (23.5)	
Chemical Traps				
Type	Chemical	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	HF Removal	Oil Removal	Oil Removal
Count	One	One	One	One
Media	Activated Carbon	Aluminum Oxide (Al ₂ O ₃)	Al ₂ O ₃	Activated Carbon

Nitrogen Purge	
Operating Pressure, mbar (psia)	<1,000 (14.5)
Gas Usage	Intermittent flow in small quantities.

Table 3.4-9 Product Blending System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the Product Blending System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the Product Blending System.
Material handling equipment is designed in accordance with the appropriate industry codes and standards and the requirements of the Occupational Safety and Health Administration. There is no QA Level 1 material handling equipment in the Product Blending System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the Product Blending System.
All process piping in the Product Blending System shall meet or exceed the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition.
All 30-in and 48-in cylinders used in the Product Blending System comply with the requirements of ANSI N14.1, Uranium Hexafluoride Packaging for Transport, version in effect at the time of cylinder manufacture.

Table 3.4-10 Product Liquid Sampling System Design Basis

Page 1 of 1

Equipment Requirements	
Component	Number Required (Total Plant)
Product Liquid Sampling Systems	1
Product Liquid Sampling Autoclaves	5

Capacity Requirements	
Product Cylinders	Equivalent 9 / week

Product Liquid Sampling Autoclaves	
Design Pressure, bar absolute (psia)	12 (174) and Full Vacuum
Design Temperature, °C (°F)	160 (320) (Pressure Vessel)
	120 (248) (Seals, Instruments)
Autoclave Cooling Water, °C (°F)	6 (42.8)

Product Cylinder	
Cylinder Type	30B
Capacity UF ₆ , kg (lb)	2,277 (5,021)

Product Sampling Manifold	
Sample Bottle Type	1S
Maximum Net Weight per bottle, kg (lb) UF ₆	0.45 (0.99)
Minimum Volume per bottle, L (gal)	0.15 (0.04)

Table 3.4-11 Product Liquid Sampling System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Product Liquid Sampling Autoclaves and their supports are designed to meet the requirements of the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section VIII, Division I, current edition at the time of detail design.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the Product Liquid Sampling System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the Product Liquid Sampling System.
Material handling equipment is designed in accordance with the appropriate industry codes and standards and the requirements of the Occupational Safety and Health Administration. There is no QA Level 1 material handling equipment in the Product Liquid Sampling System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the Product Liquid Sampling System.
All process piping in the Product Liquid Sampling System shall meet or exceed the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail design.
All 1.5-in and 30-in cylinders used in the Product Liquid Sampling System comply with the requirements of ANSI N14.1, Uranium Hexafluoride Packaging for Transport, version in effect at the time of cylinder manufacture.

Table 3.4-12 Contingency Dump System Design Basis
Page 1 of 2

Equipment Requirements			
Components	Quantity per		
	Cascade Hall	Plant Module	Plant Total
Sodium Fluoride Trap	24	48	144
Buffer Volume	8	16	48
Vacuum Pump/ Chemical Trap Set	8	16	48

System Capacity	Per Cascade Hall
Peak Dump Flow, kg/hr (lb/hr)	38.1 (84.0)
Dump Capacity, kg (lb)	15 (33.1)
Dump Time, hr	18

Chemical Trap	
Type	Sodium Fluoride Trap
Capacity UF ₆ , kg (lb)	100 (221)

Contingency Dump Vacuum Pump/Chemical Trap Set				
Vacuum Pump				
Capacity, m³/hr (cfm)			40 (23.5)	
Chemical Traps				
Type	Chemical	Chemical	Adsorption	Adsorption
Function	UF ₆ Removal	HF Removal	Oil Removal	Oil Removal
Count	1	1	1	1
Media	Activated Carbon	Aluminum Oxide (Al ₂ O ₃)	Al ₂ O ₃	Activated Carbon

Table 3.4-12 Contingency Dump System Design Basis
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Piping Headers	
Buffer Volume	
Volume, m ³ (ft ³)	1 (35.3)
Operating Pressure, mbar (in. H ₂ O)	Classified
Temperature, °C (°F)	Ambient
Primary Header	
Operating Pressure, mbar (in. H ₂ O)	Classified
Temperature, °C (°F)	Ambient
Secondary Header	
Operating Pressure, mbar (in. H ₂ O)	Classified
Temperature, °C (°F)	Ambient

Table 3.4-13 Contingency Dump System Codes and Standards

Page 1 of 1

The equipment IROFS are designed, constructed, tested, and maintained to QA Level 1. IROFS design criteria are included in Section 3.8.1, IROFS.
Rotating equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 rotating equipment in the Contingency Dump System.
Heat transfer equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 heat transfer equipment in the Contingency Dump System.
All miscellaneous equipment is designed in accordance with the appropriate industry codes and standards. There is no QA Level 1 miscellaneous equipment in the Contingency Dump System.
All process piping in the Contingency Dump System meets or exceeds the requirements of American Society of Mechanical Engineers, Process Piping, ASME B31.3, current edition at the time of detail design.

Table 3.4-14 Gaseous Effluent Vent System Codes and Standards

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Equipment Type	Code or Standard
Air Handling Units	NFPA 90A, 1999 AMCA Pub. 99 – 1986 AMCA Pub. 261 – 1998 ARI 430 – 1980 NEMA MG – 1998 REV. 3
Fans/Motors	AMCA 210 – 1999 ASHRAE 51 – 1999 ASHRAE Systems and Equipment 2000 NEMA MG1 – 1998 REV. 3
Coils	ANSI/ARI 410 – 2001
Air Cleaning Devices	ASME AG-1-1997 ERDA 76-21 – 1976 ANSI/ASME N509 – 1989 (R1996) ANSI/ASME N510 – 1989 (R1995) ASME NQA-1 – 2001 ASTM D6646-03 ANSI/AWS-D9.1 – 2000
Dampers	UL-Building Materials Directory

Table 3.4-15 Gaseous Effluent Vent System Design Bases (Separations Building)

Page 1 of 1

Equipment Requirements	
Item	Quantity
Filter Stations (prefilter, HEPA, activated carbon filter)	1 + 1 spare
Fans	1 + 1 spare
System Design Flow Rate	11,000 m ³ /hr (6474 scfm)
Filter Specifications	
Prefilter (Dust removal)	85%
HEPA Filter (Removal of uranium aerosols, mainly UO ₂ F ₂ particles)	99.97% (for ≥ 0.3 μm particle size)
Activated Carbon Filter (HF removal)	99%

Table 3.4-16 Gaseous Effluent Vent System Design Bases (Technical Services Building)

Page 1 of 1

Equipment Requirements	
Item	Quantity
Filter Stations (prefilter, HEPA, activated carbon filter)	1 (no spare)
Fans	1 (no spare)
System Design Flow Rate	18,700 m ³ /hr (11,000 scfm)
Filter Specifications	
Prefilter (Dust removal)	85%
HEPA Filter (Removal of uranium aerosols, mainly UO ₂ F ₂ particles)	99.97% (for ≥ 0.3 μm particle size)
Activated Carbon Filter (HF removal)	99%

Table 3.4-17 Functional Requirements for Centrifuge Test and Post Mortem Facilities

Page 1 of 1

Item	Test	Post Mortem
Temperature	18-25°C (64.4 – 77°F)	18-25°C (64.4 – 77°F)
Relative Humidity	55% max.	70% max.
Pressure	Ambient.	Negative pressure to prevent egress of airborne contaminated materials.
Handling	Floor based transport vehicle, jib crane.	Floor based transport vehicle, jib crane.
Physical Security	Access control for cleared personnel only.	Access control for cleared personnel only.
Personnel Facilities (common to both facilities).	Toilets, wash basins, shower, and change area.	Toilets, wash basins, shower, and change area.
Radiological Protection	Alpha in air monitors, HFC (hand foot clothing) monitor. Criticality incident detection system. PPE (gloves, overalls, face masks with appropriate filtration).	Alpha in air monitors, HFC (hand foot clothing) monitor. Criticality incident detection system. PPE (gloves, overalls, face masks with appropriate filtration).

Table 3.4-18 Utility Requirements for Centrifuge Test and Post Mortem Facilities

Page 1 of 1

Utilities	Test	Post Mortem
Electrical	440 VAC, 110 VAC, and 24VDC for instruments	Same
Liquid Nitrogen	Required	Not required
Nitrogen Gas	Required	Required
Compressed Air	Required	Required
HVAC	Required	Required
Centrifuge Test and Post Mortem Facilities Exhaust Filtration System	<p>Three separate flexible exhaust hoses are required. One is located adjacent to the feed and take-off vessels to allow removal and recharging with UF₆. The remaining two are located at the top of each Centrifuge Cubicle, to provide local extract when breaking process connections.</p> <p>The exhaust of the rotary vane vacuum pump discharges into the Centrifuge Test and Post Mortem Facilities Exhaust Filtration System.</p>	Required
Cooling Water	Proprietary stand-alone unit.	Not required

Table 3.4-19 UF₆ Feed Cylinder Delivery and Storage Requirements

Page 1 of 1

Feed Cylinders	
Code	ANSI-N14.1
Type (Typical)	48Y or 48X
Net UF ₆ Capacity	12,501 kg (27,560 lbs)
Average Rate (Cylinders/Yr)	690
Handling	
Unloading	20 Metric Ton Bridge Crane
Transfer	Rail Transport
Storage	
No. Cylinders (1 Year Supply)	708
Area/Cylinder	8 m ² (86 ft ²)
Stacking	No
Indoor/Outdoor	Indoor
Temperature	Ambient
Accountability Weighing System	
Type	Weigh Scale
Capacity	20,000 kg (44,092 lbs)
Accuracy	±2.5 kg (±5.5 lb)

Table 3.4-20 Crane Movement Requirements

Page 1 of 1

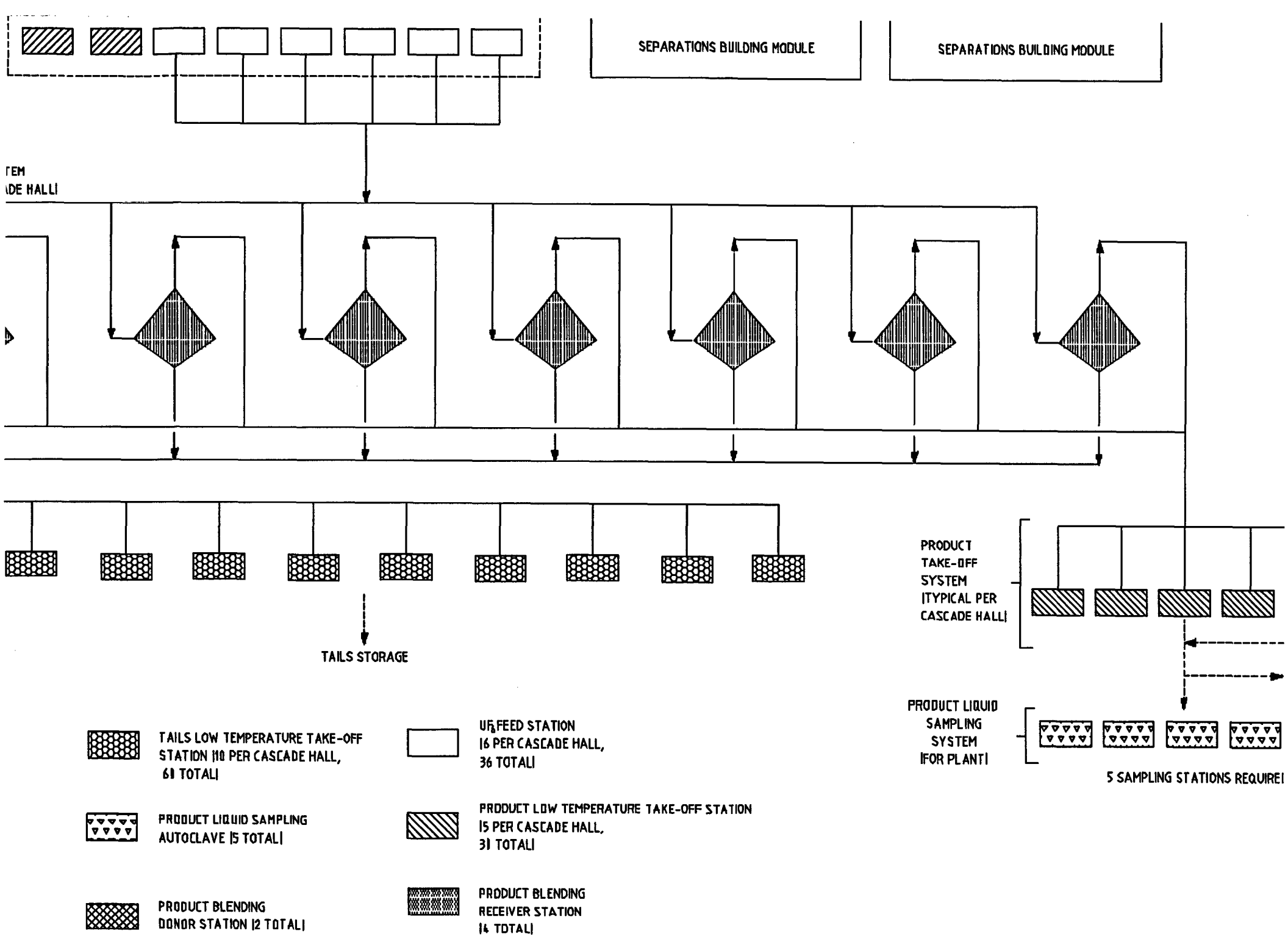
Cylinder Receipt and Dispatch Building	
Type	20 Metric Ton Bridge Crane
Quantity	2
<u>Movements: (cylinders/yr)</u>	
Feed Cylinders In	690
Product Cylinders Out	350
UBC Out	625
Empty Product In	350
Empty UBC In	625
Empty Feed Out	690
Total Crane Movements (Cylinders/Yr)	3330
UBC Storage Pad	
Type	20 Metric Ton Gantry Crane
Quantity	3
<u>Movements: (cylinders/yr)</u>	
UBC In	625
Empty Feed In	690
Empty Feed Out	690
Total Crane Movements (Cylinders/Yr)	2005

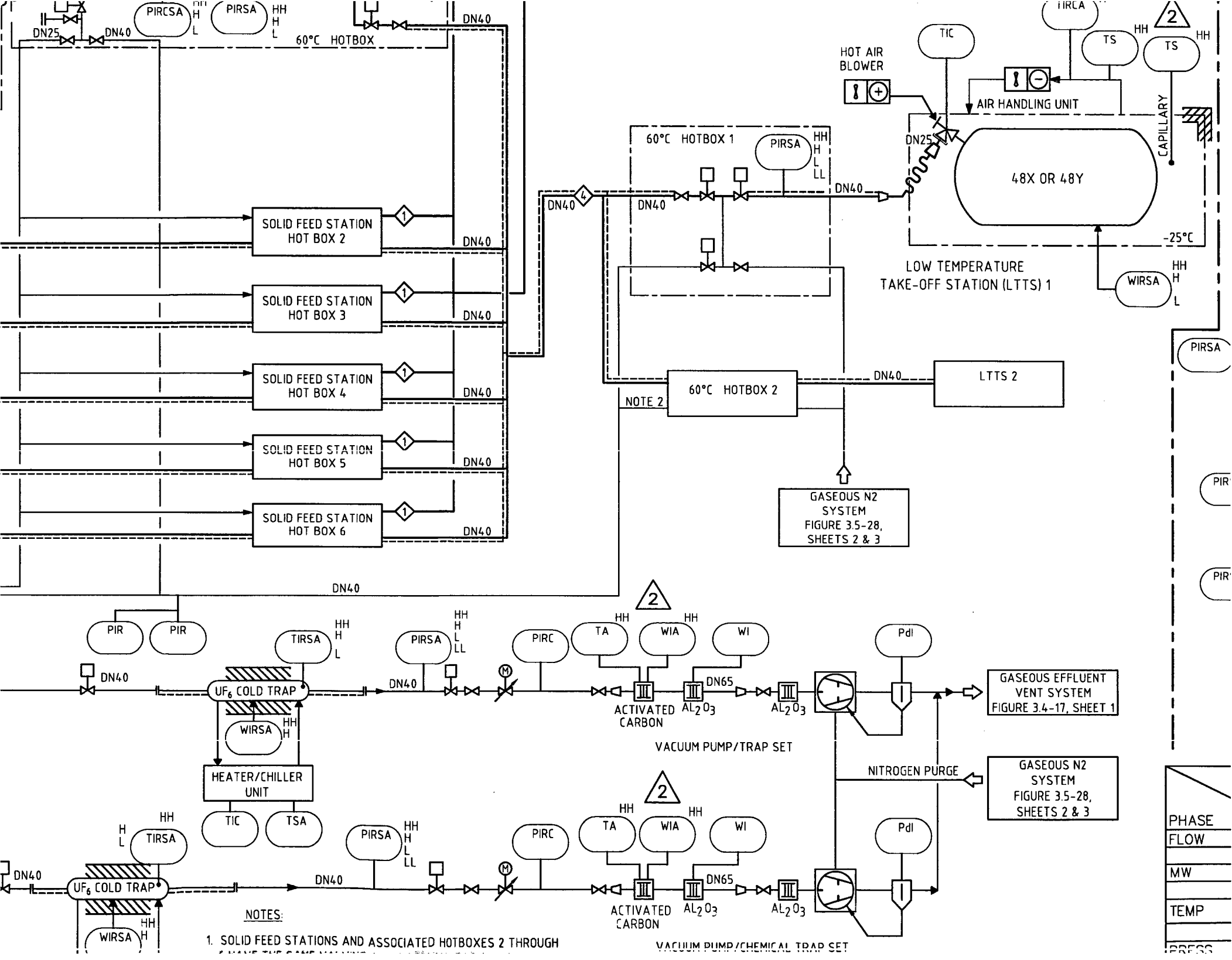
Table 3.4-21 UBC Storage System Requirements

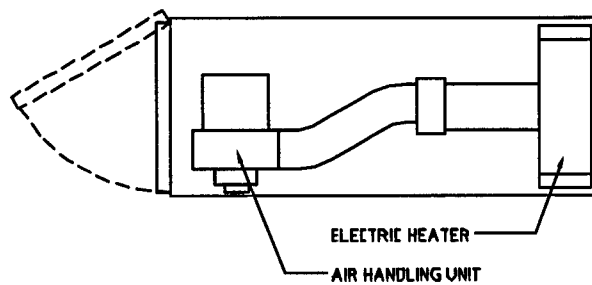
Page 1 of 1

Cylinders	
Code	ANSI-N14.1
Type (Typical)	48Y
Net UF ₆ Capacity	12,501 kg (27,560 lbs)
Rate (Cylinders/Yr)	625 maximum at full production
Storage	
No. Cylinders	15,727
Area/Cylinder	5.40 m ² (58 ft ²)
Stacking	Yes (on concrete saddles)
Indoor/Outdoor	Outdoor
Temperature	Ambient

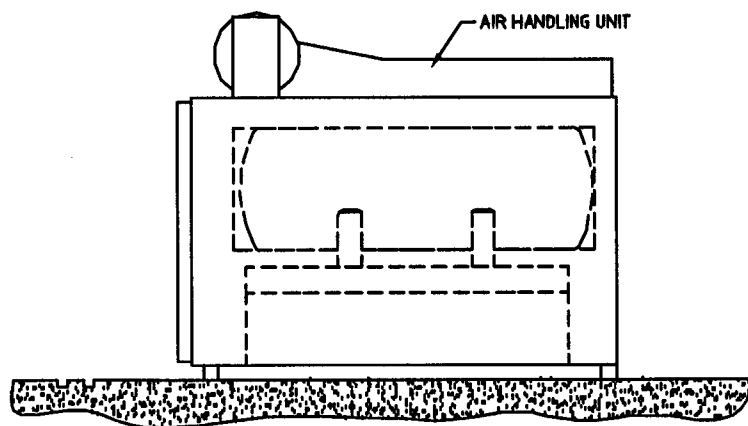
FIGURES



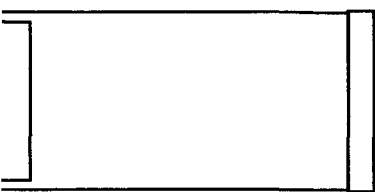




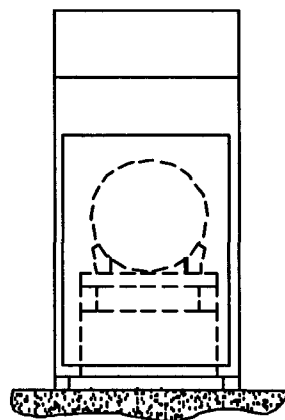
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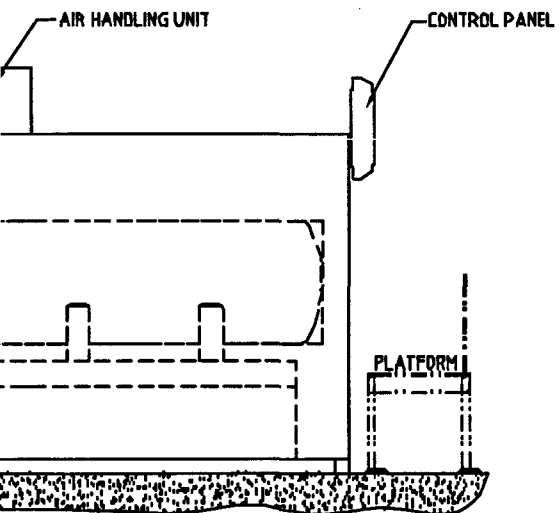
SIDE ELEVATION



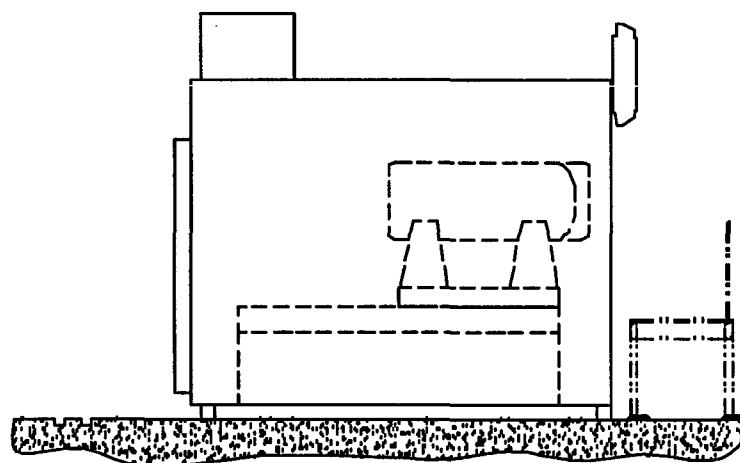
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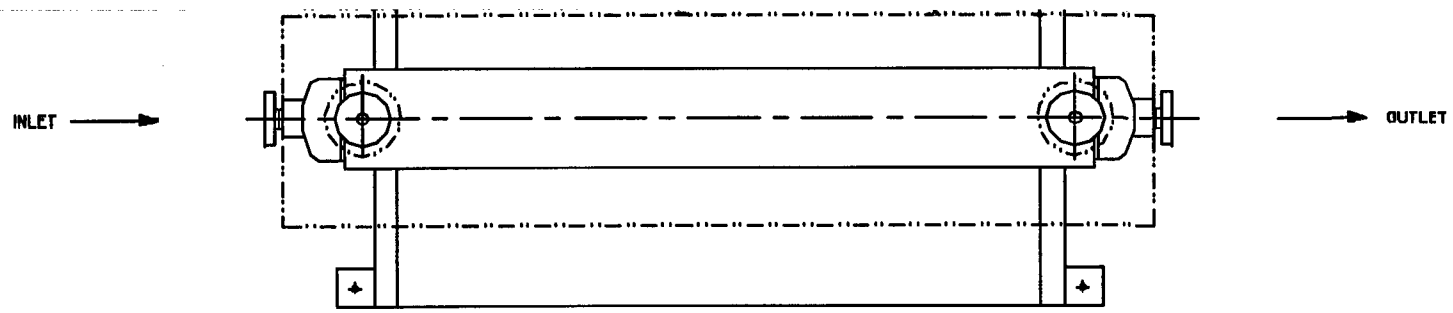
END VIEW



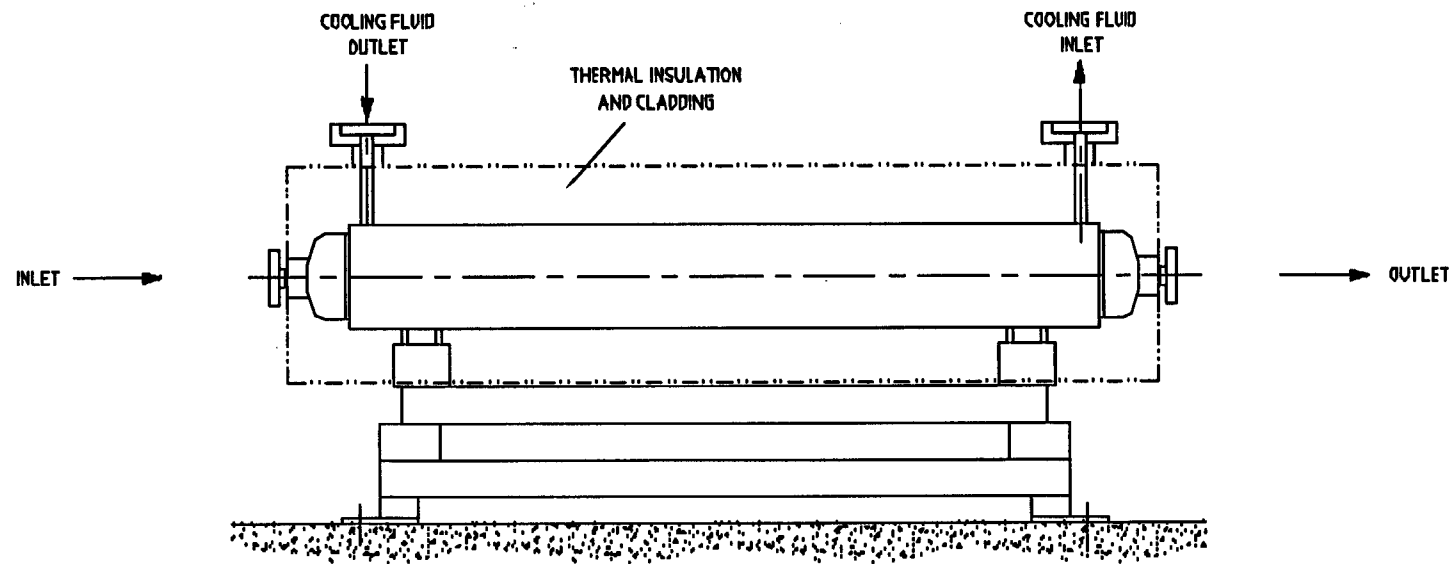
SIDE ELEVATION
(WING 48" CYLINDER)



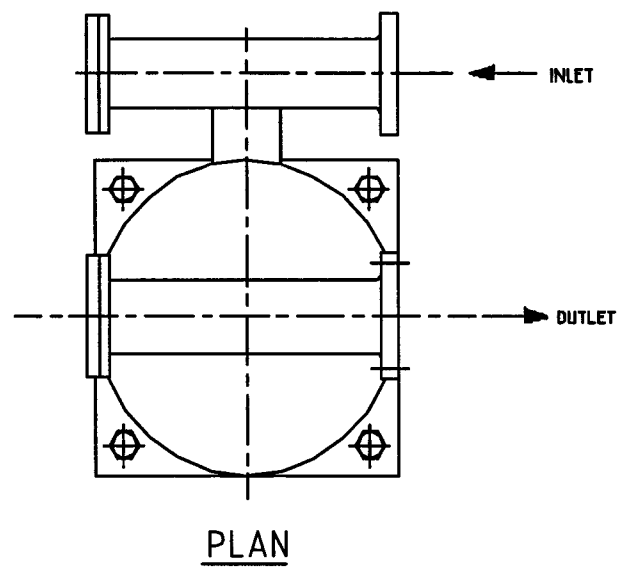
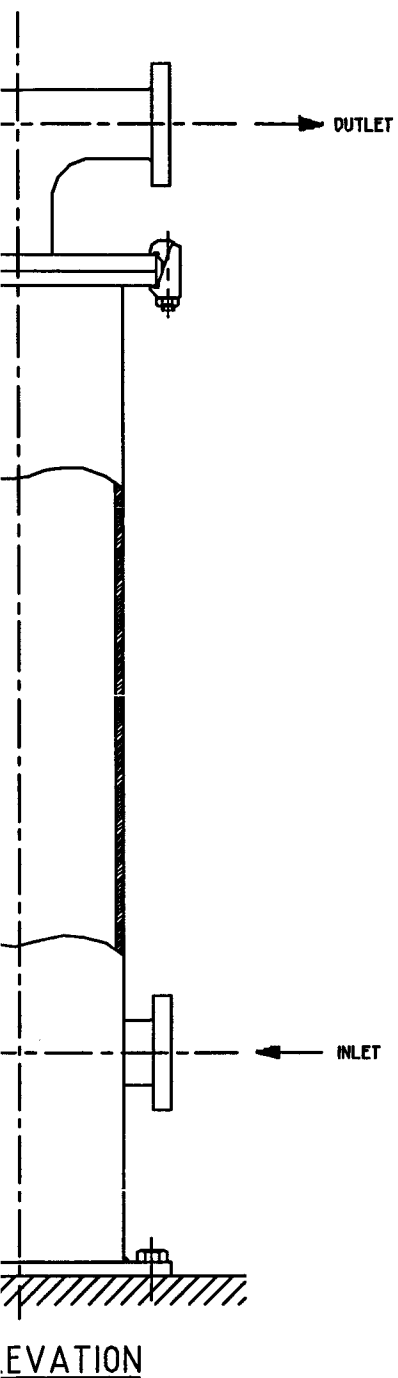
SIDE ELEVATION
(SHOWING 30" CYLINDER)

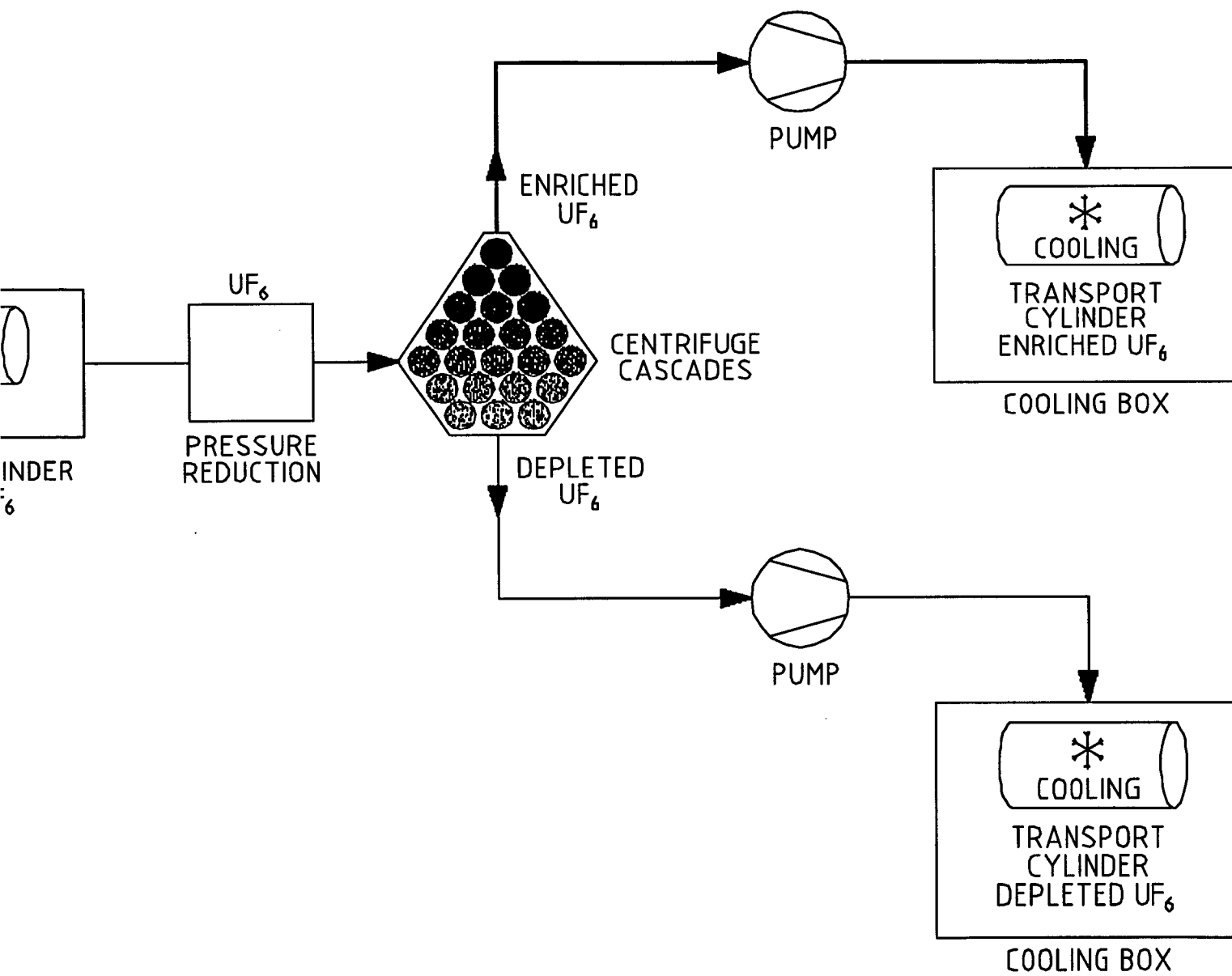


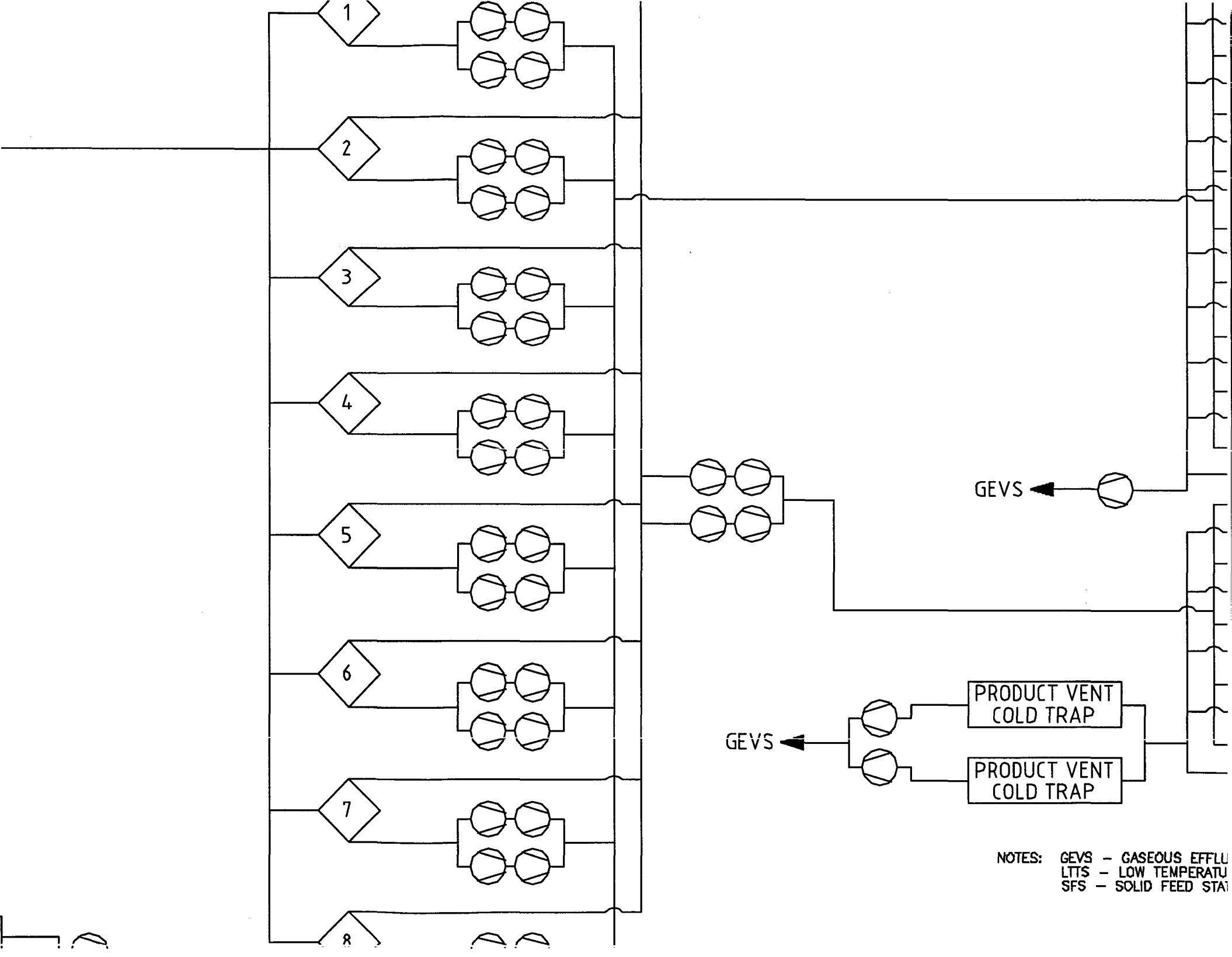
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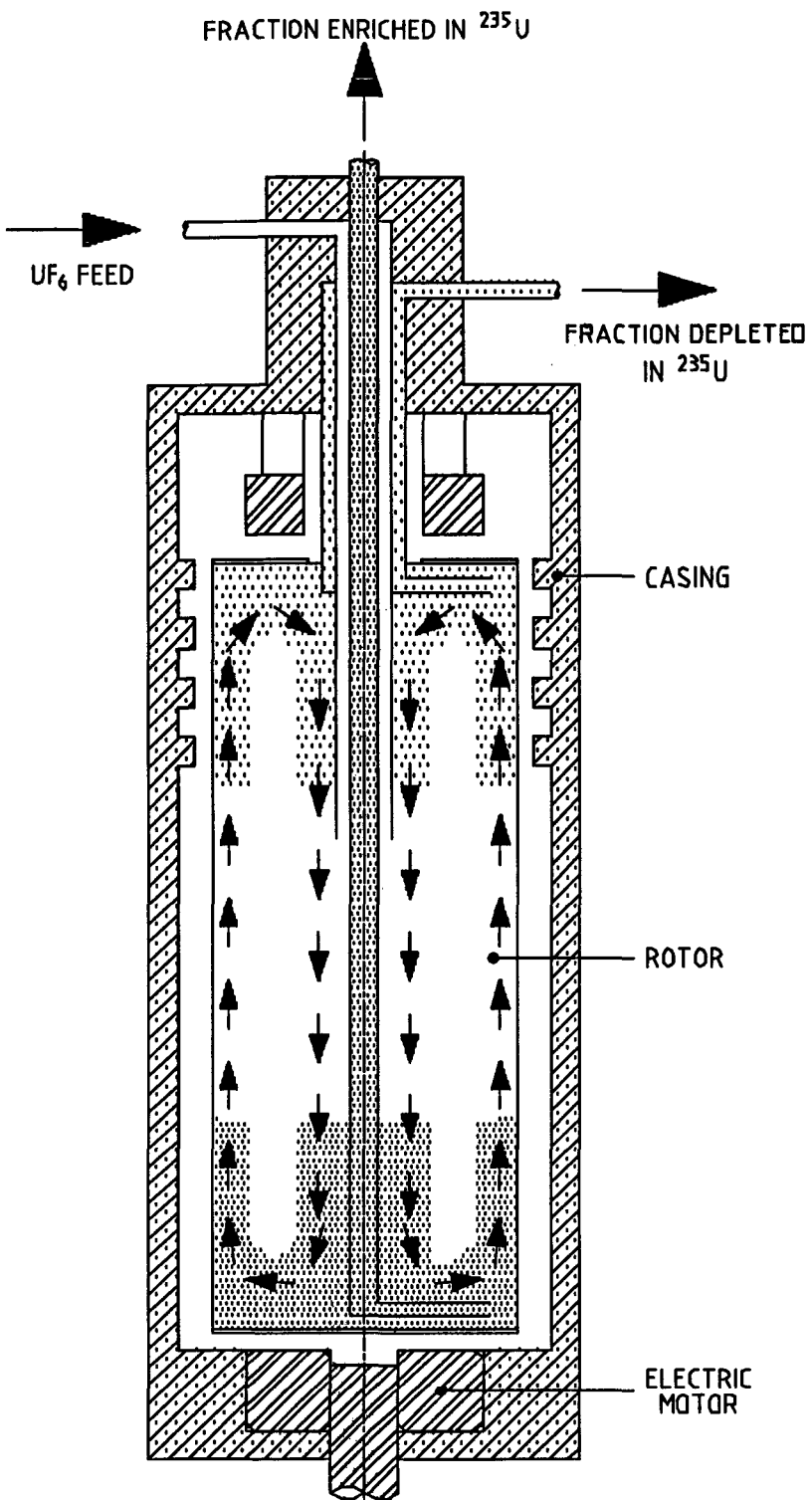


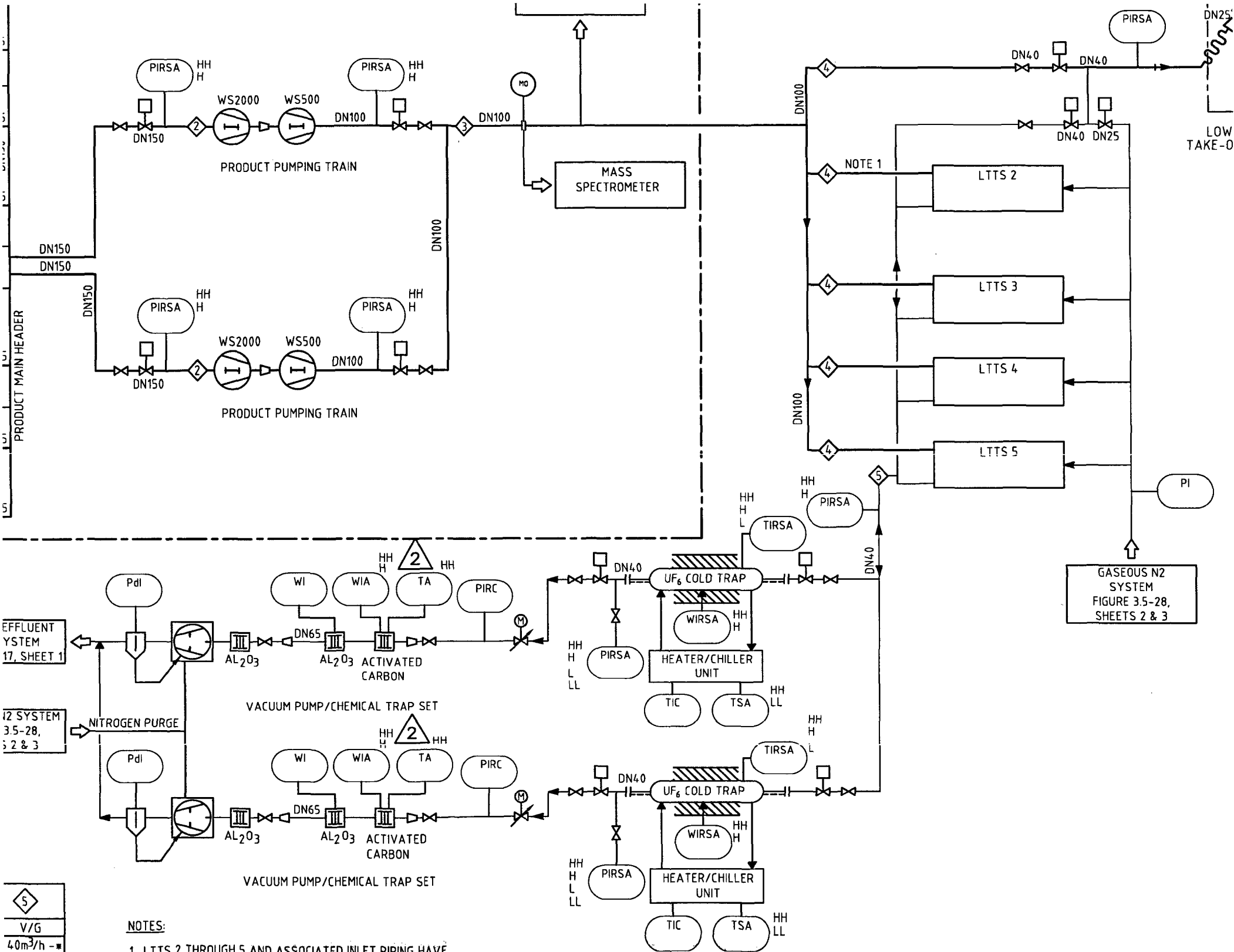
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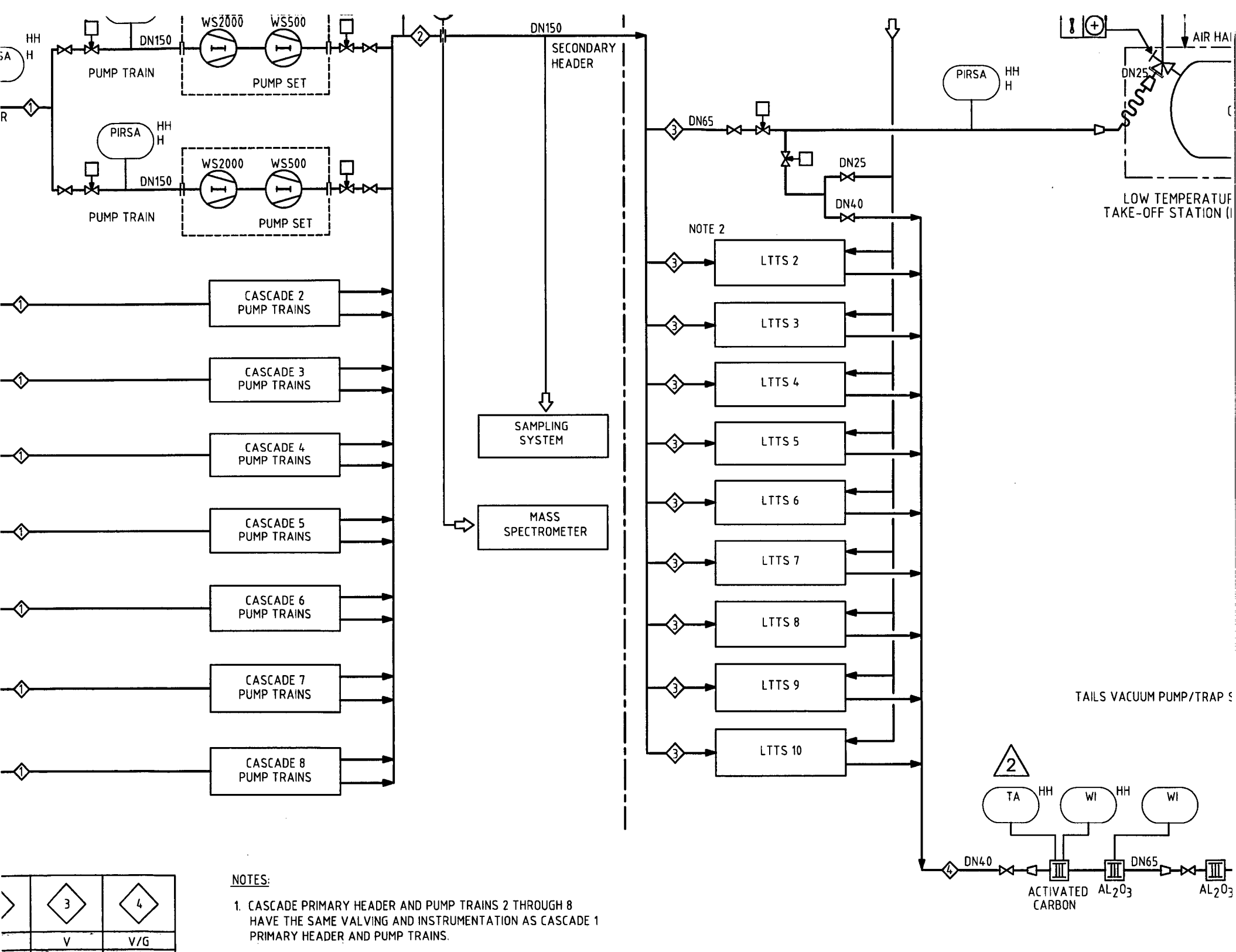


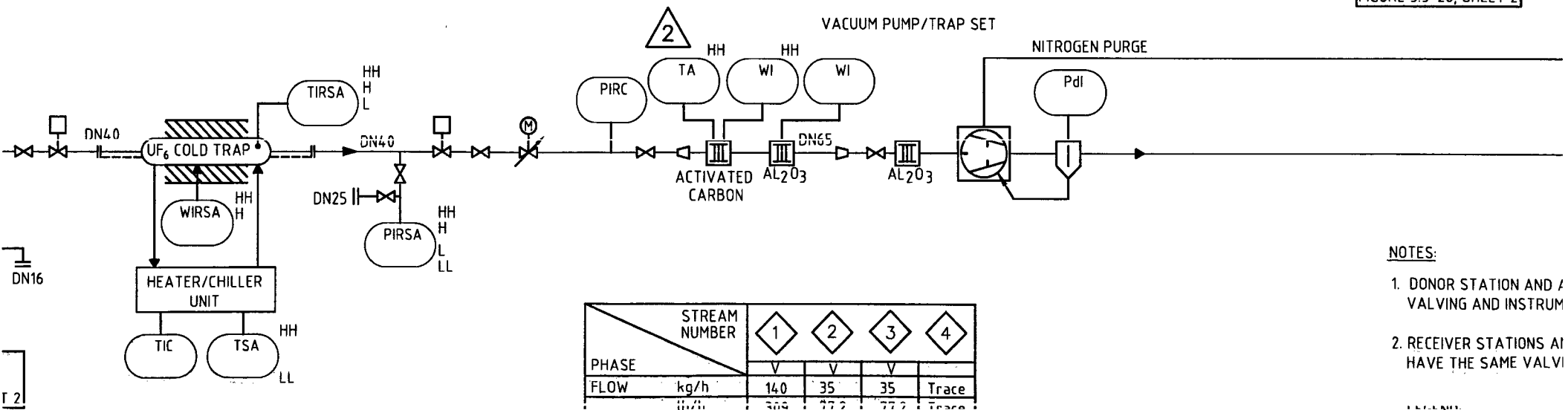
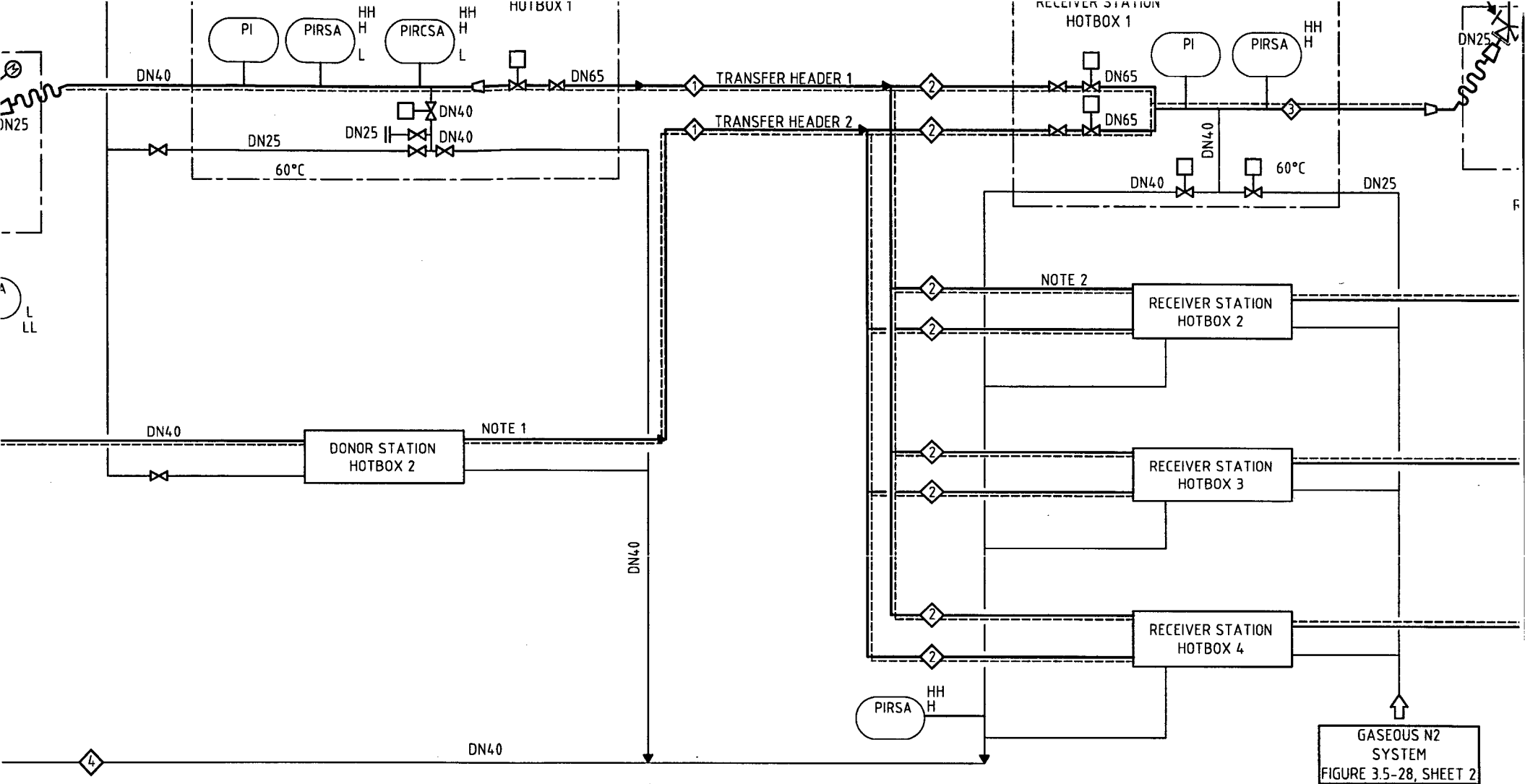






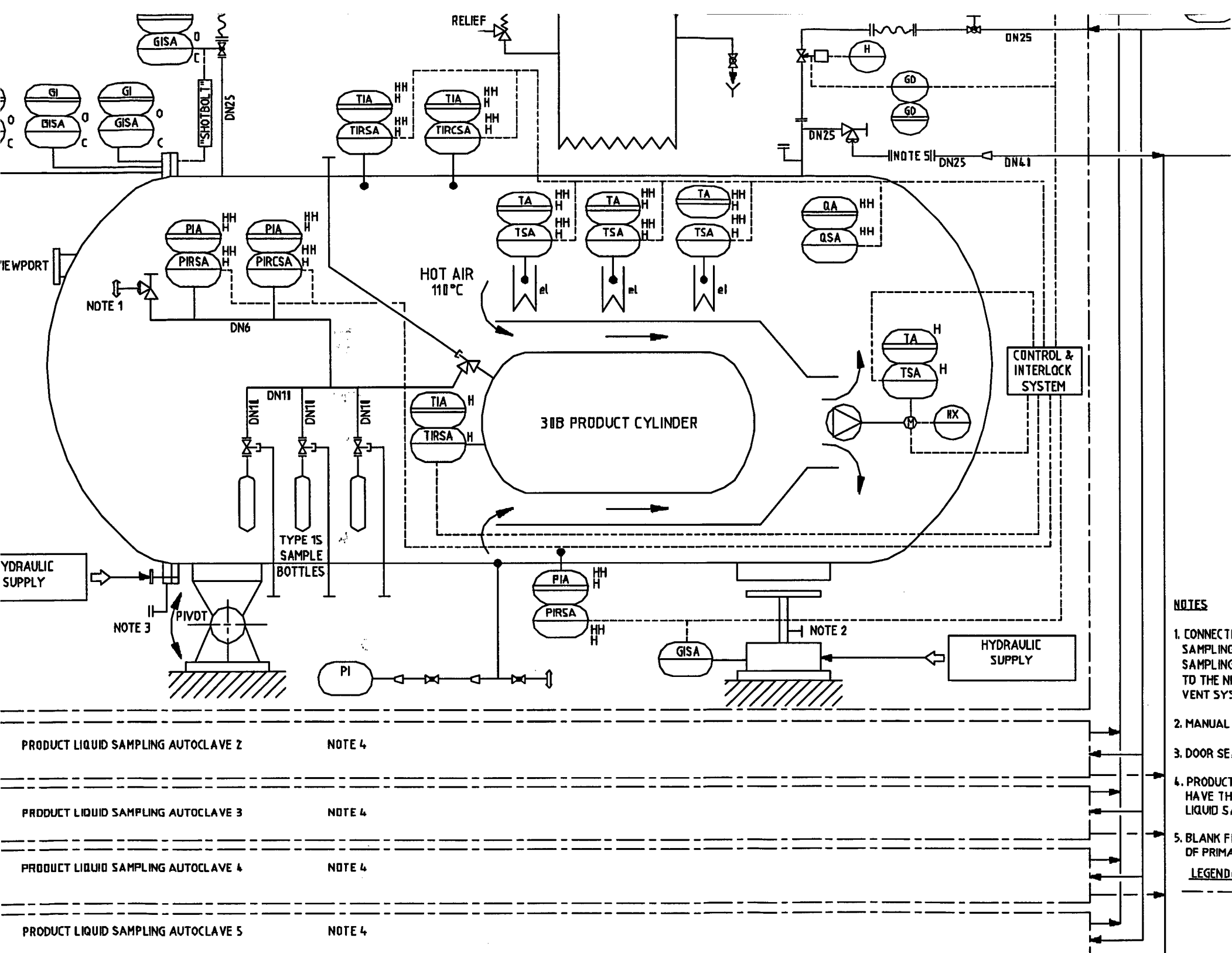






NOTES:

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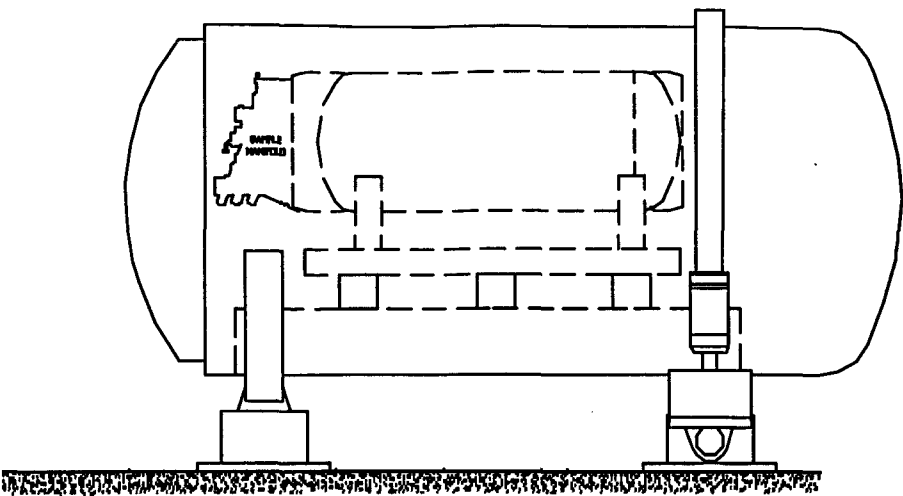
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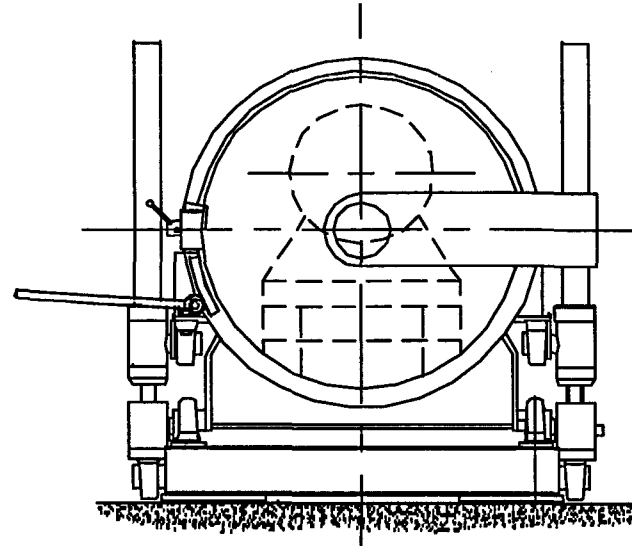
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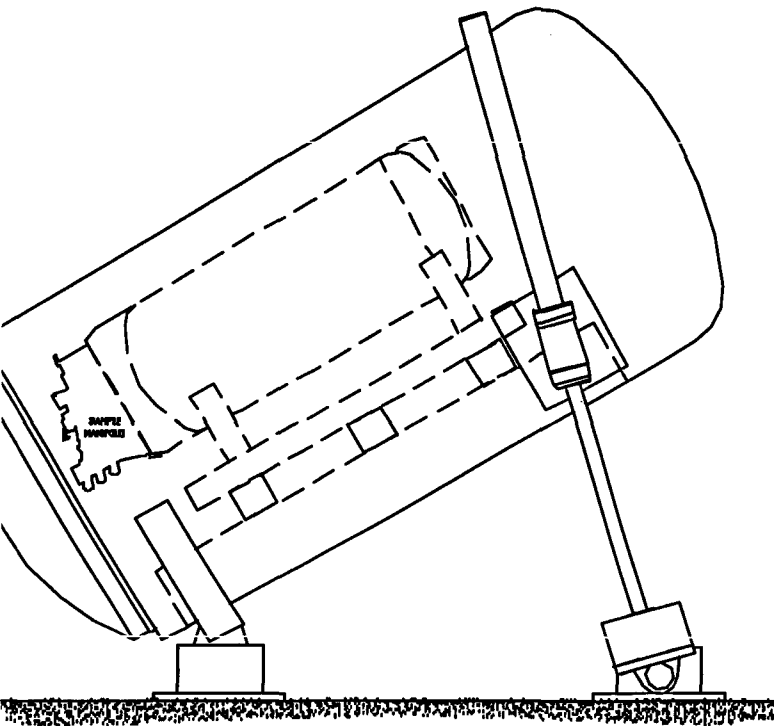
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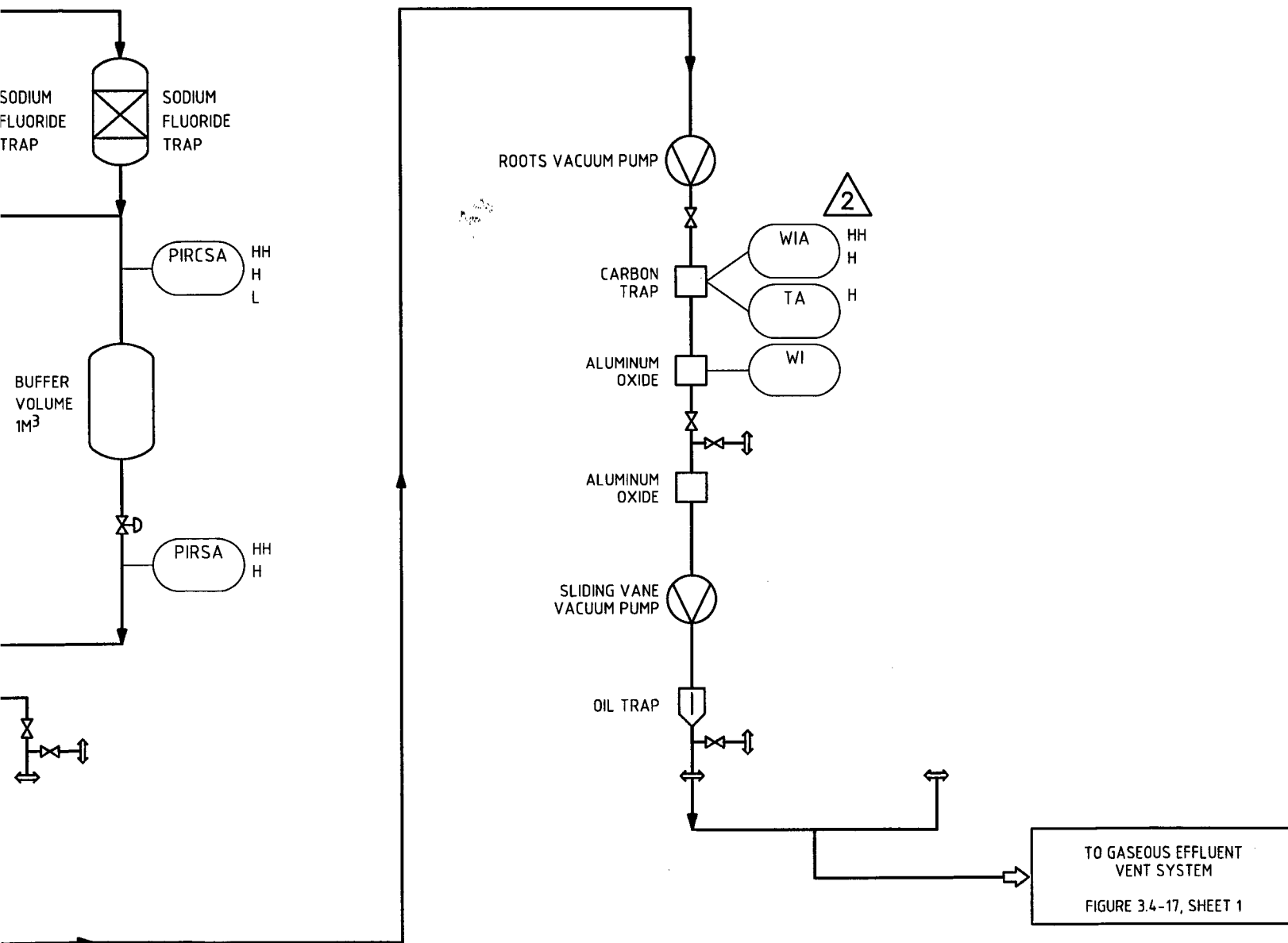
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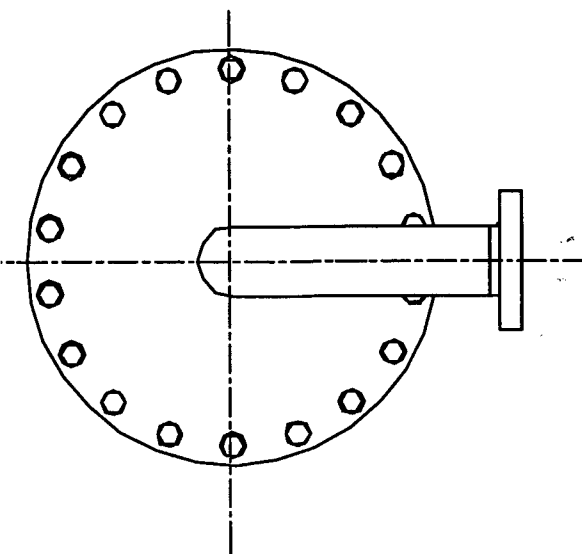


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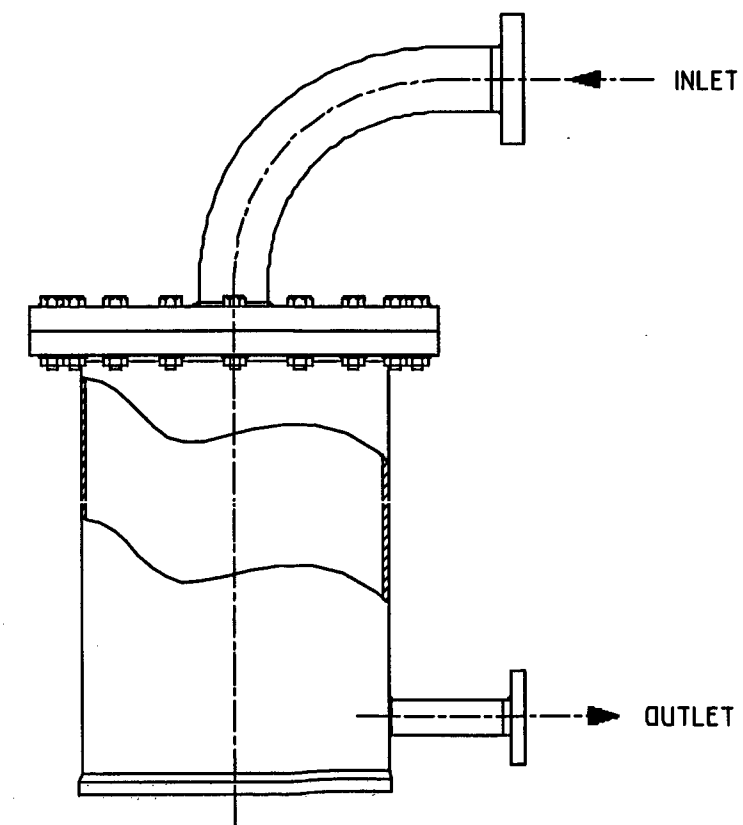


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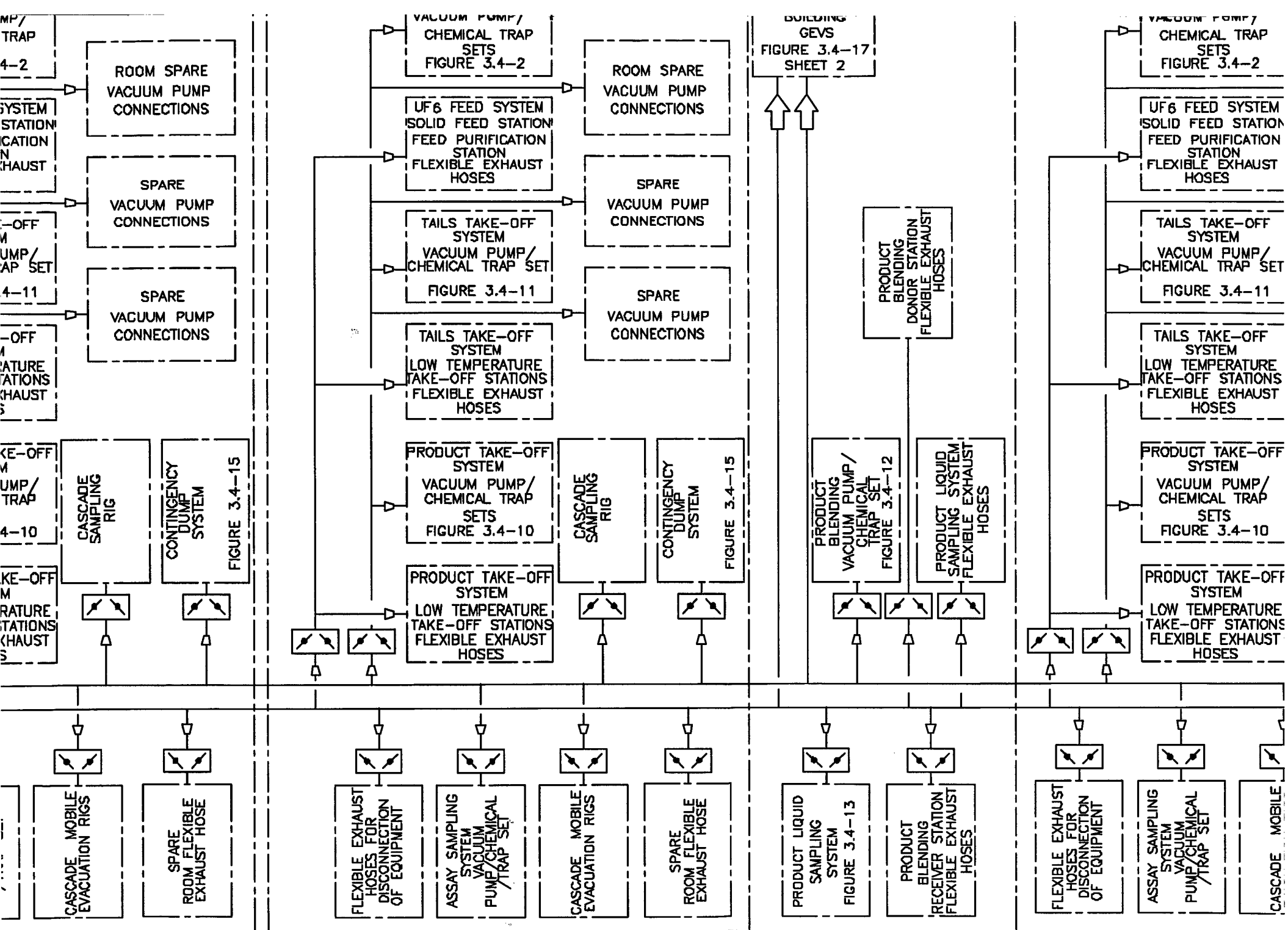


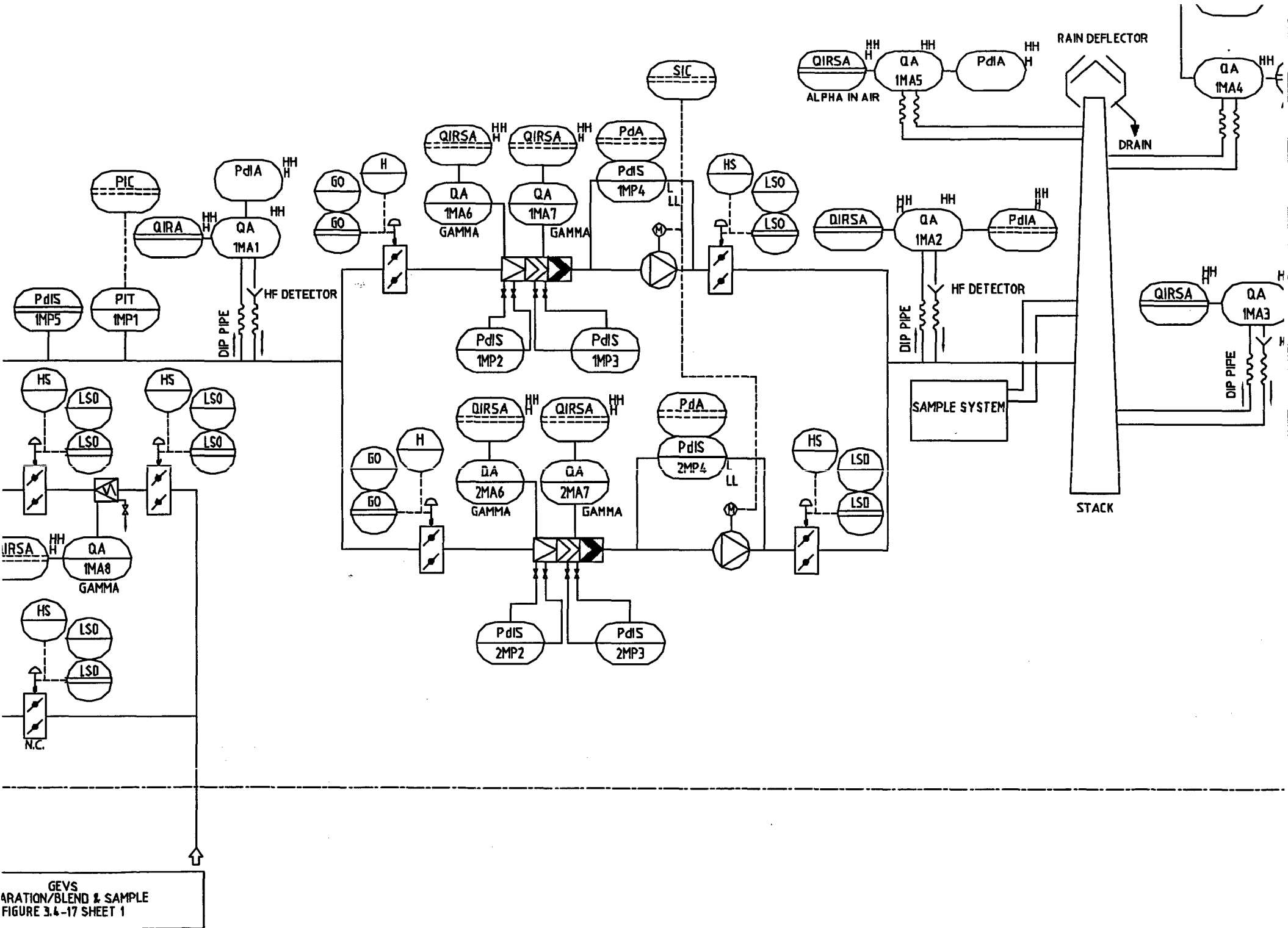


PLAN



SIDE ELEVATION





DECONTAMINATION
WORKSHOP
(INCLUDING
FOMBLIN OIL
RECOV SYSTEM)

FIGURE 3.5-39
FIGURE 3.5-41
FIGURE 3.5-40
FIGURE 3.5-42

VENTILATED ROOM
CYLINDER
PRESSURE TEST
AND PUMP OUT
FIGURE 3.5-43

VACUUM PUMP
REBUILD ROOM

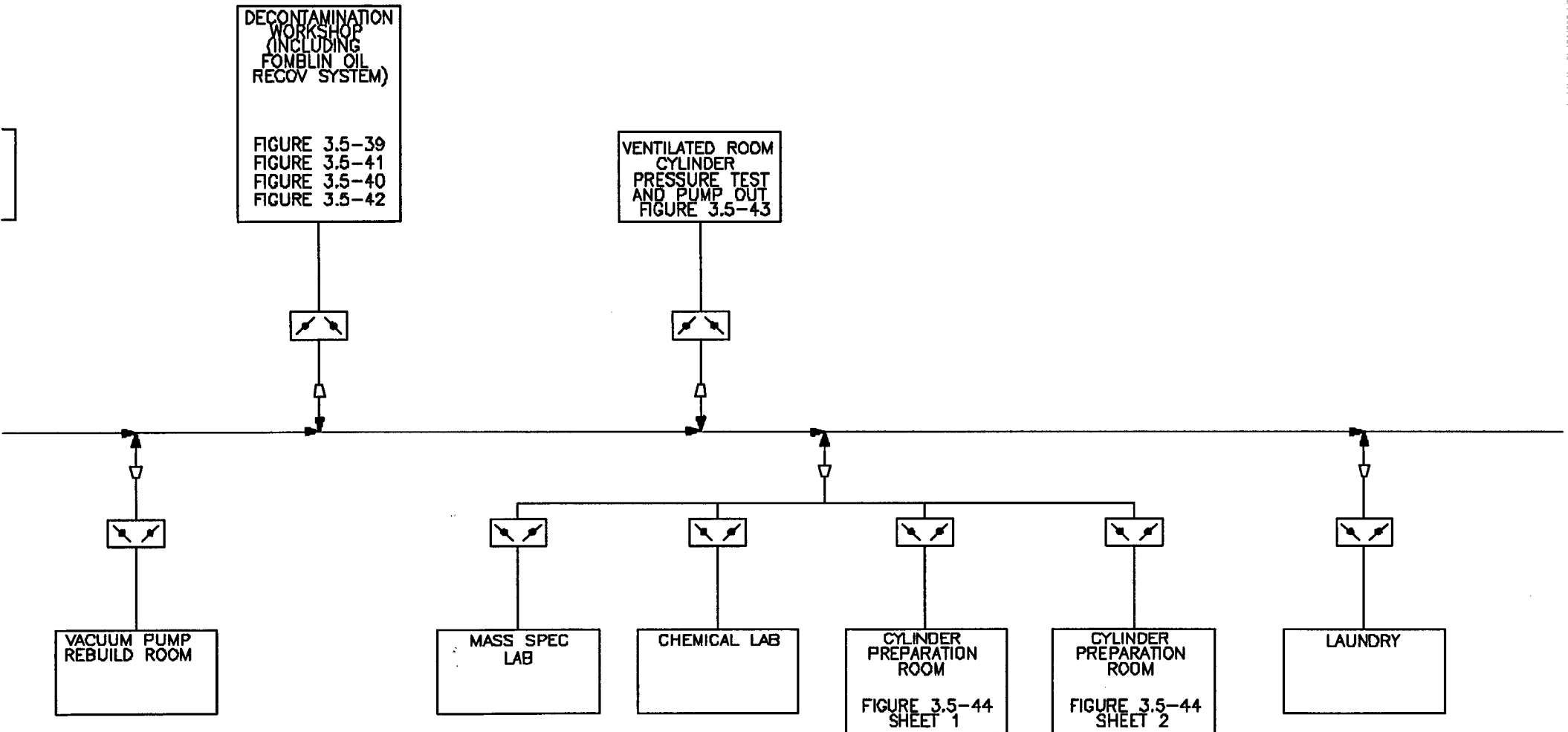
MASS SPEC
LAB

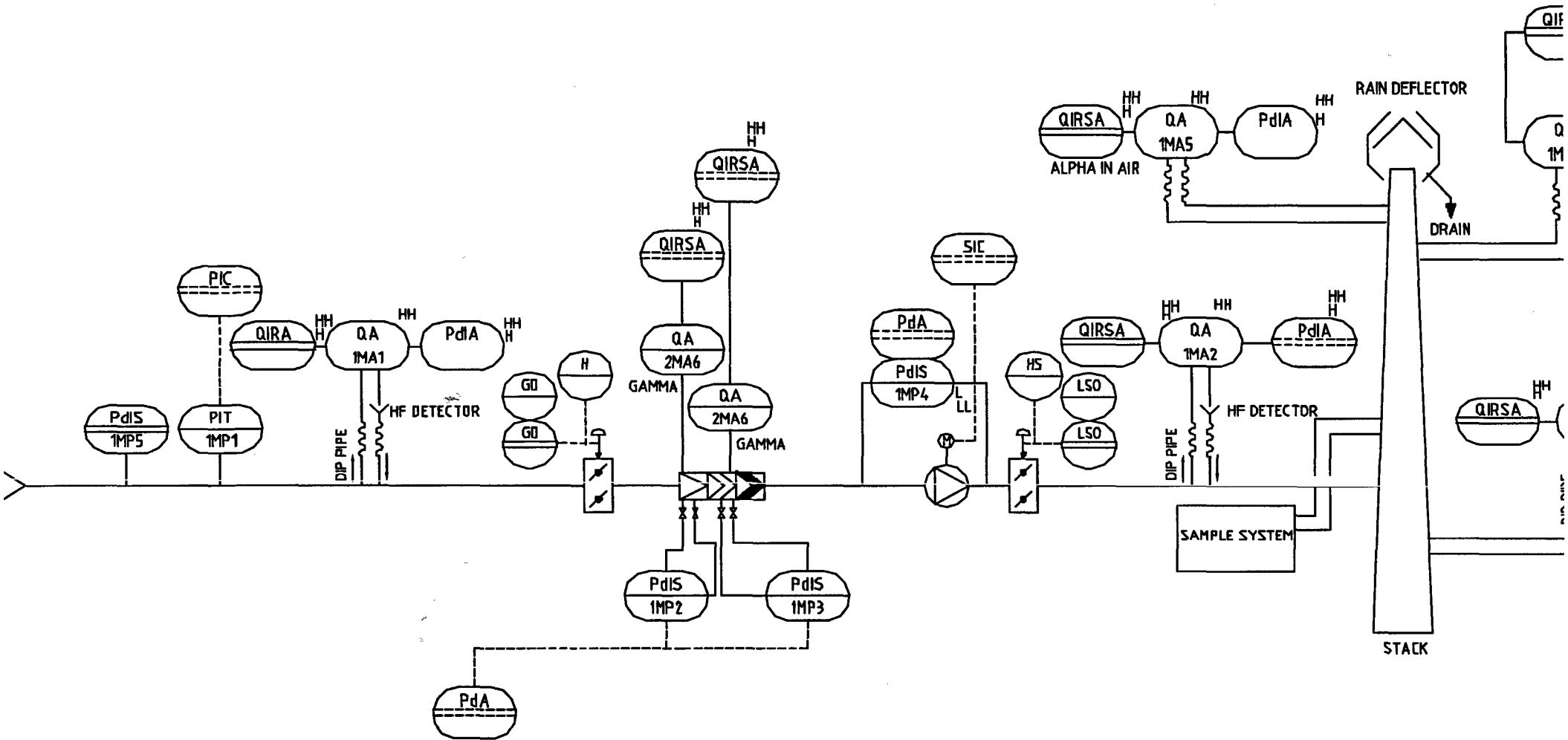
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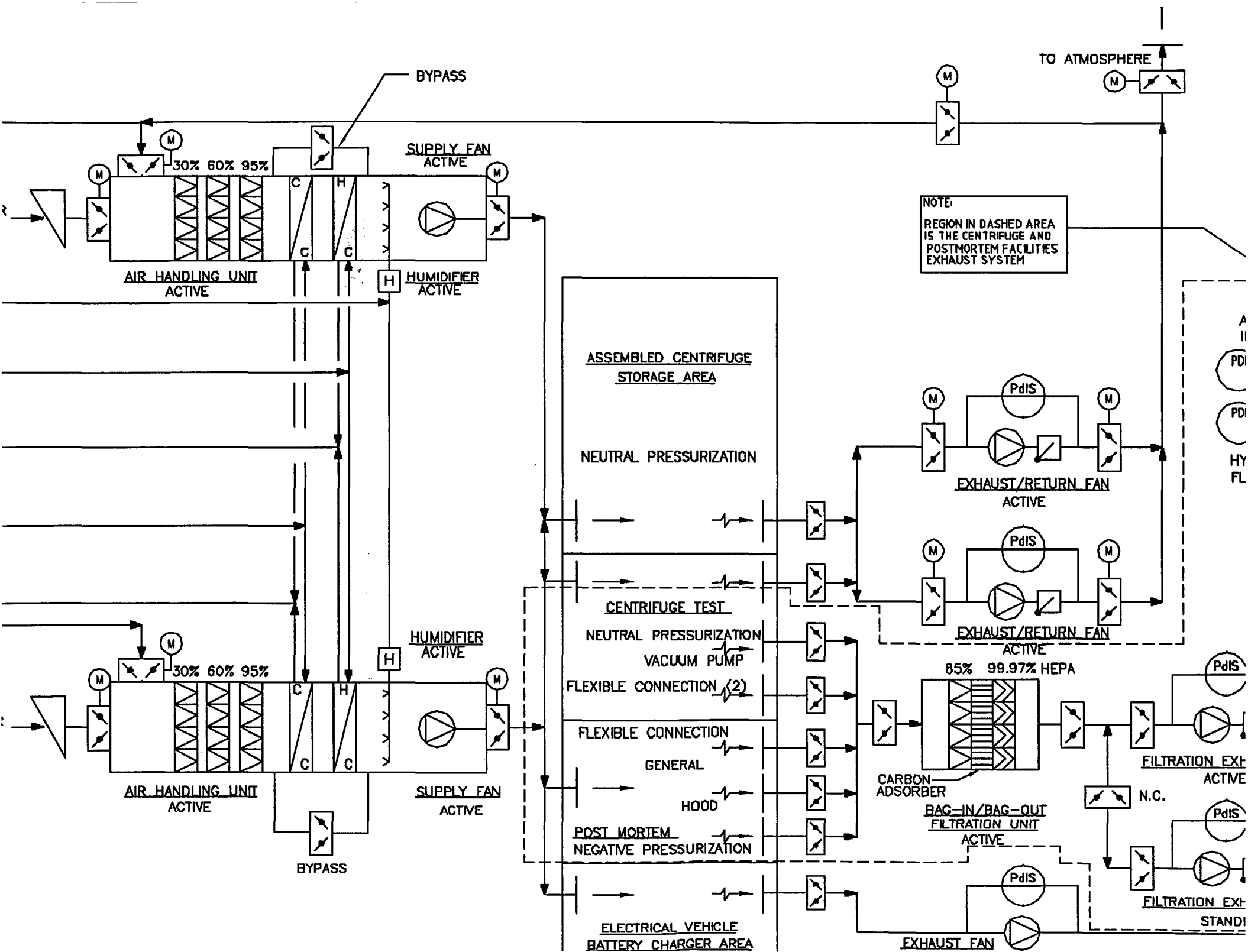
CYLINDER
PREPARATION
ROOM
FIGURE 3.5-44
SHEET 1

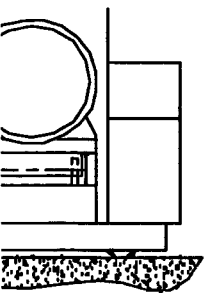
CYLINDER
PREPARATION
ROOM
FIGURE 3.5-44
SHEET 2

LAUNDRY

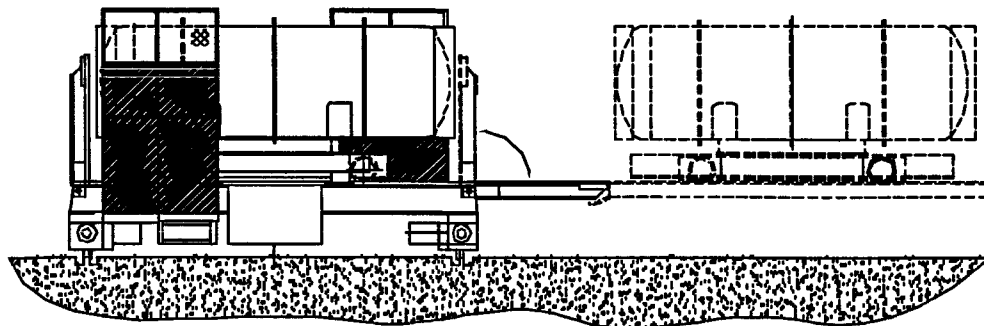




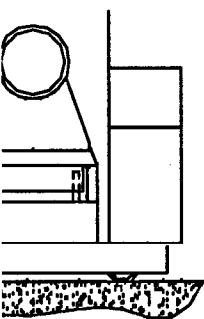




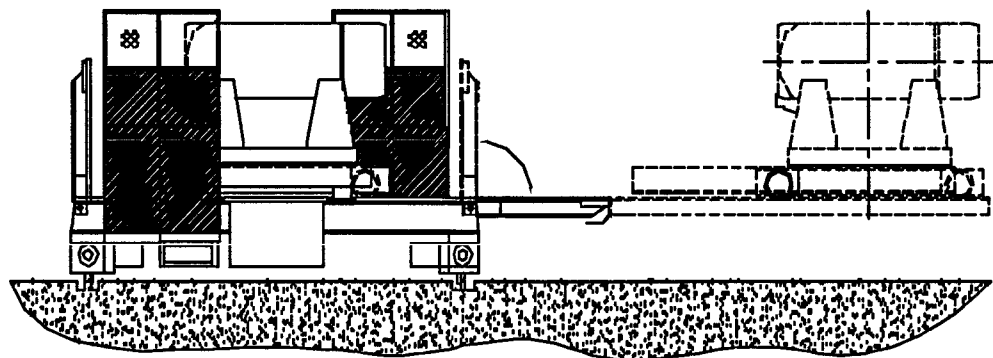
SIDE VIEW
[WITH 48" CYLINDER]



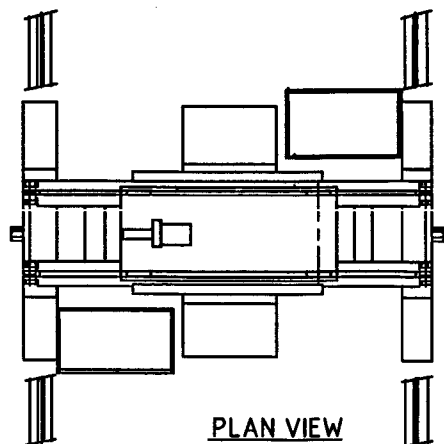
SIDE ELEVATION
[WITH 48" CYLINDER]



SIDE VIEW
[WITH 30" CYLINDER]



SIDE ELEVATION
[WITH 30" CYLINDER]



PLAN VIEW



NATIONAL ENRICHMENT FACILITY

INTEGRATED SAFETY ANALYSIS SUMMARY



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3.5 UTILITY AND SUPPORT SYSTEMS

Louisiana Energy Services' (LES) National Enrichment Facility (NEF) utility and support systems are described in this section. The information provided for each system emphasizes capacities, redundancies, and other provisions for coping with routine and non-routine events.

The Separations Building consists of three units called Separations Building Modules. Some of the utility and support systems are duplicated in each Separations Building Module while other systems serve the entire facility. The descriptions and flow diagrams of duplicated systems presented in this section represent Separations Building Module 1 systems, which are generally identical in Separations Building Modules 2 and 3. Any differences are clearly indicated in the text and figures.

The system descriptions provided for each system include functional requirements, design capacities, system interfaces, and descriptions of major components. In addition, operational characteristics are discussed for both routine operations and non-routine operations. Supporting information is provided in the form of flow diagrams to facilitate an understanding of the system design.

Finally, safety considerations are described for each system. The calculated values of k_{eff} provided in the following sections were obtained using the criticality code MONK8A (SA, 2001), in conjunction with the JEF2.2 nuclear data library. All values of k_{eff} given in the following sections are equal to $k_{\text{calc}} + 3 \sigma_{\text{calc}}$ with a safety limit of 0.95. The health and safety of the public are protected such that a failure or inadvertent operation of any of the utility systems would not result in a release of hazardous quantities of chemicals or radiation. The basis for this conclusion is presented in Section 3.7, General Types of Accident Sequences, and Section 3.8, Items Relied on for Safety (IROFS).

Although many of the utility and support systems do not contain items relied on for safety, appropriate design and operating features that enhance public safety, worker safety, and facility reliability are provided for each system. Items relied on for safety, which are associated with utility and support systems, are listed in Section 3.8, Items Relied On For Safety (IROFS). The Codes and Standards generally applicable to the utility and support systems are listed in Table 3.5-1, Codes and Standards.

In the following sections, the design process parameter values are specified with a datum of standard atmospheric pressure at sea level. These values will be finalized to reflect the site-specific NEF elevation during the design phase and the ISA Summary will be revised accordingly.

3.5.1 Building Ventilation

The Separations Building is partitioned into three Separations Building Modules. Each Separations Building Module has dedicated Heating, Ventilating, and Air Conditioning (HVAC) systems. These areas are as follows:

- A. Cascade Hall
- B. Low Voltage and Transformer Rooms

- C. Process Services Corridors
- D. Link Corridor
- E. UF₆ Handling Area.

Adjacent to the Separations Building Modules are areas and buildings where other services are performed. These areas, listed below, also have dedicated HVAC systems:

- A. Blending and Liquid Sampling Area
- B. Cylinder Receipt and Dispatch Building (CRDB).
- C. Centrifuge Assembly Building (CAB)
- D. Technical Services Building (TSB)

Separate buildings at the facility have dedicated HVAC systems. These buildings are as follows:

- A. Security Buildings
- B. Administration Building
- C. Central Utilities Building (CUB)

The individual HVAC systems are designed to maintain the specific environmental conditions associated with processes undertaken within a particular area. In areas where there is a potential for radioactive contamination, the areas are maintained at a slightly negative pressure relative to the surrounding areas. All of the floor plans for the above areas are shown on Figures 3.3-2 through 3.3-18. The flow diagrams for the HVAC systems for the above areas (with the exception of the Security Building and the Administration Building) are shown on Figures 3.5-1 through 3.5-18.

Although the individual HVAC systems have unique inside design parameters, the outside design environmental conditions are the same for every HVAC system. The outside design parameters are as follows:

Summer:	38.3°C (101°F) dry bulb, 18.9°C (66°F) wet bulb (process areas)
	36.1°C (97°F) dry bulb, 18.9°C (66°F) wet bulb (office areas)
Winter:	-10.6°C (13°F)
Wind Velocity:	Maximum 9.9 m/s (22 mph)

3.5.1.1 System Descriptions

The specific design features for each HVAC system are described in this section. Additionally, Table 3.5-12, Volume, Exhaust Flow and Area Leakage Inputs to the NEF Consequence

Calculation, provides the assumed area volumes, HVAC exhaust flow rates and area leakage utilized as inputs to the NEF consequence calculations.

3.5.1.1.1 Cascade Halls

There are no HVAC systems or HVAC equipment associated with the Cascade Halls. The Cascade Halls are confined areas that contain the centrifuges. Air is not circulated in the Cascade Halls. The heat generated from the Cascade Halls is removed by the Centrifuge Cooling Water distribution piping.

The conditions in the room are maintained as follows:

Room Temperature	33°C ± 1°C (91.4°F ± 2°F)
Relative Humidity	40% Design point

3.5.1.1.2 Electrical Room HVAC System

The first floor Electrical Room HVAC System in each Separations Building Module maintains room temperature in the Low Voltage and Transformer Rooms. The HVAC system consists of one, 100% capacity air handling unit (AHU), with two, 100% capacity supply fans, and two, 100% capacity return/exhaust fans. The Electrical Room HVAC System is shown on Figure 3.5-1, Flow Diagram, Separation Building Module, First Floor Electrical Room, HVAC System.

The environmental design parameters for the Low Voltage and Transformer Rooms are provided below:

Room Temperature	26.5°C (80°F) max, 18.0°C (65°F) min
Relative Humidity	40% Design point

A majority of the area ventilation air is recirculated and the remaining air is discharged to the atmosphere. The Low Voltage and Transformer Rooms are maintained at neutral pressure by balancing the supply flow rate with leakage, exhaust, and recirculation airflow rates.

3.5.1.1.3 Process Services Area HVAC System

The Process Services Area HVAC System in each Separations Building module maintains room temperature in the Process Services Area.

The first, second, and third floor process services area HVAC system consists of eight, 12.5% capacity AHUs per Separations Building Module and eight, 12.5% exhaust/return fans per Separations Building Module. The system components are shown on Figure 3.5-4, Flow Diagram Process Service Areas, First, Second and Third Floor, HVAC System.

The environmental control design parameters for the Process Services Areas HVAC system are provided below:

Room Temperature	25°C (77°F) max, 18°C (65°F) min
Relative Humidity	40% Design point

A majority of the area ventilation air is recirculated, and the remaining air is discharged to the atmosphere. The Process Service Areas are maintained at neutral pressure by balancing the supply flow rate with leakage, exhaust and recirculation airflow rates.

3.5.1.1.4 Link Corridor HVAC System

The "Link" Corridor Area HVAC System maintains room temperature in the "Link" corridor. The "Link" first and second floor HVAC system consists of two, 50% capacity AHUs for both floors and two, 50% exhaust/return fans. The system components are shown on Figure 3.5-2, Flow Diagram, "Link" Corridor First and Second Floor, HVAC System.

The environmental control design parameters for the "Link Corridor" Areas HVAC system are provided below:

"Link Corridor"

Room Temperature	25°C (77°F) max, 18°C (65°F) min
Relative Humidity	40% Design point

3.5.1.1.5 Above Cascade Area HVAC System

The Above Cascade Area HVAC System maintains room temperature in the Above Cascade Area. The HVAC system consists of two, 100% AHUs for each Cascade Hall (four AHUs per Separations Building Module) and two, 100% exhaust/return fans for each Cascade Hall (four fans per Separations Building Module). The system components are shown on Figure 3.5-3, Flow Diagram, Process Services Area Above Cascade, HVAC System.

The environmental control design parameters for the Above Cascade Area HVAC System are provided below:

Above Cascade Area:

Room Temperature	32°C (89.6°F) max, 18°C (65°F) min
Relative Humidity	40% Design point

3.5.1.1.6 UF₆ Handling Area HVAC System

The UF₆ Handling Area HVAC System in each Separations Building Module maintains the air temperature in the UF₆ Handling Area. The HVAC system is comprised of three, 33% capacity AHUs per Separations Building Module and three, 33% exhaust/return fans per Separations Building Module. The UF₆ Handling Area HVAC System flow diagram is shown on Figure 3.5-5, Flow Diagram, UF₆ Handling Area HVAC System.

The environmental control design parameters for the UF₆ Air Handling HVAC System are given below:

Room Temperature	25°C (77°F) max, 18°C (65°F) min
Relative Humidity	40% Design point

A majority of the ventilation air is recirculated, and the remaining air is discharged to the atmosphere. The UF₆ Handling Area is maintained at neutral pressure by balancing the supply flow rate with leakage, exhaust and recirculation airflow rates.

3.5.1.1.7 Blending and Liquid Sampling Area HVAC System

The Blending and Liquid Sampling Area HVAC System maintains the room temperature in the Blending and Liquid Sampling Area. The HVAC system consists of two, 50% capacity AHUs and two, 50% capacity return / exhaust fans. The Blending and Liquid Sampling Area HVAC System flow diagram is shown on Figure 3.5-6, Flow Diagram, Blending and Liquid Sampling Area HVAC System.

The environmental control design parameters for the Blending and Liquid Sampling Area HVAC System are provided below:

Room Temperature	25°C (77°F) max, 18°C (65°F) min
Relative Humidity	40% Design point

A majority of the area ventilation air is recirculated back to the AHUs, and the remaining air is discharged to the atmosphere.

The ventilation system for the Blending and Liquid Sampling Area is designed to maintain the area at neutral pressure by balancing the supply flow rate with leakage, exhaust and recirculation airflow rates.

3.5.1.1.8 Technical Services Building HVAC System

The TSB HVAC System maintains the room temperature in the clean areas, potentially contaminated areas, laboratories, locker rooms, link corridors, general offices, break room, storage areas and the Control Room.

The potentially contaminated rooms include the Decontamination Workshop, Cylinder Preparation Room and Ventilated Room. The HVAC system for these rooms consists of two, 50% capacity AHUs. Airflow from the potentially contaminated rooms is exhausted through two, 50% capacity Bag-In/Bag-Out high efficiency particulate air (HEPA) filters by one of two, 100% capacity filtration exhaust fans. The exhaust air is then discharged to the exhaust stack and monitored for alpha radiation and hydrogen fluoride (HF). Some potentially contaminated areas have fume hoods, which are connected to the TSB GEVS. The TSB HVAC System flow diagram is shown in Figure 3.5-7, Flow Diagram, TSB Contaminated Workshop HVAC System.

The noncontaminated areas include the TSB GEVS Room, Laundry, Mechanical/Electrical & Instrumentation (ME&I) Workshop, Solid Waste Collection Room (SWCR), Vacuum Pump Rebuild Workshop, and Liquid Effluent Collection and Treatment Room. The HVAC system consists of two 50% capacity AHUs. Airflow from the clean areas is returned/exhausted by two 50% capacity return/exhaust fans. A majority of the ventilation air from the clean areas is recirculated, and the remaining air is discharged through the exhaust stack. The Vacuum Pump Rebuild Workshop and ME&I Workshop are provided with a general exhaust system and discharged to the atmosphere. The system flow diagram is shown on Figure 3.5-8, Flow Diagram, TSB Noncontaminated Areas HVAC System.

The locker rooms, access corridors, first and second floor offices, break room, and storage rooms HVAC system consists of one 100% capacity AHU with two 50% capacity supply air fans, and two 50% capacity return/exhaust fans. The Control Room HVAC system consists of two 100% capacity computer room AC units. The system flow diagram is shown on Figure 3.5-9, Flow Diagram, TSB Offices and Control Room HVAC system.

The Chemical, Mass Spectrometry, and Environmental Monitoring Laboratory HVAC systems consists of one, 100% capacity AHU with two, 100% capacity supply air fans, and two, 100% capacity exhaust fans. The ventilation air is discharged to an exhaust stack. The Environmental Laboratory is designed to be at a positive pressure to the surrounding rooms while the Mass Spectrometry and Chemical Laboratories are maintained at a negative pressure with respect to the surrounding rooms. The system components are shown on Figure 3.5-10, Flow Diagram TSB Labs HVAC System.

The environmental control design parameters for the Technical Services Building are as follows:

- A. Cylinder Preparation Room, Ventilated Room, and Decontamination Workshop
Room Temperature 30°C (86°F) max/18°C (65°F) min
Relative Humidity 40% Design point
- B. Chemical, Mass Spectrometry, and Environmental Monitoring Laboratories
Room Temperature Year Round 21°C ± 1°C (70°F ± 1.8°F)
Relative Humidity 40% max
- C. ME&I Workshop, Solid Waste Collection Room, Vacuum Pump Rebuild Workshop, Laundry, and TSB GEVS Room and Liquid Effluent Collection and Treatment Room Areas
Room Temperature 30°C (86°F) max/18°C (65°F) min
Relative Humidity 40% Design point
- D. First and Second Floor Offices and Break Area
Room Temperature Year Round 22°C ± 2°C (72°F ± 3.6°F)
Relative Humidity 40% Design point
- E. Locker Rooms
Room Temperature Year Round 22°C ± 2°C (72°F ± 3.6°F)
Relative Humidity 40% Design point
- F. Control Room
Room Temperature Year Round 22°C ± 2°C (72°F ± 3.6°F)
Relative Humidity 40% Design point
- G. Clean Storage Areas and Truck Bay/Shipping & Receiving Area
Room Temperature 40°C (104°F) max/7°C (45°F) min
Relative Humidity 40% Design point
- H. Miscellaneous Support Areas
Room Temperature 40°C (104°F) max/7°C (45°F) min
Relative Humidity 40% Design point
- I. Truck Bay
Room Temperature 40°C (104°F) max/7°C (45°F) min
Relative Humidity 40% Design point

The confinement function of the HVAC in the TSB is designed to maintain the clean areas at positive room pressure and the potentially contaminated areas at slightly negative room pressure. The pressurization zones in the TSB are shown on Figure 3.5-11, Code and Area Classifications, Technical Services Building, HVAC Pressurization. This ensures that the airflow direction is from areas of little or no potential for contamination to areas of higher potential for contamination. Pressure zones are controlled by adjusting the filtered exhaust airflow rate and the supply airflow rate accordingly. Also, appropriate access controls are provided to maintain proper airflow patterns.

Exhaust flow from the potentially contaminated rooms (i.e., Ventilated Room, Cylinder Preparation Room and Decontamination Workshop) of the TSB is filtered by a pre-filter, activated carbon filter and HEPA filter and is then released through an exhaust stack. The exhaust stack flow is continuously monitored for alpha and HF. The stack exhaust is periodically sampled. The continuous monitoring and periodic sampling is in accordance with the guidance in Regulatory Guide 4.16 (NRC, 1985). In addition to the confinement function provided by the HVAC system for these rooms, the TSB GEVS provides filtered exhaust for potentially hazardous contaminants via fume hoods and flexible connections for the following areas: Ventilated Room, Laundry, Decontamination Workshop, Chemical Laboratory, Mass Spectrometry Laboratory, Cylinder Preparation Room, Vacuum Pump Rebuild Room and Solid Waste Collection Room. The GEVS is described in more detail in Section 3.4.9, Gaseous Effluent Vent System.

The ventilation system for the Break Room and Office Areas is designed to maintain the Control Room and Offices at slightly positive pressure to minimize the infiltration of dust and other undesirable airborne materials. This is accomplished by adjusting the supply flow rate greater than the exhaust and recirculation airflow rates. Double door entrances and/or vestibules are incorporated to help maintain pressure control.

The ventilation system for the locker area will be designed to maintain a slight negative pressure by maintaining exhaust airflow rate greater than the supply airflow rate.

The remainder of the area is maintained at atmospheric pressure. No special design features are incorporated to attain pressure control in these areas.

3.5.1.1.9 Centrifuge Assembly Building HVAC System

The Centrifuge Assembly Building (CAB) HVAC System maintains room temperature in the Centrifuge Assembly Building.

The Centrifuge Component Storage Area HVAC System consists of two, 50% capacity AHUs and two 50% exhaust/return fans. The system flow diagram is shown on Figure 3.5-12, Flow Diagram, CAB Centrifuge Component Storage Area, HVAC System.

The Centrifuge Test and Post Mortem Areas HVAC System consists of two, 50% capacity AHUs and two, 50% capacity return/exhaust fans. The system serves the Assembled Centrifuge Storage Area, Electrical Battery Charger Area, and the Centrifuge Test and Post Mortem Areas. The Centrifuge Post Mortem area confinement ventilation function incorporates an 85% efficient prefilter, activated carbon filters, and a 99.97% efficient HEPA Bag In/Bag Out filtration subsystem that continuously filters exhaust air and discharges to the exhaust stack. This subsystem is designed to operate in a once-through configuration. The subsystem flow diagram is shown on Figure 3.5-13, Flow Diagram, CAB Centrifuge Storage and Miscellaneous Areas,

HVAC System. In addition to the confinement function for the Centrifuge Post Mortem Facility, filtered exhaust from this room via a flexible connection and a fume hood is provided by the Centrifuge Test and Post Mortem Facilities Exhaust Filtration System. This system also provides filtered exhaust from the Centrifuge Test Facility via two flexible connections. The description of this system is provided in Section 3.4.10.3, Centrifuge Test and Post Mortem Facilities Exhaust Filtration System.

The Office Area HVAC System consists of one, 100% capacity AHU with two, 50% capacity supply air fans, and two, 50% capacity return/exhaust fans. The system serves the offices, canteen, change areas, and entrance areas. The system flow diagram is shown on Figure 3.5-14, Flow Diagram, CAB Offices and Miscellaneous Rooms, HVAC System.

The Centrifuge Assembly Area HVAC System consists of four, 25% capacity AHUs and 12 recirculation AHUs to provide a Class 100,000 Clean Room environment. Ceiling mounted Terminal HEPA filters are provided. The return/exhaust system consists of four, 25% return/exhaust fans. The system flow diagram is shown on Figure 3.5-15, Flow Diagram, CAB Centrifuge Assembly Area, HVAC System.

The environmental control design parameters for the CAB HVAC Systems are provided below:

A. Centrifuge Component Storage Area.

Room Temperature 33°C (95°F) max, 18°C (65°F) min
Relative Humidity 40% Design point

B. Assembled Centrifuge Storage Area, Centrifuge Test and Post Mortem Area.

Room Temperature 25°C (77°F) max, 18°C (65°F) min
Relative Humidity 40% Design point

C. Centrifuge Assembly Area.

Room Temperature 25°C (77°F) max, 18°C (65°F) min
Relative Humidity 40% Design point

D. Canteen, Offices, Maintenance, Airlock, Change Area.

Room Temperature Year Round 22°C ± 2°C (72°F ± 3.6°F)
Relative Humidity 40% Design point

3.5.1.1.10 Cylinder Receipt and Dispatch Building Heating and Ventilation System

The Cylinder Receipt and Dispatch Building (CRDB) Heating and Ventilating System maintains room temperature in the CRDB. The HVAC system consists of ten 10% capacity AHU's and ten 10% capacity return/exhaust fans. The system components are shown on Figure 3.5-16, Flow Diagram, Cylinder Receipt and Dispatch Building, HVAC System.

The environmental control design parameters for the CRDB HVAC System are provided below:

Room Temperature 35°C (95°F) max/18°C (65°F) min
Relative Humidity 40% Design point

A majority of the area ventilation air is recirculated, and the remaining air is discharged to the atmosphere. The CRDB is maintained at neutral pressure by balancing the supply flow rate with leakage, exhaust, and recirculation airflow rates.

3.5.1.1.11 Security Building HVAC System

The Security Building HVAC System maintains temperature in the Security Building.

The Security Building HVAC System consists of one packaged or split Direct Expansion system unit with one constant volume supply fan. The ventilation system for the Security Building is designed to maintain the Security Building at slightly positive pressure to minimize the infiltration of dust and other undesirable airborne materials.

The environmental control parameters for the Security Building HVAC System are provided below.

Room Temperature	Year Round $22^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($72^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)
Relative Humidity	40% Design point

A majority of the building ventilation air is recirculated, and the remaining air will leak through exfiltration.

3.5.1.1.12 Administration Building HVAC System

The Administration Building HVAC System maintains temperature in the Administration Building.

The Administration Building HVAC System consists of one Packaged Variable Volume Rooftop unit with one supply fan and one return fan. Each zone is provided with a variable air volume (VAV) box with electric heat. The Administration Building HVAC System flow diagram is shown on Figure 3.5-17, Flow Diagram, Administration Building, HVAC System.

The Administration Building HVAC System is designed to maintain the Administration Building at a slightly positive pressure to minimize infiltration of dust and other undesirable airborne materials.

The environmental control parameters for the Administration Building HVAC System are provided below.

Room Temperature	Year Round $22^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($72^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)
Relative Humidity	40% Design point

A majority of the building ventilation air is recirculated, and the remaining air is discharged through exfiltration and toilet exhaust fans.

3.5.1.1.13 Central Utilities Building HVAC System

The Central Utilities Building (CUB) HVAC System provides environmental control in the CUB. The CUB consists of the following rooms: Standby-Diesel Generator Room, Air Compressor Room, Boiler Room, Chiller Room and multiple Electrical Rooms.

The Mechanical Rooms are air conditioned and heated by two 50% capacity AHUs and five 20% exhaust fans. The cooling water facility has additional emergency ventilation with refrigerant leak detection. The system serving the Stand-by Diesel Generator Room does not maintain conditions when generators are running. The Boiler Room is provided with two fixed wall intake openings for boiler combustion air. The Electrical Rooms are air conditioned and

heated by two 50% capacity AHUs. The system components are shown on Figure 3.5-18, Flow Diagram, Central Utilities Building, HVAC system.

The environmental control parameters for the CUB HVAC System are provided below:

Electrical Room:

Room Temperature	26.5°C (80°F) max/18.3°C (65°F) min
Relative Humidity	40% Design point

Boiler, Chiller, Air Compressor and Stand-By Diesel Generator Rooms:

Room Temperature	35°C (95°F) max/7°C (45°F) min
Relative Humidity	No Control

The ventilation system for the CUB Area is designed to maintain the CUB Area at neutral pressure by balancing the supply flow rate with leakage and exhaust.

3.5.1.2 Major Components

The major components for each ventilation system are detailed above in Section 3.5.1.1, System Description.

3.5.1.3 System Interfaces

All of the HVAC systems interface with the utility systems listed below.

- A. The Hot Water System provides hot water to heating coils in the AHUs and the duct heating coils and returns the water to the hot water boilers.
- B. The HVAC Chilled Water System provides chilled water to the cooling coils in the AHU and returns the water to the facility chillers in the cooling water facility.
- C. The Compressed Air System provides instrument air to pneumatic control components.
- D. The Electrical System provides electrical power to HVAC system components.
- E. The Plant Control System provides limited monitoring and alternative start/stop control for the HVAC system.

3.5.1.4 Operational Characteristics

All of the HVAC systems are operated from local control panels. Start/stop controls, group alarms, and system status are provided in the Control Room. The operation of the AHU supply fans is interlocked with the return/exhaust fans to ensure that either neutral, slightly positive or slightly negative pressure is maintained depending on the specific area.

3.5.1.4.1 Routine Operation

After a start signal has been provided, one AHU supply fan starts. When flow through the supply fan has been established, one return/exhaust fan is started. When air flow in the room is established, the second supply fan is started, followed by the remaining exhaust fan.

Temperature control in all areas is maintained by sensing the return air temperature, the outside air temperature, and the air handling unit leaving air temperature. Modulating the position of the outside air, return air, and relief air control dampers, and appropriate water flow rate controls the room air temperature.

When the outside air temperature is above 7.2°C (45° F), the outside air, return air, and relief air damper are positioned to maintain the mixed air temperature entering the AHU as close to 11.1°C (52°F) as possible. As the outside air temperature increases toward design limits, the outside air damper closes to minimum position. The room or area air temperature is controlled by modulation of the chilled water flow rate.

When the outside air temperature is below 7.2°C (45°F), the outside air, return air, and relief air dampers are at the minimum position and the room air temperature is controlled by modulation of the hot water flow rate. The position of the relief air damper control dampers are set to match the position of the outside air control dampers so that airflows are matched and the proper amount of air is recirculated back to the unit.

The supply fan capacity is controlled by modulating the fan inlet vane control damper to maintain constant static pressure in the supply duct. The return/exhaust air flow is maintained constant by modulating the fan inlet vane control damper.

3.5.1.4.2 Non-routine Operation

Component failures would result in reduced system capacity but would not affect facility safety. A failure would be indicated and alarmed in the Control Room. The consequences of assumed failure modes are discussed below:

- A. AHU Failure. An AHU failure could result in a temperature excursion in the area. An AHU failure could cause the remaining AHUs flow control valves to open and the outside air control dampers to close on the travel stops. Note that the temperature excursion is more severe in HVAC systems that have only one AHU.
- B. Supply Fan Failure. A supply fan failure could result in temperature or pressure excursion in the area. A single fan failure could cause a return/exhaust fan to automatically shut down, the remaining supply fan inlet vane control damper to open fully, and the appropriate temperature control devices to open fully.
- C. Return/Exhaust Fan Failure. A return/exhaust fan failure could result in a pressure excursion in the area. A single return/exhaust fan failure would cause the supply fan's inlet vane control damper to adjust to a stable operating position.
- D. Control System or Electrical System Failure. A general failure of the Control System or Electrical System could lead to a total loss of ventilation due to erroneous trips or false operation.

3.5.1.5 Safety Considerations

The total failure of an HVAC system could be caused by natural phenomena, loss of offsite power, or loss of the control system. This failure could result in temperature and pressure increases or decreases in the affected area, and would be detected by flow and temperature

measurements. Failure of any of the HVAC systems would not endanger the health or safety of workers and the public.

In the event of a design basis seismic event, the HVAC system associated with Separations Building Areas will trip. This hardwired, fail safe, feature functions to minimize any exhaust release from the UF₆ Handling Area, Process Services Area, Cascade Halls, and Blending and Liquid Sampling Area to the outside environment to maximum values as presented in Table 3.5-12, Volume, Exhaust Flow and Leakage Inputs to the NEF Consequence Calculation.

During release of UF₆, HVAC Systems would be shut down in the affected area. This would limit the spread and release of airborne materials from the area. The hydrogen fluoride (HF) concentration would increase in the affected area, and un-reacted UF₆ and uranyl fluoride (UO₂F₂) would settle out in the area.

In the unlikely event of such an incident, operators would put on an air suit and re-enter the affected area to isolate the source of the release. It is not possible to give specific conditions that need to be met before the HVAC systems are restarted as every incident would be subject to a separate assessment involving senior management. In general, however, the aim is to clean up, collect and package all escaped uranic material before the HVAC systems are switched on again. No specific action is envisioned with regard to the HF associated with any release, as this would probably disperse through natural room leakage during the time uranic clean-up operations were underway. The filtered exhaust will continue to operate to limit the spread of airborne materials from the area.

3.5.2 Electrical System

The NEF overall electrical power distribution system is designed with a high level of redundancy to maintain a reliable power supply to the process equipment for investment protection. Total loss of electrical power does not have any safety implications.

3.5.2.1 System Description

The system is illustrated in Figure 3.5-19, Electrical Single Line Diagram, Overall System (Sheets 1 through 6). The Electrical System design complies with the following codes and standards.

- IEEE C2-2002, National Electrical Safety Code (IEEE, 2002)
- NFPA 70, National Electric Code (NFPA, 1996)
- NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces (NFPA, 2000).

3.5.2.1.1 Incoming Power Source

The main source of supply of electrical power for the facility is derived by means of two synchronized 115 kV overhead transmission lines from an extended ring bus loop in the Xcel Energy system grid. Each line is rated to supply the total power requirements of the facility.

The 115 kV lines power the utility substation provided by Xcel Energy for the facility service. Duplicate transformers are used in the substation to transform the 115 kV to 13 kV for the facility electrical power distribution system. Each transformer can be supplied from either 115 kV line and is rated to supply the total power requirements of the facility.

The average power requirement and the peak power requirement of the facility are approximately 30.3 MVA and 32 MVA, respectively.

3.5.2.1.2 Overall Site Power Distribution

The Xcel Energy substation transformers supply duplicate sets of 13 kV switchgear that distribute power to the site substation transformers. Either of the duplicate switchgears can be supplied from either of the Xcel Energy transformers. Each feeder circuit from the 13 kV switchgear to the site substation transformers has a connection to both switchgears and can be supplied from either switchgear. The site substation transformers convert the 13 kV supply voltage to the voltages needed for utilization in the facility.

3.5.2.1.3 Onsite Power Sources

Standby Diesel Generators are provided to power equipment that can tolerate a short break (short break load) in the normal power supply. This capability is needed to allow for an orderly shutdown of the facility. Each of the Standby Diesel Generators is sized for 100% of the short break load requirement of the equipment to which it is connected. The Standby Diesel Generators are not required for safety operation of the facility and are installed to provide protection of investment only.

Uninterruptible Power Supply (UPS) systems are provided to power the facility process equipment that does not tolerate a break (no break load) in the normal power supply. Input power for this UPS system is normally provided by the short break power system with backup from the Standby Diesel Generators. Batteries power the UPS if all other input power is lost. Each of the UPS systems is sized for 100% of its connected load.

Additional UPS systems with battery backup are installed to provide no break power to support systems such as emergency lighting. These systems are sized and located as necessary to provide the requirements of the equipment served. Systems requiring no break power are listed in Section 3.5.2.4, Operating Characteristics.

Duplicate batteries supply operating power for the 13 kV and 4160 V switchgear.

Additional batteries provide starting power for each Standby Diesel Generator and operating power for each UPS system.

3.5.2.2 Major Components

The following are the major electrical distribution system components:

- A. 115 kV – 13 kV Utility Substation. The utility substation provided by Xcel Energy will consist of 115 kV circuit breakers and switches; two, 115 kV to 13 kV Load Tap Changer (LTC) transformers; and two, 13 kV breakers to provide the dual 13 kV regulated sources for the facility.

Dual incoming power supply lines are used to assure continuous power supply to the facility. Each line can provide the total power requirement for facility operation.

Duplicate transformers are used to transform the 115 kV to 13 kV for the site electrical power distribution system. Each transformer can be supplied from either line and is rated to supply the total power requirements of the facility. To offset the voltage variations in the two incoming 115 kV lines, the transformers are equipped with automatic LTC equipment that maintains the facility supply voltage at the rated value.

- B. 13 kV Visible Blade Disconnect Switches. Visible blade 13 kV disconnect switches are provided at the points of interconnection between the utility substation supply circuits and the facility distribution system. These switches provide visual verification of the isolation of the two systems for maintenance or repair.
- C. 13 kV Switchgear. The 13 kV medium voltage distribution system consists of duplicate switchgears. Both switchgears can be supplied from either utility transformer, and the two switchgear lineups can be connected together by means of tie breakers.

Each 13 kV switchgear consists of a main bus, dual main input breakers, a tie breaker and feeder breakers. Each breaker in one lineup has a corresponding breaker in the other lineup.
- D. 13 kV Feeder Circuits. 13 kV feeder circuits supplied from dual breakers provide power to the distribution system transformers.
- E. 4160 V Switchgear. The 4160 V distribution system consists of two switchgear lineups. These switchgears are supplied from two 13 kV to 4160 V transformers. These switchgears can be supplied from either transformer and can be connected together by means of tie breakers.
- F. 480 V Switchgear. Two sets of 480 V, 3-phase, 60 Hz, switchgear are provided to supply normal load power for central utilities, the support services, the Separations Building and each of the six Cascade Halls. Loads will generally have a dedicated connection to either the A or B supply. Some loads are provided with selectable connection to either the A or B supply.

Each Separations Building Module has two double-ended switchgears to supply variable frequency drive equipment. Separations Building Module 1 switchgears are each fed from dedicated transformers. A common standby transformer serves both system's standby switchgears. Arrangement of the variable frequency drive system in Separations Building Module 2 and Separations Building Module 3 is identical to Separations Building Module 1.

- G. Short Break Load System. The short break load 480 V distribution system originates with duplicate switchgears. These switchgears are normally supplied from one of two, 13 kV to 480 V transformers, with either switchgear capable of being supplied from either transformer. Each switchgear can also be supplied by a designated Standby Diesel Generator.

The short break load distribution system supplies power to equipment listed in Section 3.5.2.4.

- H. Standby Diesel Generators. Duplicate Standby Diesel Generators supply standby power for the short break load system. Each Standby Diesel Generator supplies a designated switchgear.
- I. Process UPS (No Break) System. Two battery backed UPS units provide power for the process no break loads. Normal input power to the UPSs is from the diesel generator backed up short break switchgear lineups. The batteries power the UPSs if all normal input power is lost. Each UPS is sized for 100% of it's connected load.

The process UPS no break load distribution system supplies power to equipment listed in Section 3.5.2.4.

3.5.2.3 Interfaces

The Electrical System interfaces with the Plant Control System (PCS) for monitoring only. The Electrical System signals are centralized in the 13 kV switchgear room and re-transmitted to the PCS.

The following electrical systems are monitored by the PCS.

- A. 115 kV – 13 kV Utility Substation
- B. 13 kV Switchgear
- C. 4.16 kV Switchgear
- D. 480/460 V Switchgear
- E. Standby Diesel Generators
- F. UPS Systems.

3.5.2.4 Operating Characteristics

The facility process load requirements are categorized as follows:

Normal Loads

All normal load equipment is fed from electrical distribution equipment which is not backed-up by either the Standby Diesel Generators or the UPSs. The normal load power distribution equipment is served by the duplicate 115 kV lines, duplicate main transformers and duplicate 13 kV switchgear.

Short Break Loads

The following equipment is supplied power from the short break power distribution system described in Section 3.5.2.2, Major Components.

- A. Product Take-off System and Tails Take-off System pump sets
- B. Hot air blowers on Low Temperature Take-off Stations
- C. Fan motors in the GEVS
- D. Contingency Dump Vacuum Pump/Trap Sets

- E. Process UPS systems
- F. Diesel fuel tank pump motors for the Standby Diesel Generators
- G. Air compressor and dryer for instrument air
- H. Separations Building GEVS
- I. Power outlets for mobile pump sets

Process UPS / No Break Loads

The following equipment is supplied power from the Process UPS/no break power distribution system described in Section 3.5.2.2:

- A. Plant Control System
- B. Process Instruments.

Support Systems UPS / No Break Loads

The following equipment is supplied power from individual UPS units located, sized and equipped with batteries meeting the requirements of the equipment supplied.

- A. Emergency Lighting
- B. Site Communications System
- C. Environmental Monitoring.

3.5.2.4.1 Routine Operations

3.5.2.4.1.1 115 kV - 13 kV Utility Substation

Under normal circumstances both 115 kV incoming lines are in service, synchronized and connected together supplying both 115 -13 kV transformers. Both 115 -13 kV transformers and both 13 kV breakers are in service with each supplying approximately one half the facility load.

The 115-13 kV transformers automatic LTC equipment monitors and maintains the required supply voltage.

3.5.2.4.1.2 13 kV Distribution System

The 13 kV visible blade disconnect switches A and B are normally closed.

Utility 115 -13 kV transformer A is normally connected to the facility 13 kV switchgear bus A and utility 115 -13 kV transformer B is normally connected to the facility 13 kV switchgear bus B. The alternate connection breakers between the utility transformers and the facility 13 kV switchgear buses are normally open.

The tie breakers between 13 kV switchgear bus A and 13 kV switchgear bus B are normally open.

Each 13 kV site distribution feeder circuit is supplied from one breaker on bus A and one breaker on bus B. One of these breakers is normally closed and the other breaker is normally open.

The Electrical System is monitored in the Control Room by the Plant Control System to which all alarm conditions and status indications are transmitted.

3.5.2.4.1.3 Plant 480/460 V Distribution System

The 480/460 V power is derived from the 13 kV system through the 13 kV-480/460 V step-down transformers and is distributed through 480/460 V power distribution equipment. All step-down transformers are normally in service.

The normal load system 480/460 V switchgear is run with all normal supply breakers closed and all alternate supply breakers open. Where selection switches are provided, loads are selected to the A or B system to achieve load balance.

The short break load 480/460 V switchgear is run with the circuit breakers from the A transformer to the A switchgear and B transformer to the B switchgear closed and with the circuit breakers from the A transformer to the B switchgear and the B transformer to the A switchgear open. The breakers on both generators to the respective switchgear are normally open. Sub-distribution equipment is operated with incoming breakers closed. Where sub-distribution selection switches are provided, load is selected to the A or B system to achieve load balance.

3.5.2.4.1.4 Standby Diesel Generators

Under normal circumstances, the Standby Generators are each in a passive state with each diesel generator selected to run in the event of a power supply failure to the switchgear bus to which it is connected.

3.5.2.4.1.5 UPS Systems

Under normal circumstances the UPS units are in service supplying the UPS/no break loads and maintaining the UPS batteries in a fully charged state.

3.5.2.4.2 Non-Routine Operations

3.5.2.4.2.1 115 kV - 13 kV Utility Substation

Each 115 kV line is protected by sensitive high-speed fault detection equipment for both phase and ground faults. If a line fault occurs, the affected line is removed from service by opening the associated circuit breakers. The un-affected line will supply the total power required until the faulted line is restored.

The main 115-13 kV transformers are also equipped with sensitive high speed fault detection equipment. If a fault occurs in a 115-13 kV main transformer, the protective relays isolate the transformer by tripping 115 kV and 13 kV circuit breakers. This results in the loss of the

affected supply until the repair or replacement of the transformer is carried out. Complete site service is restored by switching the input of both sets of the facility 13 kV switchgear to the unaffected transformer supply.

In the event of an electrical fault occurring in one of the 13 kV circuit breakers or the outgoing cables, the fault again is detected and isolated by the protective devices. As with the loss of a transformer, the affected supply is lost until repairs are made, but complete facility service is restored by switching to the unaffected supply.

The loss of one 115 kV line does not interrupt the facility power supply.

The loss of one main transformer, or one 13 kV breaker or one main outgoing cable would interrupt approximately one half of the site load until switching restores service.

3.5.2.4.2.2 13 kV Distribution System

Each of the main incoming cables from the 115-13 kV main transformers, each of the duplicate 13 kV switchgears, each of the 13 kV feeder cables and each of the step-down transformers are protected by sensitive high speed fault detection equipment.

In the event of an electrical fault occurring in either of the 13 kV switchgear lineups, the protective devices will automatically de-energize the affected portion of the equipment. This fault would result in loss of supply to equipment served from the faulted area until manual switching is done to serve these loads from their alternate source.

Each outgoing feeder circuit breaker is equipped with an overcurrent and ground fault protective scheme. In the event of an electrical fault occurring on the feeder, the circuit breaker will trip. This results in the loss of supplies to only the load center step-down transformer that is connected to this circuit.

In the event of a fault occurring in a 13 kV primary voltage load center step-down transformer, the fault is detected, and the transformer is removed from service by protective devices on the dedicated 13 kV feeder that supplies the transformer.

The design of the 13 kV plant distribution system is such that any loss of power due to individual faults can be restored by the manual switching to the alternate supply.

3.5.2.4.2.3 Plant 480/460 V Distribution System

In the event of an electrical fault occurring on a 13 kV-480/460 V step-down transformer, the fault is isolated by the feeder circuit protection systems. This results in the loss of supply until the necessary corrective action is taken.

In the particular case of the normal load switchgear, faults in this equipment are isolated by the automatic action of protective devices, and power is lost to the equipment served until repairs can be made or selectable loads are switched to their alternate supply.

In the particular case of the short break load, switchgear loss of the normal supply will cause the associated Standby Diesel Generator to automatically start and restore power. Faults in this equipment are isolated by the automatic action of protective devices, and power is lost to the equipment served until repairs can be made or selectable loads are switched to their alternate supply.

3.5.2.4.2.4 Standby Diesel Generators

In the event of a loss of power to the switchgear where a Standby Diesel Generator is connected, the Standby Diesel Generator will automatically start and supply power to the connected short break loads.

After restoring of the normal power supply, the system is manually switched back to the normal source and the Standby Diesel Generator is restored to standby service.

3.5.2.4.2.5 UPS Systems

In the event of a loss of input power to a UPS unit, the batteries will automatically supply power to maintain the UPS/no break loads without interruption.

When normal input power is restored, the batteries cease supplying output power and will automatically recharge. The UPS unit will continue to supply the UPS/no break loads without interruption.

The failure of a UPS unit will initiate automatic transfer of the unit's load to UPS input power supply without interruption. When the UPS unit is repaired and restored to service, the load is synchronized and manually switched back to the UPS without interruption.

3.5.2.5 Safety Considerations

Failure of the Electrical System will not endanger the health and safety of the public. Nevertheless, redundancy is provided in the system for reliability and to provide for investment protection.

The Electrical System is designed to minimize the combustible content of the equipment and the wiring. Transformers are dry type, and wiring is low flammability rated.

3.5.3 Compressed Air System

3.5.3.1 System Description

The Compressed Air System provides "instrument air quality" compressed air at 7 barg (102 psig) for use in instruments, controls, and equipment in the Separations Building, CUB, CAB, CRDB, and TSB. The system is located in the CUB. Compressed air is used to actuate pneumatic instruments and control valves, to operate pneumatic tools and for maintenance activities.

The system consists of two, packaged, water-cooled compressed air units; two air filter/dryer units; two instrument air receivers; and associated instrumentation and distribution piping. The system is illustrated in Figure 3.5-20, Process Flow Diagram, Compressed Air System, Sheet 1 and Process Flow Diagram, Compressed Air Distribution, Sheet 2. The functional requirements of the Compressed Air System are provided in Table 3.5-2, Compressed Air System Design Parameters. The major components of the Compressed Air System are located in the Air Compressor Room of the Central Utilities Building (See Figure 3.3-18).

Outside air is filtered, precooled, compressed, and cooled prior to drying. A filter/dryer unit removes moisture and particulates to meet instrument air specifications. Two instrument air receivers act as surge vessels and provide a reserve supply of air in the event of an upset condition.

The instrument air operating pressure is established to meet the air supply pressure required to operate UF₆ valves. System surge capacity is based on supplying instrument air to all valves in UF₆ service for six operational cycles within a period of one minute at a supply pressure of 7 barg (102 psig). Service to plant air users and HVAC instruments is discontinued during operational upsets.

3.5.3.2 Major Components

The major components and design parameters are listed below.

A. Air compressor packaged units

There are two air compressor packaged units each sized to provide the total amount of plant and instrument air required in the Separations Building, Central Utilities Building, and other buildings. Each packaged unit consists of an air compressor, inlet air filter/silencer, precooler, aftercooler, intercooler, moisture separators (after each cooler), and an oil separator.

The design parameters of air compressor packages are as follows:

Quantity	2 active
Compressor type	Oil injected rotary screw
Capacity	323 m ³ /hr (190 scfm) each
Pressure	13 barg (188.5 psig)
Materials of construction	Carbon steel

B. Air filter/dryer units

There are two air filter/dryer units each sized to dry and filter the design quantity of compressed air to -40°C (-40°F) dewpoint. The duplex dryer is designed to provide continuous service and automatic regeneration. Each unit consists of an air prefilter, desiccant dryer, and an air afterfilter.

The design parameters of the air filter/dryer units are as follows:

Quantity	2 active
Dryer media	Desiccant
Capacity	323 m ³ /hr (190 scfm) each
Air dew point	-40°C (-40°F)
Materials of construction	Carbon steel

C. Instrument air receivers

There are two instrument air receivers each sized to provide the design quantity of instrument air to process valve operators at the required supply pressure for six operational cycles within a period of one minute after failure of both air compressors.

Quantity	2
Type	Vertical, 15 m ³ (530 ft ³)
Pressure relief	Yes
Materials of construction	Carbon steel

3.5.3.3 System Interfaces

The compressed air system interfaces with the following facility systems.

- A. The Centrifuge Cooling Water System supplies cooling water to the air compressor packaged units.
- B. The Process Water System water is used as backup cooling water during a power failure.
- C. The Electrical System supplies power to operate the compressor motors, dryer, heater, lighting, and instrumentation.
- D. The Standby Diesel Generator System supplies power to the compressor package units in case of primary power interruption.

3.5.3.4 Operational Characteristics

The Compressed Air System is normally operating and is designed to provide uninterrupted operation.

3.5.3.4.1 Routine Operation

The Compressed Air System is designed to provide a reliable and continuous supply of compressed air for plant and instrument use. During normal operation, both compressors operate at partial load. The system is designed to respond to changes in instrument air demand by adjustment of compressor operating capacity.

At design conditions, outside air is drawn through the compressor inlet air filter/silencer. Actual rate of air intake depends on system air demand and is adjusted by the packaged unit capacity controller. The inlet air is precooled, compressed with a positive displacement compressor, and cooled prior to drying in the system filter/dryer unit. Condensed water vapor is collected in moisture separators associated with the precooler, intercooler, and compressed air aftercooler. The compressor package unit will contain an oil separator to assure oil-free instrument air.

The compressed air is prefiltered and dried in a duplex self-regenerating desiccant dryer to a dew point of -40°C (-40°F) and is again filtered to prevent desiccant carryover. The flow of dried instrument air is split between two instrument air receivers. Instrument air is distributed through ring headers in each Separations Building Module at 13 barg (188.5 psig) pressure. Pressure regulating valves in each Separations Building Module reduce the operating pressure to 7 barg (102 psig) for distribution to users.

3.5.3.4.2 Non-Routine Operation

The Compressed Air System is designed with equipment redundancy to ensure continuous operation. If mechanical repairs are required on an air compressor packaged unit, the unit is isolated and the other unit continues to operate. The drying unit also has a spare, and one unit may be isolated to perform maintenance, repairs, or desiccant replacement during normal operation.

The consequences of potential failure modes are discussed below:

- A. Failure of the system pressure controller may result in both compressors operating at full capacity. Safety relief valves will vent the excess air to the atmosphere. Alternatively, the failure may result in insufficient air supply. In either case, high pressure alarms or low pressure alarms alert the operators to the upset condition.
- B. Failure of the moisture analyzer on the air dryers may delay switchover of operation to a regenerated dryer and allow air to enter the system above the -40°C (-40°F) dew point. A redundant moisture analyzer will actuate alarms to alert the operators of the upset condition.
- C. System surge capacity is based on supplying instrument air to all valves in UF_6 service for six operational cycles within a period of one minute at a supply pressure of 7 barg (102 psig). This capacity is estimated to be 100 m^3 .
- D. The Compressed Air System is supplied by backup power from the Standby Diesel Generator System. It remains in operation during interruption of the primary power supply.
- E. Operation of a compressor in a blocked-in state results in excessive pressure. Pressure safety valves and alarms protect the system piping and equipment in the event that this occurs.
- F. Failure of the cooling tower waterflow will result in air compressor shutdown. In this case process cooling water is used as a backup.

3.5.3.5 Safety Considerations

Failures in this system cannot endanger the health and safety of the plant personnel or the public. Nevertheless, special design and operating features enhance public safety and worker safety. The system has been designed with component redundancy and backup power supply as described above. These provisions contribute to public and worker safety by increasing the reliability of instrument air supply and thereby decreasing the probability of UF_6 process system upset.

3.5.4 Water Supply

3.5.4.1 Process Water System

3.5.4.1.1 System Description

The Process Water System provides water to users throughout the facility. Process water refers to potable water that has passed through a backflow preventer upon entrance to the facility. Potable water is water that comes from a city water system. Water from the city water system is provided at a reliable pressure adequate to serve facility requirements. The system

flow diagram is shown in Figure 3.5-21, Process Flow Diagram, Process Water Distribution System. The average daily water consumption of the NEF is provided in Table 3.5-3, Average Water Consumption.

3.5.4.1.2 Major Components

The Process Water System consists of two backflow preventers, one electric water heater, associated piping, valves, and instrumentation. Water is heated to 82.2°C (180°F) for use in the Laundry System.

The system also includes two storage tanks. Each tank has a 946,350 L (250,000 gal) capacity. Half of each tank is used for the storage of process water. The bottom half of each tank is used for fire water storage. The piping is connected so that it is impossible to use dedicated fire water for process water. Additional equipment includes one process water pump with a 100% spare and associated piping, valves, and instrumentation.

3.5.4.1.3 System Interfaces

The Process Water System interfaces with the following systems.

- A. The Process Water System provides initial fill and makeup water to the HVAC Chilled Water System, the Centrifuge Cooling Water Systems, and the DI Water Supply and Distribution System and serves as backup cooling water for the compressed air system.
- B. The Process Water System provides initial fill and makeup process feed water to the hot water expansion tanks and hot water boilers.
- C. The Process Water System provides initial fill and makeup water to the standby diesel generator cooling systems.
- D. The Process Water System supplies the Laundry System, the Decontamination System, the Liquid Effluent Collection and Treatment System (general washdown and tank flushing), various wash-down areas, and yard and construction services.
- E. The Electrical System provides power for the electric water heater.

3.5.4.1.4 Operational Characteristics

A major piping failure in the Process Water System would not affect essential services. The Centrifuge Cooling Water System, HVAC Chilled Water System, and the Fire Water System have sufficient storage capacity to perform basic functions without receiving makeup water from the city water systems for up to 48 hours.

3.5.4.1.5 Safety Considerations

Failure of this system does not endanger the health and safety of the plant personnel or the public. A sufficient storage capacity is provided for all essential users such that failure of the Process Water System would not affect the performance of essential services over a reasonable period of time.

3.5.4.2 Potable Water System

3.5.4.2.1 System Description

The Potable Water System provides potable quality water from a reliable water source to users throughout the facility.

3.5.4.2.2 Major Components

The system is a flow distribution network. It contains a backflow preventer to guard against contamination in the event that contaminated water is siphoned.

Local electric heaters provide heated potable water to various plant users such as restrooms, showers, and service sinks.

3.5.4.2.3 System Interfaces

The Potable Water System interfaces with the Septic System, the Process Water System, and the Fire Water System. The Septic System receives potable water that is not consumed. However, potable water that is potentially contaminated drains to the Liquid Effluent Collection and Treatment System.

The Potable Water System provides potable water to the following users.

- A. Separations Building. Restrooms, service sinks, drinking fountains, emergency showers, and eyewash stations
- B. CAB. Restrooms, service sinks, canteen, drinking fountains, eyewash stations, and emergency showers
- C. CRDB. Restrooms, service sinks, and drinking fountains
- D. TSB. Restrooms, break room, service sinks, drinking fountains, laboratory emergency showers, and eyewash stations
- E. Administration Building and Visitor Center. Restrooms, service sinks, canteen, and drinking fountains
- F. CUB. Restroom, service sink, drinking fountain, emergency shower, and eyewash stations.

3.5.4.2.4 Operational Characteristics

Potable water is available for use on demand. The use of potable water is intermittent, and there are no continuous users. The only control function performed by the system is thermostatic control of the electric water heaters.

3.5.4.2.5 Safety Considerations

Failure of this system does not endanger the health and safety of the plant personnel or the public.

3.5.4.3 Deionized Water Supply and Distribution System

Deionized (DI) water is produced on site. A single DI Water Supply and Distribution System provides DI water to the Centrifuge Cooling Water Distribution System of each Separation Building Module, to the laboratory users, to the Liquid Effluent Collection and Treatment System areas, and the Decontamination Workshop areas in the TSB.

3.5.4.3.1 System Description

A single DI Water Supply and Distribution System is located in the CUB. The system consists of a DI water storage tank, a supply pump, bag filter, ultraviolet sterilizers, heat exchanger, replaceable vessel style deionizers, and associated piping and instrumentation. This equipment serves each Separations Building Module, the DI water users in the TSB, and each HVAC unit humidifier. The DI Water Make-up System operates on an intermittent basis, while the DI Water Distribution System operates continuously. The system flow diagram is shown on Figure 3.5-22, Process Flow Diagram, DI Water Supply and Distribution System. The functional requirements of the DI Water Supply and Distribution System are provided in Table 3.5-4, Deionized Water Supply and Distribution System Design Parameters.

3.5.4.3.2 Major Components

The major components and design parameters are listed below.

- A. DI water storage tank. The DI water storage tank has a capacity of approximately 1,893 L (500 gal). Fiberglass reinforced plastic (FRP) is used because of its compatibility with DI water and low cost. The tank is designed and equipped with a nitrogen blanket to deter biological growth.

Type	Dome roof
Quantity	1
Capacity	1893 L (500 gal)
Operating temperature	Ambient
Operating pressure	Approx. 76.2 mm (3 in) water column
Materials of construction	FRP

- B. DI water loop supply pump. The DI water loop supply pump delivers DI water to the Centrifuge Cooling Water Distribution Systems and other users. A minimum flow bypass is provided to protect the pump from damage due to low flow operation.

Type	Centrifugal
Quantity	2 active
Design capacity	1.3 L/s (20 gpm)
Operating capacity	1.3 L/s (20 gpm)

Materials of construction Stainless steel (no copper or pumps with copper bearings allowed)

- C. Raw water bag filter. This filter is sized for approximately 2.6 L/s (40 gpm) and to remove suspended particulate material of 20 micron nominal.
- D. Chlorine destruct ultraviolet sterilizer. The UV sterilizer is sized for approximately 2.6 L/s (40 gpm) and to remove free and total chlorine residual from the chlorinated water supply.
- E. Deionizers. The replaceable ion exchange vessels are supplied with cation, anion, and mixed bed ion exchange resins, sized for 2.6 L/s (40 gpm) operation.
- F. DI water cooling heat exchanger. This plate and frame stainless steel heat exchanger utilizes process chilled water supply to maintain the DI water loop temperature.
- G. Biokill ultraviolet sterilizer. The UV sterilizer reduces the biological growth within the circulation loop with the chlorine residual removed.

3.5.4.3.3 System Interfaces

The DI Water Supply and Distribution System interfaces with the following plant systems.

- A. The Process Water System supplies make up water for the DI Water Supply System.
- B. The DI Water Supply and Distribution System provides fill and make up water to the Centrifuge Cooling Water Distribution Systems, laboratories, HVAC unit humidifiers, and the liquid effluent systems.
- C. The Electrical System provides power to operate the pump, ultraviolet sterilizers, lighting, and instrumentation in the DI Water Supply and Distribution System.
- D. The HVAC Chilled Water System supplies chilled water to cool the heat exchanger.
- E. The Compressed Air System supplies instrument air to actuate instruments and control valves in the DI Water Supply and Distribution System.
- F. The Nitrogen System provides nitrogen for tank blanketing.

An additional interface of this system is with the outside supplier of the replaceable deionizer vessels. The deionizers are delivered by truck as required.

3.5.4.3.4 Operational Characteristics

The DI Water Supply and Distribution System operates intermittently for the make up system, and the distribution system operates continuously to fill and make up DI water to the expansion vessels in the Centrifuge Cooling Water Distribution System, and to the other users of DI water.

3.5.4.3.4.1 Routine Operation

The make up system for the DI Water Supply and Distribution System normally operates intermittently, depending on the level of the DI water storage tank. The distribution loop system operates continuously, returning DI water to the DI water storage tank. The DI water supply pumps run continuously. When the DI water storage tank reaches a low water level, the inlet

make up control valve opens, and the chlorine destruct ultraviolet sterilizer is turned on, allowing refill of the DI water storage tank. DI water is pumped at approximately 2.6 L/s (40 gpm) from the DI water storage tank to the loop serving the Centrifuge Cooling Water Distribution System expansion vessel in each of the three Separations Building Modules. The inlet control valve for the expansion tank is automatically opened and closed by a signal from a level control on the Centrifuge Cooling Water Distribution System expansion vessels. DI water is supplied at approximately 1.48 L/s (20 gpm) to the Centrifuge Cooling Water System expansion vessel in each of the three Separations Building Modules from the distribution loop. DI water is supplied at approximately 0.74 L/s (10 gpm) to the HVAC humidifiers.

The supply of DI water from the anion deionizer is monitored and alarmed for specific conductivity, alerting the plant staff of the need to replace the cation-anion vessels.

3.5.4.3.4.2 Non-routine Operation

The following non-routine operations are considered:

- A. Empty DI water storage tank. A low level shutdown switch on the storage tank protects the DI water loop supply pump from this condition.
- B. DI water loop supply pump discharge line and minimum flow line isolated. The pump could be operated in a blocked-in condition that could result in pump damage. An operator would be alerted to this condition when the loop supply flow rate fails to meet design flow conditions.
- C. DI water storage tank level control signal failure. This could result in continued make up water flow to the DI water storage tank after the tank level is established. If the inlet control valve is not closed, make up water will spill out of the tank overflow.
- D. Centrifuge Cooling Water Distribution System expansion tank level control signal failure. This could result in continued make up water flow to a Centrifuge Cooling Water Distribution System expansion vessel after the vessel level is established. If the inlet control valve is not closed, DI water will spill out of the vessel overflow.

The DI Water Supply and Distribution System does not have redundant components or a backup power supply because its function is non-essential.

3.5.4.3.5 Safety Considerations

Failure of the DI Water Supply and Distribution System does not endanger the health and safety of the plant personnel or the public.

3.5.4.4 Hot Water System

The Hot Water System is located in the Central Utilities Building. The system provides hot water for building and area HVAC heating requirements.

3.5.4.4.1 System Description

The closed loop Hot Water System provides heating service for the HVAC systems in the CUB, UF₆ Handling Areas, Cascade Halls 1 through 6, TSB, Blending and Liquid Sampling Area, CRDB, and the CAB.

The Hot Water System provides hot water to the HVAC AHUs. It only services the HVAC requirements for building heat. The Hot Water System consists of two, 100% capacity systems, with one system serving as redundant back up for the primary system. Each system consists of a hot water expansion bladder type tank, a natural gas fired hot water boiler with boiler circulation pump, a chemical feeder unit, dual primary hot water loop supply pumps, and the associated distribution piping, instrumentation, and controls. The Hot Water System is shown on Figure 3.5-23, Process Flow Diagram, Boilers and Hot Water Distribution System. The functional requirements of the Hot Water System are provided in Table 3.5-5, Hot Water System Design Parameters.

3.5.4.4.2 Major Components

The major components and design parameters are listed below.

- A. Hot water expansion tank. The hot water expansion tank is sized to accommodate the thermal expansion of water in the hot water distribution system.

Type	Horizontal type with internal expansion bladder
Quantity	2 (1 per hot water boiler)
Capacity	3785 L (1000 gal)
Operating temperature	5.6°C – 82.2°C (42°F – 180°F)
Operating pressure	2.1 bar (30 psi).
Materials of construction	Carbon steel

- B. Boiler circulation pumps. These pumps circulate hot water through the boilers from the hot water loop return and from the hot water expansion tank.

Type	Centrifugal
Quantity	2; 1 per hot water boiler
Design capacity	9.46 L/s (150 gpm)
Operating capacity	8.52 L/s (135 gpm)
Materials of construction	Cast iron with bronze impeller

- C. Chemical feeder unit. The chemical feeder operates on a manual basis to add oxygen scavenger and corrosion inhibitor to the closed loop hot water boiler system.

Quantity	1
Vessel capacity	7.6 L (2.0 gal)
Materials of construction	Carbon steel

- D. Hot water boilers. These fire tube type boilers are designed to heat circulating hot water to 82.2°C (180°F).

Type	Natural gas fired
Quantity	2; 1 operating, 1 spare
Peak duty	2943.3 kW (10.045 Million BTUH), nominal capacity each
Materials of construction	Carbon steel

- E. Hot water air separator. This unit is sized to remove entrained air from the hot water prior to the hot water supply pumps to eliminate cavitation.

Type	Tangential
Quantity	1
Operating temperature	15.6°C – 82.2°C (60°F – 180°F)
Operating pressure	6.89 bar (100 psi)
Materials of construction	Carbon steel

- F. Primary hot water supply pumps. These pumps circulate hot water to the HVAC AHUs within the facility.

Type	Centrifugal
Quantity	2; 1 operating, 1 standby
Design capacity	69.4 L/s (1100 gpm)
Operating capacity	63.1 L/s (1000 gpm)
Discharge pressure	6.89 bar (100 psi)
Materials of construction	Cast iron with bronze impeller

The piping in the Hot Water System is fabricated from carbon steel.

3.5.4.4.3 System Interfaces

The Hot Water System interfaces with the following plant systems:

- A. The Compressed Air System provides compressed air to actuate process equipment.
- B. The HVAC systems use hot water to heat air in the HVAC AHUs.
- C. The Process Water System provides make up process feed water to the hot water expansion tanks and hot water boilers.
- D. The Electrical System supplies power to operate the pumps, hot water boiler system packages, and instrumentation.

3.5.4.4.4 Operational Characteristics

3.5.4.4.4.1 Routine Operations

The Hot Water System normally operates as a continuously circulating, temperature-controlled, closed loop hot water system. Heating loads vary depending on seasonal and daily variations in the HVAC System loads.

The hot water supply temperatures in the system are maintained with temperature controllers on the outlets of the two hot water boilers, which increase or decrease natural gas burning rates as required.

A constant hot water supply temperature of 82.2°C (180°F) to the HVAC air handler units is maintained. Hot water supply to the HVAC equipment has a high temperature alarm and a high-high temperature shutdown control to ensure that the supply hot water temperature does not exceed 82.2°C (180°F).

3.5.4.4.4.2 Non-routine Operations

- A. Equipment Failure. The pumps, hot water boilers, and components in the Hot Water System are equipped with redundancy to provide maximum reliability. The hot water expansion tanks are included with the redundancy of the hot water boiler packaged equipment. The chemical bypass feeder systems are used daily to ensure oxygen scavenger residuals. They are redundant with the hot water boilers.
- B. Instrument Failure. Failure of instrumentation may lead to incorrect temperature control of the hot water. Overheating of supply hot water to the HVAC units results in high temperature alarms, and equipment isolation and shut down.
- C. Instrument Air Failure. Failure of instrument air results in the instruments failing to a safe position.
- D. Power Failure. A power failure to the Hot Water System results in shutdown of the system. Supply of hot water to the HVAC AHUs is interrupted until power is restored. This system is not supplied with standby power.
- E. Operator Error. The Hot Water System is an automated packaged system and there is little or no routine operator intervention required. The operator could incorrectly adjust the set points on the temperature controllers, but alarms would alert personnel of incorrect water temperatures.

3.5.4.4.5 Safety Considerations

Failure of this system will not endanger the health and safety of the plant personnel or the public. Active components are redundant throughout the system for maximum reliability.

3.5.5 Cooling Water Systems

3.5.5.1 HVAC Cooling Water System

The HVAC Cooling Water System consists of multiple chillers and cooling towers. A chilled water loop discharges excess facility heat to the atmosphere through a cooling tower loop.

3.5.5.1.1 System Description

The HVAC Cooling Water System and equipment design bases are shown on Figure 3.5-24, Process Flow Diagram, HVAC Cooling Water System, Chillers/Pumps. The system consists of the HVAC Chilled Water System and the HVAC Cooling Tower Water System. Each chiller of the HVAC Chilled Water System has dedicated and spare primary chilled water pumps. This primary loop also includes an expansion tank. The secondary chilled water loop of the HVAC Chilled Water System delivers chilled water from the CUB to other areas of the facility. The functional requirements of the HVAC Cooling Water System are provided in Table 3.5-6, HVAC Cooling Water System Design Parameters.

The HVAC Chilled Water System provides 5.6°C (42°F) chilled water to the following systems:

- A. Various HVAC Systems
- B. Product Liquid Sampling System
- C. DI Water Supply and Distribution System
- D. Evaporator/Dryer Condenser (Liquid Effluent Collection and Treatment System)

The centrifugal chillers of the HVAC Chilled Water System cool the chilled water using R-134a refrigerant. An expansion tank in the chilled water return line is provided to accommodate liquid expansion in the system. System equipment and distribution piping are insulated to limit heat gains and prevent condensation on the piping surface.

The HVAC Cooling Tower Water System circulates water from the cooling towers through the condenser side of the chillers and back to the cooling towers. This loop includes multiple cooling towers, multiple cooling tower water pumps, and chemical treatment. The HVAC Cooling Tower Water System and component design basis are shown on Figure 3.5-25, Process Flow Diagram, HVAC Cooling Tower Water System, Cooling Towers and Pumps, Sheet 1.

3.5.5.1.2 Major Components

The major components and design parameters of the HVAC Chilled Water System are listed below.

- A. Chillers. Each chiller is sized to meet 50% of the total system duty.

Type	Centrifugal
Quantity	2 operating, 1 spare
Refrigerant	R-134a
Chilled water supply temperature	5.6°C (42°F)

- B. Primary chilled water pumps. The primary chilled water pumps are sized to provide 100% flow through each of the chillers.

Type	Centrifugal
Quantity	1 operating and 1 spare per chiller (6 total)
Material of construction	Cast iron with bronze impeller

- C. Secondary chilled water pumps. The number and size of the secondary chilled water pumps are sufficient to meet flow requirements for user loads with an 5.6°C (42°F) temperature rise.

Type	Centrifugal
Quantity	To be determined during the design phase
Material of construction	Cast iron with bronze impeller

- D. Chilled water expansion tank. The expansion tank is sized to accommodate the expansion of water in the system over the temperature range of 5.6°C to 26.7°C (42°F to 80°F) and to accommodate leakage from the system.

Type	Horizontal
Quantity	1
Operating temperature	Ambient
Operating pressure	Atmospheric or pressurized
Materials of construction	Epoxy coated carbon steel

The major components and design parameters of the HVAC Cooling Tower Water System are listed below.

- A. Cooling tower. The cooling towers are sized to meet 100% of the total system duty.

Type	Closed Circuit Evaporative Coolers
Quantity	8 operating, 2 spare (10 total)
Material of construction	Galvanized carbon steel with stainless steel wetted parts

- B. Cooling tower water pumps. The number and size of the cooling tower water pumps are sufficient to meet flow requirements for user loads of the chillers.

Type	Centrifugal
Material of construction	Cast iron with bronze impeller

- C. Cooling tower water expansion tank. The expansion tank is sized to accommodate the expansion of water in the system over the temperature range of 5.6°C to 32.2°C (42°F to 90.1°F) and to accommodate leakage from the system.

Type	Horizontal
Quantity	1
Operating temperature	Ambient
Operating pressure	Atmospheric or pressurized
Materials of construction	Epoxy coated carbon steel or fiberglass reinforced polyester (FRP)

All components of the HVAC Cooling Water System, except the cooling towers are located in the Chiller Room of the CUB. The cooling towers are located outside the CUB.

3.5.5.1.3 System Interfaces

The HVAC Cooling Water System interacts with the following plant systems.

- A. The Blending and Liquid Sampling Systems are supplied with 5.6°C (42°F) chilled water to cool the autoclaves.
- B. The various HVAC systems are supplied with 5.6°C (42°F) chilled water to cool the ventilation air.
- C. The Compressed Air System supplies instrument air to actuate the chilled water system control valves and instruments.
- D. The Process Water System supplies makeup water.
- E. The Electrical System supplies power to operate the primary and secondary chilled water pumps, condenser water pumps, lighting, and instrumentation. The Electrical System supplies power to the chillers and cooling towers.
- F. Provide 5.6°C (42°F) cooling water to the DI Water System.
- G. Provide 5.6°C (42°F) water to cool the Evaporator/Dryer in the Liquid Effluent Collection and Treatment System.

3.5.5.1.4 Operational Characteristics

During normal operation, the HVAC Chilled Water System, supported by the HVAC Cooling Tower Water System, provides a continuous supply of chilled water to plant users. Chilled water is pumped to the various users by the secondary distribution loop. The temperature of the chilled water is maintained at 5.6°C (42°F).

3.5.5.1.4.1 Routine Operation

The chilled water supply temperature is maintained at 5.6°C (42°F) with centrifugal chillers. Multiple 50% capacity chillers are provided to accommodate fluctuating HVAC cooling loads and all plant loads.

3.5.5.1.4.2 Non-routine Operation

The HVAC Cooling Water System is designed with redundancy to provide maximum reliability. The consequences of potential failure modes are discussed below.

- A. Equipment Failure. All equipment in this system, except the chilled water expansion tank, is provided with redundancy. In the event of equipment failure, spare equipment is placed into service. If the expansion tank develops a leak, the vessel is bypassed while the leak is repaired. The multiple, 50% capacity chillers permit maintenance on one chiller at a time. The others remain in service, providing 100% of the plant cooling needs.
- B. Instrumentation Failure. All instruments and control valves are designed to fail in a safe position. Control valves may be isolated and bypassed for maintenance.

- C. Instrument Air Failure. All control valves and instruments that operate on instrument air will fail to a safe position in the event of instrument air failure.
- D. Power Failure. All equipment in this system will shutdown in the event of power failure.
- E. Operator Error. If a chilled water pump is operated with a closed discharge valve, a low flow switch is provided in the pump discharge line to trip the pump. If an operator erroneously shuts down a cooling water chiller, a high chilled water temperature alarm is initiated.

3.5.5.1.5 Safety Considerations

Failure of this system does not endanger the health and safety of the plant personnel or the public. Redundancy is provided for all major components to enhance the reliability of the system.

3.5.5.2 Centrifuge Cooling Water System

The Centrifuge Cooling Water System provides cooling water to the centrifuge cooling jacket coils, thus maintaining the required centrifuge operating temperatures necessary for efficient isotope separation.

3.5.5.2.1 System Description

The Centrifuge Cooling Water System consists of multiple closed cell cooling towers that discharge excess process heat to the atmosphere through a combination of multiple cooling towers. Other components of the loop include tower water pumps and an expansion tank. The cooling tower water loop delivers cooling water to the air compressors and to the Centrifuge Cooling Water Distribution System.

The Centrifuge Cooling Water System is illustrated on Figure 3.5-25, Process Flow Diagram, Centrifuge Cooling Water System, Cooling Towers and Pumps, Sheet 2.

The Centrifuge Cooling Water System provides 28.0°C (82.5°F) cooling tower water to the Centrifuge Cooling Water Distribution System.

Expansion tanks in the cooling tower water return line are provided to accommodate liquid expansion in the system. System equipment and distribution piping are insulated to limit heat gains.

3.5.5.2.2 Major Components

The equipment design parameters are listed below.

- A. Centrifuge cooling water pumps. The number and size of centrifuge cooling water pumps are sufficient to provide 100% flow through each of the towers.

Type	Centrifugal
Quantity	To be determined during the design phase
Material of construction	Stainless steel

- B. Cooling tower. The cooling towers are sized to meet 100% of the total system duty with 43% spare capacity.

Type	Closed cell cooling tower
Quantity	7 operating, 3 spare (10 total)
Material of construction	Stainless steel

- C. Cooling tower water expansion tanks. The expansion tanks are sized to accommodate the expansion of water in the system over the temperature range of 4.4°C to 37.8°C (40°F to 100°F) and to accommodate leakage from the system.

Type	Horizontal
Quantity	2
Operating temperature	Ambient
Operating pressure	Atmospheric or pressurized
Materials of construction	Epoxy coated carbon steel or fiberglass reinforced polyester (FRP)

All components of the Centrifuge Cooling Water System, except the cooling towers are located in the CUB. The cooling towers are located outside the CUB.

3.5.5.2.3 System Interfaces

The Centrifuge Cooling Water System interacts with the following plant systems.

- A. The Centrifuge Cooling Water Distribution System is supplied with 28.0°C (82.5°F) cooling tower water.
- B. The Compressed Air System supplies instrument air to actuate the cooling tower water system control valves and instruments.
- C. The Process Water System supplies makeup water to the centrifuge cooling tower water basins.
- D. The DI Water System supplies makeup water to the Centrifuge Cooling Water System.
- E. The Electrical System supplies power to operate the chillers, cooling towers, primary and secondary chilled water pumps, condenser water pumps, lighting, and instrumentation.
- F. The air compressors will be supplied with 28.0°C (82.5°F) cooling tower water.

3.5.5.2.4 Operational Characteristics

During normal operation, the Centrifuge Cooling Water System provides a continuous supply of cooling tower water to process centrifuge users and air compressors. The temperature of the cooling tower water is maintained at 28.0°C (82.5°F).

3.5.5.2.4.1 Routine Operation

The cooling tower water supply temperature is maintained at 28.0°C (82.5°F). Multiple towers are provided to accommodate fluctuating process cooling loads.

3.5.5.2.4.2 Non-routine Operation

The Centrifuge Cooling Water System is designed with redundancy to provide maximum reliability. The consequences of potential failure modes are discussed below.

- A. Equipment Failure. All equipment in this system, except the cooling tower water expansion tank, is provided with redundancy. In the event of equipment failure, spare equipment is placed into service. If the expansion tank develops a leak, the vessel is bypassed while the leak is repaired. The multiple towers permit maintenance on up to 3 towers at a time. The others remain in service, providing 100% of the process centrifuge cooling needs.
- B. Instrumentation Failure. All instruments and control valves are designed to fail in a safe position. Control valves may be isolated and bypassed for maintenance.
- C. Instrument Air Failure. All control valves and instruments that operate on instrument air will fail to a safe position in the event of instrument air failure.
- D. Power Failure. All equipment in this system will shutdown in the event of power failure.
- E. Operator Error. If a cooling tower water pump is operated with a closed discharge valve, a low flow switch is provided in the pump discharge line to trip the pump. If an operator erroneously shuts down a cooling tower, a high cooling tower water temperature alarm is initiated.

3.5.5.2.5 Safety Considerations

Failure of this system does not endanger the health and safety of the plant personnel or the public. Redundancy is provided for all major components to enhance the reliability of the system.

3.5.5.3 Centrifuge Cooling Water Distribution System

3.5.5.3.1 System Description

The Centrifuge Cooling Water Distribution System is located in the Process Services Area in each Separations Building Module. The Centrifuge Cooling Water Distribution System supplies DI cooling water to the centrifuge cooling jackets in each cascade, maintaining the required operating temperature and ensuring efficient isotope separation during uranium enrichment. The system is shown on Figure 3.5-26, Process Flow Diagram, Centrifuge Cooling Water Distribution System. The functional requirements of the Centrifuge Cooling Water Distribution System are provided in Table 3.5-7, Centrifuge Cooling Water Distribution System Design Parameters.

The Centrifuge Cooling Water Distribution System consists of identical equipment in each Separations Building Module and includes piping, instrumentation, and controls. The cascade circulation pumps are located in the Process Services Area adjacent to the respective cascade that they service. During normal operation, centrifuge cooling water is cooled by the Centrifuge Cooling Water Distribution System and is circulated through the centrifuge cooling jackets in each cascade.

The primary functional requirement of the Centrifuge Cooling Water Distribution System is to provide a heat sink for the heat load produced by centrifuges in each Separations Building Module. The system is initially filled with DI water from the DI Water Distribution System.

3.5.5.3.2 Major Components

The major components and design parameters are listed below.

- A. Cascade circulation pumps. The cascade circulation pumps are sized to provide sufficient flow to each cascade to meet heat removal requirements.

Type	Centrifugal
Quantity	32 per Separations Building Module; 1 operating, 1 spare for each cascade
Operating capacity	27.2 L/s (431.5 gpm)
Materials of construction	Stainless steel

Materials of construction are selected to be compatible with the highly corrosive DI water and with the aluminum cascade cooling coils.

3.5.5.3.3 System Interfaces

The Centrifuge Cooling Water Distribution System interfaces with the following plant systems:

- A. Centrifuge cooling water is supplied to the Cascades.
- B. The Centrifuge Cooling Water System supplies process cooling water used to cool the Centrifuge Cooling Water Distribution System.
- C. The DI Water Supply and Distribution System supplies make up DI water to the Centrifuge Cooling Water Distribution System.
- D. The Compressed Air System supplies instrument air to actuate instruments and control valves in the Centrifuge Cooling Water Distribution System.
- E. The Electrical System provides power to operate cascade circulation pumps and instrumentation.

3.5.5.3.4 Operating Characteristics

This system operates continuously and is designed to provide highly reliable operation. In the event the UF₆ flow through a centrifuge or cascade is interrupted, the Centrifuge Cooling Water Distribution System continues operating without need for shutdown.

3.5.5.3.4.1 Routine Operation

This system is designed to provide high reliability and operate continuously to remove heat from the centrifuges. The system operates within a tightly controlled temperature range. Temperatures are closely regulated to ensure the efficiency of isotope separation.

The flow is split evenly between the two cascade halls in each Separations Building Module, and then again among the eight centrifuge cascades in each cascade hall.

3.5.5.3.4.2 Non-routine Operation

The Centrifuge Cooling Water Distribution System is designed with redundancy of components to provide maximum reliability. The consequences of projected potential failure modes are discussed below.

- A. Equipment Failure. This system is designed with a high degree of equipment redundancy to ensure continuous operation.
- B. Instrumentation Failure. Failure of the temperature control instrumentation in the cascade area could result in under or over-cooling of the centrifuges, which has no safety impact.
- C. Instrument Air Failure. All control valves and instruments that operate on instrument air will fail in a safe position in the event of instrument air failure.
- D. Cooling Water Failure. Failure of the cooling water supply to the centrifuges would cause the cooling water temperature to rise.
- E. Power Failure. All equipment in this system will shutdown in the event of power failure.
- F. Operator Error. Extended operation of any pump in a blocked-in or dry condition could result in damage and potential failure of the pump. The resultant pump failure could result in under-cooling of the centrifuges.

3.5.5.3.5 Safety Considerations

Failure of this system will not endanger the health and safety of the facility personnel or the public. Active components are redundant throughout the system for maximum reliability.

3.5.6 Septic System

3.5.6.1 System Description

The Septic System is designed to treat, collect, and transport all domestic sewage generated at the NEF. The system is capable of handling approximately 40,125 L (10,600 gal) per day.

The system includes multiple septic tanks and drain fields. Septic tanks are located at the Security Building, at the Administration Building, and at other places in the facility where a concentration of toilets exist.

3.5.6.2 Safety Considerations

Failure of this system does not endanger the health and safety of the plant personnel or the public.

3.5.7 Communication and Alarm Annunciation Systems

The Communication and Alarm Annunciation System is designed to provide reliable intra-facility and facility-to-offsite communications, as well as offsite emergency communications with public emergency response agencies.

3.5.7.1 Communication Systems Description

The primary communication systems at the facility are the facility telephone system and the two-way radio system.

3.5.7.1.1 Facility Telephone System

This system, which is permanently connected to the commercial telephone system, is the normal means of communications between local law enforcement authorities, public emergency response agencies and the facility.

The system is a conventional landline based private business exchange (PBX) telephone system that has a central switchboard. The system is a state of the art digital facility with the capabilities to offer special features in addition to basic telephone service such as; call tracing or call recording.

A sufficient quantity of telephones will be located strategically to allow facility personnel easy access to telephones from all facility locations.

The telephone lines enter the facility and interface with the site network in the main communications room located on the first floor of the Administration Building. The commercial telephone lines are terminated on protectors located in the communications room and extended to telephones located throughout the facility. The site lines leave the room through underground conduit to communication rooms located throughout the facility.

3.5.7.1.2 Two-way Radio System

This system, which can be connected with local law enforcement or other agencies during emergencies, is the primary communications system for the site security services.

This form of communication consists of radio base stations, mobile radios and handheld radios. Radio base stations are placed in the Security's Central Alarm Station (CAS) and Security Building. The radios have multiple channels, one of which is dedicated entirely to security.

Two-way radio communication is used by site security or by other personnel when the facility telephones are not accessible.

Two-way radios will not normally be used within the Separations Building due to the fact that radio interference from these systems can adversely affect the operation of plant control systems. During emergencies, however, their use will be unrestricted.

Radio signals may be sent via a centrally located radio tower or radio towers distributed throughout the facility.

The radio base stations are in separate locations so that it is unlikely that a fault would take the system out of service. Therefore, a reliable communication both on and off site is present at all times whether the plant is experiencing a normal or abnormal situation.

The radio base stations are powered by diesel-backed AC sources and remain operative following loss of offsite power.

Radio communications use the appropriate FCC licensed radio frequencies for the plant.

The communication systems are designed to provide appropriate redundancy so that a single failure in one system will not leave the facility without communication capability.

The design also permits continuous communications between the Control Room, the CAS, and security personnel on duty at the facility.

In the event of a failure of the facility telephone system, voice paging and direct conversation can be accomplished by the use of two-way radio.

Direct voice communication within the facility is handled by the facility telephone system using extension telephones with direct dialing between extensions.

Facility personnel may be paged through the public address (PA) system from a base station located in the Administration Building or the CAS. The control room operator also has direct access to the system from a third PA system base station in the control room. During emergencies the use of the CAS base station overrides the normal Administration Building paging operation.

3.5.7.1.3 Alarm Annunciation System

Facility alarm systems which provide security, safety and environmental protection such as fire alarm, radiation monitoring, gas release, equipment failure, etc. all provide audio and visual annunciation in either the Control Room or CAS. Control Room and/or security personnel will respond to the alarm condition directly and if applicable annunciate the condition over the PA system.

The PA system is tied into the phone system through a designated access number. The PBX has an override function that when the PA system is being accessed through the designated access number, voice communication will stop and a prerecorded alarm will sound. The prerecorded alarm is used to indicate an emergency situation such as a fire, an injury, or site evacuation. An alarm will sound and be followed immediately with a message giving directions over the PA system. The Control Room base station has complete control of the system and is able to switch the alarm off and give a voice message or initiate a prerecorded message. If the PA system is inoperable, two-way radios or telephones can be used.

Speakers are strategically located around the site both inside and outside so that personnel at any location on the site can be clearly notified of an event. The PA system will have a dual

architecture such that during a single failure the system will still allow alarms to be annunciated. The PA system allows communication to people in remote areas of the facility where telephones are not accessible.

3.5.7.2 System Interfaces

The facility telephone system ties in with the local telephone company. The Communication and Alarm Annunciation Systems are powered by the Electrical System.

3.5.7.3 Major Components

The following items are provided as part of the Communication and Alarms System:

- A. Facility Telephones. Telephones are fixed wall mounted or desktop style.
- B. Two-way Radio (Portable). The portable two-way radio is hand held and has multi-channel capability. The radio signal is strong enough such that anyone can be contacted on site.
- C. Two-way Radio (Mobile). The mobile two-way radio is mounted in vehicles on an extra stable mount. It is capable of multi-channel communication. The radio signal is strong enough to reach all areas of the facility from any point within the facility and communicate with offsite emergency agencies.
- D. Radio Base Station. The radio base station is a desktop model with multi-channel capability. The range extends to the hospital, fire department, and law enforcement even under the worst possible environmental conditions.

3.5.7.4 Operational Characteristics

3.5.7.4.1 Routine Operation

During normal operation, the site communication system provides facility telephone, radio, PA, and alarms for operation, security and administration communication.

3.5.7.4.2 Non-routine Operation

During off-normal operation, the site communication system provides telephone, PA, radio, and alarms for response to abnormal process operation, hazards (fire, chemical and radiological) and security events. The communication system aids in the following:

- A. The evacuation of personnel from the site or buildings
- B. The actuation of appropriate systems and components
- C. The identification of a need for containment of a hazard and appropriate measures to be taken

- D. Notification of local law enforcement of an event
- E. Communicating the need for fire fighting, medical, or security assistance.

3.5.7.5 Safety Considerations

Failure of the Communication and Alarm Annunciation Systems would not endanger public health and safety. Nevertheless, the Communication and Alarm Annunciation Systems are designed with redundant devices for emergency communications, as described above. Backup power is supplied to essential devices to assure communications during abnormal conditions.

3.5.8 Not Used

3.5.9 Control Systems

3.5.9.1 Functional Requirements

The Plant Control System (PCS) performs the following functions:

- Provide asset protection
- Enable operators to supervise and control all enrichment plant operations
- Control and protect the enrichment process
- Provide local operators with facilities to enable preparation of the enrichment process
- Provide a supervisory interface for auxiliary systems
- Provide historical data for analysis.

The detailed instrumentation needed to achieve the functionality identified above is included in the process system descriptions (Section 3.4 Enrichment and other Process Descriptions).

Facility control and monitoring systems are designed to handle abnormal levels of data and alarms that may occur during upset and emergency conditions. The Control Room is designed to accommodate equipment to monitor, alarm, and record environmental, effluent, and fire protection data.

Field-proven designs fabricated from proven materials for intended services and operating conditions are specified. In all cases the system utilizes standard, current technology instrumentation as well as hardware and software purchased from proven manufacturers and vendors with many years experience in the industry.

All process instrumentation specified has been qualified for use in uranium enrichment plants.

3.5.9.2 System Description

The PCS is designed to accommodate the full separation plant operation. The system is configured to enable integration using standard control technology together with connected, but separate, protection systems that provide the required level of protection.

The PCS includes the following:

- Central Control System (CCS), including SCADA, Servers, Operator Stations, Overview Screens and Communications Networks
- Local Control Systems (LCS), including Programmable Logic Controllers (PLC) and Local Operator Interface
- Interfaces to process equipment and Auxiliary Systems
- Training System
- Process Instrumentation and Wiring.

3.5.9.2.1 Central Control System

The Central Control System (CCS) is the top-level supervisory system. It is computer-based and consists of the Supervisory Control and Data Acquisition (SCADA) System, redundant server system, fiber and copper networks, operator workstations and overview screens. The core of the CCS is located in the Control Room with network expansion throughout the facility connecting each LCS. A pictorial representation of the CCS is shown in Figure 3.5-27, Plant Control System, Central Control System, Sheet 1.

The purpose of the CCS is to:

- A. Enable the minimum number of operators to carry out remote operation of the process.
- B. Provide operators and maintenance personnel with information about the status of the equipment in the facility.
- C. To allow remote control room operation of some frequently required operations, e.g., changing the state of a feed station.
- D. Provide alarms for the operators in case of abnormal events so that action can be taken to prevent an interruption of the process.
- E. Provide real-time and historical data storage to allow analysis of:
 - Facility performance
 - Post event protection actions
 - Comparison between historical and real-time events.

The CCS architecture is configured such that no single failure will prevent the operators from controlling and monitoring the process. The level of CCS redundancy in terms of operator

stations, servers, communication modules and networks provides a high availability of the system for monitoring and supervisory control.

The CCS provides supervisory monitoring and control as its primary function. Process protection, and protection of workers, the environment, and the public is implemented locally by facility equipment.

The SCADA system, which is implemented as part of the CCS, provides the operator with a complete visual interface to the plant. Facility mimics, overviews, trends, alarms, events, and control functionality is provided for the operator.

Facility visualization is provided through the facility overview screen or the operator workstations. The operator interface is organized in hierarchical levels to reduce duplication and complexity and minimize operator response time. The organizational levels of the interface has a maximum of four display levels:

- A. Object Level. Objects are pumps, valves, blowers, and other assorted individual pieces of equipment.
- B. Process Level. A process is a combination of individual objects grouped together by the overall process they control.
- C. System Level. A system is a combination of specific processes that are grouped together to control a specific system, for example feed stations or assay pump trains.
- D. Overview. The overview is a strategic view of the entire process, shown in clear and concise format to provide the operator with a constant and immediate understanding of the plant processes.

As a minimum a four level password security system is provided to manage access to the SCADA, providing a range of access from view-only to engineering access for changes to operating parameters.

All facility alarms are shown on the SCADA systems. The principle for alarms and alarm handling is such that alarms do not occur, and the alarm list is empty during normal operations, with alarms provided for abnormal operation only. When alarms do occur, they are listed in chronological order, displayed in defined colors and are brought to the operator's attention both audibly and visually. Alarm classes and filtering are provided to increase alarm recognition and improve operator response to alarm conditions.

3.5.9.2.2 Local Control Systems

The Local Control System (LCS) is the process-level control and protection system that includes process instrumentation and Local Control Centers (LCC) installed locally in the process area. Local Operator Interfaces (LOI) are provided for local operator control and monitoring. Each LCC has sufficient functionality to completely operate and protect its associated process system without any CCS intervention. A pictorial representation of the LCS is shown in Figure 3.5-27, Plant Control System, Local Control System, Sheets 2 and 3.

The architecture of the LCS follows the unit-architecture of the process facility. Specifically, where operational redundancy of the process system is provided (for example multiple Tails Stations), a dedicated control and protection system is provided (1 LCC per Tails Station).

Remote I/O and Local Area Networks (LANs) are used to communicate the status of process equipment and auxiliary systems with the LCC-mounted PLC systems. The LCS control equipment, software and hardware are designed to maintain the process parameters within the required process control limits during all normal and abnormal operations.

The Local Control Cabinet provides the physical housing accommodating all the necessary equipment for local operator control, automatic control and protection as well as remote monitoring interfaces for a designated process control system. Each Local Control Cabinet provides all the terminations, signal conditioning, power supplies, etc. that are required to interface with the field instrumentation. Field wiring and related installation equipment as well as signal conditioning equipment are reduced to a minimum to ensure the integrity, accuracy and long-term reliability of the system. The positioning of the LCCs provides for monitoring, control, and protection of all plant processes as close to the system as possible.

LCCs consist of the following major components:

- A. PLC and hardwired systems to perform the required process control and system protection as well as support the local operator functions. In some cases more than one PLC is provided.
- B. Proprietary software specifically designed to operate with the PLC hardware. The software provides all the advanced functionality required for the most complex of control schemes as well as including facilities for software documentation and fault analysis.
- C. Redundant process network communication modules make LCC data available to the CCS equipment.
- D. Interfaces for LAN or remote I/O allowing the transfer of data between the LCC control equipment and the related process equipment.
- E. Local Operator Interface (LOI), where required, to provide the operator with a process visualization, a display of equipment status and operating data, and the facility to transfer control of the related process system from local to remote control.
- F. Regulating control valve controllers, where required. These are rack-mounted devices with proprietary hardware and software-based operating systems.
- G. Redundant UPS-backed power supplies to ensure that continuous operation of the LCS in all power conditions.

3.5.9.2.3 Control System Interfaces

While the Plant Control System (PCS) provides the primary control for the process areas, there are several specialized monitoring and control systems that interface with and are integrated into the PCS for supervisory monitoring and control, as follows:

- A. Centrifuge Monitoring System. This system is a stand-alone, standard system developed by Urenco that provides detailed status conditions of each centrifuge during run-up and normal operation. The system is provided for investment monitoring and equipment protection.

- B. Centrifuge Drive System. Each drive system provides power for the centrifuge motors of one cascade, and provides the speed control and status condition to the operator, as well as providing the controls for isolating and connecting the centrifuges to the drive converters.
- C. Uranium Hexafluoride Inventory System (HIS). This is a site-based system, providing the operators with information about the current UF₆ situation at the site. The PCS system, through the LCCs, provides data to this system regarding in-process operations.
- D. Criticality Accident Alarm System (CAAS). This system is provided to detect and alarm in the unlikely event of a criticality accident. The CAAS is completely stand-alone for safety reasons, but alarm signals are interfaced to the PCS for centralized alarm and event recording purposes.

In addition to these specialized systems, there are several auxiliary systems that are interfaced with the PCS, as follows:

- Product Liquid Sampling System
- Fire Protection System
- Compressed Air System
- Liquid Effluent Collection and Treatment System
- Gaseous Effluent Vent System
- Nitrogen Supply System
- Hot Water System
- HVAC systems
- HVAC Cooling Water System
- Electrical System
- Environmental and Continuous Air Monitoring Systems.

These systems have simple interfaces to the PCS, are supervisory in nature, and are not provided with control interfaces at the LCS level.

In addition to these systems identified above, there are several specific process systems that are stand-alone, self-supporting and self-contained, complete with all wiring and controls:

- Solid Feed Stations
- Product and Tails Pumping Trains
- Low Temperature Take-off Stations

- UF₆ Cold Traps
- UF₆ Cold Trap Heater/Chiller Units
- Vacuum Pump/Chemical Trap Sets.

Each unit has a self-contained control system that provides complete control and protection functionality, fault analysis, and operator interface when required. Protection provided by the process system is designed to be simple, local and direct and totally isolated from the supervisory protection provided by the PCS. The interface between these process systems and the PCS for protection actions is simple and hardwired and always made at the LCS level.

3.5.9.2.4 Training System

The PCS training system is a stand-alone system that replicates the PCS in all operational functions. The system consists of a tutor station; operator station and hardware cabinet that contains equipment that replicates the CSS and LCS systems and PCS networks.

The training system provides two main functions, software testing and commissioning, and operator training. The training system is used to develop both the hardware and software of the PCS from detail design through system acceptance. The system allows the developer to simulate and test all aspects of the process, including controls and interlocks. Also, because the training operator interface is identical to the PCS operator stations, trainees can easily learn how to respond to operational and alarm conditions and quickly acclimate to the on-line PCS.

3.5.9.2.5 Process Instrumentation and Wiring

The instrumentation associated with the PCS is generally limited to the measurement of absolute pressure and temperature as well as control/monitoring of the process by means of control/solenoid valves with associated valve position indication.

The UF₆ process systems generally operate below atmospheric pressure and are monitored by absolute pressure transducers qualified for the process. These instruments have standardized pressure ranges and are provided with process connections that allow in-place calibration to take place. All pressure transducers are connected directly to and are powered by their process associated LCC.

All temperature measurement elements are non-intrusive (surface mount) types that are: Standard RTD PT100, Class-A, and 3-wire minimum. All temperature elements are connected directly to the LCC mounted PLC I/O cards.

The PCS interfaces with two types of process valves, modulating control valves and automatic on/off valves. The modulating control valve is a servo motor driven device that has its own controller mounted within the LCC. The valve controller receives position demand signals from the PCS via the LCC-mounted PLC and positions the valve where demanded, providing position feedback to the PLC. Automatic on/off valves are solenoid-operated valves, with open and closed limit switches for positive feedback to the PLC.

All instruments and control wiring are wired directly back to its associated LCC. To reduce the likelihood of common-mode failures junction boxes and multi-conductor cables are not used. Wherever possible, routing of cables for individual equipment or systems is kept separate.

Conversion of process signals is kept to a minimum with field instrumentation wired directly to PLC inputs and outputs. The PLC inputs and outputs are fully isolated with each instrument and valve signal such that common-mode interference is minimized.

3.5.9.3 Safety Considerations

The Plant Control System (PCS), when tied to all auxiliary systems is designed with these priorities in mind:

- Advise adverse conditions for safety of the public, environment, and facility personnel
- Protection of plant assets
- Production protection (maximize process availability).

Of paramount importance is the design priority given to safety of the public, environment, and facility personnel. The process is safe by design, normally operating at sub-atmospheric pressures, and shutdown systems are automatic, with no operator response or intervention required.

The PCS is required for remote operation, production protection and asset protection. It is not required and does not play a role in the direct protection of the public or environment. In all instances, where required, protection is carried out by the local control and protection systems of the individual process equipment. The PCS, including the hardwired bus system (described below) is not an IROFS.

For protection of facility assets and production, multiple design features are provided, including:

- A. Redundant Hardware and Control Networks. The level of CCS redundancy provided in terms of operator stations, servers, and networks provides a high level of availability. At the CCS level, the architecture is designed in such a way that no single failure will prevent operators from controlling and monitoring the process. The subsystems of the CCS (operator stations, overview screens and servers) are provided with dual power supplies, and the process control network is redundant for maximum availability.
- B. Inner/Outer Protection Envelope (Cascades). Each Cascade has two PLC systems in their respective LCC, a control PLC and an investment protection PLC. The control PLC provides normal cascade operating functions, an inner protection "envelope" and the communications interface to the CCS. The protection PLC only has a protection function that provides an outer investment protection "envelope" which sets the cascade to a safe state should the control PLC fail to control and protect within the inner protection envelope. In addition, the two PLCs constantly handshake to ensure they are synchronized. The cascade goes into safe state if the PLCs fail to maintain synchronization.
- C. 1 out of 2 Logic. In specific areas, two instruments are provided for redundancy and process availability. These instruments are wired to separate analog input modules in

their respective PLC. If either analog signal exceeds the programmed signal threshold, the software alarms the condition and the program recognizes it as a "tripped" condition and reacts accordingly.

- D. 2 out of 3 Logic. In specific areas, three instruments are provided for redundancy. These instruments are wired to separate analog input modules in their respective PLC. If any one analog signal exceeds the program signal threshold, the software notes the condition, but the program ignores the condition. If two signals exceed the threshold the software alarms the condition and the program recognizes it as a "tripped" condition and reacts accordingly.
- E. Hardwired, Failsafe 24vdc Digital Bus. When investment protection instrumentation is wired into a PLC, it is tied together in logic to drive an output, either wired in series or parallel depending on the protection function. These outputs are wired into a hardwired, failsafe 24vdc digital bus that is wired into the protection PLC of the process equipment. If the bus fails to maintain its 24vdc level, due to a failure of the 24vdc power or a failure of the input that drives the output, the process equipment shuts down or goes into a safe state as required. This hardware bus wiring and logic is not considered or intended to be a "safety system" in terms of personnel or environmental safety. It is provided for asset protection only.
- F. Operational Redundancy. As described earlier, the architecture of the control system follows the architecture of the process plant. Where operational redundancy is provided, control system redundancy is provided. In this manner, common mode failure is minimized and process availability is maximized.

For specific details regarding the role of the PCS in the control and protection of the process equipment, refer to the process control descriptions included in previous sections of this document.

3.5.10 Standby Diesel Generator System

The Standby Diesel Generator System provides backup 480 volt power to the NEF during a loss of normal power. The Standby Diesel Generator System is not a requirement for safe operation of the plant and is installed to provide protection of investment only.

3.5.10.1 System Description

The Standby Diesel Generator System is comprised of two, 100% rated generators that supply the total backup power required. The Standby Diesel Generator System is installed in the Central Utilities Building. In the event of normal power failure, the Standby Diesel Generator System maintains plant services that protect the capital investment.

The functional requirement of the Standby Diesel Generator System is to provide backup power within approximately 10 seconds after a normal power interruption. There is sufficient fuel storage capacity to operate the system at rated capacity until the process equipment is run to standstill.

3.5.10.2 Major Components

The following are the major Standby Diesel Generator System components:

- A. Diesel Generator Package units with engine, generator, controls, cooling system and diesel fuel day tank with leak containment
- B. Diesel Fuel Bulk Storage Tanks with spill and leak detection and containment
- C. Diesel Fuel Pumps and Controls
- D. Diesel Fuel Hand Pumps.

3.5.10.3 System Interfaces

The Standby Diesel Generator System interfaces with the following plant systems:

- A. The Plant Control System (PCS) monitors the status and operation of the Standby Diesel Generator System.
- B. The Utility Water System supplies fill and make-up water to the generator cooling system. No make-up water is required by the diesel generators during operation.
- C. The Electrical System provides power to maintain the charge on the electrical starter batteries during normal plant operation. This system receives power from the Standby Diesel Generator System during loss of normal power supply.

3.5.10.4 Operational Characteristics

This system is designed for high reliability. Each generator normally is in standby mode and operates on an intermittent basis.

3.5.10.4.1 Routine Operation

The switchgear where the generators are connected is normally supplied power through the utility dual service, the site dual power distribution system and dual step-down transformers. If the normal power supply to a generator switchgear is lost a demand for standby power is created. Each affected diesel generator automatically starts-up and restores the power supply within approximately 10 seconds after the demand for standby power. When the normal power supply has been restored to each switchgear, the associated generator is manually shut down and returned to stand-by status.

Periodic operational test runs are conducted on each Standby Diesel Generator System.

The generator diesel fuel day tanks are monitored and maintained at full storage capacity by an automatic fuel supply system.

3.5.10.4.2 Non-routine Operation

- A. Equipment Failure. This system is designed with a high degree of equipment redundancy to provide reliable operation. The standby power loads are divided between

the two generators to minimize the impact on operations if one generator fails to operate when needed. Redundant diesel fuel tank pumps are used to transfer diesel fuel from the bulk storage tanks to the diesel day tanks. In the event of failure of the normal pumps, hand pumps are provided.

- B. Instrument Failure. Failure of a level control instrument on a diesel day tank could result in an inadequate supply of fuel to a standby generator and subsequent generator shutdown.
- C. Instrument Air Failure. Failure of instrument air has no impact on this system. *Pneumatic operated instrumentation is supplied with control air by the standby generator package units.*
- D. Operator Error. Operation of any pump in a blocked-in or dry condition may result in damage to the pump. The operational sequence of the standby generators is automatic. If the fuel pumps fail, it is necessary for operators to set up the proper valve positioning and manually operate a hand pump.

3.5.10.5 Safety Considerations

Failure of this system will not endanger the health and safety of the public. Nevertheless, redundancy is provided in the major components for reliability to provide investment protection.

3.5.10.6 Diesel Fuel Spill Control and Leak Detection

Diesel fuel is stored on site in bulk storage tanks and the day tanks of the standby generators. Each of the tanks is provided with a secondary containment in the event of a tank leak or spill.

3.5.11 Nitrogen System

3.5.11.1 System Description

The Nitrogen System provides gaseous and liquid nitrogen to users from a vendor-supplied liquid nitrogen storage tank. The liquid nitrogen storage and distribution system consists of four tanks. The nitrogen storage tanks are located outside, adjacent to the area that they serve. The Nitrogen Systems also provide liquid nitrogen via cryogenic piping to four dispensing stations. Two dispensing stations are located inside the Separations Building to facilitate the filling of portable Dewars. One dispensing station is located in the TSB and one is in the Centrifuge Assembly Building. Gaseous nitrogen is generated in the nitrogen system and piped throughout the Separations Building. It is used for line purging, pressure testing, and blanketing equipment in UF₆ service.

The four Nitrogen Systems are vendor-supplied packaged systems. Each unit consists of a liquid nitrogen storage vessel, a pressure build-up coil, a duplex vaporizer, associated instrumentation, and cryogenic piping. The system is illustrated in Figure 3.5-28, Process Flow

Diagram, Nitrogen System, Sheets 1 through 3. The functional requirements of the Nitrogen System are provided in Table 3.5-8, Nitrogen System Design Parameters.

The functional requirements of the Nitrogen System are to provide a 30-day supply of liquid and gaseous nitrogen to the users.

3.5.11.2 Major Components

The system contains the following equipment:

Nitrogen package unit. The liquid nitrogen storage tank is sized to supply 30 days of nitrogen based on normal operating conditions. Each of the four units consists of the following components:

Liquid N ₂ storage vessel type	Vertical, double walled
Capacity	9464 L (2500 gal)
Duplex vaporizer	Air exchanger
Vaporization capacity	170 m ³ /hr (100 scfm) continuous
Pressure build-up coil	Air exchanger
Pressure relief	Yes

Distribution Piping. Vacuum insulated cryogenic piping is used for the liquid transfer lines. Gaseous nitrogen lines are fabricated from carbon steel or copper.

3.5.11.3 System Interfaces

The Nitrogen System interfaces with the following plant systems.

- A. The Cascade System uses gaseous nitrogen for blanketing centrifuges and cascades during construction. Liquid nitrogen is supplied to mobile pump sets.
- B. The UF₆ Feed System uses gaseous nitrogen to blanket the insulation box at the UF₆ cold trap unit and purge distribution piping at the feed cylinders.
- C. The Product Take-off System uses gaseous nitrogen to blanket the insulation box at the UF₆ cold trap unit and purge distribution piping at the product cylinders.
- D. The Tails Take-off System uses gaseous nitrogen to purge distribution piping at the Uranium Byproduct Cylinders (UBCs).
- E. The Product Liquid Sampling System uses gaseous nitrogen to purge the sample manifold in each Product Liquid Sampling Autoclave. The Product Liquid Sampling Autoclaves are also pressurized with gaseous nitrogen.
- F. Nitrogen is also used for purging in pump replacement operations and in other miscellaneous process gas system maintenance operations, e.g. valve replacement.
- G. The Electrical System provides power to the electric heater and the instrumentation in the Nitrogen System.
- H. The DI water storage tank uses nitrogen for blanketing.
- I. The cylinder pressure test and pump out system in the ventilated room of the Technical Services Building uses gaseous nitrogen for testing and purging.

- J. The Mass Spectrometry, Environmental Monitoring and Chemical Labs also use gaseous nitrogen.

3.5.11.4 Operational Characteristics

The Nitrogen System is designed to supply liquid and gaseous nitrogen on demand.

3.5.11.4.1 Routine Operation

Liquid nitrogen is delivered to the four outside liquid nitrogen storage tanks by truck. Liquid nitrogen is transferred from the outside storage tanks through vendor-supplied double wall vacuum insulated cryogenic piping to two dispensing stations located inside of the Separations Building, and one each for the TSB and CAB. Portable Dewars are filled at the dispensing station and are used to transport the liquid nitrogen to the points of use. Gaseous nitrogen is generated by vaporizing liquid nitrogen through an ambient air vaporizer. Two vaporizers are provided to assure continued production of gaseous nitrogen when one vaporizer is being defrosted. A pressure regulator prevents storage tank over-pressure by releasing tank boil-off nitrogen to the gaseous nitrogen distribution piping. A pressure build-up coil maintains nitrogen storage tank pressure at 3.1 barg (45 psig) for transfer of liquid nitrogen.

Storage tank back pressure control valves vent excess nitrogen to the atmosphere in the event that tank boil off rate exceeds nitrogen consumption. Safety relief valves are provided to protect against tank over-pressurization. The safety relief valves on the tanks are set for 16.2 barg (235 psig.) Relief valves are also provided at users per Figure 3.5-28 and are typically set for 950 mbarg (13.8 psig).

Automatic switching valves divert liquid nitrogen to spare vaporizers during defrost cycles, and a manual valve is provided at the liquid nitrogen dispensing station for filling Dewars.

Pressure regulating valves in gaseous nitrogen supply lines maintain distribution pressure. There are four subsystems designed to distribute gaseous nitrogen; the four subsystems operate at 2.4 barg (35 psig). The distribution is shown on Figures 3.5-28, sheet 2 of 3 and sheet 3 of 3.

3.5.11.4.2 Non-routine Operation

- A. Equipment Failure. This system is not considered critical to facility operation and spare components are not installed. Dual vaporizers permit continuous production of gaseous nitrogen and provide some redundancy in the event of failure of one of the vaporizers. A small inventory of liquid nitrogen is available from the Dewars in the event of an interruption of the liquid nitrogen transfer line. In addition, the four tanks add redundancy.
- B. Instrument Failure. Instrument failure may lead to over-pressurization of the liquid nitrogen storage vessel. A pressure relief valve is provided on the tank to protect against over-pressurizing the tank.

- C. Instrument Air Failure. Instrument air failure does not affect this system. In the event of instrument air failure, the vaporizer diversion valves fail open and both vaporizers are placed into service.
- D. Instrument Failure. Instrument failure of system or header regulators could cause overpressurization of the gaseous system. Multiple relief valves are provided to protect against overpressure.

3.5.11.5 Safety Considerations

Failure of this system will not endanger the health and safety of the plant personnel or the public.

3.5.12 Liquid Effluent Collection and Treatment System

Various types of aqueous and non-aqueous liquid wastes are generated in the facility. These effluents may be contaminated, potentially contaminated with low amounts of contamination, or non-contaminated.

A Liquid Effluent Collection and Treatment System is located in the Liquid Effluent Collection and Treatment Room in the TSB. The Liquid Effluent Collection and Treatment System equipment location and arrangement is shown in Figure 3.5-29, Liquid Effluent Collection and Treatment Room, Equipment Arrangement. Non-contaminated aqueous effluents that are generated are collected, monitored for contamination, and discharged directly to the Treated Effluent Evaporative Basin (TEEB) if found to meet all regulatory and administrative requirements. Non-aqueous liquid wastes that are generated are collected and disposed of in accordance with all federal, state, and local regulations and in accordance with good and accepted industrial practice. All effluent collection, treatment, and disposal is done with respect to the safety of all personnel and in strict accordance with all federal, state, and local regulations. All contaminated effluents are handled to keep radiation doses to operating personnel and the public as low as reasonably achievable (ALARA).

3.5.12.1 Aqueous Liquid Effluents

Quantities of radiologically contaminated, potentially radiologically contaminated, and non-radiologically contaminated aqueous liquid effluents are generated in a variety of operations and processes in the TSB and in the Separations Building. All aqueous liquid effluents generated in the TSB are categorized as contaminated, potentially contaminated, or non-contaminated based on their uranic content. The majority of all potentially radiologically contaminated aqueous liquid effluents are generated in the TSB. All aqueous liquid effluents generated in the TSB are collected in tanks that are located in the Liquid Effluent Collection and Treatment Room in the TSB. The collected effluent is sampled and analyzed to determine if treatment is required before release to the TEEB.

3.5.12.1.1 System Description

3.5.12.1.1.1 Citric Acid

When the Citric Acid Tank in the Decontamination Workshop is drained, all the effluent is transferred to the Spent Citric Acid Collection Tank in the Liquid Effluent Collection and Treatment Room (see Figure 3.5-30, Process Flow Diagram, Spent Citric Acid). A "sludge" remains in the bottom of the Citric Acid Tank. This "sludge" consists primarily of uranium and metal particles. This sludge is flushed out with DI water. The combination of the sludge and the DI water also goes to the Spent Citric Acid Collection Tank. The spent citric acid effluent/sludge contains the wastes from the Sample Bottle and Flexible Hose Decontamination Cabinets, which are manually transferred to the Citric Acid Tank in the Decontamination System. The contents of the Spent Citric Acid Collection Tank are constantly agitated to keep all solids in suspension and to provide a homogeneous solution. This is necessary to prevent build-up of uranic material in the bottom of the tank.

3.5.12.1.1.2 Degreaser Water

When the Degreaser Tank in the Decontamination Workshop is drained, all the effluent is transferred to the Degreaser Water Collection Tank in the Liquid Effluent Collection and Treatment Room (see Figure 3.5-31, Process Flow Diagram, Degreaser Water). A "sludge" remains in the bottom of the Degreaser Tank after the degreasing water is drained. This "sludge" consists primarily of Fomblin oil and uranium. This sludge is flushed out with DI water. The combination of the sludge and the DI water also goes to the Degreaser Water Collection Tank. The contents of the Degreaser Water Collection Tank remain agitated to keep all solids in suspension and to provide a homogeneous solution. This is necessary to prevent build-up of uranic material in the bottom of the tank. Since this effluent contains Fomblin oil, it is not possible to send the degreaser water to the Precipitation Treatment Tank for treatment. Therefore, the Fomblin oil must be removed first.

For Fomblin oil removal, the contents of the Degreaser Water Collection Tank circulate through a small centrifuge. The oil and sludge are centrifuged off, collected in a container, and sent for offsite low-level waste disposal.

3.5.12.1.1.3 Laboratory Effluent

Aqueous laboratory effluents with uranic concentrations are sampled to determine their uranic content and then pumped from the labs to the agitated Miscellaneous Effluent Collection Tank in the Liquid Effluent Collection and Treatment Room (see Figure 3.5-32, Process Flow Diagram, Miscellaneous Effluent). Floor washings are sampled to determine their uranic content and then manually emptied into the Miscellaneous Effluent Collection Tank. Condensate may be either manually transported or pumped through piping to the tank after sampling.

3.5.12.1.1.4 Laundry

All washing machine water is discharged from the clothes washers to the Laundry Effluent Monitor Tanks in the Liquid Effluent Collection and Treatment Room (see Figure 3.5-33, Process Flow Diagram, Laundry Effluent). Due to the very low contamination of this effluent and the constant flow into these tanks, they are not agitated. Samples of the effluents are regularly taken to the laboratory for analysis. Lab testing determines pH, soluble uranic content, and insoluble uranic content. The analysis determines if the effluent meets regulatory requirements and administrative levels set prior to release into the TEEB. Previous operating experience indicates that the clothes washed contain very small amounts of UO_2F_2 and trace amounts of UF_4 .

The laundry effluent is expected to meet the requirements mentioned above for release. If the effluent is determined to meet all the requirements, it is released to the TEEB. If the laboratory analysis shows it is not in conformance, then the effluent is held in one of the Laundry Effluent Monitor Tanks. Depending on the laboratory analysis, it can either be sent to the Precipitation Treatment Tank for processing through the treatment system, or it can be sent off-site for treatment and disposal as low-level waste.

3.5.12.1.1.5 Washes and Showers

All water from the personnel hand washes and showers in the TSB, Separations Building Modules, Blending and Liquid Sampling Area, and the Centrifuge Test and Post Mortem Areas goes to the Hand Wash / Shower Monitor Tanks in the Liquid Effluent Collection and Treatment Room (see Figure 3.5-34, Process Flow Diagram, Hand Wash/Shower Effluent). Since these effluents are expected to be non-contaminated, there is no need to provide agitation in these tanks. Samples of the effluents are regularly taken to the laboratory for analysis. Lab testing determines pH, soluble uranic content, and insoluble uranic content. The analysis determines if the effluent meets all federal, state, and local requirements in addition to administrative levels set prior to release to the TEEB. If it is determined the effluent meets all the requirements, it is released to the TEEB. There is little probability these effluents are contaminated. Therefore, it is assumed the effluent always meets the requirements for release to the TEEB. No provisions are provided for any treatment of these effluents.

3.5.12.1.1.6 Precipitation Treatment Tank

When a batch has been added to, processed at, sampled at, and analyzed at the Spent Citric Acid Collection Tank, Degreaser Water Collection Tank, or Miscellaneous Effluent Collection Tank, the contents are transferred to the Precipitation Treatment Tank.

The Precipitation Treatment Tank (see Figure 3.5-35, Process Flow Diagram, Precipitation/Treatment) is used to remove the majority of the uranium that is in solution. After the effluent is transferred to the Precipitation Treatment Tank, a precipitating agent, such as potassium hydroxide (KOH) or sodium hydroxide (NaOH), is added. The addition of the precipitating agent raises the pH of the effluent to the range of 9 to 12. This makes the soluble uranium compounds become insoluble compounds that precipitate from the solution. The tank contents are constantly agitated to provide a homogeneous solution. The precipitated compounds are then removed from the effluent by circulation through a small filter press. The material removed by the filter press is deposited in a container and sent for off-site low-level waste disposal.

The clean effluent from the filter press is re-circulated back to the Precipitation Treatment Tank. Depending on the characteristics of the effluent and the filter press design, the effluent may have to be circulated through the filter press numerous times to obtain the percent of solids removal required. A sample of the effluent is taken to determine when the correct amount of solids has been removed. When it is determined that the correct amount of solids have been removed, the effluent is transferred to the Contaminated Effluent Hold Tank.

3.5.12.1.1.7 Contaminated Effluent Hold Tank

The effluent in the Contaminated Effluent Hold Tank is transferred to the agitated Evaporator/Dryer Feed Tank (see Figure 3.5-36, Process Flow Diagram, Evaporator/Dryer). Acid is added via a small chemical addition unit to reduce the pH back down to 7 or 8. This is necessary to help minimize corrosion in the Evaporator/Dryer.

3.5.12.1.1.8 Evaporator/Dryer Feed Tank and Evaporator/Dryer

From the Evaporator/Dryer Feed Tank, the effluent is pumped to the Evaporator/Dryer. The Evaporator/Dryer is an agitated thin film type that separates out the solids in the effluent. The Evaporator/Dryer is heated by steam (generated by an electric boiler in the room) in a jacket or from an electric coil. As the effluent enters the Evaporator/Dryer, the effluent is heated, and the water is vaporized. The Evaporator/Dryer discharges a "dry" concentrate into a container located at the bottom of the Evaporator/Dryer. Container contents are monitored for criticality, labeled, and stored in the radioactive waste storage area. When full, the container is sent for shipment off-site to a licensed radioactive waste disposal facility. Liquid vapor exits the evaporator and is condensed in the Evaporator/Dryer Condenser, which is cooled with process chilled water.

The condensate from the condenser is collected in the Distillate Tank before being transferred to one of the Treated Effluent Monitor Tanks (see Figure 3.5-37, Process Flow Diagram, Treated Effluent Polishing). The effluent in these tanks is sampled and tested for pH and uranic content to validate compliance with regulatory and administrative guidelines prior to release to the TEEB. If the effluent test results are acceptable, then it is released to the TEEB. However, if the lab tests show the effluent does not meet regulatory and administrative guidelines, the effluent can be further treated. Depending on what conditions the lab testing show, the effluent is either directed back to the Evaporator/Dryer Feed Tank for another pass through the Evaporator/Dryer, or it can be directed through the Mixed Bed Demineralizers. After either option, the effluent is transferred back to a Treated Effluent Monitor Tank where it is again tested. When the lab tests are acceptable, the effluent is released to the TEEB.

3.5.12.1.2 Major Components

Handling and eventual disposition of the aqueous liquid effluents is accomplished in two stages, collection and treatment. All aqueous liquid effluents are collected in tanks that are located in the Liquid Effluent Collection and Treatment Room in the TSB.

Table 3.5-9, Liquid Effluent Collection and Treatment System, Collection Tanks, lists the collection tanks, their respective sizes, and the effluents deposited into them.

In addition to the listed tanks, which are used for effluent collection from the various areas throughout the plant, there are other tanks in the Liquid Effluent Collection and Treatment Room used for monitoring and treatment prior to release of the effluents to the TEEB.

These tanks, their size, and their purpose are listed in Table 3.5-10, Liquid Effluent Collection and Treatment System, Monitoring and Treatment Tanks.

3.5.12.1.3 Interfaces

The Liquid Effluent Collection and Treatment System interfaces with the following other plant systems and areas:

- A. Decontamination Workshop. The spent citric acid waste and the spent degreaser water are pumped from this system to their respective tanks in the Liquid Effluent Collection and Treatment Room. Small amounts of floor washings from this area are also collected in the Miscellaneous Effluent Collection Tank.
- B. Compressed Air System. This system provides air for any diaphragm pumps that may be used in the Liquid Effluent Collection and Treatment System in addition to any requirements for instrumentation or pneumatic controls in the room.
- C. Deionized Water Supply Distribution System. The water is used for rinsing out the tanks and pumps in the system to prevent potential sludge build-ups.
- D. Solid Waste Collection System. Solid waste from the filter press, centrifuge, and evaporator is collected in containers. This tank collects and handles other solid wastes, such as cloths and rags, and ensures that it is disposed of offsite appropriately.
- E. Separations Building. Small amounts of floor washings and miscellaneous condensates from this area are collected in the Miscellaneous Effluent Collection Tank.
- F. Ventilated Room. Small amounts of floor washings from this area are collected in the Miscellaneous Effluent Collection Tank.
- G. Vacuum Pump Rebuild Workshop. Small amounts of floor washings from this area are collected in the Miscellaneous Effluent Collection Tank.
- H. UF₆ Handling Area. This area of the facility containing UF₆ has small amounts of floor washings that are collected in the Miscellaneous Effluent Collection Tank.
- I. Personnel Hand Wash and Shower Areas. Effluent water is generated from employees who work in contaminated areas washing their hands and taking showers after dealing with contaminated materials. This is not expected to be contaminated effluent.
- J. Laundry System. Effluent water from the washing machines enters the Liquid Effluent Collection and Treatment System if it is found to be contaminated.
- K. Treated Effluent Evaporative Basin. Receives treated and non-contaminated effluent from the Liquid Effluent and Treatment System.
- L. Chilled Water Distribution System. Chilled water is used to condense the vaporized effluent downstream of the evaporator.
- M. Electrical System. Power is required for the process for some of the equipment and instrumentation.

- N. Laboratories. Liquid effluent from the Chemical Laboratory, the Environmental Monitoring Laboratory, and the Mass Spectrometry Laboratory are collected in the Miscellaneous Effluent Collection Tank.

3.5.12.1.4 Safety Considerations

Equipment for effluent collection and treatment in the Liquid Effluent Collection and Treatment Room in the TSB are separated into various radiological zones depending on contamination levels. The Laundry Effluent Tanks and the Wash/Shower Tanks are generally non-contaminated (or contain very low levels of uranium) and are located together in one corner of the room. The tanks with higher contamination are located in the opposite corner of the room. This separation helps keep exposures to ALARA (as low as reasonably achievable.) All tanks have overflow piping and atmospheric vents. The tanks also have inspection hatches to ensure that they are completely empty after a batch has been processed.

The criticality safety for tanks that are not "geometrically safe" or "geometrically favorable" will utilize two independent IROFS for mass control, one IROFS is referred to as "bookkeeping measures" and the second IROFS is referred to as "sampled and analyzed," e.g., tank contents are sampled and analyzed before being transferred to another tank or out of the system. The "bookkeeping measures" is a process to calculate the potential mass of uranium in the tank for any batch operation to ensure that no tank holds more than a safe mass of uranium. This calculated mass of uranium is then compared to a mass limit, which is based on the double-batching limit on mass of uranium in a vessel from the criticality safety analyses. The "bookkeeping measures" process is described in further detail below.

For NEF, the "bookkeeping measures" are only applied to tanks where the mass of uranium involved, even when double batching error is considered, is far below the safe value. Bookkeeping measures are a documented running inventory estimate of the total uranium mass in a particular tank. The mass inventory for each batch operation is calculated based on the mass of material to be transferred during each batch operation and the mass inventory in the tank prior to the addition of the material from the batch operation.

There are two types of batch operations that are considered. The first type is liquid transfer between tanks based on moving a volume of liquid with uranic material present in the volume. The second is transferring a number of components into the tank with the uranic material contained within or on the components transferred in each batch operation. For both types of operations, the initial mass inventory is set after emptying, cleaning, and readying the tank for receipt of uranic material. For each batch operation, the amount of uranic material to be transferred during a particular batch operation is estimated. This quantity of material is then credited/debited to/from each tank as appropriate. A new mass inventory in each tank is calculated. The calculated receiving tank mass inventory is compared to the mass limit for the tank prior to the transfer.

For the second type, a transfer of a number of facility components into an open tank during a batch operation, the mass inventory on/within the components is estimated, and that mass credited to the receiving tank. The final mass inventory in the tank is calculated and the total is compared to the mass limit for the tank prior to the transfer. Open tanks associated with this system are located in the Decontamination Workshop.

The Spent Citric Acid Collection Tank, Degreaser Water Collection Tank, Miscellaneous Effluent Collection Tank, and Precipitation Treatment Tank are all located in a contained area. The containment consists of a curb around all the above-mentioned tanks. The curbed area is capable of containing at least one catastrophic failure of one tank (1325 L (350 gal), minimum). In the event of a tank failure, the effluent in the confined area is pumped out with a portable pump set.

Due to the low probability of a uranic contamination in the Laundry Effluent Tanks or the Hand Wash/Shower Monitor Tanks, no curbed confinement of these tanks is provided in the event of a catastrophic failure. Any small amounts of these effluents that leak onto the floor drain to a floor sump. The effluents in this sump are pumped out with a portable pump set.

3.5.12.1.5 Operating Characteristics

The uranium content of tanks is important to prevent a criticality accident. None of the tanks in the collection and treatment system are "geometrically safe" or "geometrically favorable". Administrative controls (by mass) are applied to prevent a criticality accident.

The pH of the Dryer Feed Tank is important to minimize the corrosion in the equipment. The pH is always maintained within the manufacturer's recommended range.

Aqueous radiologically contaminated liquid effluents are processed on-site to remove the uranic content. After treatment these effluents and all non-contaminated aqueous effluents are discharged to the TEEB. Reduced volume, radiologically contaminated wastes that are produced as a by-product of the treatment system, as well as contaminated non-aqueous wastes, are packaged and shipped to a licensed radioactive waste disposal facility.

3.5.12.2 Non-Aqueous Liquid Effluents

Various non-aqueous liquid effluents are generated throughout the plant. The majority of these are non-radiologically contaminated and are generated outside areas in which radioactive materials are handled. A small percentage may be radiologically contaminated. These wastes are ones that cannot be collected and treated in the Liquid Effluent Collection and Treatment System because of their chemical characteristics (i.e., they cannot be processed through the system because they might damage or decrease the performance of the equipment in the treatment system). These chemicals also might be EPA hazardous chemicals that cannot enter the aqueous waste stream that goes to the TEEB. Special treatment and/or disposal methods are required for these wastes. They are not mixed with any of the effluent streams in the Liquid Effluent Collection and Treatment System.

3.5.12.2.1 System Description

Non-aqueous liquid wastes are generated throughout the plant. These wastes are collected, identified, and temporarily stored in a waste storage area. Appropriate containers are used for storage of all wastes to preclude leakage, intermixing, evaporation, and spillage. All potentially radioactive wastes are stored in a criticality safe manner to preclude a criticality accident.

The non-aqueous portion of the liquid effluent system arises from the following areas:

- Radiologically contaminated solvents from Chemical Laboratory, Environmental Monitoring Laboratory, and the Decontamination Workshop.
- Non-radiologically contaminated effluents from the General Mechanical, Electrical and Instrumentation Workshop, Diesel Generator Area, CUB, CAB, and the Laboratories.

The following non-aqueous liquid wastes are collected, packaged, stored and disposed of:

- A. Lubrication Oils and Greases. Consist of various hydrocarbon lubricants collected during maintenance activities of maintenance equipment, plant vehicles, utilities equipment (such as air compressors and chillers), and from normal workshop activities. None of these oils or greases are radiologically contaminated. (Fomblin oil is excluded from this non-aqueous waste disposal.)
- B. Solvents. Non-radiologically contaminated solvents are produced in the maintenance workshops and in the Centrifuge Assembly Building. Contaminated solvents arise from the various laboratories. These are handled as "mixed" waste and sent offsite for processing and disposal by a licensed facility.
- C. Laboratory Chemicals. Waste chemicals are produced in the various laboratories.
- D. Miscellaneous Wastes. Special wastes need special disposal or are recycled as part of good industry practice. Examples of such materials are ethylene glycol coolants and refrigerants.

Wet solid wastes and Fomblin oil are not handled in the same manner as these other non-aqueous wastes.

The non-aqueous liquid wastes are collected manually in special containers. All waste containers are identified to show the contents (material type), potential for being radioactive, and potential for being hazardous. Each waste container is also marked with a unique identification number. A determination is then made as to whether analysis is needed to determine if a waste is radioactive or hazardous. A typical method for testing liquid waste for radioactive contamination is with a gamma detection system. Liquid wastes that cannot be processed in the Liquid Effluent Collection and Treatment System are stored in the SWCR of the TSB prior to being sent off-site for processing and disposal. All liquid waste storage areas are designed to collect and contain spills and leakage in a safe manner.

Separate storage areas are provided for industrial, hazardous, and radioactive wastes.

3.5.12.2.2 Design Considerations

The Liquid Effluent Collection and Treatment System and the system to collect non-aqueous wastes are sized to process effluents generated in an average year under normal conditions. The systems are designed with some extra capacity to handle upset or abnormal volumes. In the event of a catastrophic failure of the treatment system, provisions can be made to send all effluent off-site to a licensed processing and waste disposal facility.

All piping and equipment in the system that could contain potentially radioactive fluids are constructed of appropriate corrosion resistant metallic or plastic materials. None of the effluents

are of such a chemical nature that special materials of construction is necessary. Industrial-grade piping and equipment is used.

All process piping is designed in accordance with American Society of Mechanical Engineers, ASME B31.3-2002, Process Piping (ASME, 2002). To provide system integrity and prevent leaks, welded construction is used everywhere practical. All collection tanks are designed in accordance with American Water Works Association (AWWA), American Petroleum Institute (API), or ASME Standards. The tanks are vertical cylindrical tanks with conical or dished-head bottoms to promote drainage. All outlets are at the low point of the tank – no space exists for solids to accumulate. All tank vents are open to atmosphere and directed away from personnel/equipment; all tank overflows are directed to sumps or do not pose a serious hazard. All tanks have inspection hatches to ensure the tanks are emptied. Mixers or recirculation loops are provided for each tank that requires mixing prior to sampling to ensure that each sample is representative of the tank contents.

None of the tanks are “geometrically safe” or “geometrically favorable.” Criticality is controlled by administrative controls. The entire system is designed so that all operation and maintenance activities can be performed while keeping personnel radiation exposures ALARA.

3.5.13 Solid Waste Collection System

Solid wastes are produced in a number of plant activities and require a variety of methods for treatment and disposal. Solid wastes are categorized into wet solid waste and dry solid waste due to differences in handling, storage, and disposal requirements. Dry solid wastes for this facility contain, as defined in 10 CFR 61.56 (a)(3) (CFR, 2003a), “as little free standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.” Wet solid wastes, for this plant, are defined as those that have as little free liquid as reasonably achievable, but have no limit with respect to percent of volume.

The Solid Waste Collection System is simply a group of methods and procedures, all applied as appropriate to the various solid wastes. Each individual waste is handled differently according to its unique combination of characteristics and constraints. Wet and dry solid wastes are described separately below.

3.5.13.1 Wet Solid Wastes

The wet waste portion of the Solid Waste Collection System handles all radiological, hazardous, mixed, and industrial solid wastes from the plant that do not meet the above definition of dry solid waste. The system assures the waste is properly handled, stored, and disposed of for the protection of the public, the plant workers, and the environment.

3.5.13.1.1 System Description

The Solid Waste Collection System handles several different types of wet solid waste: wet trash, oil recovery sludge, electrostatic precipitator sludge, oil filters, resins, degreaser sludge, and uranic waste precipitate. The system collects, identifies, prepares, records, and stores these wastes for shipment.

Wet solid wastes that are generated in the plant are divided into radioactive, hazardous, mixed, or industrial waste categories. Mixed waste is that which includes both radioactive and hazardous waste. Industrial waste does not include either radioactive or hazardous waste. Each waste category is segregated during collection, during packaging for shipment, and in storage.

This system, primarily consisting of a number of manual steps, has no major components. Minor components, such as container assay equipment, a container compactor, and a container weigh scale, are employed when appropriate for packaging of waste in the SWCR of the TSB.

3.5.13.1.2 Interfaces

The wet solid waste portion of the Solid Waste Collection System interfaces with the Fomblin Oil Recovery System and the Liquid Effluent Collection and Treatment System. Handling of each waste type is described below.

3.5.13.1.2.1 Wet Trash

In this facility, trash typically consists of waste paper, packing material, clothing, rags, wipes, mop heads, and absorption media. Wet trash consists of trash that contains water, oil, or chemical solutions.

Generation of "radioactive" wet trash is minimized as much as possible. Trash with radioactive contamination is collected in specially marked plastic-bag-lined drums. These drums are located in Restricted Areas as necessary. Wet trash is collected in separate drums from dry trash. When a drum of wet trash is full, the drum is then taken to the SWCR. The plastic bag is removed from the drum and sealed. The bag is then checked for leaks and excessive liquid, and the exterior is monitored for contamination. If necessary, excess liquids are drained and the exterior is cleaned. The trash is identified, packaged, labeled, and recorded. Collected radioactive trash is stored in an appropriate container in the SWCR until it can be shipped offsite for treatment and then disposal.

The radioactive trash is shipped to a Central Volume Reduction Facility (CVRF) that can process wet trash. The licensed CVRF reduces the volume of the trash and then repackages the resulting waste for disposal. The waste package is then shipped to a licensed radioactive waste disposal facility.

Trash with "hazardous" (CFR, 2003b) contamination is collected in special plastic bag-lined drums. When full, the drum is taken to the SWCR, the plastic bag containing wet trash is removed from its container, sealed, the exterior monitored for hazardous material, and the exterior cleaned if necessary. The trash is identified, packaged, labeled, and recorded. All hazardous trash is stored in the SWCR until it is shipped to a licensed hazardous waste disposal facility. To prevent accidental reactions, different types of hazardous materials are not mixed together.

Empty containers (CFR, 2003c) that at one time contained hazardous materials are considered waste if designated such by administrative guidelines. After such a container is emptied, it is resealed and taken to the SWCR for identification, labeling, and recording. The container can be handled as if it is hazardous waste and be shipped to a licensed hazardous waste processing facility for cleaning and/or disposal. Otherwise, the container is used to store

compatible hazardous waste and to ship that waste to a licensed hazardous waste processing facility for processing and container disposal.

"Mixed" (CFR, 2003b) trash results from using wipes and rags with solvent on uranium-contaminated components. It is collected in appropriate containers and segregated from other trash. The waste is identified, packaged, labeled, recorded, and stored in accordance with regulations for both hazardous and radioactive wastes. Mixed waste is shipped to a facility licensed to process mixed waste. Waste resulting from the processing by the licensed facility is then forwarded to a qualified disposal facility licensed to dispose of the particular resulting waste.

"Industrial" trash is collected in specially marked receptacles in all parts of the plant. Trash that contains free liquids is dewatered before it is put into a receptacle. The trash from the Restricted Area is collected in plastic bags and taken to the SWCR for inspection to ensure that no radioactive contamination is present. The inspected trash and the trash from outside Restricted Area are then taken to one of several dumpsters around the plant. The trash is stored in these dumpsters until it is transported to a local landfill by a contract carrier.

3.5.13.1.2.2 Oil Recovery Sludge and Electrostatic Precipitator Sludge

The recovery process for Fomblin oil generates an oily sludge which is handled by this system. The sludge results from the removal of uranium and hydrocarbons from Fomblin (perfluorinated polyether) oil. Sodium carbonate, charcoal, and celite contribute to this sludge. Another source of contaminated oil sludge is the electrostatic precipitator for the Separations Building GEVS. A contracted radioactive waste processor will process the waste at an off-site location. Alternatively, the waste may be shipped offsite to a licensed CVRF for volume reduction. Regulations and technology current at the time of waste production will dictate treatment methods. In either case the waste is disposed of at a licensed low-level radioactive waste disposal facility.

3.5.13.1.2.3 Oil Filters

Used oil filters are collected from the diesel generators and from facility vehicles. No filters are radioactively contaminated. The used filters are placed in containers and transported to the SWCR. There the filters are drained completely and transferred to a drum. The drained waste oil is drummed with other non-radioactive waste oil and handled appropriately. Once a drum is full of spent filters, absorbent material is added and the drum is sealed and labeled. The drums are shipped to an appropriate off-site licensed waste disposal contractor.

3.5.13.1.2.4 Resins

Spent ion exchange resin is collected from the Centrifuge Cooling Water Distribution System polishers. These resins are not radioactively contaminated. The spent resins are received, used, dewatered, and returned to an independent contractor for regeneration or disposal under a lease agreement.

Radioactively contaminated resin is collected from the Liquid Effluent Collection and Treatment System deionizers. Normally, the resins for deionizer operation are contained in a portable vessel suitable for disposal by the lease contractor. The vessel is disconnected, dewatered,

sealed, and stored in the SWCR. The vessel of resin is shipped to a contractor for disposal in a licensed low-level radioactive waste disposal facility.

3.5.13.1.2.5 Degreaser Sludge

The Degreaser Tank in the Decontamination Workshop handles radioactive components. Sludge is pumped from the Degreaser Tank to the Degreaser Water Collection Tank and then to the Degreaser Water Centrifuge. The sludge discharge from the centrifuge is collected, packaged, labeled, and stored as radioactive waste. The waste is shipped to a facility licensed to process radioactive waste. Waste resulting from the processing is then forwarded to a qualified disposal facility licensed to dispose of the particular resulting waste.

The UF₆ Pump workshop handles only decontaminated components, so the sludge is collected, packaged, labeled, and stored in the SWCR as hazardous waste. This hazardous waste is shipped to a licensed hazardous waste disposal facility.

3.5.13.1.2.6 Uranic Waste Precipitate

Aqueous uranic liquid waste is processed in a precipitator filter press to remove most of the uranium prior to evaporation of the liquid stream in the Evaporator/Dryer (see Section 3.5.12, Liquid Effluent Collection and Treatment System). This aqueous waste is from the Miscellaneous Effluent Collection Tank, Spent Citric Acid Collection Tank, Degreaser Water Collection Tank, and the Laundry Effluent Hold Tank. The uranium is precipitated out of solution and water is removed by the filter press. The remaining precipitate is collected, packaged, labeled, and stored in the SWCR. The waste is disposed of in a licensed low-level radioactive waste disposal facility.

3.5.13.1.3 Operating Characteristics

Since the "wet" solid waste system is actually a series of steps performed manually, the system description in the above paragraphs also serves to provide the system operating characteristics.

All solid radioactive waste is Class A low-level waste as defined in 10 CFR 61 (CFR, 2003d).

3.5.13.1.4 Safety Considerations

Failure of this system will not endanger the health and safety of the public. Nevertheless, design and operating features enhance public and worker safety. This system assures safety by containment of materials, by strict administrative procedural controls, and by systematic inspections of waste materials. Minor leaks and spills onsite would be collected by a temporary bund, from where these would be soaked up with mops and rags. Shipment of wastes offsite strictly adheres to regulations for packaging and transportation. The mass limit of fissile material prepared for offsite shipment shall not exceed the fissile material limits of 10 CFR 71, (CFR, 2003f). Appropriate protective clothing and respiratory equipment is required for plant workers as needed depending on the material being handled.

3.5.13.2 Dry Solid Wastes

The dry solid waste portion of the Solid Waste Collection System handles dry radiological, hazardous, mixed, and industrial solid wastes from the plant. The system assures the waste is

properly handled and disposed of for the protection of the public, the plant workers, and the environment.

3.5.13.2.1 System Description

The dry solid waste portion of the Solid Waste Collection System handles several different types of waste: trash, activated carbon, activated aluminum oxide, activated sodium fluoride, HEPA filters, scrap metal, laboratory waste, and Evaporator/Dryer concentrate. The system collects, prepares, identifies, records, and stores these wastes for shipment in the SWCR.

Dry solid wastes that are generated in the plant are divided into radioactive, hazardous, mixed, or industrial waste categories. Mixed waste is that which includes both radioactive and hazardous waste. Industrial waste does not include either radioactive or hazardous waste. Each waste category is segregated during collection, during packaging for shipment, and in storage.

No major components are used in the handling of dry solid wastes. Minor components, such as container assay equipment, a container compactor, and a container weigh scale, are employed when appropriate for packaging of waste in the SWCR. System interfaces, and techniques and procedures for handling each of the major waste types is provided below.

3.5.13.2.2 Interfaces

The dry waste portion of the Solid Waste Collection System interfaces with the following other plant systems and structures:

- A. Gaseous Effluent Vent System for the TSB and the Separations Building. Prefilters, HEPA filters, and activated carbon filters from this system are handled in the Solid Waste Collection System.
- B. Technical Services Building HVAC System. Filter elements of this system used to support the confinement ventilation function for the Cylinder Preparation Room, Decontamination Workshop, and Ventilated Room are handled in the Solid Waste Collection System.
- C. Centrifuge Assembly Building. Filter elements from this building, including prefilters, HEPA filters, and activated carbon filters from the Centrifuge Test and Post Mortem Facilities Exhaust Filtration System, are handled in the Solid Waste Collection System.
- D. Contingency Dump System. Activated sodium fluoride from this system is handled in the Solid Waste Collection System.
- E. Ventilated Room. Adsorber vessels containing radioactively contaminated activated carbon, activated aluminum oxide, and sodium fluoride are emptied in this room.
- F. Solid Waste Collection System (wet waste portion). Solid wastes that do not meet the requirements for liquid content are transferred to the dry waste portion of the Solid Waste Collection System.
- G. Compressed Air System. Filter elements from this system are transferred to the Solid Waste Collection System.

- H. UF₆ Process Vent Systems. Activated carbon and activated aluminum oxide are transferred from the UF₆ Feed System, Product Take-off System, Tails Take-off System, Product Liquid Sampling System, Product Blending System Cylinder test, and Ventilation Room Cylinder pump out systems to the Solid Waste Collection System for disposal.
- I. Mobile Pump Sets. Activated carbon and activated aluminum oxide are transferred from these pump sets to the Solid Waste Collection System for disposal.
- J. Administration Building HVAC System. Filter elements from this building are disposed of in the Solid Waste Collection System.
- K. Decontamination Workshop. Contaminated material removed from equipment during disassembly are transferred to the Solid Waste Collection System. Contaminated metallic wastes may be transferred to the Decontamination Workshop for cleaning rather than disposal as radioactive waste. Metallic wastes and other unusable components that are successfully decontaminated in the Decontamination Workshop are transferred to the Solid Waste Collection System for disposal.

Wastes handled by this system are addressed below.

3.5.13.2.2.1 Dry Trash

Dry trash sources are the same as the wet trash sources, and dry trash is handled in much the same way as wet trash. Section 3.5.13.1.1, System Description, describes the handling of wet trash and should be referred to for details. Only the differences in wet and dry trash handling are provided below.

Steps to remove liquids are unnecessary for dry trash. The dry waste portion of the Solid Waste Collection System accepts wet trash that has been dewatered, as well as dry trash.

"Radioactive" trash is shipped to a licensed CVRF. The licensed CVRF reduces the volume of the trash and then repackages the resulting waste for disposal. Waste handled by the CVRF is disposed of in a licensed radioactive waste disposal facility.

Trash containing "hazardous" material is handled as described above with the wet waste portion of the Solid Waste Collection System.

Aerosol spray cans may be disposed of as industrial trash if they are first totally discharged and then punctured. Special receptacles for spray cans used in the Separations Building are provided and each can is inspected for radioactive contamination, total discharge, and puncture before it can be included with industrial trash.

"Mixed" trash is handled as described above with the wet waste portion of the Solid Waste Collection System. Mixed trash results from use of rags and wipes, with solvent, on radioactively contaminated components.

3.5.13.2.2.2 Activated Carbon

Activated carbon is used in a number of systems to remove uranium compounds from exhaust gases. Due to the hazard of airborne contamination, personal protective clothing and respiration equipment is used during activated carbon handling to prevent exposure of plant personnel. Administrative controls for shape, mass, and areal density, along with appropriate

selection of storage containers, prevent criticality. Adsorber vessels containing the spent carbon are transported to the Ventilated Room where the activated carbon is removed from the filter vessel and placed in appropriate containers. This includes 10 kg (22.0 lb) of product trap activated carbon in 12 L (3.2 gal) containers. The contents of the container are sampled to determine the quantity of ^{235}U present. The container is then sealed, the exterior is monitored for contamination, and the container is properly labeled. The container is then temporarily stored in an engineered array in the SWCR. Containers are sent to a licensed CVRF to reduce the volume of the waste, and the licensed CVRF then repackages the resulting waste for shipment to a licensed low-level radioactive waste disposal facility.

Carbon filters are also used in the laboratories where they can become contaminated with hazardous as well as radioactive material. The filters are handled according to their known service. Those potentially hazardous are handled as hazardous, and those potentially containing both hazardous and radioactive material are handled as mixed wastes. Each type of waste is collected, packaged, labeled, recorded, stored in the SWCR, and is then shipped to an appropriately licensed facility for processing/disposal of hazardous and/or mixed waste.

3.5.13.2.2.3 Activated Aluminum Oxide

Activated aluminum oxide is used in a number of systems to remove hydrogen fluoride (HF) from exhaust gases. Spent aluminum oxide is carefully removed, using personal protective equipment, from absorber vessels in the Ventilated Room to prevent the spread of contamination. The contents of a full container are sampled to determine the quantity of ^{235}U present. The container is then sealed, the exterior is monitored for contamination, and the container is properly labeled. The waste is stored in the SWCR until it is shipped to a licensed radioactive waste disposal facility.

Activated aluminum oxide is also used as a desiccant in the Compressed Air System. This aluminum oxide is not radioactively contaminated and is non-hazardous. It is disposed of in a landfill.

3.5.13.2.2.4 Activated Sodium Fluoride

Activated sodium fluoride (NaF) is used in the Contingency Dump System to remove UF_6 and HF from exhaust gases. The Contingency Dump System is not expected to operate except during transient conditions that occur during a power failure. The NaF is not expected to saturate during the life of the plant. However, if the system is used often and the NaF saturates, the adsorber vessel containing the spent sodium fluoride is transported to the Ventilated Room where the sodium fluoride is removed from the vessel and placed in appropriate containers.

The contents of the container are sampled to determine the quantity of ^{235}U present. The container is then sealed, the exterior is monitored for contamination, and the container is properly labeled. The container is then temporarily stored in the SWCR. Containers are sent to a licensed CVRF to reduce the volume of the waste, and the licensed CVRF then repackages the resulting waste for shipment to a licensed low-level radioactive waste disposal facility. It is expected that NaF will not require treatment and disposal until decommissioning.

3.5.13.2.2.5 Filter Elements

Prefilters and HEPA filters are used in several places throughout the plant to remove dust and dirt, uranium compounds, and hydrogen fluoride.

Filters associated with the HVAC System in the Centrifuge Assembly Building remove dust and dirt from the incoming air to ensure the cleanliness of the centrifuge assembly operation. When removed from the housing, the filter elements are wrapped in plastic to prevent the loss of particulate matter. These filter elements are not contaminated with radioactive or hazardous materials so disposal is with industrial trash.

Filters used in the GEVS, and the Centrifuge Test and Post Mortem facilities Exhaust Filtration System and the filters supporting the confinement function of the TSB HVAC System remove HF and trace uranium compounds from the exhaust air stream. When the filter elements become loaded, they are removed from the housings and wrapped in plastic bags to prevent the spread of radioactive contamination. Due to the hazard of airborne contamination, bag-in-bag-out type filter housings are used. Additionally, either special ventilation equipment or personal protective clothing and respiration equipment is used during filter element handling to prevent contamination of plant personnel. The filter elements are taken to the SWCR where a sample is taken to determine the quantity of ^{235}U present. The exterior of the bag is monitored for contamination and the package is properly marked. The filter elements are sent to a licensed CVRF for processing and then shipped to a licensed low-level radioactive waste disposal facility.

The filter elements used in these units are handled as described immediately above for the GEVS filter elements.

The filter elements are handled as industrial trash unless the ventilation unit is used in a Restricted Area. These filter elements are removed from the unit, wrapped in plastic, and taken to the SWCR to be sampled for uranium compounds. If they are found to be non-contaminated they are handled as industrial trash. If they are found to be contaminated they are handled as described above for the Gaseous Effluent Vent System filter elements.

Air filters from the Non-Contaminated HVAC Systems, Compressed Air System, and the Diesel Generators are handled as industrial waste.

3.5.13.2.2.6 Scrap Metal

Metallic wastes are generated during routine and abnormal maintenance operations. The metal can be either clean, can be contaminated with radioactive material, or can contain hazardous material. Radioactive contamination of metal is always in the form of surface contamination caused by uranium compounds adhering to the metal or caught in cracks and crevices. No process in this facility results in activation of any materials.

Clean scrap metal is collected in bins. This material is transported by contract carrier to a local scrap metal vendor for disposal. Items collected outside of Radiation Areas are disposed of as industrial scrap metal unless there is reason to suspect it contains hazardous material.

Scrap metal is monitored for contamination before it leaves the site. Any metal found to be contaminated is either decontaminated or disposed of as radioactive waste. When feasible, decontamination is the preferred method.

Decontamination is performed in the Decontamination Workshop. Decontamination of large items should not be required until the end of plant life. After decontamination, the item is inspected again for radioactive contamination and disposed of in accordance NRC approved method.

Items that are not suitable for decontamination are inspected to determine the quantity of uranium present, packaged, labeled, and shipped either to a licensed CVRF or a licensed radioactive waste disposal facility.

Metallic items containing hazardous materials, as defined in 40 CFR Part 261 (CFR, 2003e), are collected at the source of the hazardous material. The items are wrapped to contain the material and taken to the SWCR. The items are then cleaned onsite if practical. If onsite cleaning cannot be performed, the items are sent to a licensed hazardous waste processing facility for offsite treatment and disposal.

3.5.13.2.2.7 Laboratory Waste

Small quantities of dry solid hazardous wastes are generated in laboratory activities, including small amounts of unused chemicals and materials with residual hazardous compounds. These materials are collected, sampled, and stored in the SWCR. Precautions are taken when collecting, packaging, and storing to prevent accidental reactions. These materials are shipped to a hazardous waste processing facility where the wastes are prepared for disposal.

Some of the hazardous laboratory material is radioactively contaminated, and is collected, labeled, stored, and recorded as mixed waste. This material is shipped to a licensed facility qualified to process mixed waste for ultimate disposal.

3.5.13.2.2.8 Evaporated/Dryer Concentrate

Potentially radioactive aqueous waste is evaporated in the Evaporator/Dryer to remove effectively all remaining uranium prior to release of the condensed vapor to the TEEB. The Evaporator/Dryer discharges dry concentrate directly into drums. These drums are checked for ²³⁵U content, labeled, and stored in the SWCR. The concentrate is shipped to a licensed low-level radioactive waste disposal facility.

3.5.13.2.3 Operating Characteristics

Since the dry waste portion of the Solid Waste Disposal System is actually a series of steps performed manually, the system description in the above paragraphs also serves to provide the system operating characteristics.

All solid radioactive waste is Class A low-level waste as defined in 10 CFR 61 (CFR, 2003d).

3.5.13.2.4 Safety Considerations

Failure of this system will not endanger the health and safety of the public. Nevertheless, design and operating features enhance public and worker safety. Protection from hazardous, radioactive, and mixed material is provided by containment of materials, by strict administrative

procedural controls, and by systematic inspections of waste materials. Onsite spills, if they occur, remain contained within Restricted Areas. Shipment of wastes offsite strictly adheres to regulations for packaging and transportation. The mass limit of fissile material prepared for offsite shipment shall not exceed the fissile material limits of 10 CFR 71 (CFR, 2003f). Appropriate protective clothing and respiratory equipment is required for plant workers depending on the material being handled.

Controls on shape, mass, area density, and selection of waste containers prevent criticality events.

In addition, MONK8A (SA, 2001) calculations were performed for a single 12 L (3.2 gal) residue container holding charcoal/uranium fluoride/water mixture over a range of H/U ratios. The container was modeled as an equiaxed cylinder of radius 12.4 cm (4.9 in) and height 24.8 cm (9.8 in) which was placed on a 20 cm (7.9 in) thick concrete layer with reflection beneath the lower face to simulate infinite depth of concrete. The cylinder volume was completely filled with the charcoal/uranic mixture. A 2.5 cm (0.984 in) thick water layer enclosed the cylinder sides and top surface. At the optimum H/U ratio of 24, the value of k_{eff} is 0.7025 compared with a maximum value for k_{eff} of 0.8570 for an isolated 12 L (3.2 gal) cylinder of oil/UF₄ mixture. This indicates that the charcoal mixture will be safe when stored in 12 L (3.2 gal) containers.

For the array, a 5x5 horizontal array of cylinders was modeled explicitly with an additional container in contact with the center cylinder of the 5x5 unit to simulate accidental movement of an extra container into a storage array. The containers were modeled resting on a 30 cm (11.8 in) thick concrete layer and a 2.5 cm (0.984 in) water reflector was placed around each container. The uranic/oil mix was at an H/U ratio of 21. The value of k_{eff} obtained for the array model was 0.9281.

Therefore, arrays of up to 5x5 12 L (3.2 gal) containers containing chemical absorber material are therefore safe under worst-case conditions with 60 cm (23.6 in) spacing between containers.

3.5.14 Decontamination Workshop

The Decontamination Workshop is located in the Technical Services Building. The layout is shown in Figure 3.5-38, Decontamination Workshop Equipment Arrangement. The decontamination systems in this workshop are designed to remove radiation from contaminated materials and equipment used in uranium hexafluoride systems, waste handling systems, and miscellaneous other areas of the plant. Space is provided to break down and strip contaminated equipment prior to decontamination. The workshop is also used for the temporary storage and dismantling of failed equipment.

The only significant forms of radioactive contamination found in the facility are uranium hexafluoride (UF₆), uranium tetrafluoride (UF₄), and uranium fluoride (UO₂F₂).

3.5.14.1 System Description

The Decontamination System has three basic subsystems:

- Equipment decontamination

- Sample bottle and valve decontamination
- Flexible hose decontamination

Equipment decontamination takes place in the Equipment Decontamination Cabinet and includes larger equipment items such as pumps and trap bodies. Sample bottles, valves, and flexible hoses are decontaminated in separate cabinets because of the difficulty of handling the specific shapes. Sample bottles and valves are decontaminated in the Sample Bottle Decontamination Cabinet and flexible hoses are decontaminated in the Flexible Hose Decontamination Cabinet.

3.5.14.1.1 Equipment Preparation for Decontamination

Equipment and components are stored in critically-safe arrays upon delivery to the Decontamination Workshop. These items are then degassed and drained before being broken down and stripped. Once equipment and components are stripped, they are ready to be decontaminated.

3.5.14.1.2 Equipment Decontamination

Stripped equipment and components are put into baskets when they are ready to be decontaminated in the Equipment Decontamination Cabinet (Figure 3.5-39, Process Flow Diagram, Equipment Decontamination System). The baskets are submerged in multiple heated baths, including a degreasing water bath, a citric acid bath, and two rinse water baths to decontaminate items. After the items are dry, they go to the Vacuum Pump Rebuild Workshop for reassembly. Typical equipment items are vacuum pumps and pump components, but may include valves, piping, instruments, tools, and scrap metal.

3.5.14.1.3 Sample Bottle Decontamination

Sample bottles and valves are decontaminated in the Sample Bottle Decontamination Cabinet (Figure 3.5-40, Process Flow Diagram, Decontamination System for Sample Bottles). Valves are linked together and citric acid is pumped through them, followed by DI water. Sample bottles are individually rinsed with citric acid to decontaminate them, followed by a DI water rinse. The bottles are initially dried using heated, compressed air before being placed into an oven to insure total dryness. The sample bottles are returned to the laboratories in the TSB where they are used for analysis.

3.5.14.1.4 Decontamination of Flexible Hoses

In the Flexible Hose Decontamination Cabinet (Figure 3.5-41, Process Flow Diagram, Decontamination System for Flexible Hoses), flexible hoses are decontaminated by pumping a citric acid solution through them. DI water is then pumped through the hoses before they are dried using heated, compressed air. The dried hoses are moved into the Vacuum Pump Rebuild Workshop for reuse in the plant.

3.5.14.2 Major Components

The major components associated with breaking down and decontaminating the equipment included in this system are:

- A. Tools for moving equipment (e.g., cranes)
- B. Tools for stripping equipment.
- C. Radiation monitors.
- D. Equipment Decontamination Cabinet
 - 1. Degreaser Tank with: an electric heater, ultrasonic agitator, recirculation pump, associated pipework and valves, instruments and controls, and water spray system.
 - 2. Citric Acid Tank with: an electric heater, ultrasonic agitator, recirculation pump, associated pipework and valves, instruments and controls, and water spray system.
 - 3. Two Rinse Water Tanks each with: an electric heater, ultrasonic agitator, recirculation pump, transfer pump, associated pipe work and valves, instruments and control.
 - 4. Monorail hoist.
 - 5. Citric Acid Tank and Degreaser Tank clean-up ancillary items, each with: portable transfer pump and associated equipment.
- E. Exhaust system with ductwork connected to the Gaseous Effluent Vent System (GEVS), where required, and general HVAC system for the room.
- F. Sample Bottle Decontamination Cabinet - a small citric acid tank (for a fresh solution); a small DI water tank; a pump and associated equipment; a small citric acid tank (for fresh and waste solutions) for washing the valves; and 5-L (1.3 gal) containers for citric acid/uranic waste.
- G. Flexible Hose Decontamination Cabinet - a small citric acid tank (for fresh and waste citric acid), a small DI water tank, and two pumps and associated equipment.

3.5.14.3 Interfaces

The Decontamination Workshop interfaces with the following other plant systems and areas:

- A. Gaseous Effluent Vent System (GEVS). This system in the TSB pulls a vacuum to capture contaminated or hazardous vapors locally from the decontamination cabinets, the stripping tables, and the Outgas Area.
- B. Fomblin Oil Recovery System. This system receives the contaminated oil drained from the pumps.
- C. Potable Water System. This system provides the water for the hand wash sinks in the People Air Lock.

- D. Compressed Air System. Compressed air is used in the decontamination process for drying sample bottles and flexible hoses. This system may also supply pneumatics to some tools in the workshop.
- E. Electrical System. This system provides power to most equipment in the workshop.
- F. Liquid Effluent Collection and Treatment System. This system collects, treats, and disposes of the liquid waste coming from the Decontamination Workshop.
- G. Solid Waste Collection System. This collects and handles solid wastes, such as cloths, rags, and sludges, and ensures that it is disposed of off-site appropriately.
- H. Deionized Water Supply and Distribution System. This provides water to the decontamination system for rinsing the citric acid and solid contaminants.
- I. Chemical Laboratory. Samples from the decontamination tanks and systems are taken here to check for uranic content.
- J. Heating, Ventilation and Air Conditioning (HVAC) System. This system provides general services to the Decontamination Workshop

3.5.14.4 Operating Characteristics

Decontamination in the Decontamination Workshop begins with the receipt and preparation of contaminated equipment and components. The process consists of a series of steps to dismantle, clean, and rinse the contaminated items individually. Sample bottles, valves, pumps, and equipment that fail or are taken out of the enrichment facility for maintenance are part of the input stream for the workshop. The typical items and quantities expected to be processed in the Decontamination Workshop on an annual basis are listed in Table 3.5-11, Items Processed in the Decontamination Workshop.

3.5.14.4.1 Equipment Preparation for Decontamination

Equipment to be decontaminated must be taken from the facility and prepared for decontamination. Equipment is taken offline prior to removal from the facility. It is then transported to the workshop and stored before being dismantled.

Most of the equipment that is decontaminated are process vacuum pumps. Pumps are taken offline, and the flanges are sealed in the facility prior to movement to the Decontamination Workshop. Pumps enter the Decontamination Workshop through airlock doors. The internal and external doors are electrically interlocked such that only one door can be opened at a time. Pumps may enter the workshop individually or in pairs on pump frames. Valves, piping, flexible hoses, and general plant components are accepted into the room either in plastic bags or with the ends sealed.

Pumps waiting to be processed are stored in the pump storage array (Storage Area on Figure 3.5-38, Decontamination Workshop, Equipment Arrangement) to eliminate the possibility of accidental criticality. Each row of the array has a 300 mm (11.8 in) spacing between containers. The distance between rows is 600 mm (23.6 in). Pumps are not accepted if there are no vacancies in the array.

Before being broken down and stripped, all pumps are placed in the Outgas Area (shown on Figure 3.5-38), and the local ventilation hose is positioned close to the pump flange. The flange covers are then removed from the pumps. HF and UF₆ fumes from pumps are exhausted via the vent hose, typically over a period of several hours. While in the Outgas Area, Fomblin oil is drained from the pump, and if required, the first stage pumps are separated from the second stage pumps. The oil is drained into 5-L (1.3 gal) plastic containers that are labeled so each can be tracked through the process. Miscellaneous equipment is placed in bins and taken to the Outgas Area as necessary.

Prior to removal from the Outgas Area, the outside of equipment bins, pump frames, and oil containers are monitored for radiological contamination. The various items are then taken to the decontamination system or to the Fomblin oil storage array as appropriate.

Oil waiting to be processed is stored in the Fomblin oil storage array to eliminate the possibility of accidental criticality. When ready for processing, the oil is transferred to the Fomblin Oil Recovery System where the uranics and hydrocarbon contaminants are separated from the oil prior to its reuse.

After outgassing, individual pumps are removed from the Outgas Area and placed on either of the two hydraulic stripping tables using an overhead crane. The tables can be height-adjusted, and a pump can be moved and positioned on the table. The pump and motor are stripped to component level using various hydraulic and hand tools. Using the overhead crane or mobile jig truck, the components are placed in bins ready for transportation to the Equipment Decontamination Cabinet.

3.5.14.4.2 Equipment Decontamination

Decontamination for pumps and general equipment is done in a series of steps. The equipment is put into a degreaser water bath, a citric acid bath, and is then rinsed with DI water baths. It is transported between baths in a basket using an integral monorail hoist inside the Equipment Decontamination Cabinet (Figure 3.5-39, Process Flow Diagram, Equipment Decontamination System). The decontamination process for most plant components is described below, with a typical cycle time of approximately one hour.

Degreasing takes place in the Degreaser Tank in the Equipment Decontamination Cabinet. Components requiring degreasing are cleaned manually and then immersed into the Degreaser Tank. An open top tank with a sloped bottom is used for removing the residual Fomblin oil and greases that may inhibit the decontamination process. The sloped bottom construction is provided for draining the tank completely. During the degreasing process, a pump continuously recirculates the tank contents to accommodate sampling for criticality prevention. The tank has a capacity of 800 L (211 gal), and level control with a local alarm is provided to maintain the liquid level. It is furnished with an ultrasonic agitation facility, and a thermostatically controlled electric heater to maintain the temperature at 60°C (140°F). The tank has a ring header and a manual hose to rinse out residual solids/sludge with DI water after the batch has been pumped to the Liquid Effluent Collection and Treatment System. The degreased components are inspected and then transferred to the Citric Acid Tank for the decontamination part of the process.

Decontamination is accomplished by immersing the contaminated component in a citric acid bath. The Citric Acid Tank and pump system have the same components and are operated and

controlled in the same fashion as the Degreaser Tank and pump system. In order to minimize uranium concentration, the rinse water from the final Rinse Water Tank is pumped into the other Rinse Water Tank (closer to the Citric Acid Tank), which in turn is pumped into the Citric Acid Tank. This counter-current system eliminates a waste product stream by concentrating the uranics in the Citric Acid Tank. The rinse water transfer pump is linked with a high level alarm on the Citric Acid Tank to prevent overfilling. After approximately 15 minutes, the component is removed from the Citric Acid Tank to be rinsed.

Two open top Rinse Water Tanks with sloped bottoms are provided to rinse excess citric acid from decontaminated components. Each of the tanks has a liquid capacity of 800 L (211 gal). Both of these tanks are furnished with ultrasonic agitation, a thermostatically controlled electric heater to maintain the content's temperature at 60°C (140°F), and a recirculation pump facility to accommodate sampling for criticality prevention. The sloped bottom is provided for draining the tank completely. Fresh DI water is manually added to the final rinse tank as needed. The water from this tank is pumped into the other Rinse Water Tank (closer to the Citric Acid Tank) to minimize uranium concentration. Level control is provided to maintain the rinse water level. A manual spray hose is available for rinsing each tank after it has been emptied.

All components are dried after decontamination. This is performed manually using compressed air inside the cabinet while the components are still in the basket.

Each of the tanks is sampled periodically to determine the condition of the solution and any sludge present. The Citric Acid Tank and Degreaser Tank contents are analyzed for uranium concentration and citric acid concentration. The results of the analysis are compared to administrative limits set for the uranic content and for the pH of the solutions. Spent solutions, consisting of citric acid, degreasing water, and various uranyl and metallic citrates, are transferred to collection tanks in the Liquid Effluent Collection and Treatment System. After monitoring, the Degreaser Tank waste contents are pumped into the Degreaser Water Collection Tank and the Citric Acid Tank waste solution is pumped into the Spent Citric Acid Collection Tank. The solids contents from both tanks are sprayed with fresh DI water and the resultant mixtures are also pumped to their respective destinations. The Rinse Water Tanks are checked for satisfactory pH and uranic levels; unusable water is transferred to an effluent collection tank in the Liquid Effluent Collection and Treatment System. The quantity of contamination remaining is "as low as reasonably achievable." Components released for unrestricted use do not have contamination exceeding administrative limits. However, if all of a component's surface contamination cannot be monitored or if the contamination exceeds administrative limits, then the component is disposed of as low-level waste. All materials of construction are compatible with the process solutions at operating conditions.

The activities carried out in the Decontamination Workshop give rise to a potentially contaminated gaseous stream, which requires treatment before discharging to the atmosphere. These streams consist of air with traces of UF_6 , HF, and uranium particulates (mainly UO_2F_2). Air exhausted from the Equipment Decontamination Cabinet, the Sample Bottle Decontamination Cabinet, and the Flexible Hose Decontamination Cabinet is vented to the TSB GEVS to ensure airborne contamination is controlled. There are local ventilation ports in the stripping area and Outgas Area that operate under vacuum with all air discharging through the TSB GEVS. The TSB GEVS is designed to route these streams to a filter system and to monitor, on a continuous basis, with the resultant exhaust stream discharged to the atmosphere. The room itself has HVAC ventilation.

3.5.14.4.3 Sample Bottle Decontamination

The Decontamination Workshop has a separate area dedicated to sample bottle storage, disassembly, and decontamination, called the Sample Bottle Decontamination Cabinet (Figure 3.5-40, Process Flow Diagram, Decontamination System for Sample Bottles). Valves are also decontaminated in this cabinet. The decontamination system for valves and sample bottles requires a citric acid rinse and a DI water rinse for both items.

Used sample bottles are weighed to confirm the bottles are empty upon entry into the workshop. The sample bottle valves are loosened outside the cabinet and then are removed once inside the cabinet. A small open container is filled with a citric acid solution. The sample bottles are filled with a clean citric acid solution from this container. Any loose material inside the bottle is dissolved in the solution, which is then poured into a waste container. The sample bottles are then filled with DI water and left to stand for approximately an hour.

The removed valves are linked together in series before being placed downstream of a pump. The pump is fed from a small open container filled with citric acid solution. Citric acid is then recirculated in a closed loop through the valves for an hour. The valves are rinsed after the decontamination step using fresh DI water.

After the bottles and valves have a second DI water rinsing, they are dried manually using heated compressed air and inspected for contamination and rust.

The resulting waste solutions from cleaning the bottles and the valves are collected in 5-L citric acid/uranic waste containers. The solutions are then manually transferred to the Citric Acid Tank in the Equipment Decontamination Cabinet. Any liquid spillages / drips are soaked away with paper tissues that are disposed of in the Solid Waste Collection System.

During the process, air from the cabinet vents to the GEVS to ensure that airborne contamination is controlled. The bottles are then put into an electric oven to ensure total dryness, and on removal are ready for reuse. The cleaned components are transferred to a clean workshop for reassembly followed by pressure and vacuum testing.

3.5.14.4.4 Flexible Hose Decontamination

The decontamination of flexible hoses is performed in a Flexible Hose Decontamination Cabinet (Figure 3.5-41, Process Flow Diagram, Decontamination System for Flexible Hoses). This decontamination cabinet is designed to process only one flexible hose at a time and consists of recirculation loops of citric acid solution and of DI water.

The flexible hose is attached in a closed loop downstream of a closed citric acid tank and a recirculation pump. The flexible hose is flushed with a heated citric acid solution. After the citric acid wash, the hose is attached in a closed loop downstream of a closed DI water tank and a pump. It is then rinsed with heated DI water in a recirculation system. Each flexible hose is then dried in the cabinet using heated compressed air. The cleaned, dry flexible hose is then transferred to the Vacuum Pump Rebuild Workshop for reassembly and pressure testing prior to reuse in the plant.

Interlocks are provided in both recirculation loops such that the recirculation pumps cannot be started if the flexible hose has not been connected correctly at both ends. The cabinet doors are also on an interlock system to ensure that the pump does not start with the doors open. The

tanks each have a temperature transmitter, a level transmitter with high and low alarms, and controls on the electric heating element. Both the citric acid and DI water recirculation pumps are equipped with 15-min timer devices. The two tanks are maintained at 60°C (140°F) when in operation.

The used solutions (citric acid and DI water) are transferred into the Citric Acid Tank in the Equipment Decontamination Cabinet for disposal. The exhaust air goes to the GEVS to ensure airborne contamination is controlled. Spillages from the drip tray are routed to either the citric acid tank or the hot water recirculation tank in the cabinet depending upon the decontamination cycle.

3.5.14.5 Safety Considerations

Failure of this system does not endanger the health and safety of the public. Design and operating features enhance public and worker safety.

To minimize worker exposure, airborne radiological contamination resulting from dismantling is vented to the GEVS. Air suits and portable ventilation units are available for further worker protection.

Containment of chemicals and wastes is provided by equipment and piping components, designated containers, and air filtration systems. All pipe work and vessels in the Decontamination Workshop are provided with design measures to protect against spillage or leakage. Hazardous wastes and materials are contained in tanks and other appropriate containers, and are strictly controlled by administrative procedures. Chemical reaction accidents are prevented by strict control on chemical handling procedures and physical segregation of chemicals in storage locations.

Personnel entry into the facility will be via a sub-change facility. This area has the required boot barrier access, washing and monitoring facilities.

Criticality is precluded through the control of geometry, mass, and the selection of appropriate storage containers. Administrative measures are applied to uranium concentrations in the Citric Acid Tank, Degreaser Tank, and Rinse Water Tanks in the Equipment Decontamination Cabinet to maintain these controls.

In addition, a MONK8A (SA, 2001) calculation was performed for a generic model of arrays of pumps of volume not exceeding 14 L (3.7 gal). The pumps were modeled simply as equiaxed cylinders of uranic material of 14 L (3.7 gal) volume surrounded by an iron annulus of 0.5 cm (0.2 in) thickness representing typical casing thickness for UF₆ pumps. The uranic material was uranyl fluoride/water mixture at an H/U atomic ratio of 7 and at 6.0 % ²³⁵U enrichment. The two pumps were modeled in contact along the cylinder wall and a 2.5 cm (0.984 in) water annulus was included around each pump to simulate spurious reflection. The pumps were positioned above a 20 cm (7.9 in) thick concrete layer but separated from this layer by the 2.5 cm (0.984 in) water thickness. Reflection was used to simulate an infinite linear array of pump pairs with 60 cm (23.6 in) edge spacing between pairs. The resulting value of k_{eff} was 0.8552.

The MONK8A (SA, 2001) model described above was modified to replace the two touching 14 L (3.7 gal) pumps with two pump sets in contact, each pump set assumed a combination of a Leybold WS2000 pump and a Leybold WS500 pump.

For the WS2000 pump, a detailed model was used based on the actual construction of the pump from information supplied by the manufacturer. Some conservative modeling simplifications were required mainly for the gearbox and motor assemblies. In the case of the WS500 pump, which has a free volume of 8.52 L (2.25 gal), the simple equiaxed cylinder model was used. To simulate spurious reflection, the two pumps were modeled as being separated vertically by the thickness of the 2.5 cm (0.984 in) water annulus around the cylinder of the WS500 pump. This spurious reflection assumption is less than the actual separation when the pumps are in their pump frame.

Two pump sets were explicitly modeled but rather than being side by side as was the case for the 14 L (3.7 gal) pumps, the pump sets were orientated in line such that the WS2000 pumps were in contact at the gearbox end. Sensitivity studies show this to be the most reactive configuration for the pump sets. It was also assumed that the pumps were filled with the same uranic mixture as for the 14 L (3.7 gal) pumps and the infinite linear array was again used. The resulting value of k_{eff} was 0.8202.

Therefore, a linear array of pump pairs with 60 cm (23.6 in) spacing is safe.

3.5.15 Fomblin Oil Recovery System

Fomblin oil is a highly fluorinated, inert oil selected especially for use in uranium hexafluoride (UF_6) systems to avoid reaction with UF_6 . The Fomblin Oil Recovery Unit recovers used Fomblin oil from pumps used in UF_6 process systems. Used Fomblin oil is recovered by removing impurities that inhibit the oil's lubrication properties. The impurities collected are primarily uranyl fluoride (UO_2F_2) and uranium tetrafluoride (UF_4) particles. The recovery process also removes trace amounts of hydrocarbons, which if left in would react with UF_6 . Flow through the Fomblin Oil Recovery System, located in the Decontamination Workshop is shown in Figure 3.5-42, Process Flow Diagram, Fomblin Oil Recovery System.

The process employed is essentially a laboratory scale unit that has been developed to a production level. Fomblin oil recovery is carried out as a batch operation, one batch being up to 12 L (3.2 gal) of oil, using the fully enclosed, self-contained Fomblin Oil Recovery Unit. Only one batch of oil is processed at any one time representing a maximum of 12 L (3.2 gal). The unit has a uranium removal section followed by a hydrocarbon removal section. Dimensions of the recovery unit are approximately 3 m (9.84 ft) long by 1 m (3.28 ft) wide by 2.2 m (7.22 ft) high.

3.5.15.1 System Description

The Fomblin oil recovery process consists of oil collection, uranium precipitation, trace hydrocarbon removal, oil sampling, and storage of cleaned oil for re-use. Each step is performed manually.

Fomblin oil is collected in the Decontamination Workshop as part of the pump disassembly process. The oil is transferred for processing to the Fomblin Oil Recovery Unit in criticality safe, 5 L (1.32 gal), plastic containers. The containers are labeled so each can be tracked through the process. The used oil awaiting processing is stored in the Fomblin oil receipt storage array to eliminate the possibility of accidental criticality. Each row of the array has 300 mm (0.984 ft)

spacing between containers (edge to edge). The distance between rows is 600 mm (1.97 ft) (edge to edge). Containers are not accepted if there are no vacancies in the array.

Uranium compounds are removed from the Fomblin oil in the Fomblin Oil Recovery Unit to minimize personnel exposure to airborne contamination. Dissolved uranium compounds are removed by the addition of anhydrous sodium carbonate (Na_2CO_3) to the oil container which causes the uranium compounds to precipitate into sodium uranyl carbonate ($\text{Na}_4\text{UO}_2(\text{CO}_3)_3$). The mixture is agitated and then filtered through a coarse screen to remove metal particles and small parts such as screws and nuts. This waste is transferred to the Solid Waste Collection System. The oil is then heated to 90 °C (194 °F) and stirred for 90 minutes to speed the reaction. The oil is centrifuged to remove UF_4 , sodium uranyl carbonate, and various metallic fluorides. The particulate that is removed from the oil is collected and transferred to the Solid Waste Collection System for subsequent offsite disposal.

After uranium compounds are removed, trace amounts of hydrocarbons are removed in the Fomblin Oil Recovery Unit by adding activated carbon to the Fomblin oil and heating the mixture to 100°C (212°F) for two hours. The activated carbon adsorbs the hydrocarbons, and the carbon in turn is removed by filtration through a bed of celite. The resulting sludge is transferred to the Solid Waste Collection System for disposal.

Recovered Fomblin oil is sampled, and the samples are dissolved and analyzed in the Chemical Laboratory to determine if the criteria for purity have been met. Oil that meets the criteria can be re-used in the UF_6 system while oil that does not meet the criteria is reprocessed. The following limits have been set for recovered Fomblin oil purity for re-use in the plant:

- Uranium - 50 ppm by volume.
- Hydrocarbons - 3 ppm by volume.

Recovered Fomblin oil is stored in 5 L (1.32 gal), plastic containers in the chemical storage area. No precautions are required to prevent criticality accidents during the handling and storage of clean Fomblin oil.

3.5.15.2 Major Components

The following major components are included in this system:

- Fomblin Oil Recovery Unit. One Fomblin Oil Recovery Unit is provided to control the release of airborne radioactive contamination or HF during oil processing. Discharge air is filtered and is discharged from the plant via the Gaseous Effluent Ventilation System.
- Fomblin Oil Centrifuge. One Fomblin oil centrifuge is provided within the recovery unit to remove particulate from the oil. The centrifuge capacity is approximately 60 L/hr (15 gph).

3.5.15.3 Interfaces

The Fomblin Oil Recovery System interfaces with the following plant systems and areas:

- A. Gaseous Effluent Vent System. Exhaust from the fume hood of the Fomblin Oil Recovery Unit is filtered and discharged from the plant via the TSB Gaseous Effluent Vent System.
- B. Solid Waste Collection System. The Solid Waste Collection System will receive uranic precipitate and filter cake resulting from the uranium and hydrocarbon removal processes, and solvent resulting from rinse-out of filters, tubing, and clean oil containers.
- C. Decontamination Workshop. Fomblin oil collected in the pump disassembly areas of the Decontamination Workshop is transferred to the Fomblin Oil Recovery System – also in the Decontamination Workshop - for processing. The Fomblin oil centrifuge bowls and parts are transferred for decontamination in the Decontamination System - also in the Decontamination Workshop.
- D. Vacuum Pump Rebuild Workshop. Cleaned Fomblin oil is transferred to the Vacuum Pump Rebuild Workshop to await reuse in rebuilt pumps.

3.5.15.4 Operating Characteristics

The total annual volume of oil processed in this system is approximately 530 L (140 gal). The above system description serves to describe operating characteristics as well since oil recovery is simply a series of manual steps.

3.5.15.5 Safety Considerations

Failure of this system will not endanger the health and safety of the public. Nevertheless, design and operating features are included which contribute to the safety of plant workers. Containment of chemicals and wastes is provided by components, designated containers, and air filtration systems. Chemical reaction accidents are prevented by strict control on chemical handling procedures and physical segregation of chemicals in storage locations. Fomblin oil is rated as non-combustible and is thermally stable up to 300°C (571°F). Strict control of oil temperatures during heating precludes threat of fire. To minimize worker exposure, the Fomblin Oil Recovery System fume hood extracts all airborne radiological contamination resulting from oil recovery. Where necessary, air suits and portable ventilation units are available for further worker protection.

Criticality associated with Fomblin oil recovery is precluded through the control of shape, mass, and the selection of appropriate storage containers.

The maximum volume of any vessel on the Fomblin Oil Recovery Unit is 12 L (3.2 gal) and is intrinsically safe. However, MONK8A (SA, 2001) calculations demonstrate that the unit would remain safe even if all vessels were completely filled with uranyl fluoride-water mixture at 6.0 % enrichment and at optimum moderation. Uranyl fluoride/water mixture is more conservative than a Fomblin oil/UF₄ mixture. In the Fomblin oil/UF₄ mixture, dissolved HF provides the moderation and HF solubility in Fomblin oil is extremely low.

The MONK8A (SA, 2001) calculations for the Fomblin Oil Recovery Unit modeled the fixed vessels in their normal positions and included one 12 L (3.2 gal) container adjacent to the first mixing vessel to represent the batch of oil being moved to the unit. A 2.5 cm (0.984 in) water layer was modeled around the vessels to simulate spurious reflection. All vessels contained uranyl fluoride-water mixture as stated above, and a range of H/U atomic ratios were considered to

determine the optimum moderation. The maximum value of k_{eff} for the calculations was 0.7976 at an H/U ratio of 14.

3.5.16 Laundry System

The Laundry System cleans contaminated and soiled clothing and other articles which have been used throughout the plant. It contains the resulting solid and liquid wastes for transfer to appropriate treatment and disposal facilities. The Laundry System receives the clothing and articles from the plant in plastic bin bags, taken from containers strategically positioned within the plant. Clean clothing and articles are delivered to storage areas located within the plant. The Laundry System components are located in the Laundry Room of the TSB.

3.5.16.1 System Description

The Laundry System collects, sorts, cleans, dries, and inspects clothing and articles used throughout the plant in Radiation Areas (RAs). The laundry system does not handle any articles from non-RAs. Laundry collection is divided into two main groups- articles with a low probability of contamination and articles with a high probability of contamination. Those articles unlikely to have been contaminated are further sorted into lightly soiled and heavily soiled groups. The sorting is done on a table underneath a vent hood that is connected to the GEVS in the TSB. All lightly soiled articles are cleaned in the laundry. Heavily soiled articles are inspected and any considered to be difficult to clean (i.e., those with significant amounts of grease or oil on them) are transferred to the Solid Waste Collection System without cleaning. Special containers and procedures are used for collection, storage, and transfer of these items as described in the Solid Waste Collection System section. Articles from one plant department are not cleaned with articles from another plant department.

Special water-absorbent bags are used to collect the articles that are more likely to be contaminated. These articles may include pressure suits and items worn when, for example, it is required to disconnect or "open up" an existing plant system. These articles that are more likely to be contaminated are cleaned separately. Expected contaminants on the laundry include slight amounts of uranyl fluoride (UO_2F_2) and uranium tetrafluoride (UF_4).

When sorting is completed, the articles are placed into the front-loading washing machine in batches. The cleaning process uses 80°C (176°F) minimum water, detergents, and non-chlorine bleach for dirt and odor removal, and disinfection of the laundry. Detergents and non-chlorine bleach are added by vendor-supplied automatic dispensing systems. No "dry cleaning" solvents are used. Wastewater from the washing machine is discharged to one of three Laundry Effluent Monitor Tanks in the Liquid Effluent Collection and Treatment System. The laundry effluent is then sampled, analyzed, and transferred to the TEEB for disposal (if uncontaminated) or to the Precipitation Treatment Tank for treatment as necessary.

When the washing cycle is complete, the wet laundry is placed in a front-loading, electrically heated dryer. The dryer has variable temperature settings, and the hot wet air is exhausted to the atmosphere through a lint drawer that is built into the dryer. The lint from the drawer is then sent to the Solid Waste Collection System as combustible waste.

Dry laundry is removed from the dryer and placed on the laundry inspection table for inspection and folding. Folded laundry is returned to storage areas in the plant.

3.5.16.2 Major Components

The following major components are included in this system:

- A. Washers. Two industrial quality washing machines are provided to clean contaminated and soiled laundry. One machine is operating, and one is a spare for standby. Each machine has an equal capacity that is capable of washing the daily batches.
- B. Dryers. Two industrial quality dryers are provided to dry the laundry cleaned in the washing machine. One dryer is operating, and one is a spare for standby. Each machine has an equal capacity that is capable of drying the daily batches. The dryer has a lint drawer that filters out the majority of the lint.
- C. Air Hood. One exhaust hood mounted over the sorting table and connected to the TSB GEVS. The hood is to draw potentially contaminated air away as laundry is sorted prior to washing.
- D. Sorting Table. One table to sort laundry prior to washing.
- E. Laundry Inspection Table. One table to inspect laundry for excessive wear after washing and drying.

3.5.16.3 Interfaces

The Laundry System interfaces with the following other plant systems:

- A. Liquid Effluent Collection and Treatment System. The wastewater generated during the laundry process is pumped to one of three Laundry Effluent Monitor Tanks.
- B. Solid Waste Collection System. The Solid Waste Collection System receives clothing that has been laundered but is not acceptable for further use. It also receives clothing rejected from the laundry system due to excess quantities of oil or hazardous liquids. It also receives lint from the Laundry Dryer.
- C. TSB Gaseous Effluent Vent System. Air from the sorting hood is sent to the TSB Gaseous Effluent Vent System.
- D. Process Water System. The Process Water System supplies hot and cold water to the washer.
- E. Compressed Air System. Compressed air is supplied as required to support options selected for the laundry washers and dryers.
- F. Electrical System. The washing machines and dryers consume power.

3.5.16.4 Operating Characteristics

Clothing processed by this system normally includes overalls, lab coats, shirts, towels and miscellaneous items. Approximately 113 kg (249 lb) of clothing is washed each day. Upon completion of a cycle, the washer discharges to one of three Laundry Effluent Monitor Tanks in the Liquid Effluent Collection and Treatment System.

The washed laundry is dried in the hot air dryers. The exhaust air passes through a lint drawer to the atmosphere. Upon completion of a drying cycle, the dried laundry is inspected for excessive wear. Usable laundry is folded and returned to storage for reuse. Unusable laundry is handled as solid waste as described in the Solid Waste Collection System section.

3.5.16.5 Safety Considerations

Failure of this system does not endanger the health and safety of the plant workers, the public, or the environment. Additional design and operating features have been included, though, which contribute to the safety of plant workers. Some of the features are specialized to laundry systems and some of them are inherent in plant design.

Piping, piping components, and a laundry room sump provide containment of any liquid radiological waste. Small leaks and spills from the washer are collected and sent to the Liquid Effluent Collection and Treatment System. A rarely occurring large leak is to be captured in the laundry room sump. Any effluent captured in the sump is transferred to the Liquid Effluent Collection and Treatment System by a portable pump.

Contaminants from the washers are rinsed to the Liquid Effluent Collection and Treatment System. The exhaust air blows to atmosphere because there is little chance of any contaminant being in it.

The washer and dryer are equipped with electronic controls to monitor the operation. The dryer has a fire protection system that initiates an isolated sprinkler inside the dryer basket if a fire is detected in the dryer.

3.5.17 Ventilated Room

The function of the Ventilated Room is to provide a facility for the maintenance of chemical traps and UF₆ cylinders. The facility also deals with faults associated with cylinders and cylinder valves.

This includes safe emptying of chemicals from chemical traps and replacement of faulty valves on full UF₆ cylinders. The Ventilated Room is used for temporary storage of full and empty chemical traps and of the contaminated chemicals used in the chemical traps. The Ventilated Room is in physical proximity to the Decontamination Workshop through which the emptied chemical traps and other components are processed. Full maintenance records are kept for all chemical traps and UF₆ cylinders passing through the Ventilated Room.

3.5.17.1 System Description

The main activities carried out in the Ventilated Room are servicing chemical traps by removing spent carbon, aluminum oxide and sodium fluoride from the chemical traps and replacing damaged and leaking valves on cylinders which contain UF₆.

Personnel can enter the Ventilated Room from two places. One is through an airlock off the corridor of the Technical Services Building. The other is through a roll-up door entering from the Cylinder Preparation Room. See Figure 3.3-7, Technical Services Building, First Floor, for the location and arrangement of the Ventilated Room. The entry through the corridor in the

Technical Service Building is equipped with a change area and appropriate scanning equipment to monitor for contamination.

The Ventilated Room is maintained at a negative pressure relative to the surrounding areas. The negative pressure is to help mitigate any releases of hazardous materials to areas outside of the room. The activities carried out in the Ventilated Room may result in potentially contaminated gaseous effluents that require treatment before being discharged to the atmosphere. These effluents are UF₆, Hydrogen Fluoride, and Uranyl Fluoride.

The most frequent activity in the Ventilated Room is the servicing of chemical traps. After the chemical traps enter the Ventilated Room, they are stored in safe array storage racks. To remove the spent chemicals, a specially designed rig is used. The chemical trap is placed into the rig, and the rig inverts the chemical trap to dump the chemicals. The rig has a connection to the TSB GEVS to dispose of any airborne contaminants. Removed spent chemicals are placed in containers and sampled for uranium content. After sampling the spent chemicals are transferred to the Solid Waste Collection System. The empty chemical traps are then transported to the Decontamination Workshop and then refilled for future use.

In addition to servicing the chemical traps, UF₆ cylinders with faulty valves are serviced. The cylinders are transported into the Ventilated Room through the adjoining Cylinder Preparation Room via a rail transporter. Once in the room, the faulty valve is removed and the threaded connection in the cylinder is inspected. A new valve is then installed in accordance with the requirements of ANSI N-14.1 (ANSI, 2001). After the valve is installed, the cylinder will undergo a pressure test with gaseous nitrogen to 1.345 bar absolute (19.5 psia). The Cylinder Pressure test and Pump-Out System is shown in Figure 3.5-43, Piping & Instrumentation Diagram, Cylinder Pressure Test & Pump Out. The valve and its connection into the cylinder are tested for leakage. If no leakage is detected, the cylinder is pumped down to 250 mbar (absolute) (100 in. H₂O) and returned to service. Damaged, contaminated valves are decontaminated and transported to the Solid Waste Collection System.

3.5.17.2 Major Components

The major components of the Ventilated Room and systems within the Ventilated Room are:

- A. Powered roll-up door for cylinder entry through the Cylinder Preparation Room
- B. Personnel air-lock for access from the Technical Services Building corridor
- C. Chemical Trap Emptying Rig
- D. Cylinder Pressure Test & Pump Out Rig
- E. Transporter rails
- F. Slings and shackles for use with the lifting devices and a suitable storage facility
- G. Storage areas for contaminated traps; contaminated, dismantled, component bins and contaminated combustible waste
- H. Various stripping and dismantling tools, vacuum cleaner, and storage facilities.

3.5.17.3 Interfaces

The Ventilated Room interfaces with the following systems and utilities.

- A. Technical Services Building-GEVS
- B. Decontamination Workshop
- C. Solid Waste Collection System
- D. Nitrogen System
- E. Compressed Air System
- F. Electrical System
- G. HVAC System.

3.5.17.4 Safety Considerations

Numerous design and operating features are incorporated into the Ventilated Room and the systems within it to provide safe operation and protect the plant operators and the public.

Emptying the chemical traps will generate airborne particulates. Airborne particulates are greatly minimized by emptying the chemical traps in a specially designed rig. The rig is designed to prevent the airborne particulates from escaping from the rig and into the Ventilated Room. The rig is connected to the TSB GEVS. Operation of the TSB GEVS is required to establish airflow away from the worker when handling sodium fluoride trap material containing uranic material. In addition to controlling airborne contaminants, the rig is designed to meet criticality control requirements and is safe by geometry.

Plant operators are also required to wear respirators when they are handling chemical traps containing uranic material or when performing positive pressure testing of UF_6 cylinders after repair/replacement of a leaking cylinder component. There are numerous control measures in the Ventilated Room to prevent criticality accidents. Among these are safe storage arrays, moderation control, sampling and mass control.

An automatic trip of the vacuum pump on high weight of the carbon trap for the Ventilated Room evacuation skid and an automatic trip of the vacuum pump on high temperature in the Ventilated Room evacuation skid carbon trap are provided.

An automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limits are provided to ensure public consequences due to offsite exposure from Ventilated Room outflow are maintained low.

Calculations have also been performed on the storage arrays of product vent chemical (carbon) traps. The calculations also cover the storage of alumina traps, which are of similar dimensions but have a lower uptake of uranium. The alumina traps are not normally exposed to uranium (their purpose is to remove HF), but it is possible that an alumina trap could be connected to the plant by mistake in place of a carbon trap. The modeling of alumina traps as carbon traps covers this possibility.

The chemical traps are essentially empty steel cylinders into which steel internal parts including perforated plates to carry the activated carbon are placed. The activated carbon in the trap

adsorbs UF_6 which, is then assumed to be hydrated (by moist air inleakage) to form a uranyl fluoride/water mixture with a maximum H/U ratio of 7.

The traps are of internal diameter 20.3 cm (8.0 in) and height 105.8 cm (41.7 in). The diameter is less than the maximum safe diameter (21.9 cm (8.6 in)) for 6.0 % enriched material for a single cylinder. However, it is possible that large numbers of traps (e.g., in storage arrays) are more reactive.

Arrays of chemical traps were modeled using MONK8A (SA, 2001). An array of 7x7 traps and a vacuum cleaner yields a k_{eff} of 0.9191 assuming 6.0 % enrichment. This was modeled with the sidewalls of the traps touching, which could not happen in practice since there is a lip at the top. Taking account of one of these lips to give 5 cm (2.0 in) spacing between the traps an array of 11x11 traps and a vacuum cleaner was modeled and gave a reduced k_{eff} of 0.8665. The vacuum cleaner was assumed to be a cleaner of internal diameter 20.3 cm (8.0 in) and length 66 cm (26.0 in) and was assumed to be entirely filled with uranic material with an enrichment of 6.0 %. MONK8A (SA, 2001) calculations have also been carried out for an isolated cylinder using these dimensions, filled with uranyl fluoride/water at optimum moderation and with 2.5 cm (0.984 in) water reflection. This gave a value for k_{eff} of 0.8037. The cleaner has high efficiency particulate air (HEPA) filtration on the exhaust, and will be dedicated for cleaning operations where uranic material is involved and will be marked clearly.

It can be concluded that arrays of these chemical traps containing uranium of up to 6.0 % enrichment are safe up to an 11x11 array configuration with no spacing restriction. The only stipulation that needs to be made is that stacking of traps in an array is not allowed.

3.5.18 Chemical Laboratory

The prime function of the Chemical Laboratory is to analyze the product material to ensure that it meets the product purity specification. This involves the handling and storage of a large number of 1S sample bottles and the production of hydrolyzed UF_6 solutions for the subsequent analysis. There may also be a requirement for this laboratory to deal with other samples, for example, those from the Decontamination System's tanks. These samples will have uranium concentrations much less than the hydrolyzed UF_6 solutions considered below and as such can be treated in the same manner. There may be a requirement for other solid samples to be analyzed such as deposits removed from plant components prior to decontamination and these can be dealt with on a formal mass accountancy basis. The double batching mass limit of 45% of the minimum critical mass is used in the nuclear criticality safety for these samples.

Samples of UF_6 are typically received in 1S cylinder sample bottles. The storage system for 1S bottles is a rack system within two storage areas of approximate dimensions of 1 meter wide and 2.5 m (8.2 ft) high. These have a combined total of 168 slots and normally up to three bottles would be placed in one slot. The normal capacity is approximately 500 bottles.

3.5.18.1 System Description

Samples enter the Chemical Laboratory from across the plant for analysis. The samples are categorized as follows.

- A. UF_6 product samples

- B. Waste water samples
- C. Samples from the Decontamination Workshop
- D. Oil samples from compressors
- E. Samples from chemical absorbers
- F. Miscellaneous samples.

3.5.18.2 Major Components

The major components of the Chemical Laboratory include the following.

- A. Inductively-coupled Plasma Mass Spectrometer
- B. Inductively-coupled Plasma Optical Emission Spectrometer
- C. Analytical Laboratory Equipment (UV Spectrometer, pH meter, conductivity meter, titrators, water bath, analytical balances)
- D. Fume Collection and Exhaust Hoods
- E. Ultra Pure Water Equipment
- F. Sub-sampling Unit.

The sub-sampling unit allows smaller samples of UF_6 to be dispensed from plant sample containers (1S or 2S bottles) into P-10 tubes that are then used for analysis or shipment to customers. The unit consists of three independently heated dispensing stations mounted on a common base. It is located inside a fume collection exhaust hood.

Each dispensing station is contained in its own electrically heated, insulated hot box. A fan circulates the air inside the hot box. Instrumentation controls the temperature of the hot box and shuts off the heating system on high temperature or loss of vacuum. Two stations are capable of handling 1S sample bottles, and the third station can handle either 1S or 2S sample bottles.

Each station has the necessary piping and valves to transfer a specific quantity of UF_6 into the smaller type P-10 sub-sample tube. The sub-sample tube is located outside the hot box and is cooled with liquid nitrogen in a Dewar flask.

A common manifold connects the sample piping in each station to vacuum pumps via UF_6 cold traps. Three vacuum pumps are mounted on the unit base. For initial system pump down and to remove moisture, a set of two pumps in series is used. For normal operation of the unit a single pump installed in parallel to the dual pump set is used. The vacuum pumps exhaust into the fume collection exhaust hood.

Dual UF_6 cold traps, connected in series, precede the vacuum pumps. The UF_6 cold traps are cooled using liquid nitrogen in Dewar flasks. UF_6 in the exhaust gas is desublimed in the UF_6 cold traps before being exhausted through the vacuum pump.

3.5.18.3 Interfaces

The Chemical Laboratory interfaces with the following systems and utilities.

- A. Samples are received from throughout the plant
- B. TSB Gaseous Effluent Vent System
- C. TSB Laboratory HVAC System
- D. Nitrogen System
- E. Compressed Air System
- F. Potable Water System
- G. Deionized Water Supply and Distribution System
- H. Electrical System
- I. Liquid Effluent Collection and Treatment System
- J. Solid Waste Collection System.

3.5.18.4 Safety Considerations

Failure of this system (laboratory accidents) will not endanger the health and safety of the public. Nevertheless, design and operating features are included that contribute to the safety of plant workers. Wastes are contained in designated containers and the air filtration systems. Criticality is precluded through the control of geometry and mass of fissile materials. To minimize worker exposure, airborne contamination resulting from laboratory operations is exhausted through the TSB GEVS. Operation of TSB GEVS connected to the chemical hood is required to establish airflow away from the worker when the UF₆ sub-sampling unit is operated.

A UF₆ cold trap high temperature interlock to close the Cold Trap No. 2 valve is provided in line to sub-sampling rig vacuum pump. This hard-wired single train, fail-safe, feature functions to prevent flow of UF₆ to the TSB GEVS in the event the associated UF₆ cold trap is above an adequate desublimation temperature.

A high temperature trip of the UF₆ sub-sampling Unit hot box heater is also provided. This automatic, fail-safe, feature functions to trip the hot box heaters at the UF₆ sub-sampling Unit on high hot box internal temperature to ensure sample bottle integrity.

The 1S sample bottles containing enriched uranium, that are stored in the Chemical Laboratory, are filled from 30B product cylinders that are subject to criticality control on moderator content such that the H/U ratio of the contents does not exceed unity. Product UF₆ is controlled to a product specification of 99.5% UF₆ purity equivalent to an H/U ratio of only 0.088 (impurity assumed to be all HF). Although 1S bottles are not strictly moderator controlled in the sense that product cylinders are, their contents are expected to be representative of the UF₆ product.

A full 30B cylinder contains more than 2,000 kg (4,409 lb) of UF₆ that is safe at an H/U ratio of unity. The maximum permitted fill for 1S bottles is 450 g (0.99 lb) UF₆ (plant fill limit is 400 g (0.88 lb)) and therefore approximately 4,000 filled 1S bottles are equivalent to one full 30B cylinder.

The storage array can be considered as a heterogeneous system of vessels in a regular lattice arrangement. A series of MONK8A (SA, 2001) calculations have been carried out for generic storage of 1S bottles which include lattice arrangements of 1S bottles in array sizes exceeding the number stored in the laboratories. These calculations modeled a 25x25 array of 1S bottles containing 450 g (0.99 lb) of UF₆-HF mixture at 6.0 w/o ²³⁵U enrichment. The array was modeled at optimum spacing (triangular pitch) and the water reflection conditions considered included water flooding although flooding of the array is not credible. The most reactive case from the above MONK8A (SA, 2001) calculations gave a value for k_{eff} of 0.6549.

Based on this analysis, the 1S sample bottles are safe in an array.

3.5.19 Cylinder Preparation Room

The function of the Cylinder Preparation Room is to provide a facility to test and inspect new or cleaned 30B, 48X, or 48Y cylinders for use in the Separations Plant and the Blending and Liquid Sampling Area. Figure 3.3-7, Technical Services Building, shows the location of the Cylinder Preparation Room within the Technical Services Building.

The primary functions performed in the Cylinder Preparation Room include cylinder identification, external visual inspection, internal inspection, pressure testing, and helium leak testing.

Each test stand has a connection to the TSB GEVS, the Compressed Air System, and to the Cylinder Preparation vacuum pump as indicated in Figure 3.5-44, Process Flow Diagram, Cylinder Preparation, Vacuum Pump and Trap Set System, Sheets 1 and 2.

3.5.19.1 System Description

The Cylinder Preparation Room has four testing and inspection positions and is capable of preparing all the empty cylinders for the entire facility including cylinders used in the Blending and Liquid Sampling Area. Based on a one shift per day operation, the four testing positions are capable of handling more than 350 cylinders per year. The functions performed in the Cylinder Preparation Room are described below.

- A. Cylinder Identification. Prior to any operation in the Cylinder Preparation Room, a series of administrative checks are performed to ensure that the proper cylinder will be tested.
- B. External Visual Inspection. The external inspection includes an inspection of the following: valve orientation, the number of engaged threads on the valve, valve protector inspection, cylinder plug, the cylinder welds, the cylinder shell, stiffening rings and skirts and a wipe test for possible surface contamination.
- C. Cylinder Pressure Check. Following the external visual inspection, the cylinder is connected to the test rig. The cylinder pressure is checked and if it is at atmospheric pressure, the cylinder is connected to the GEVS. If the cylinder is below atmospheric pressure, dry compressed air is used to pressurize the cylinder to 1050 mbar (15.2 psi). When 1050 mbar (15.2 psi) has been reached, a valve is opened to connect the cylinder to the GEVS.

- D. Internal Inspection. With the cylinder connected to the GEVS, the cylinder valve spindle is removed and an endoscope is passed through the opening to check the inside for contaminants or rust.
- E. Pressure Testing. After internal inspection, the cylinder is pressure tested to 7 barg (102 psig) with compressed air. Bubble testing of the valve packing and threaded connection is performed. After the valve packing and threaded connection are tested, the valve seat is leak tested. On satisfactory completion of the pressure test, the flexible pipe is reconnected and the cylinder is slowly evacuated to the GEVS.
- F. Helium Leak Test. With the GEVS and compressed air valves closed, the cylinder is evacuated to 0.01 mbar (0.004 in. of H₂O) using the cylinder preparation vacuum pump and trap set. The vacuum pump valve is closed, and a pressure rise test is completed. If satisfactory, the cylinder is evacuated to 0.01 mbar (0.004 in. of H₂O) and a helium leak test of the cylinder is then performed. Helium is injected near any joint on the outside of the cylinder that could have a leak. If the leak detector does not pick up any helium, the cylinder passes the leak test. After satisfactory completion of the leak test, the cylinder is disconnected from the test stand and removed from the room.

3.5.19.2 Major Components

The major components of the Cylinder Preparation System are as follows:

- A. Vacuum pump/chemical trap set (including a sliding vane vacuum pump, an activated carbon trap, and an aluminum oxide trap)
- B. Instrumentation and control system
- C. Cradles to support the cylinders at each test station
- D. Helium Leak Detection System
- E. Helium gas cylinders.

3.5.19.3 Interfaces

The Cylinder Preparation System interacts with the Gaseous Effluent Ventilation System serving the Technical Services Building, the Compressed Air System and the HVAC System.

3.5.19.4 Safety Considerations

Potential hazards of the Cylinder Preparation Room are high-pressure air, surface contamination on the cylinders, and cylinders containing UF₆.

Measures have been taken to make the facility as safe as possible. The potential hazard associated with high-pressure air is minimized by the system being designed, inspected, and tested to national standards. Surface contamination is prevented through the performance of a surface wipe test on each cylinder prior to inspection and testing. A gamma detection system at the preparation monitors the presence of ²³⁵U and an alarm will sound when threshold values are exceeded.

A weight trip on the activated carbon trap of the vacuum pump/chemical trap set will stop the vacuum pump to ensure the carbon trap does not become saturated with UF₆. A temperature trip on the activated carbon trap will close all station vacuum and vent valves.

3.5.20 References

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TABLES

Table 3.5-1 Codes And Standards

Page 1 of 3

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ACI 349-90, Code Requirements for Nuclear Safety Related Concrete Structures, 1990.
AIChE, Guidelines for Hazard Evaluation Procedures, 1992.
AISC Manual of Steel Construction – Allowable Stress Design, Ninth Edition, 1989
ANSI N14.1-2001, American National Standard for Nuclear Materials - Uranium Hexafluoride Packaging for Transport, 2001.
ANSI N15.5-1972, Statistical Terminology and Notation for Nuclear Materials Management, 1972.
ASCE 58, Structural Analysis and Design of Nuclear Plant Facilities, Manuals and Reports on Engineering Practice, 1980.
ASCE 7-98, Minimum Design Loads for Building and Other Structures, 1998.
ASME B31.3-2002, Process Piping, 2002.
ASME, Boiler and Pressure Vessel Code, Section VIII, Division 1, 1999.
ASME, NQA-1-1994, Quality Assurance Requirements for Nuclear Facility Applications, 1994.
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ASTM E 814, Fire Tests of Through-Penetration Fire Stops.
ERDA 76-21, Nuclear Air Cleaning Handbook, 1976.
IEEE 336, Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities, 1991.
IEEE C2-2002, National Electrical Safety Code, 2002.

Table 3.5-1 Codes And Standards

Page 2 of 3

ISO 668: 1995, Series 1 Freight Containers - Classification, Dimensions and Ratings, 1995.
NFPA 1, Fire Prevention Code, 1997.
NFPA 10, Portable Fire Extinguishers, 1994.
NFPA 101, Life Safety Code, 1997.
NFPA 12, Carbon Dioxide Systems, 1993.
NFPA 13, Installation of Sprinkler Systems, 1996.
NFPA 14, Standpipe, Private Hydrant and Hose Systems, 1996.
NFPA 15, Water Spray Fixed Systems for Fire Protection, 1996.
NFPA 20, Installation of Stationary Pumps, 1996.
NFPA 2001, Clean Agent Fire Extinguishing Systems, 1996.
NFPA 22, Water Tanks for Private Fire Protection, 1996.
NFPA 221, Fire Walls and Fire Barrier Walls, 1997.
NFPA 24, Private Fire Service Mains and Their Appurtenances, 1995.
NFPA 25, Water Based Fire Protection Systems, 1995.
NFPA 30, Flammable and Combustible Liquids Code, 2003.
NFPA 5000, Building Construction and Safety Code, 2003.
NFPA 54, National Fuel Gas Code, 1996.
NFPA 55, Compressed & Liquefied Gases in Cylinders, 1993.
NFPA 58, Liquefied Petroleum Gas Code, 2001.
NFPA 600 Industrial Fire Brigades, 1996.
NFPA 70, National Electric Code, 1996.
NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, 2001.
NFPA 72, National Fire Alarm Code, 1996.
NFPA 75, Electronic Computer/Data Processing Systems, 1995.
NFPA 780, Lightning Protection Systems, 1997.
NFPA 80, Fire Doors and Fire Windows, 1995.
NFPA 801, Fire Protection for Facilities Handling Radioactive Materials, 2003.
NFPA 80A, Exterior Fire Exposures, 1993.
NFPA 90A, Installation of Air Conditioning and Ventilating Systems, 1996.
NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems, 1996.

Table 3.5-1 Codes And Standards

Page 3 of 3

NFPA 91, Exhaust Systems for Air Conveying of Materials, 1995.	
NFPA, Fire Protection Handbook, 18 th Edition, Section 9, Chapter 30, Nuclear Facilities, 1997.	
NFPA 110, Standard for Emergency and Standby Power Systems, 2002.	
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PCI Design Handbook, Fifth Edition, 1999.	
Uniform Building Code (UBC), 1997.	
Uniform Mechanical Code (UMC), 1997.	
Uniform Plumbing Code (UPC), 1997.	

Table 3.5-2 Compressed Air System Design Parameters

Page 1 of 1

Nos. of Air Compressors and Air System Components Required	Two of each
Design Air Compressor Capacity, each	323 m ³ /hr (190 scfm) – Peak 60 m ³ /hr (35 scfm) - Normal
Design Compressor Outlet Air Pressure	13 barg (188.5 psig)
Compressed Air Receiver Tank, Operating Pressure	13 barg (188.5 psig)
Compressed Air Distribution System Supply Design Pressure	13 barg (188.5 psig)
Compressed Air Receiver Tank Surge Capacity	100 m ³ /hr (58.3 scfm) 6 cycles/valves/1 minute
Compressed Air Receiver Tank Storage Capacity	15 m ³ (530 ft ³) each of two tanks
Compressed Air Dew Point	-40°C at 12.06 barg (-40°F at 175 psig)
Maximum Oil Concentration in Compressed Air	0.5 mg/m ³
Maximum Particle Size in Compressed Air	1.0 micron

Table 3.5-3 Average Water Consumption
Page 1 of 1

	Average (L/s (gal/d))
Potable Water	0.2 L/s (5,250 gal/d)
Process Water (Cooling Tower Water)	2.5 L/s (56,338 gal/d)
Process Water (Other)	0.1 L/s (1,835 gal/d)
Total	2.8 L/s (63,423 gal/d)

Table 3.5-4 Deionized Water Supply and Distribution System Design Parameters

Page 1 of 1

Process Water Make Up Rate	0-2.5 L/s (0-40 gpm)
Deionized Water Distribution Supply Rate	2.6 L/s (40 gpm)
Deionized Water Storage Tank Capacity	1893 L (500 gal)
Deionized Water Distribution Temperature	21.1°C (70°F maximum)
Deionized Water Quality: Minimum Resistivity Maximum Total Silica	12 Megohm/cm at 25°C 1.0 mg/l as SiO ₂

Table 3.5-5 Hot Water System Design Parameters

Page 1 of 1

Design Hot Water Circulation Supply and Return Flow Rate	Maximum, 69.4 L/s (1100 gpm) Operating, 63.1 L/s (1000 gpm)
Design Hot Water Circulation Supply Temperature	82. 2°C (180°F)
Design Hot Water Circulation Minimum Return Temperature	71.1°C (160°F)
Hot Water Expansion Tank Capacity	3785 L, (1000 gal), each for two tanks
Hot Water Design Heating Load	2943.3 kW (10.045 Million BTUH)
Hot Water Boilers	2 boilers for 100% redundancy
Boiler Fuel Source	Natural Gas fired

Table 3.5-6 HVAC Cooling Water System Design Parameters
Page 1 of 1

HVAC Cooling Water System	
Supply Temperature	5.6°C (42°F)
Return Temperature	11.1°C (52°F)

User System Design Duties	
HVAC Systems	12,207.5 kW (11580 Btu/s)

Table 3.5-7 Centrifuge Cooling Water Distribution System Design Parameters

Page 1 of 1

Centrifuge Cooling Tower Water Supply Loop Circulation Rate	397 L/s (6300 gpm)
Centrifuge Cooling Tower Water Supply Loop Temperature	32.3°C (90.1°F)
Centrifuge Cooling Tower Water Return Loop Temperature	28°C (82.5°F)
Centrifuge Cooling Water Distribution Loop Circulation Rate	133 L/s (2109 gpm), per 2 Cascade Halls 66.5 L/s (1054.5 gpm), per Cascade Hall
Centrifuge Cooling Water Distribution Loop Supply Temperature	28.0°C (82.5°F maximum)
Centrifuge Cooling Water Distribution Loop Return Temperature	32.3°C (90.1°F maximum)
Cascade Cooling Water Temperature Control Range	30.5 to 31.9°C (86.9 to 89.4°F)

Table 3.5-8 Nitrogen System Design Parameters

Page 1 of 1

Liquid Nitrogen Storage Capacity	4 Storage Tanks, each at 9464 L, (2500 gal), 30 day supply each.
Liquid Nitrogen Supply Rate	0.315 L/s (5 gpm)
Liquid Nitrogen Supply Pressure	3.1 barg (45 psig)
Gaseous Nitrogen Supply Rate	170 m ³ /hr (100 scfm)
Gaseous Nitrogen Supply Pressure	2.4 barg (35 psig)
Nitrogen Maximum Particle Size	1.0 micron

Table 3.5-9 Liquid Effluent Collection and Treatment System, Collection Tanks

Page 1 of 1

TANK	QUANTITY	SIZE L (gal)	CONTENTS
Spent Citric Acid Collection	1	1,325 (350)	Spent citric acid
Degreaser Water Collection	1	1,325 (350)	Used degreaser water
Miscellaneous Effluent Collection	1	1,325 (350)	Lab wastes, condensate, floor washings
Hand Wash/Shower Monitor	3	15,142 (4,000)	Water from the active areas hand washes and showers
Laundry Effluent Monitor	3	3,785 (1,000)	Washing machine water

Table 3.5-10 Liquid Effluent Collection and Treatment System, Monitoring and Treatment Tanks

Page 1 of 1

TANK	QUANTITY	SIZE L (gal)	PURPOSE
Precipitation Treatment	1	1,325 (350)	Receives and treats effluents from the Citric Acid Collection Tank, the Degreaser Water Collection Tank, and, the Miscellaneous Effluent Hold Tank.
Contaminated Effluent Hold	1	1,325 (350)	Receives effluent from the Precipitation Treatment Tank. Provides capacity for the effluent batches processed in the Precipitation Treatment Tank.
Evaporator/Dryer Feed	1	1,325 (350)	Receives effluent from the Contaminated Effluent Hold Tank. Provides holding capacity for the effluent batches to be processed in the Evaporator/Dryer. pH is adjusted (lowered) in this tank prior to evaporation / drying.
Distillate	1	1,325 (350)	Receives effluent from the Evaporator/Dryer.
Treated Effluent Monitor	2	1,325 (350)	Receives effluent from Evaporator/Dryer Distillate Tank. Effluent is sampled and tested in these tanks prior to release to the TEEB or treatment in the polishing demineralizers.

Table 3.5-11 Items Processed in the Decontamination Workshop

Page 1 of 1

Equipment	Typical Annual Quantities
Pump & Component Sets	300
Valves	60 valves
Sample Bottles	4500
Manifolds	118
Flexible Hoses	200
Chemical Trap Bodies	871
Transducers	148
Cylinder Seals	4 Baskets
Sludge Residue Buckets / Lids	44
Scrap Metal	60 Baskets
Scrap Plastic	11 Baskets
Scrap Pipe Work, Fittings, Connections	85 Baskets
Miscellaneous	10 Baskets

**Table 3.5-12 Volume, Exhaust Flow and Area Leakage Inputs to the
NEF Consequence Calculation**

(Note A)

Page 1 of 1

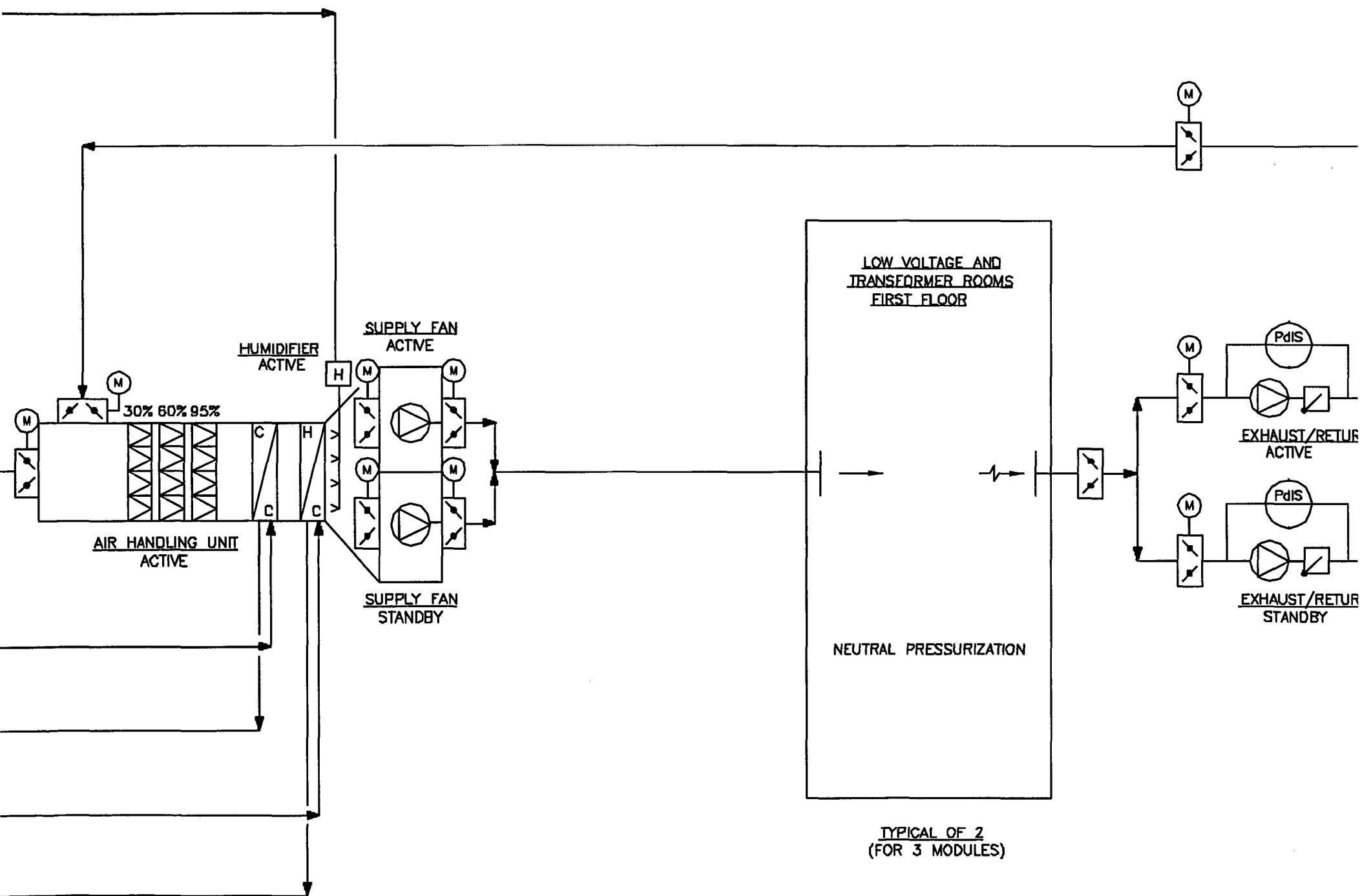
Area	Area Volume (m ³)	HVAC Exhaust Flow (cfm) (Note B)	Area Leakage Post HVAC Trip (cfm) (Note C)
UF ₆ Handling Area 1&2	23,747	90,564	4,850
UF ₆ Handling Area 3&4 and 5&6	47,494	180,239 (total)	4,500
Cascade Halls 1&2	111,535	160,821	2,400
Cascade Halls 3&4 and 5&6	223,070	321,642	2,150

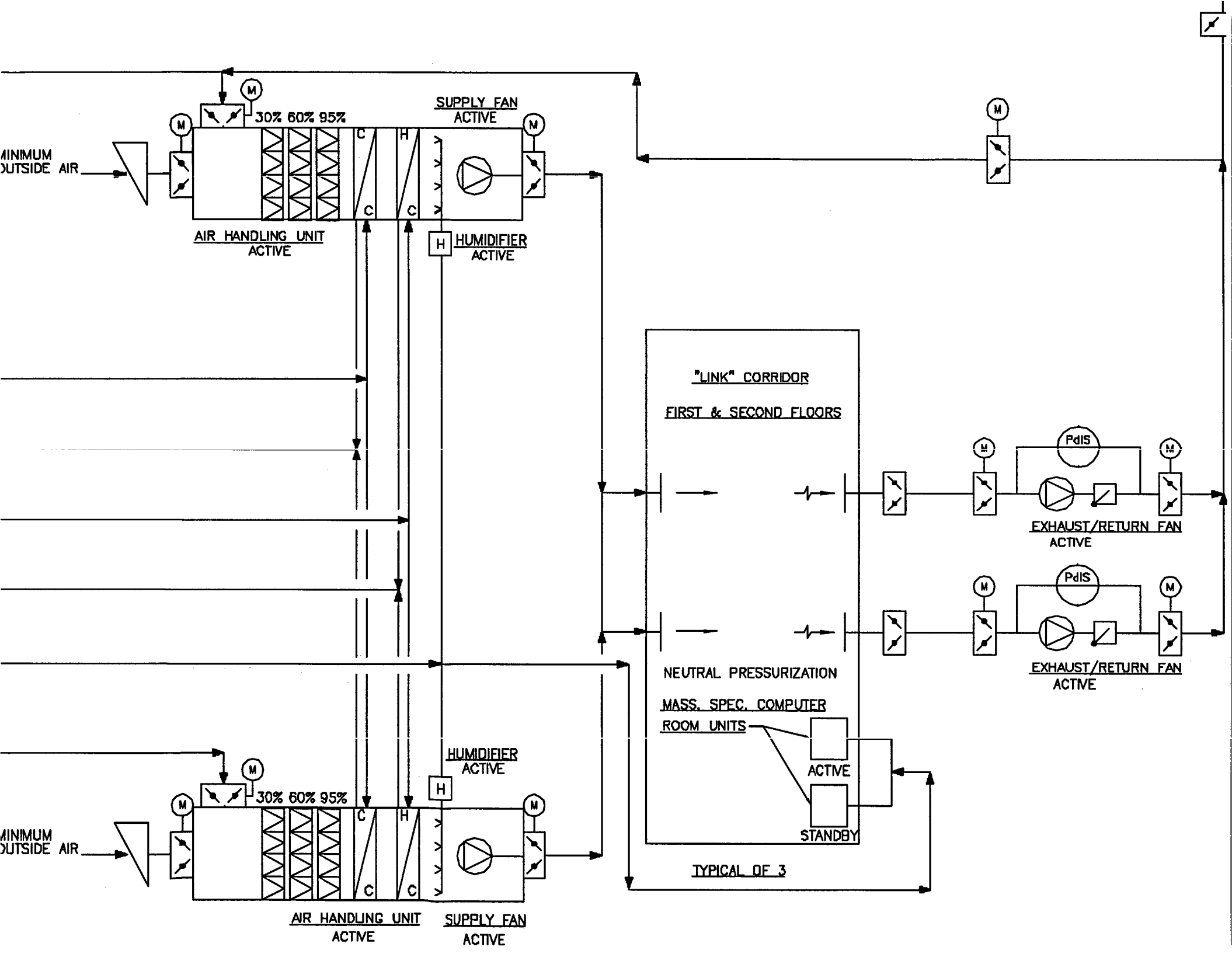
Notes:

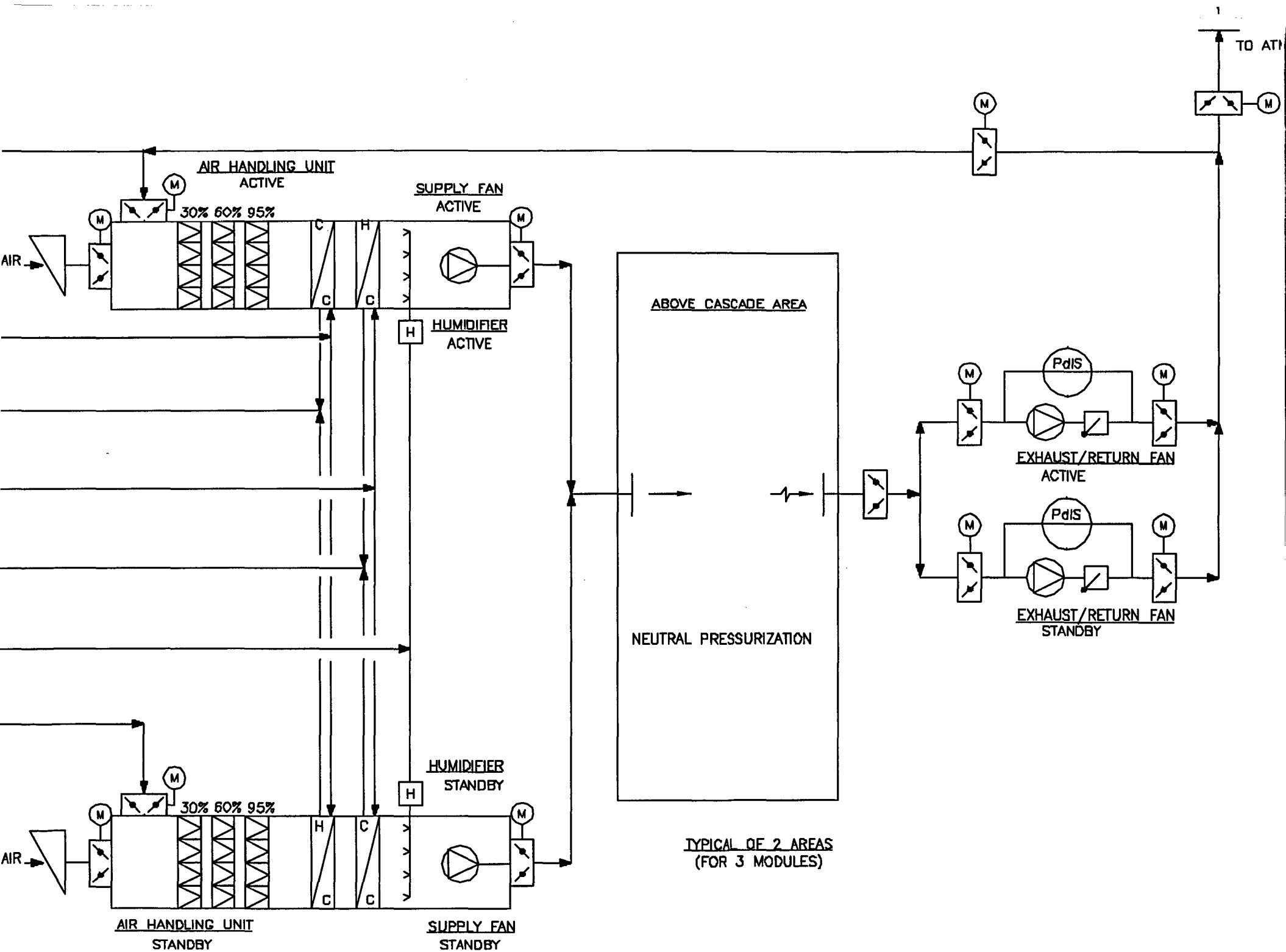
- A. For the building area internal air conditions, the consequence calculation used standard temperatures and pressures (STP).
- B. HVAC flow to outside of building, in the Economizer Mode (i.e., full flow out area / building). Room volumetric flow equal to the economizer mode was only for public exposure calculations. For worker exposures, no volumetric flow was credited.
- C. Maximum leakage out of the building, with HVAC not operating, is such that the consequence of an accident of concern remains a consequence category "low" per 10 CFR 70.61 criteria.

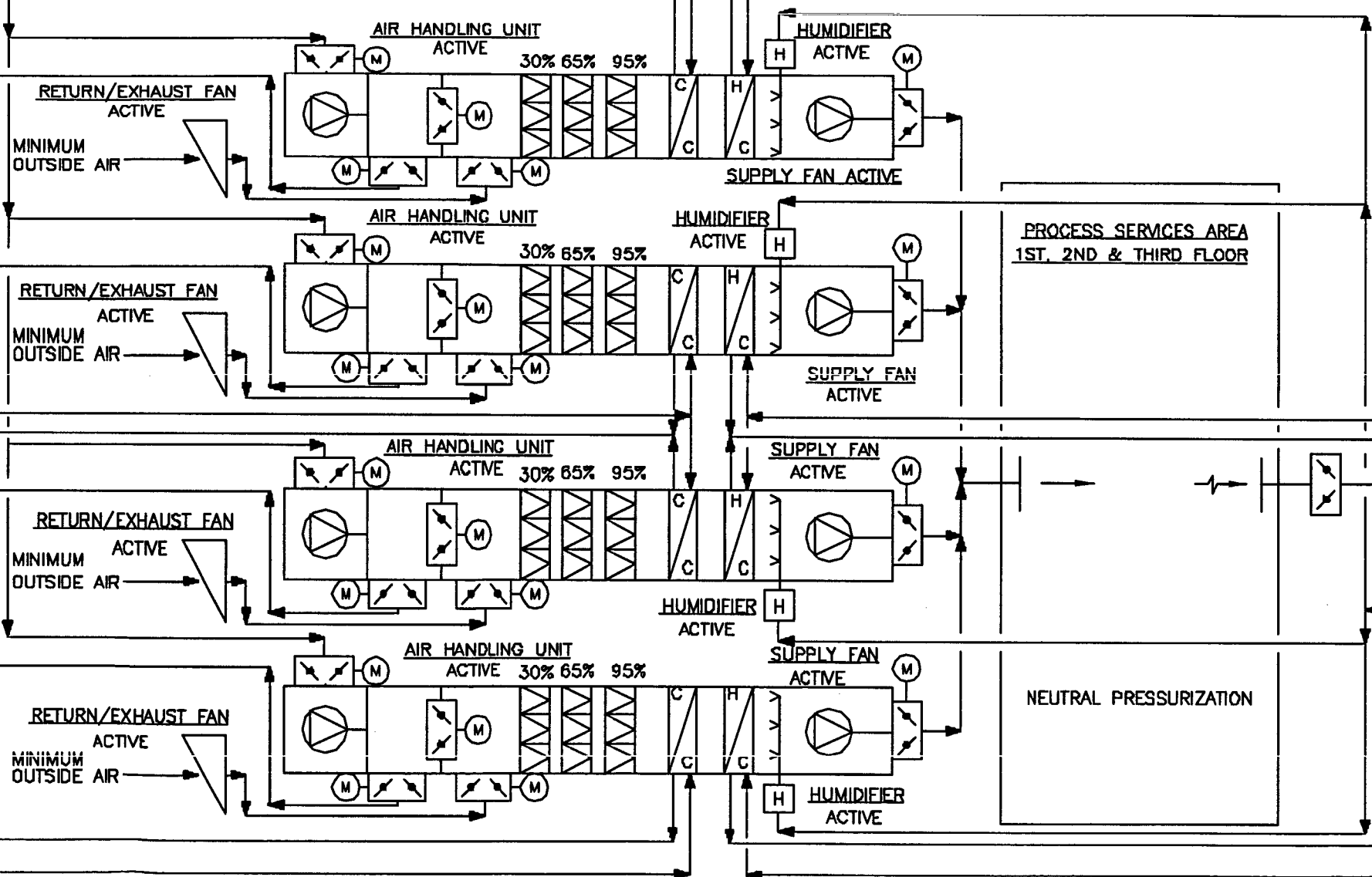
FIGURES

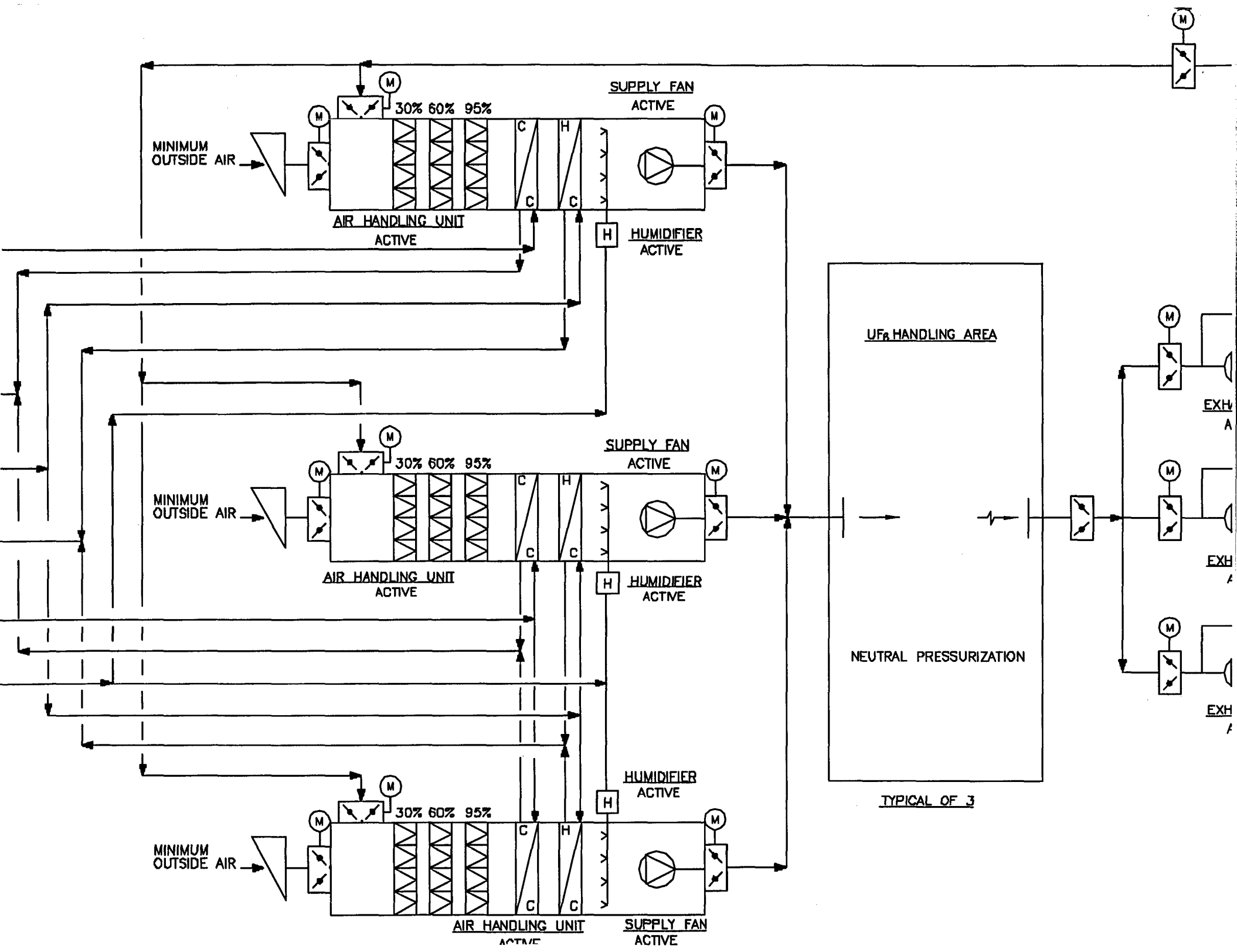
TO ATMO

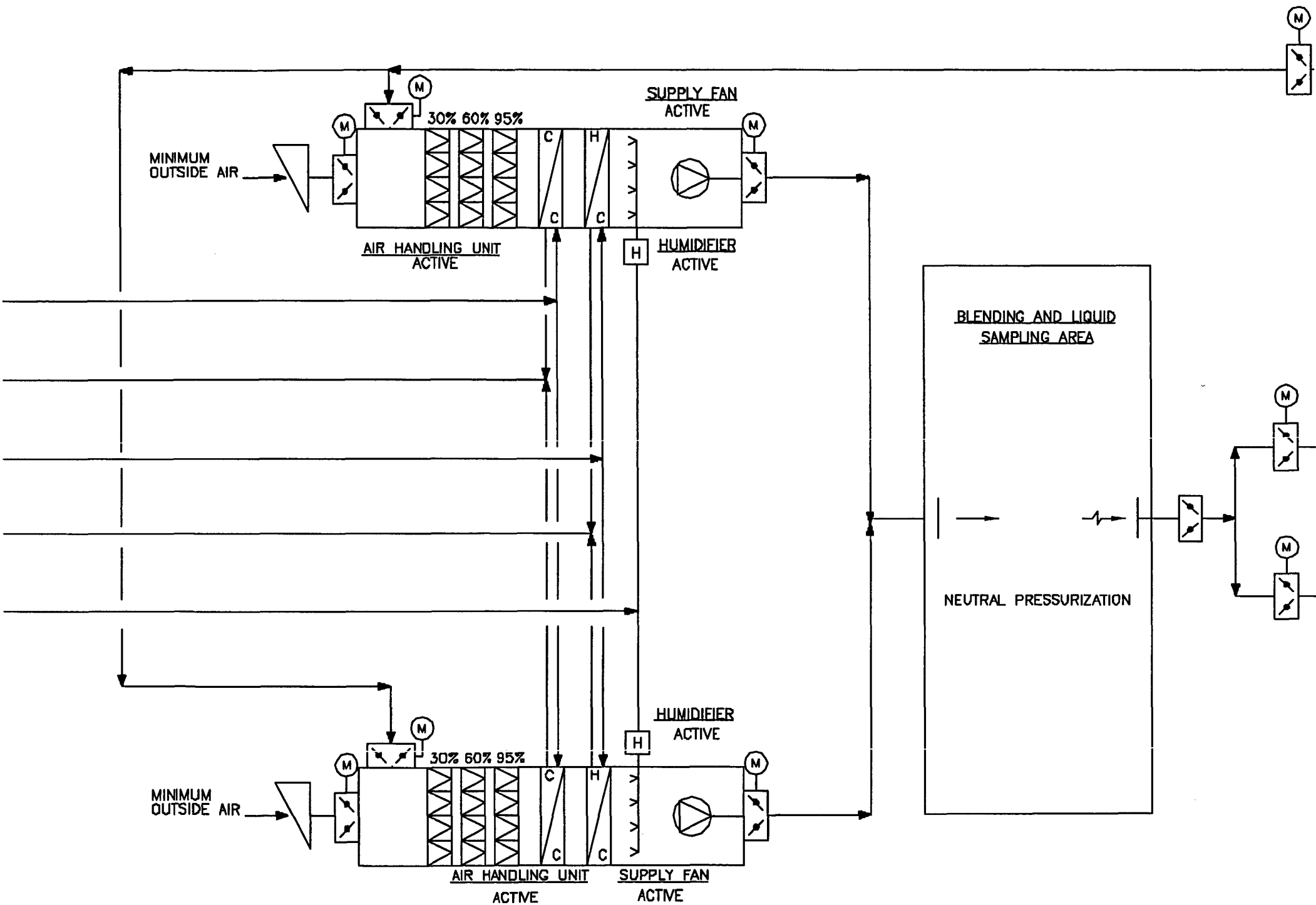


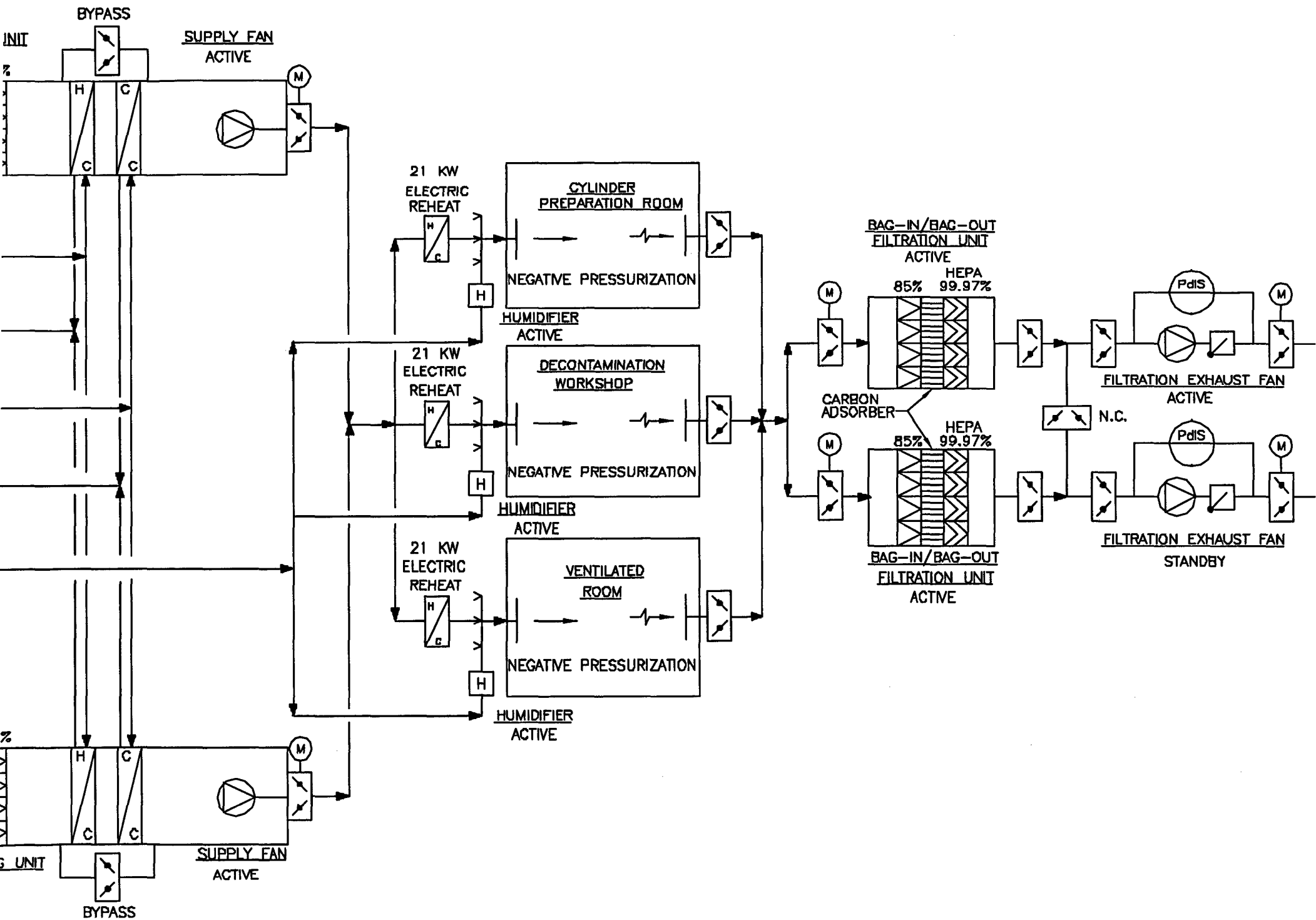


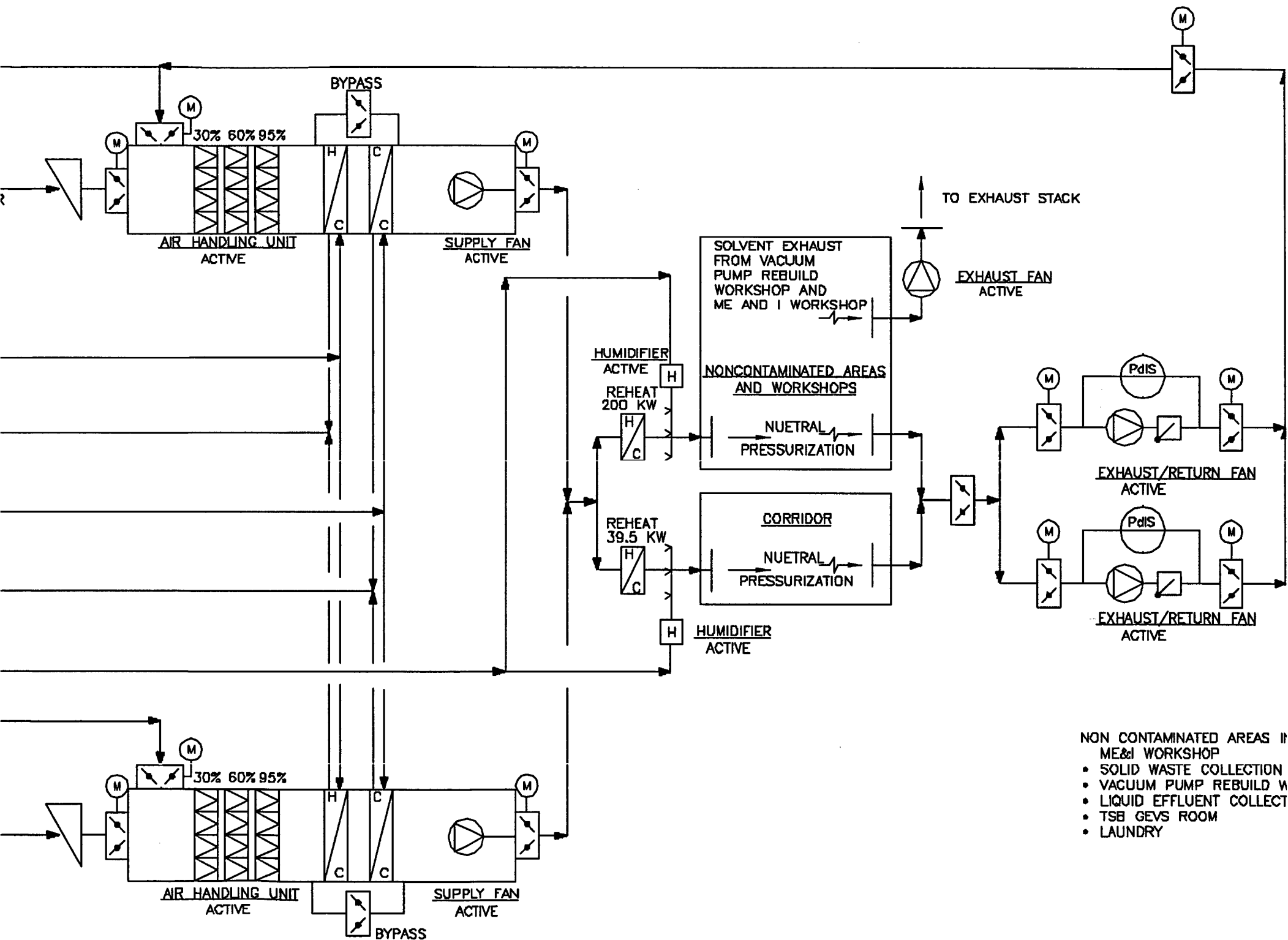


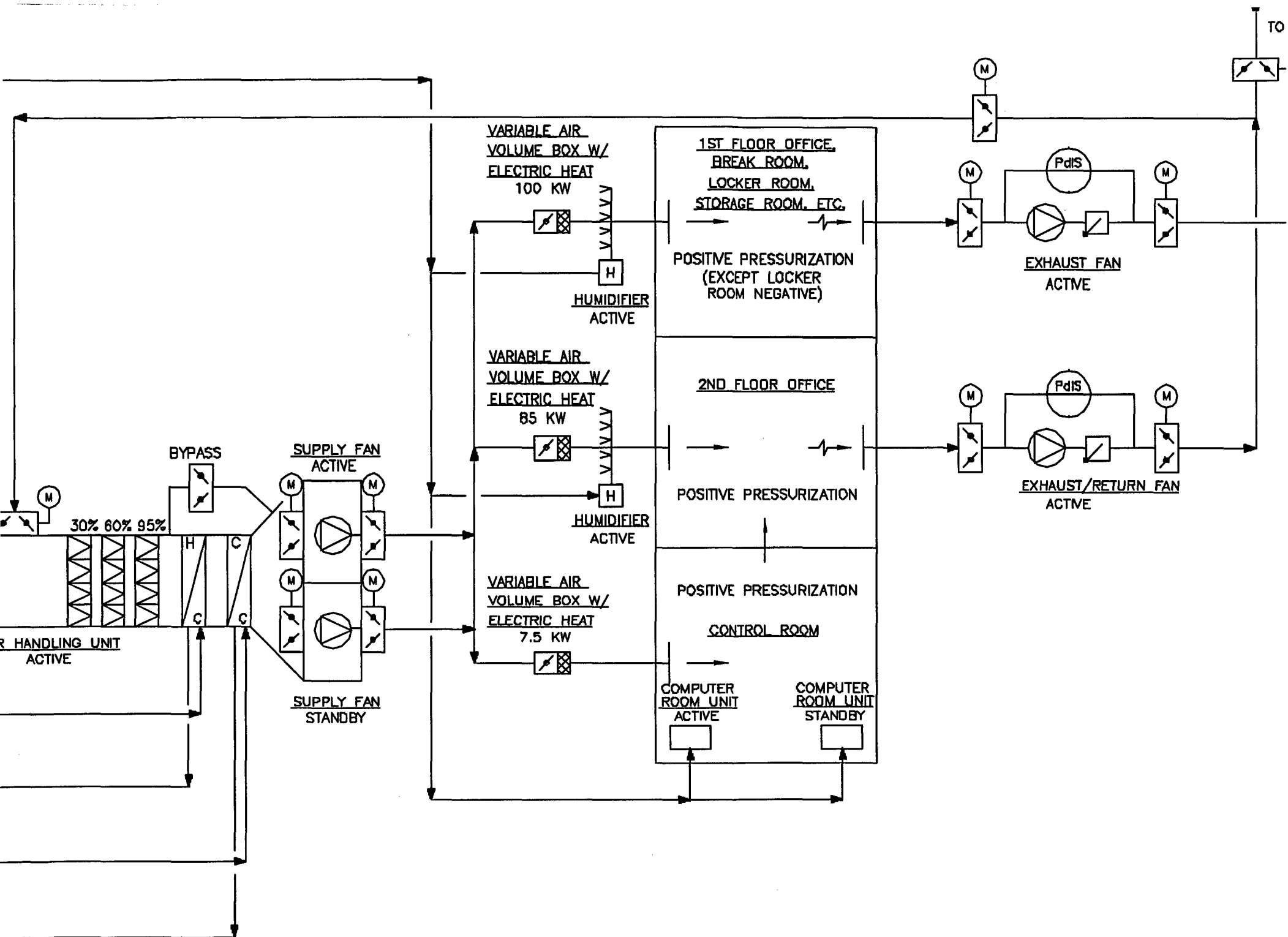


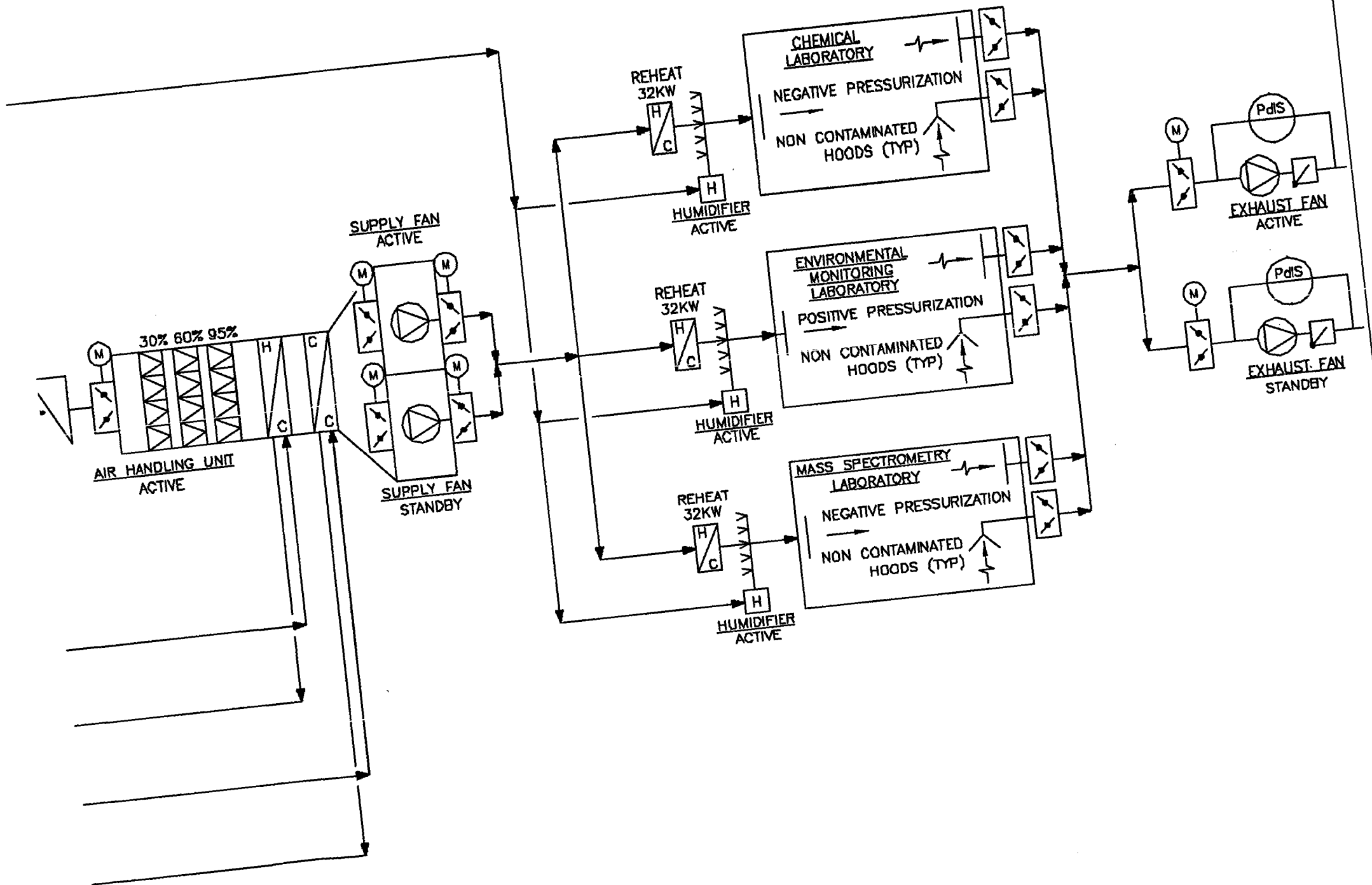






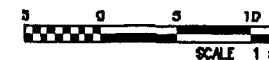
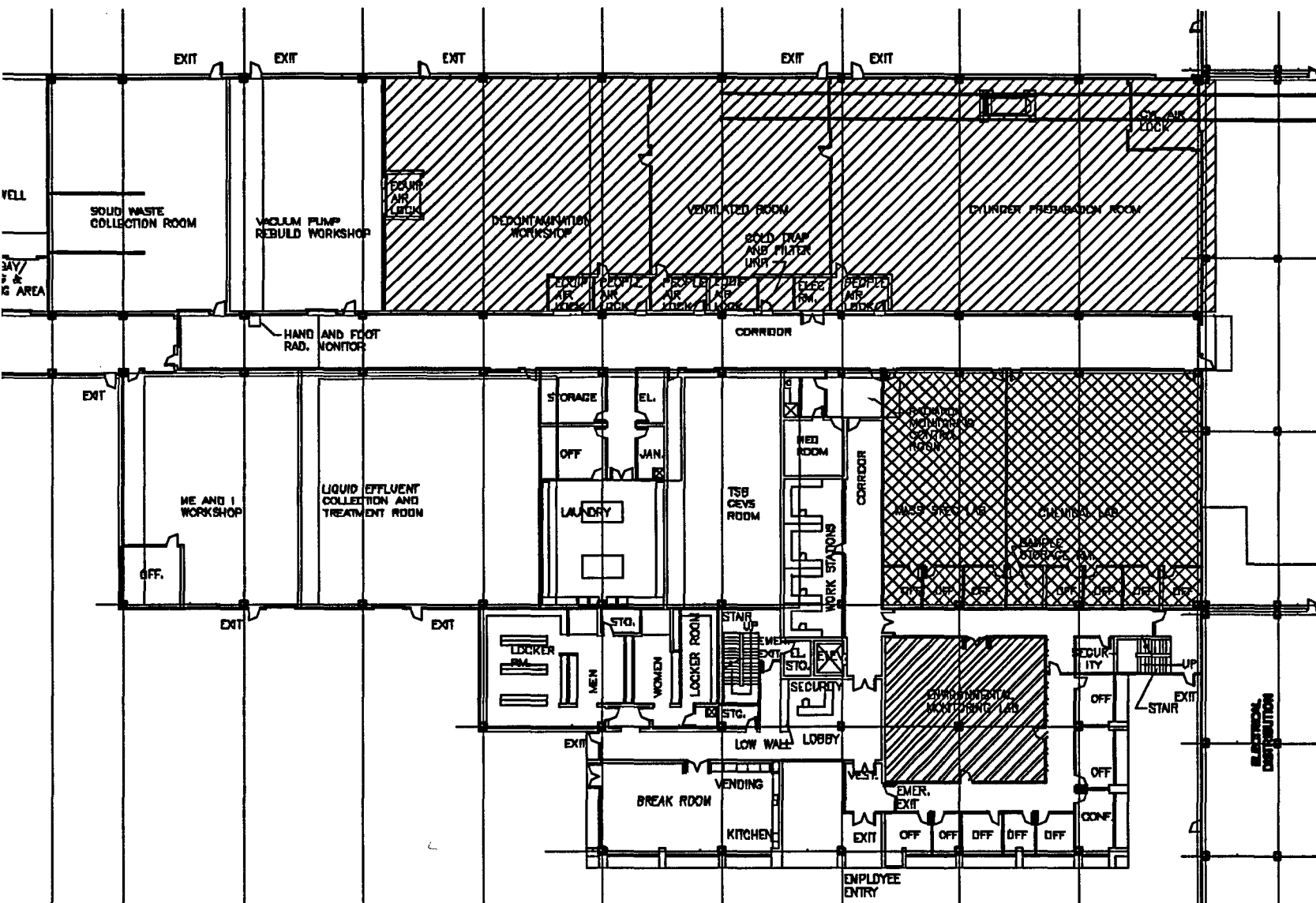


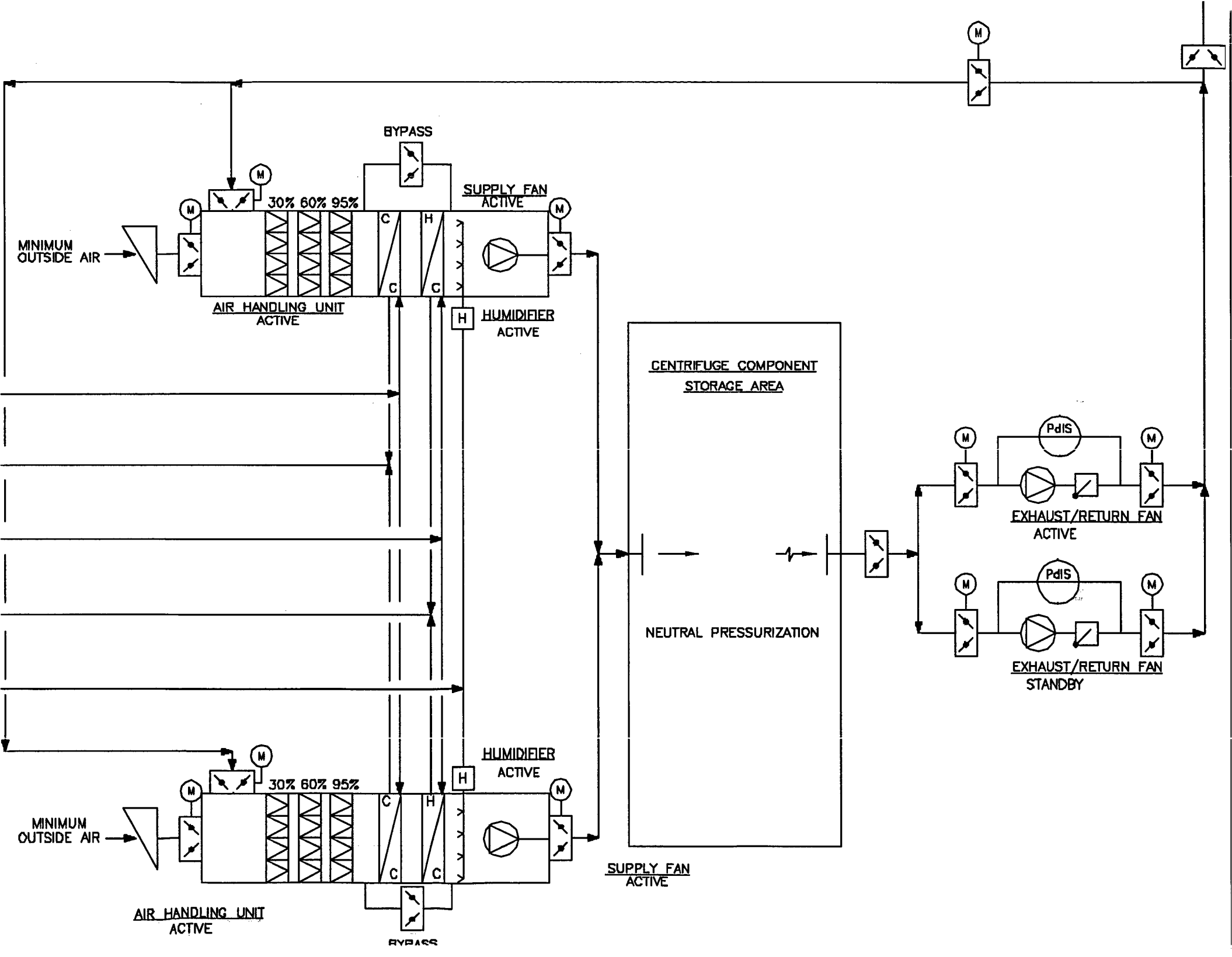


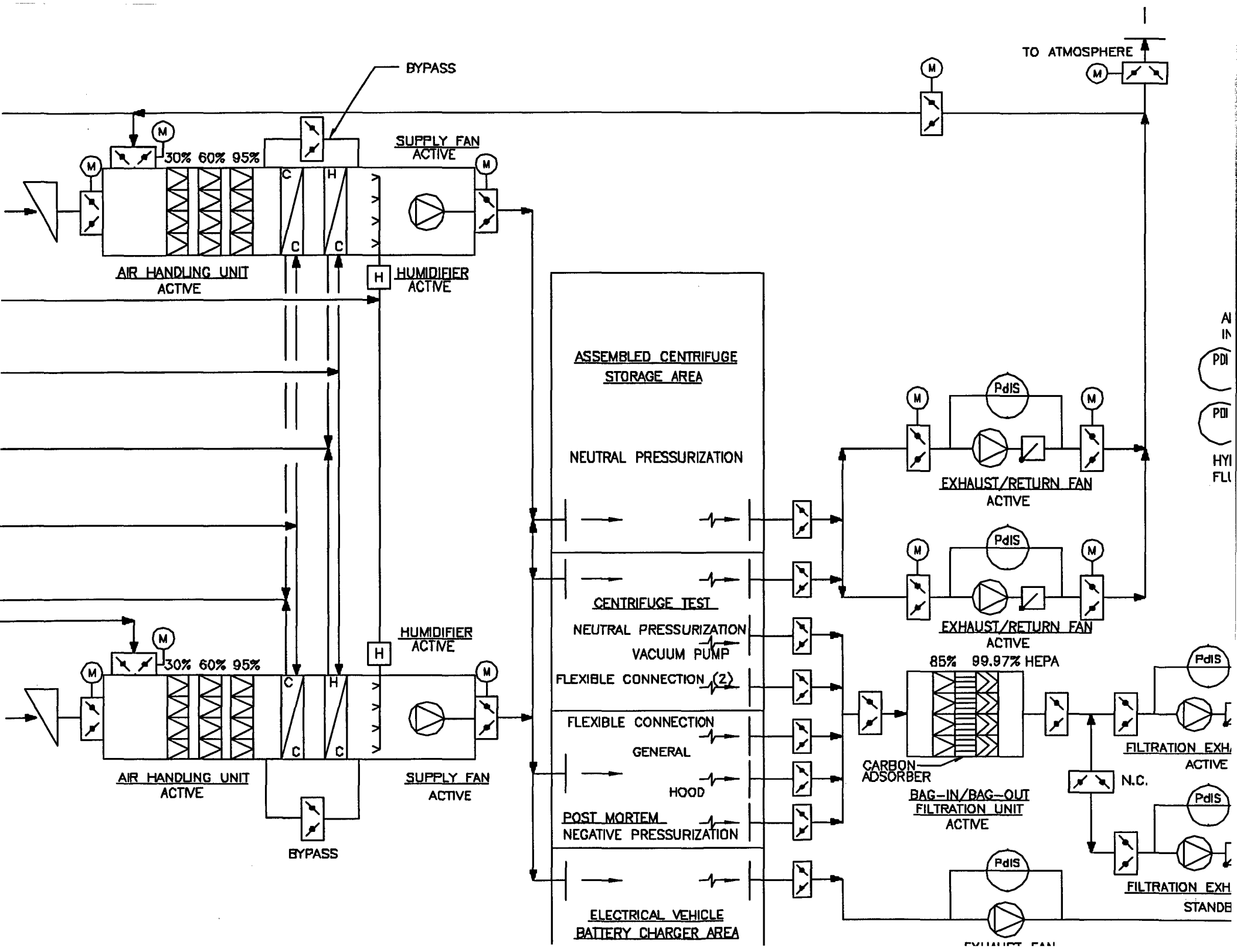


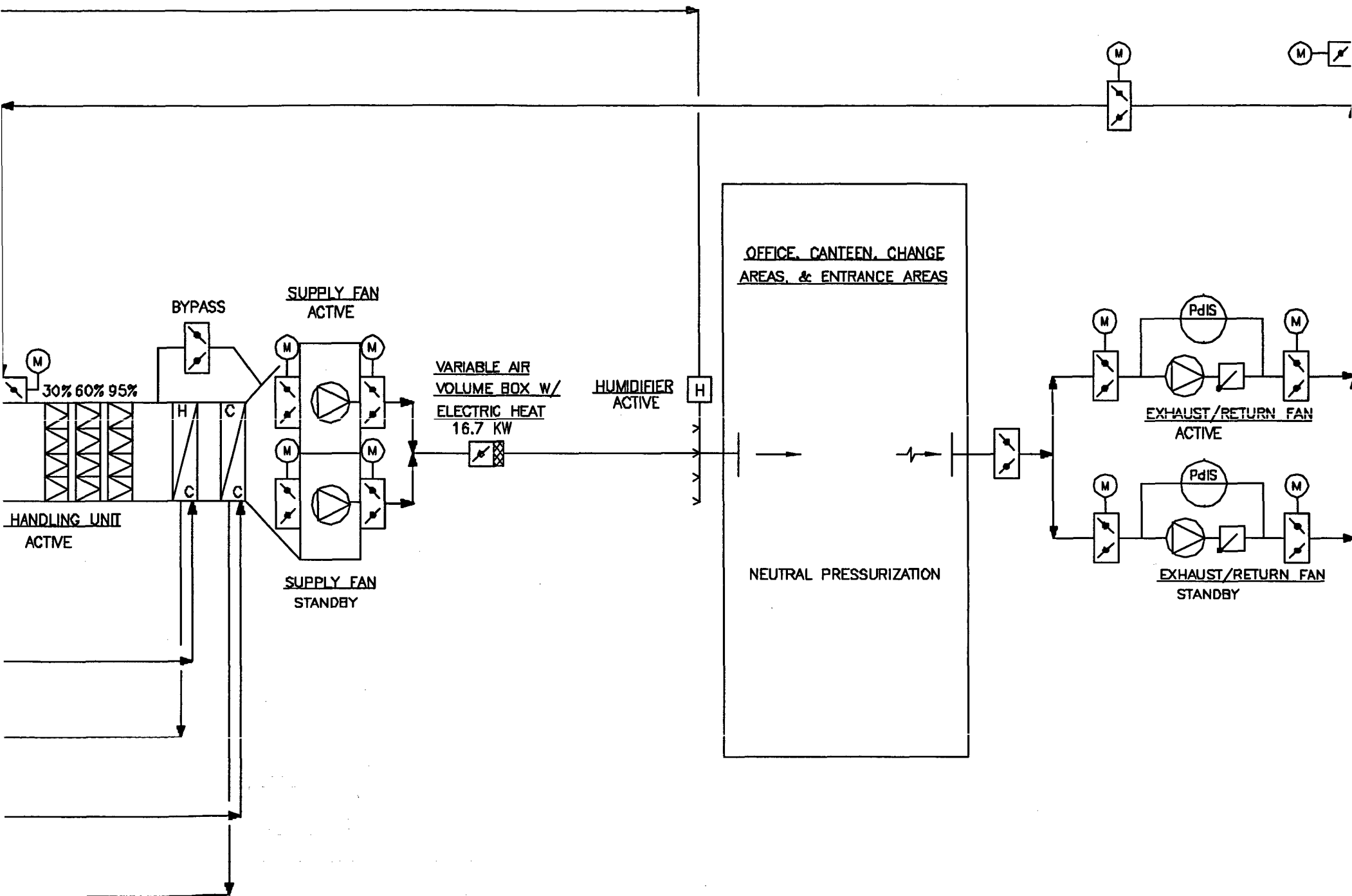
SSURE WITH HEPA FILTRATION

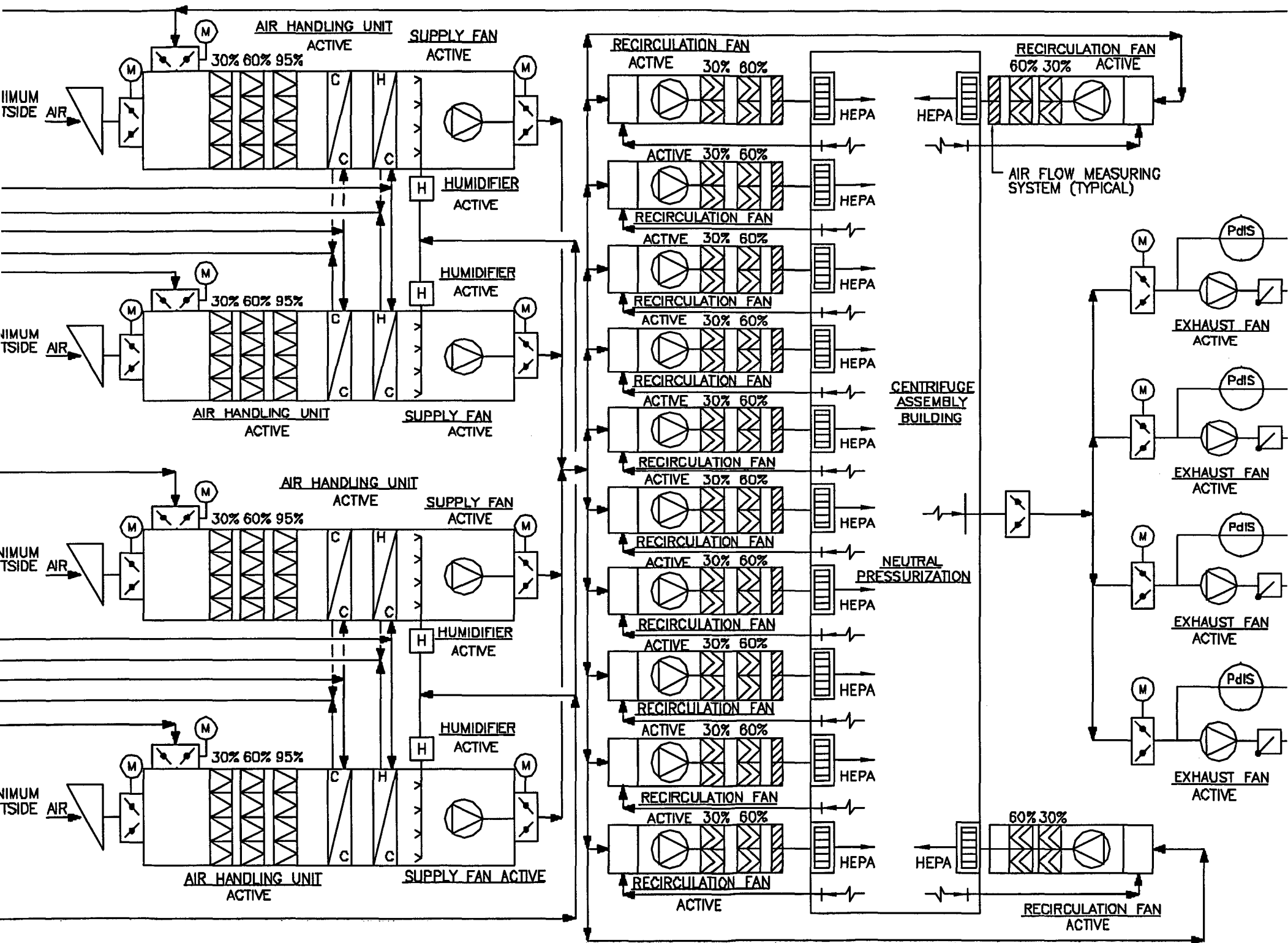
SSURE WITHOUT HEPA FILTRATION

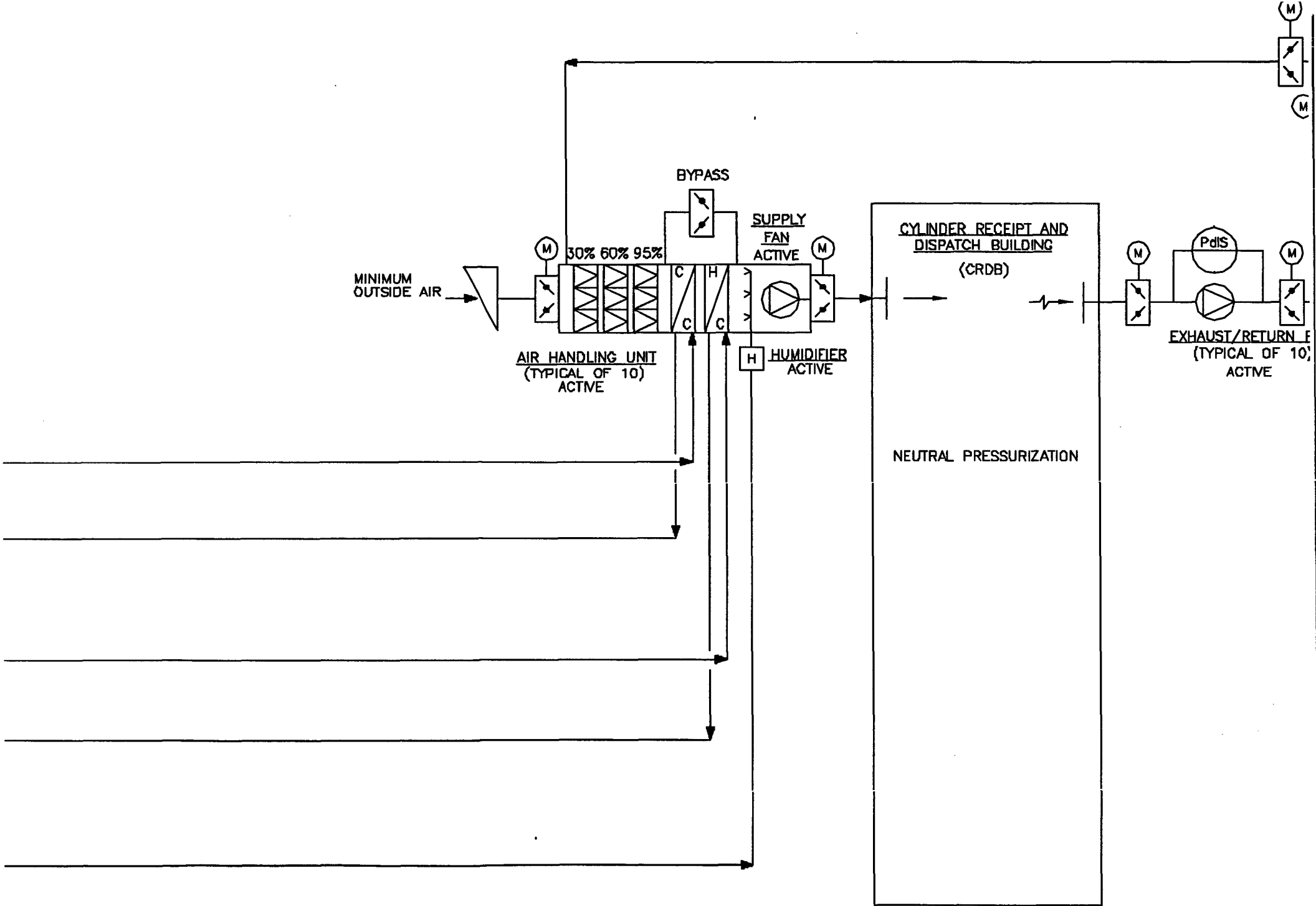


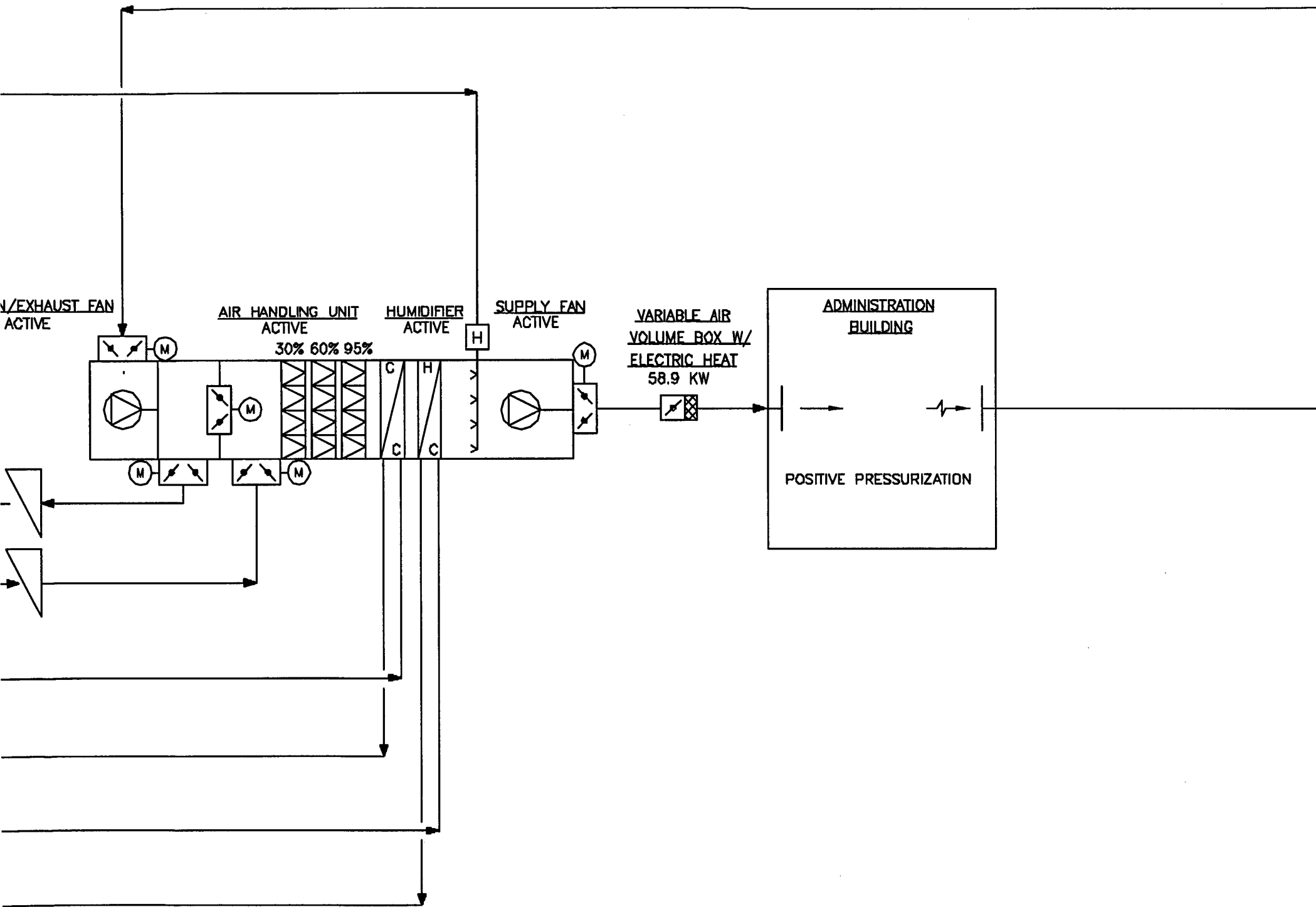


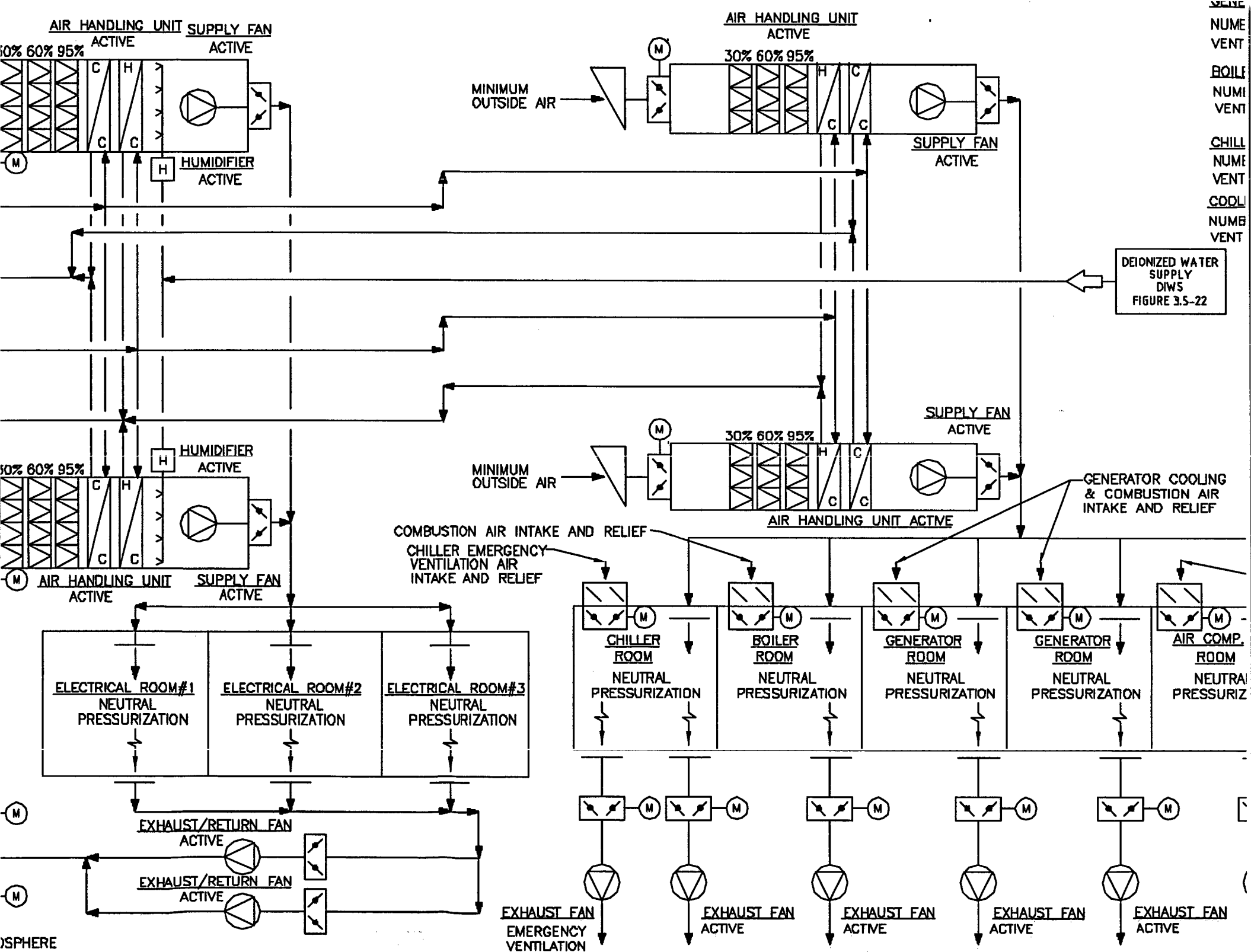


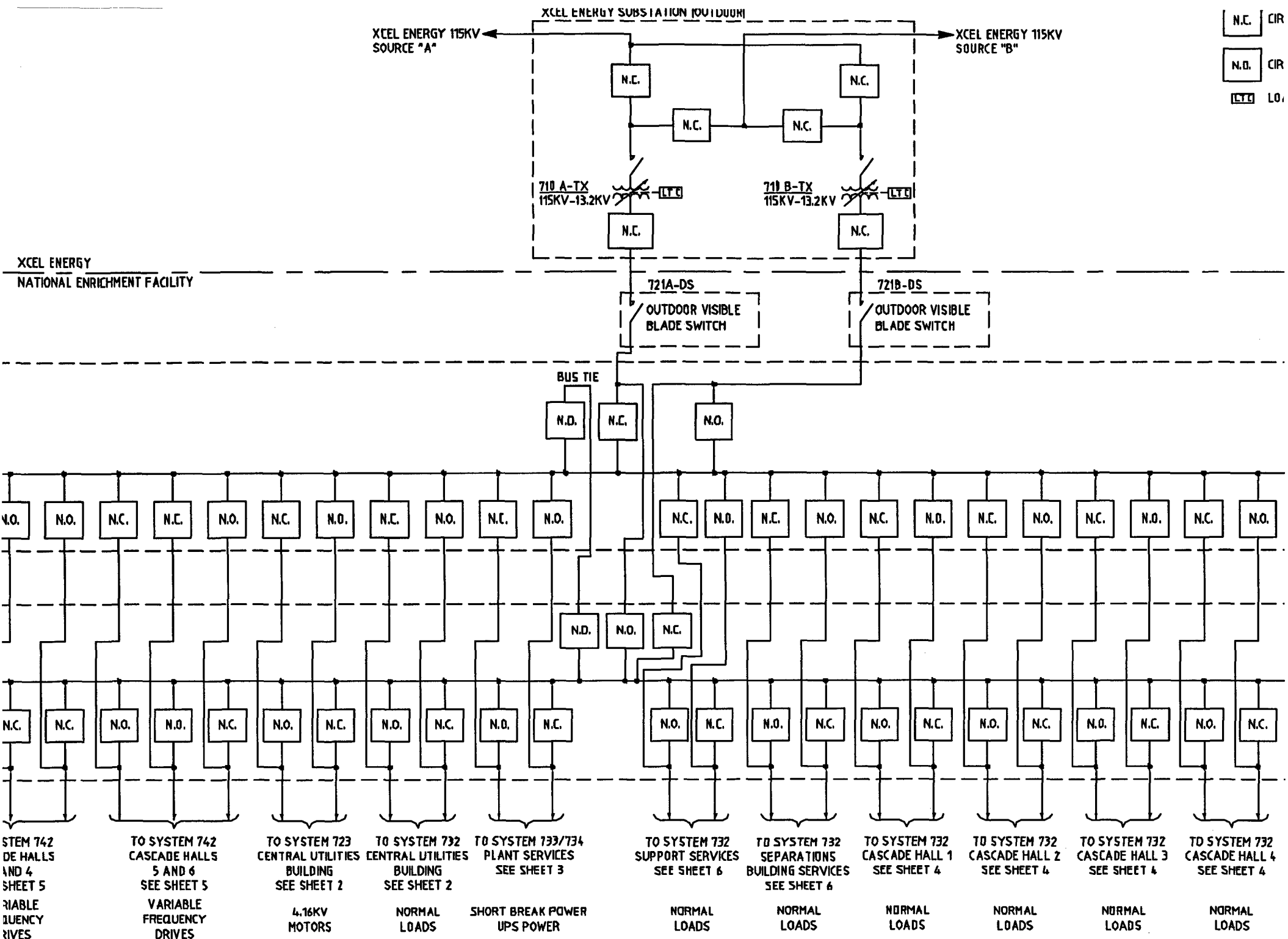


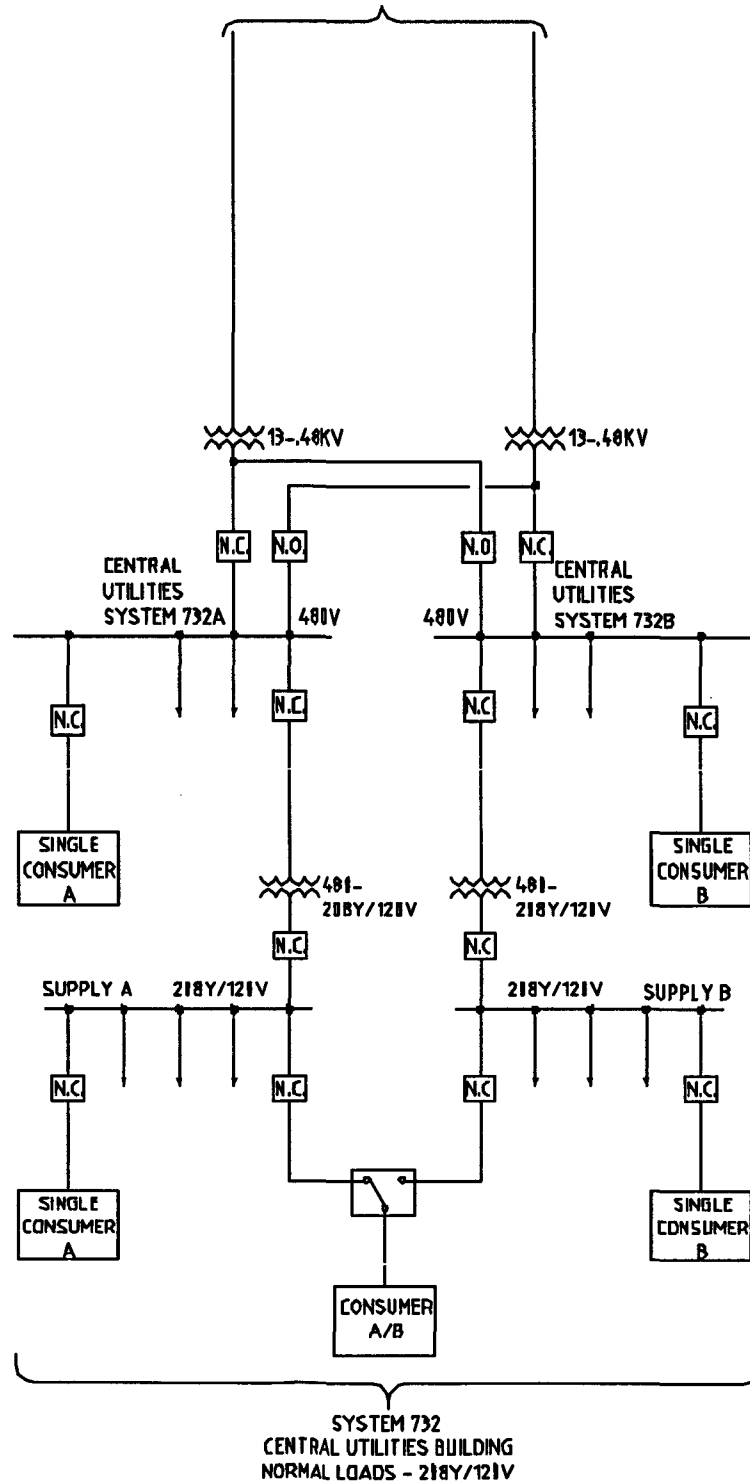
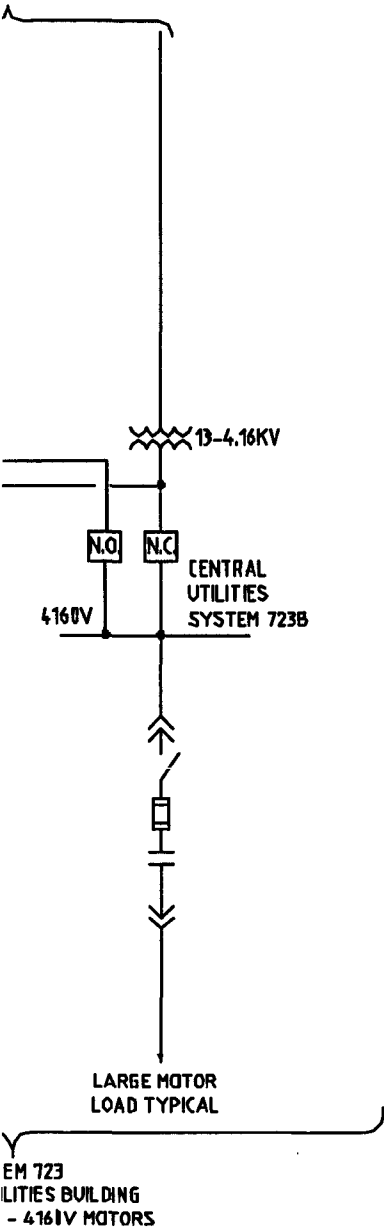






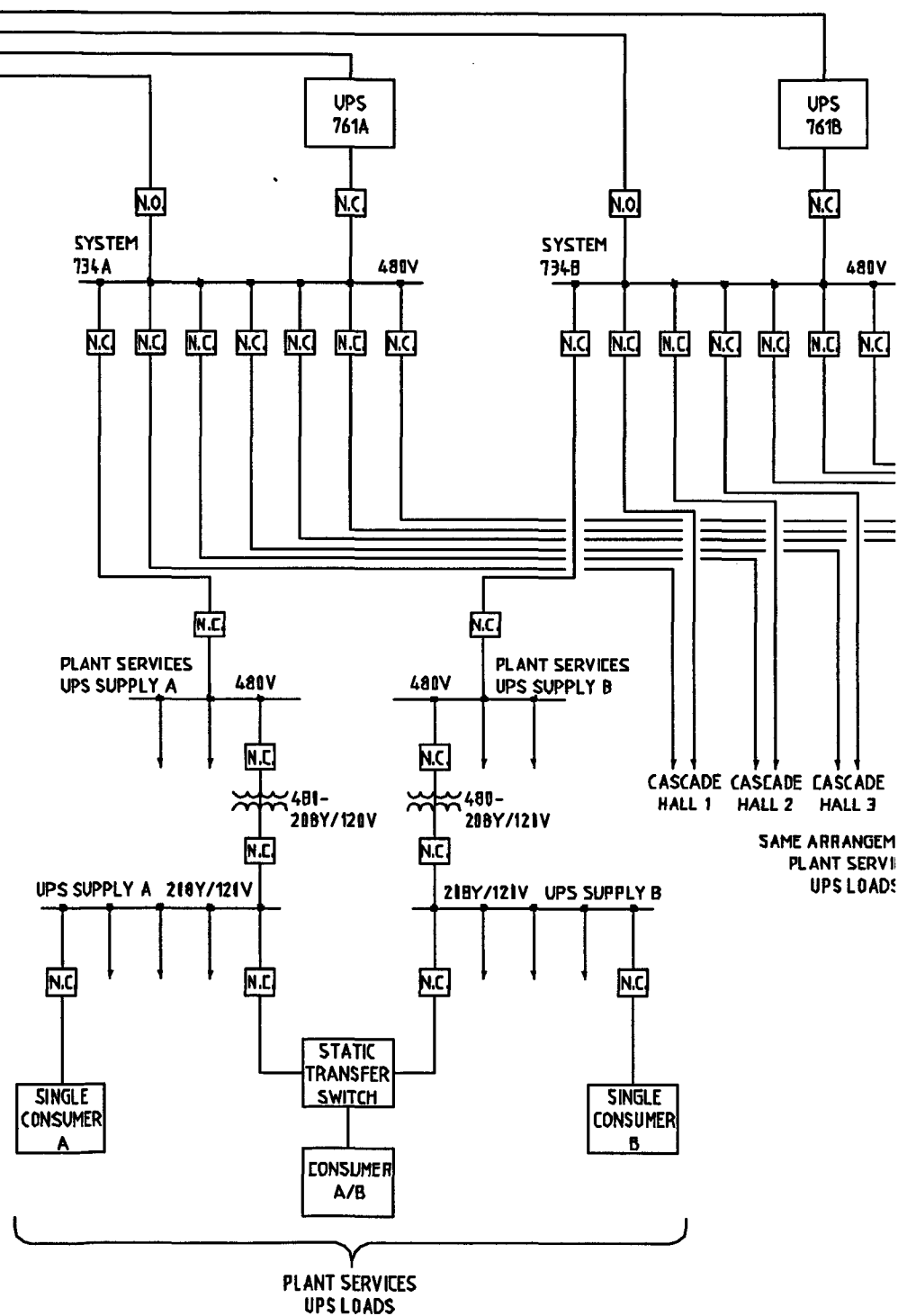
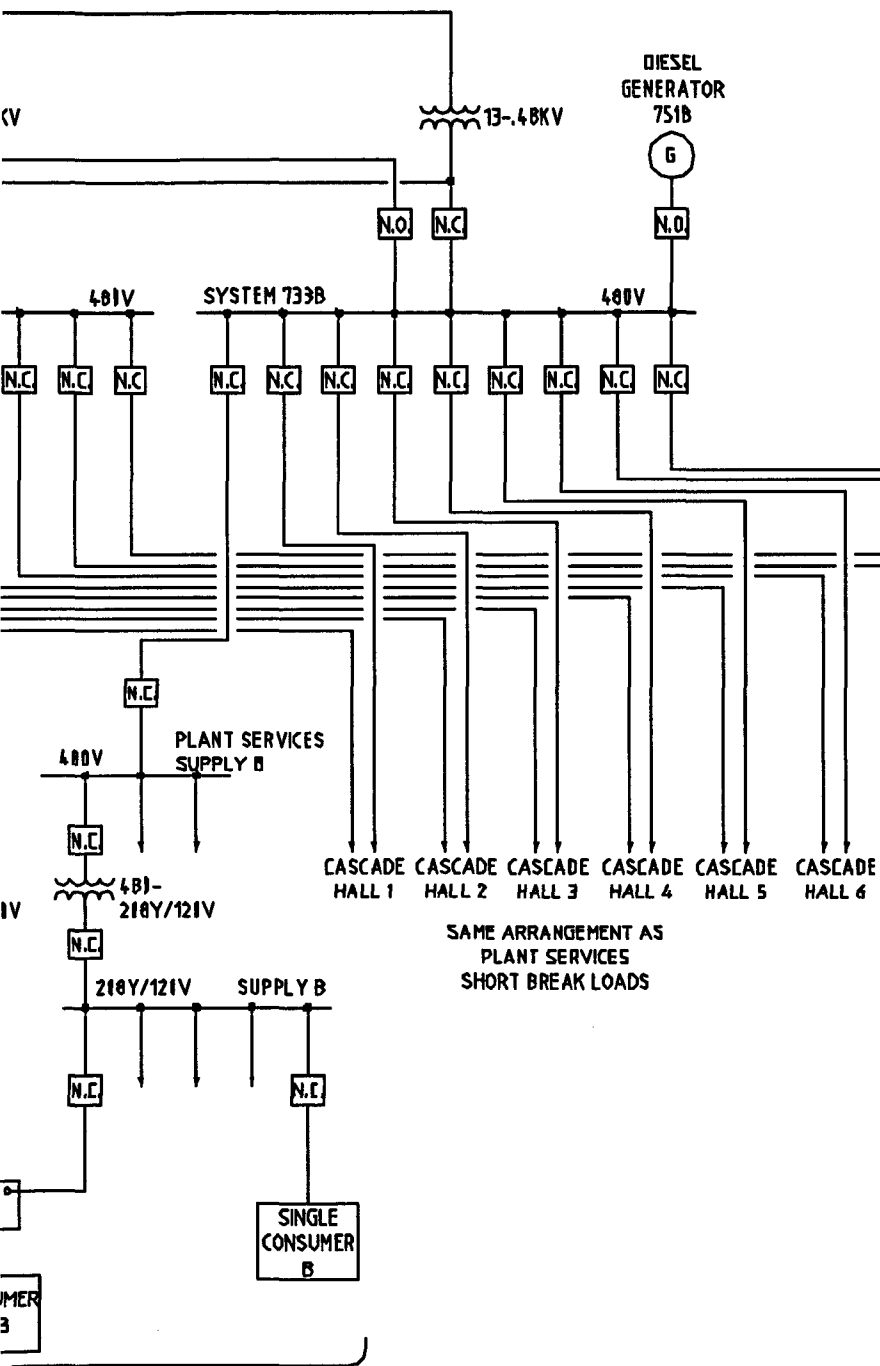


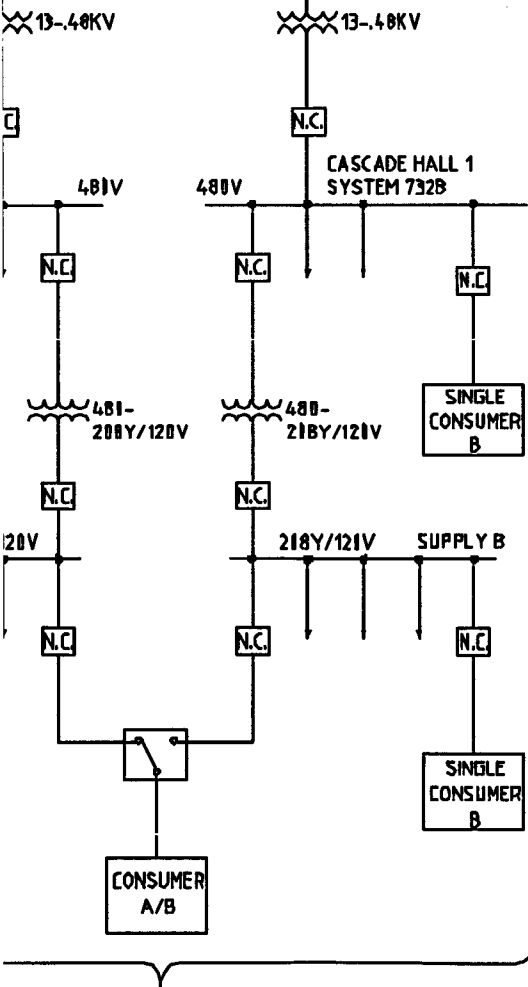
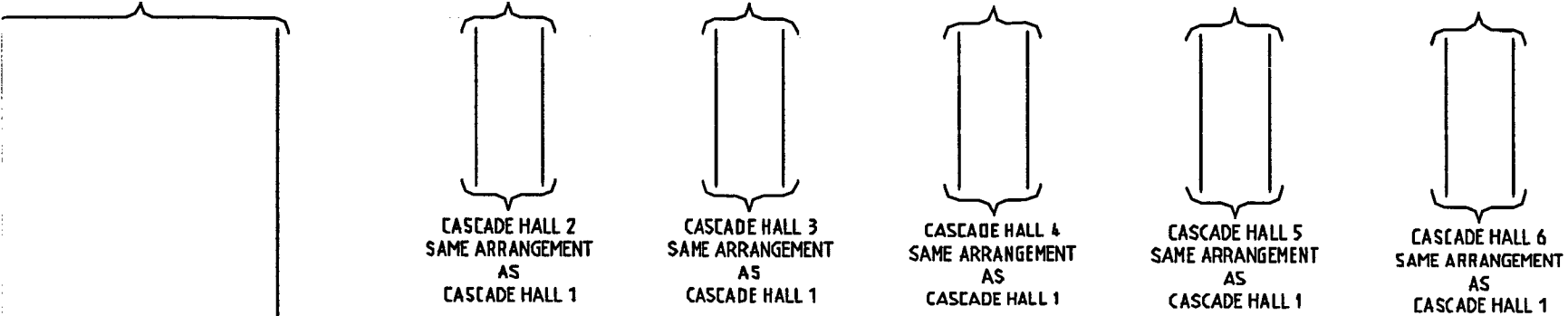




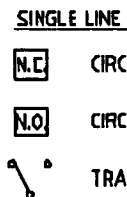
SINGLE LINE

N.C	CIRC
N.O	CIRC
TRA	





SYSTEM 732 CASCADE HALL 1
NORMAL LOADS
TYPICAL ALSO FOR
CASCADE HALLS 2,3,4,5 & 6

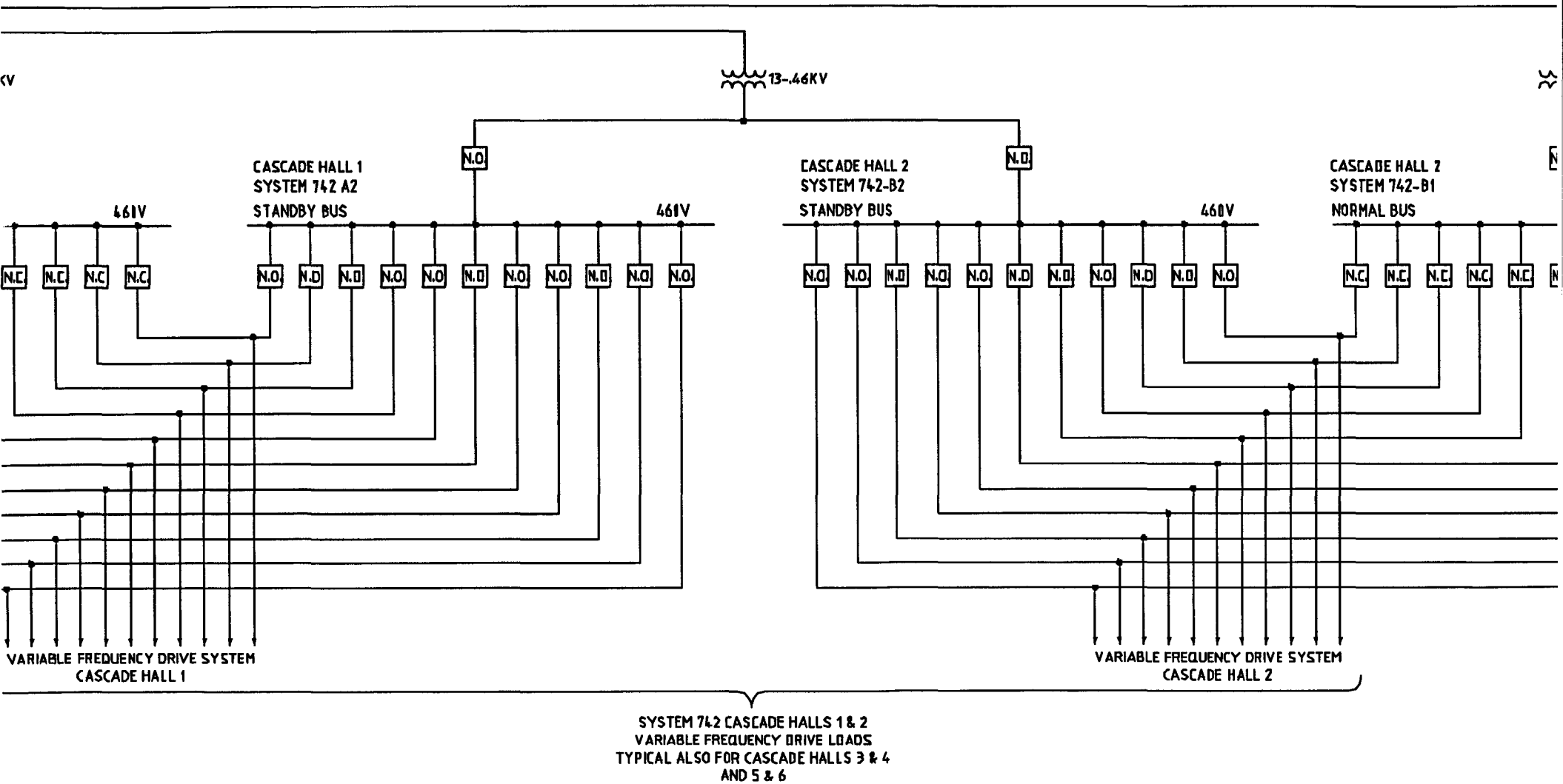


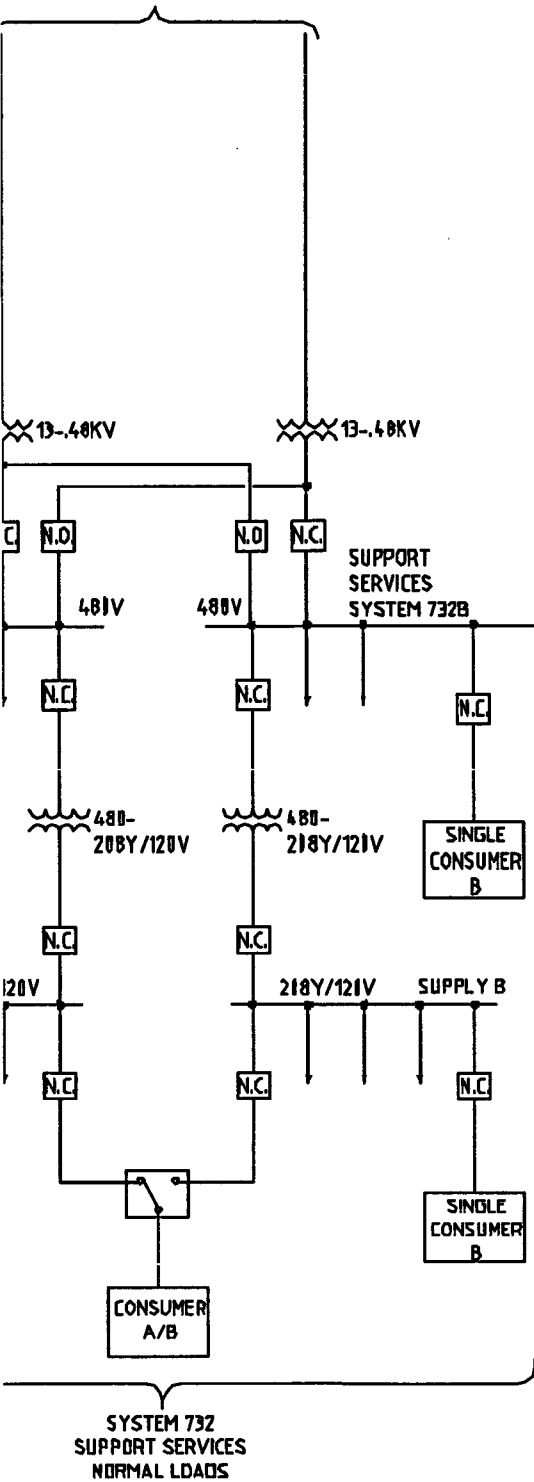
☐ N.C. CIRC

☐ N.O. CIRC

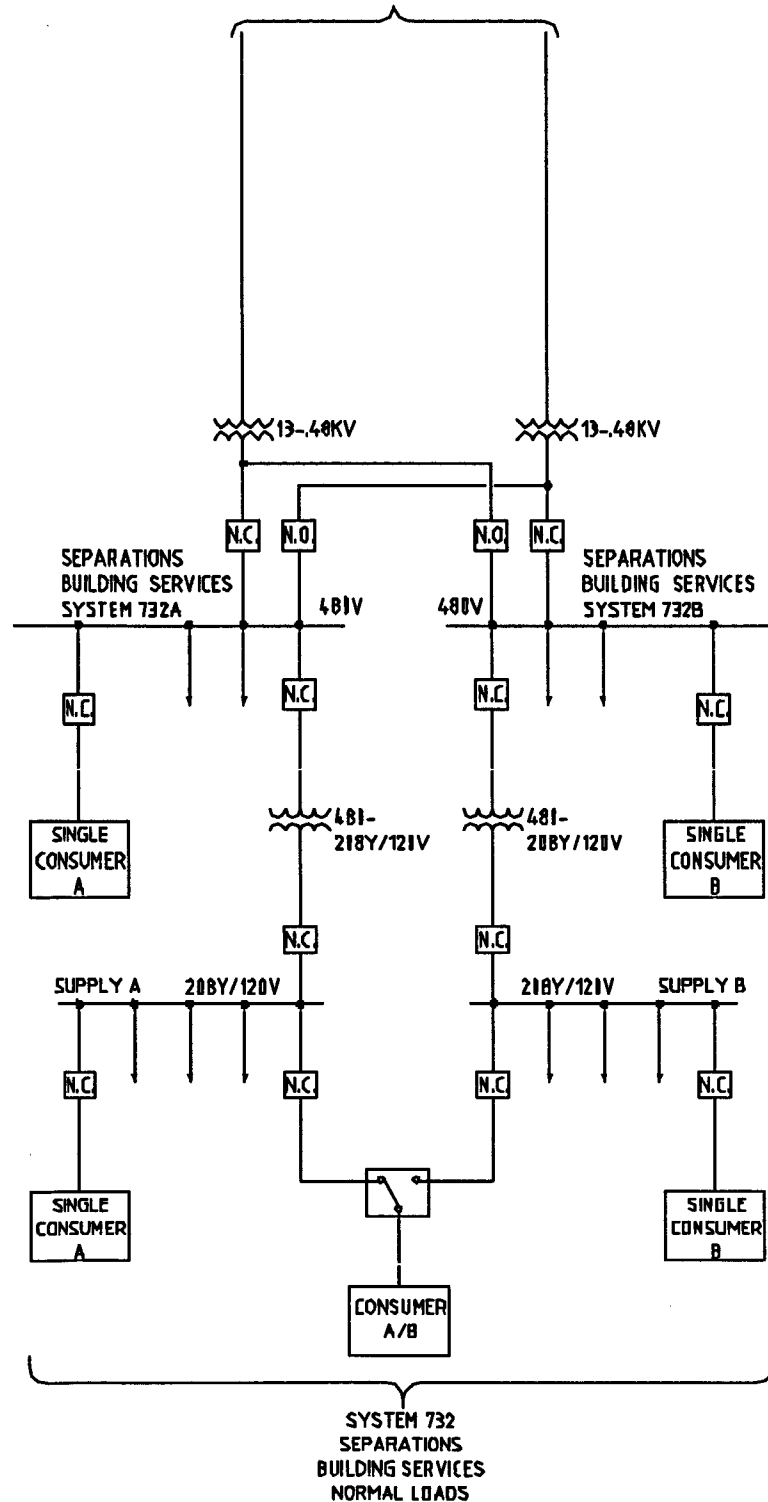
CASCADE HALL 3 & 4
SAME ARRANGEMENT
AS
CASCADE HALL 1 & 2

CASCADE HALL 5 & 6
SAME ARRANGEMENT
AS
CASCADE HALL 1 & 2



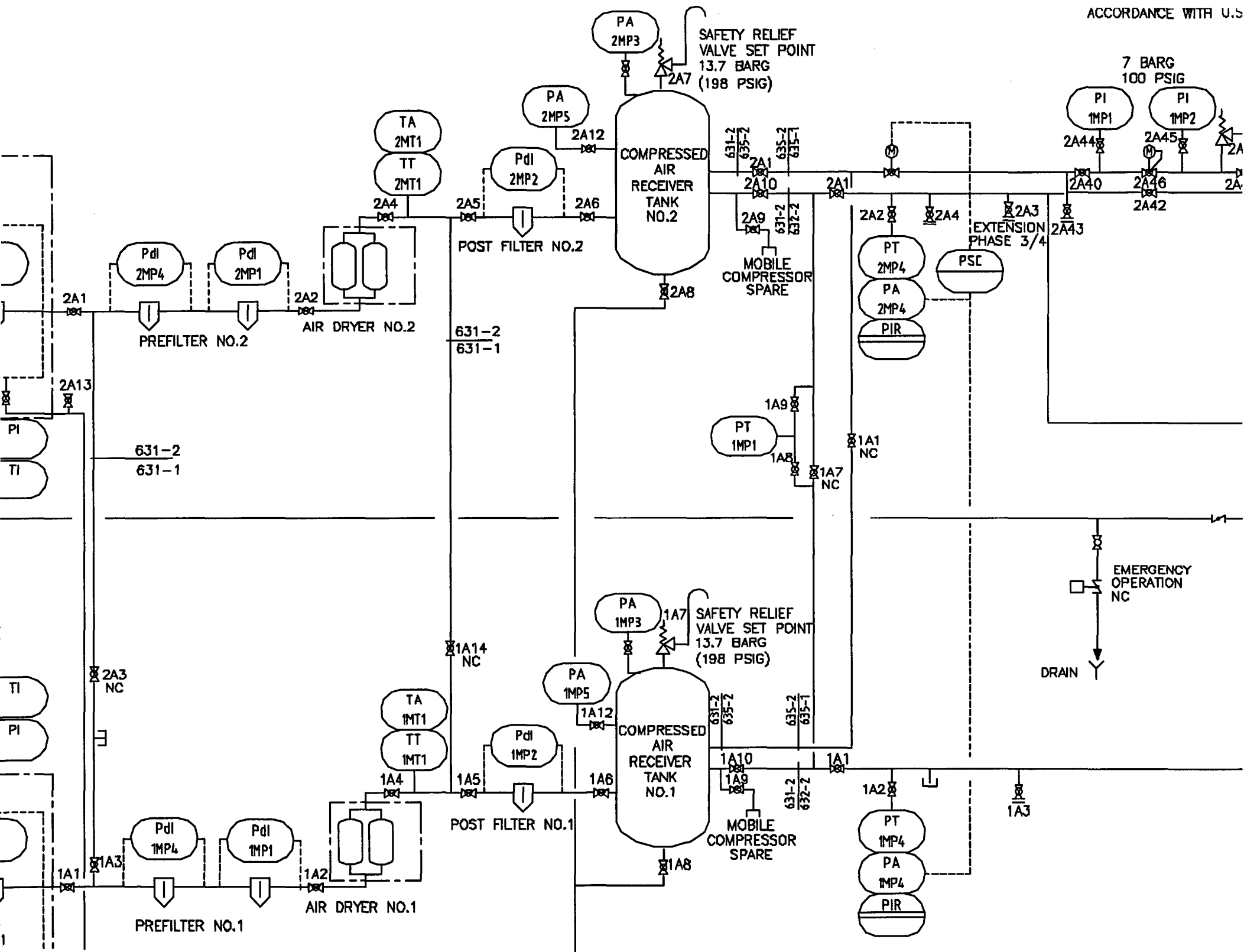


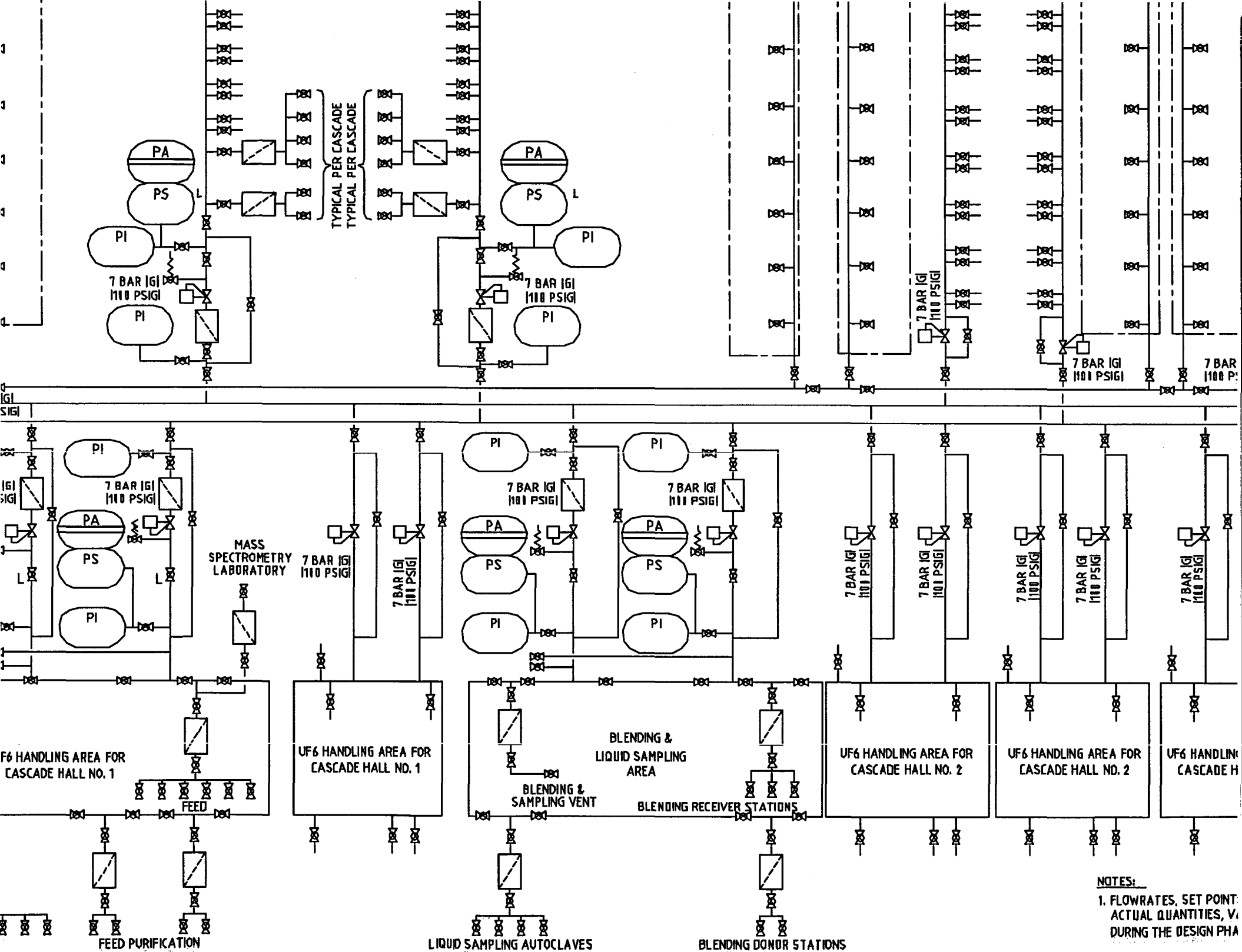
ATION BUILDING, TECHNICAL SERVICES BUILDING,
E ASSEMBLY BUILDING, CYLINDER RECEIPT AND
UILDING, BLENDING AND LIQUID SAMPLING AREA



CASCADE HALLS 1 - 6

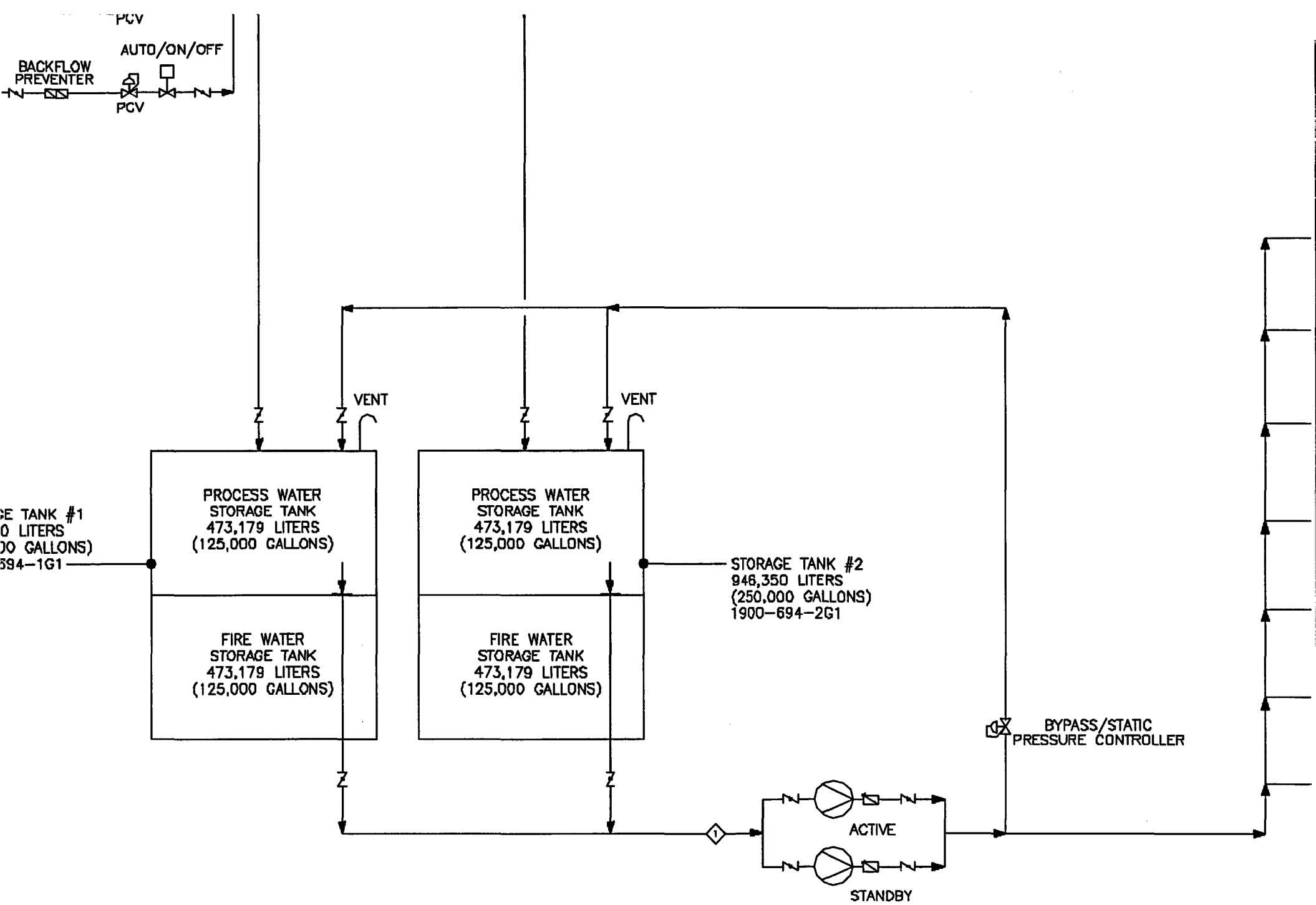
SINGLE LINE I
N.C. CIRCUIT
N.O. CIRCUIT
TRAIL

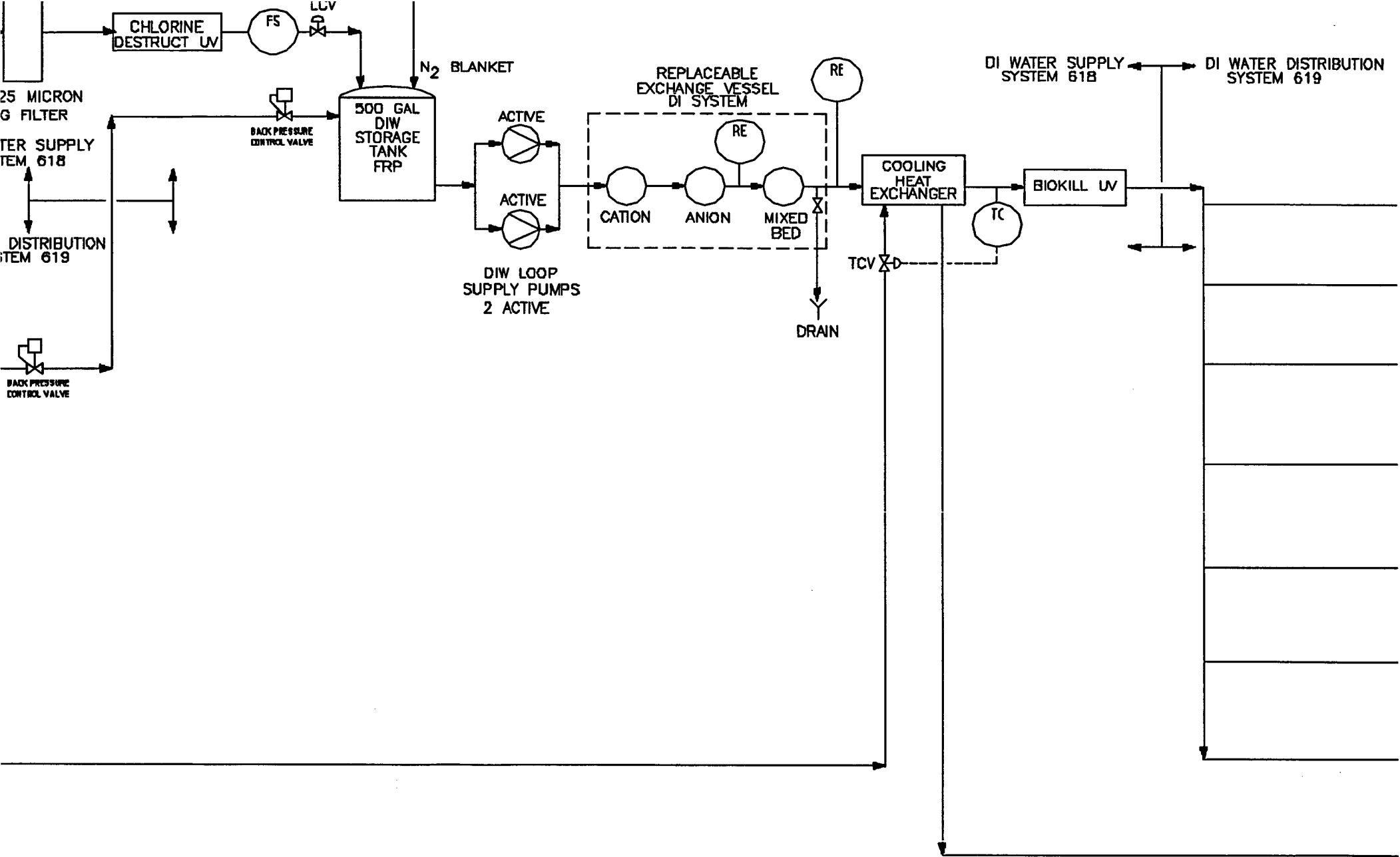


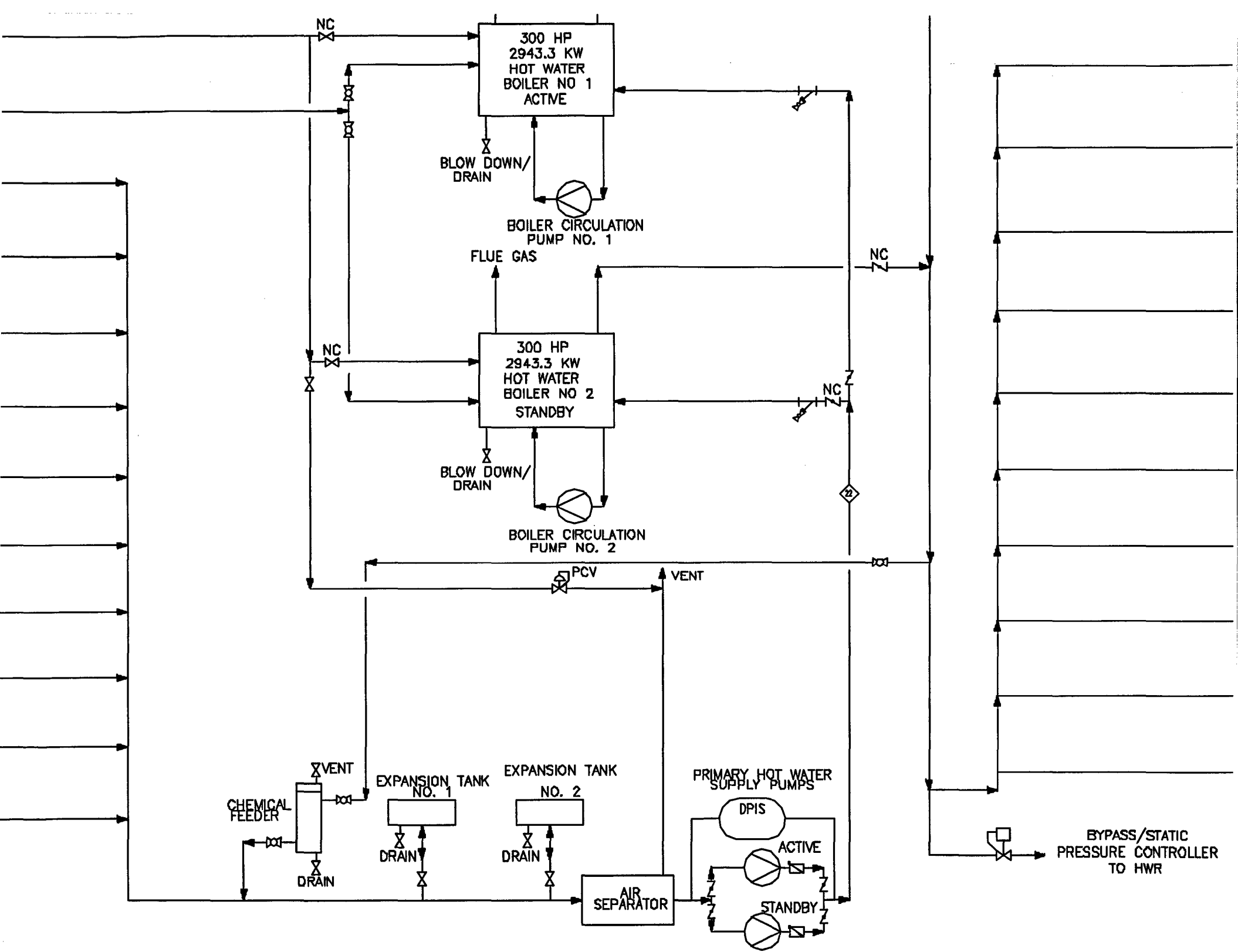


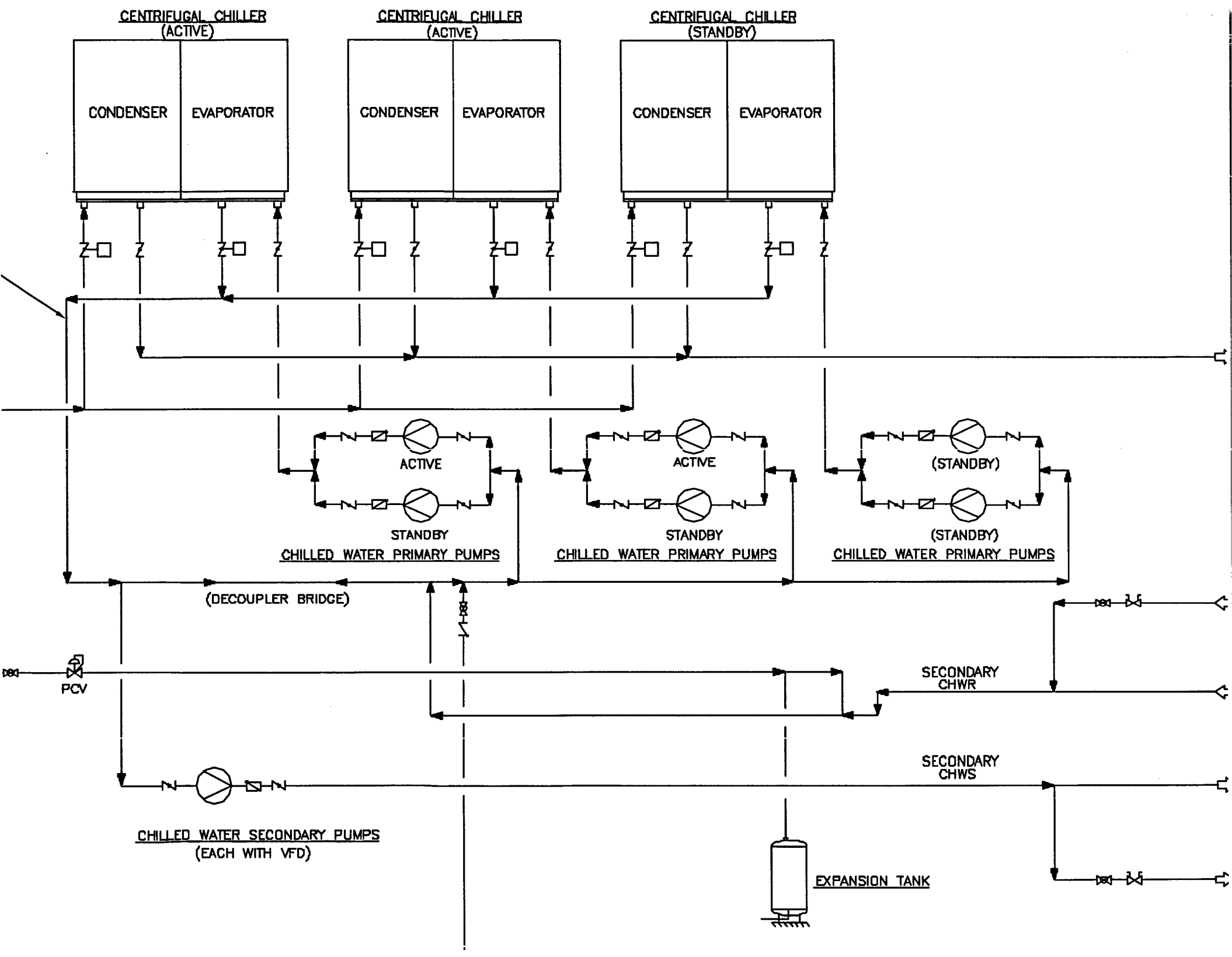
NOTES:

1. FLOWRATES, SET POINT, ACTUAL QUANTITIES, V, DURING THE DESIGN PHA

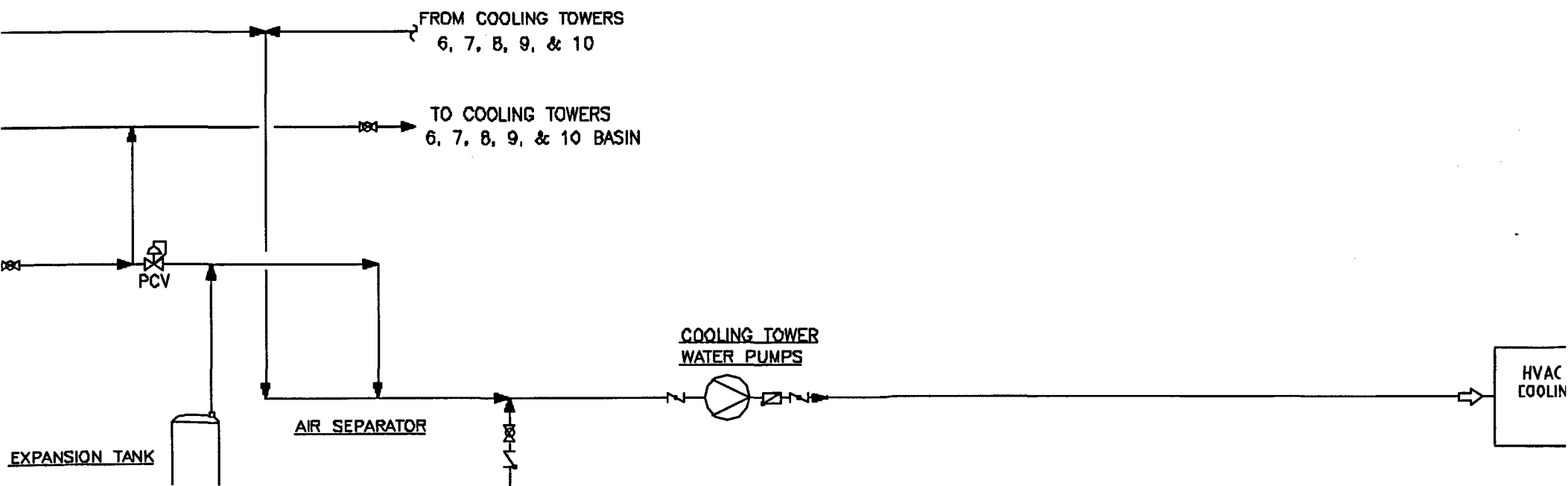


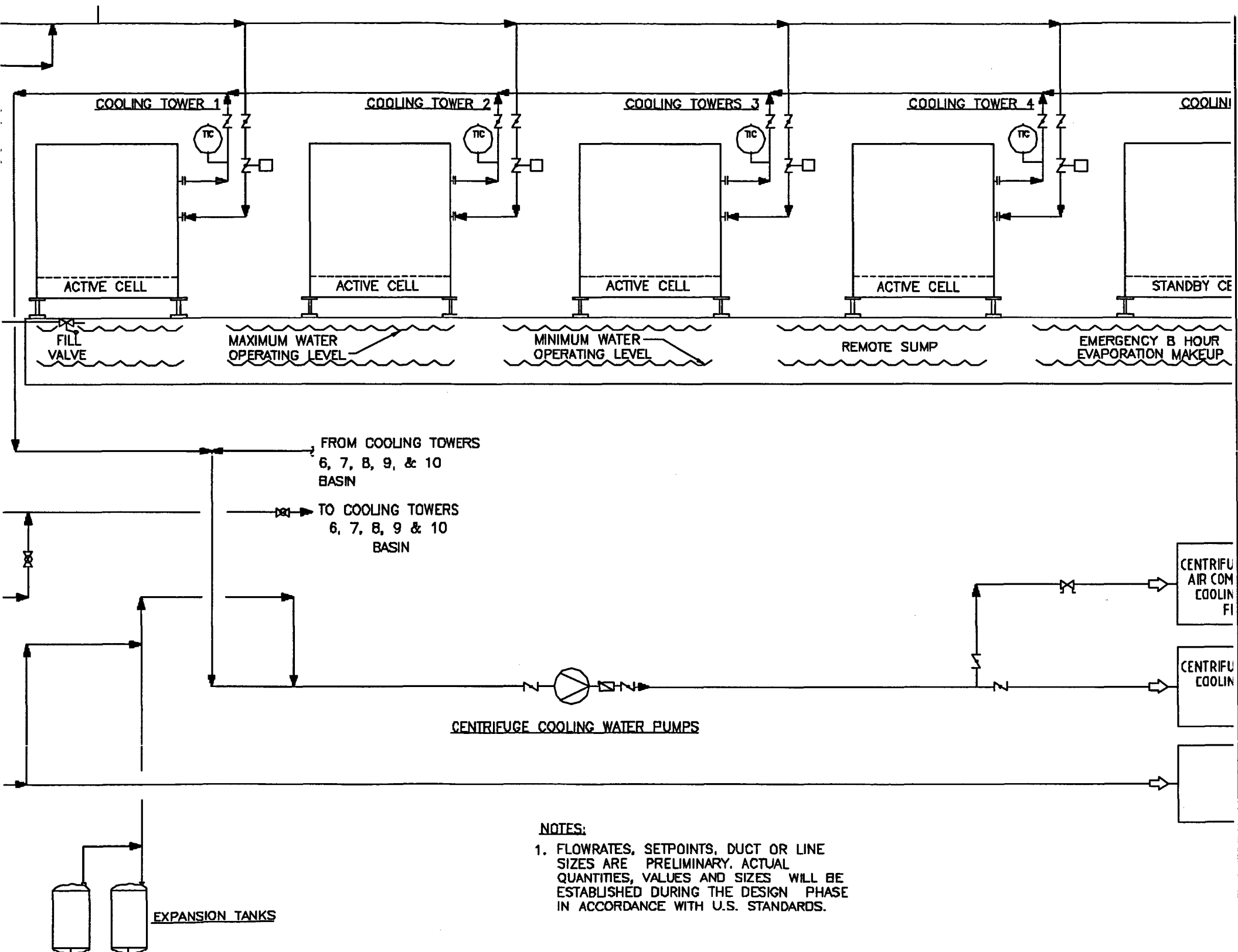






The diagram illustrates the cooling water system for the 1000 MW reactor. It features four cooling towers labeled COOLING TOWER 2, COOLING TOWER 3, COOLING TOWER 4, and COOLING TOWER 5. Each tower has an associated Active Cell or Standby Cell (COOLING TOWER 5 is labeled STANDBY CELL). The system includes a Remote Sump and Emergency 8 Hour Evaporation Makeup. The flow is controlled by TIC (Temperature Indicating Controller) and Z (Zone) valves. The diagram also shows the Maximum Water Operating Level and Minimum Water Operating Level for the cooling water system.





CENTRIFUGE COOLING WATER RETURN
FROM CASCADE HALL NO. 5 AND 6

CENTRIFUGE
COOLING WATER
CASCADE HALL
CASCADE NO. 1

CIRCULATION PUMPS
(1 ACTIVE, 1 STANDBY)

TO CASCADE NO.1
(TYP OF 8)

FROM
CASCADE
NO. 1

TO CASCADE
NO. 2

TO CASCADE
NO. 3

TO CASCADE
NO. 4

TO CASCADE
NO. 5

TO CASCADE
NO. 6

FROM
CASCADE
NO. 2

FROM
CASCADE
NO. 3

FROM
CASCADE
NO. 4

FROM
CASCADE
NO. 5

FROM
CASCADE
NO. 6

DPC

FROM
CASCADE
NO. 1

FROM
CASCADE
NO. 2

FROM
CASCADE
NO. 3

FROM
CASCADE
NO. 4

FROM
CASCADE
NO. 5

FROM
CASCADE
NO. 6

TO CASCADE
NO. 1
(TYP OF 8)

CENTRIFUGE
COOLING WATER
CASCADE HALL NO. 2

CASCADE
CIRCULATION PUMPS
(1 ACTIVE, 1 STANDBY)

TO
CASCADE
NO. 2

TO
CASCADE
NO. 3

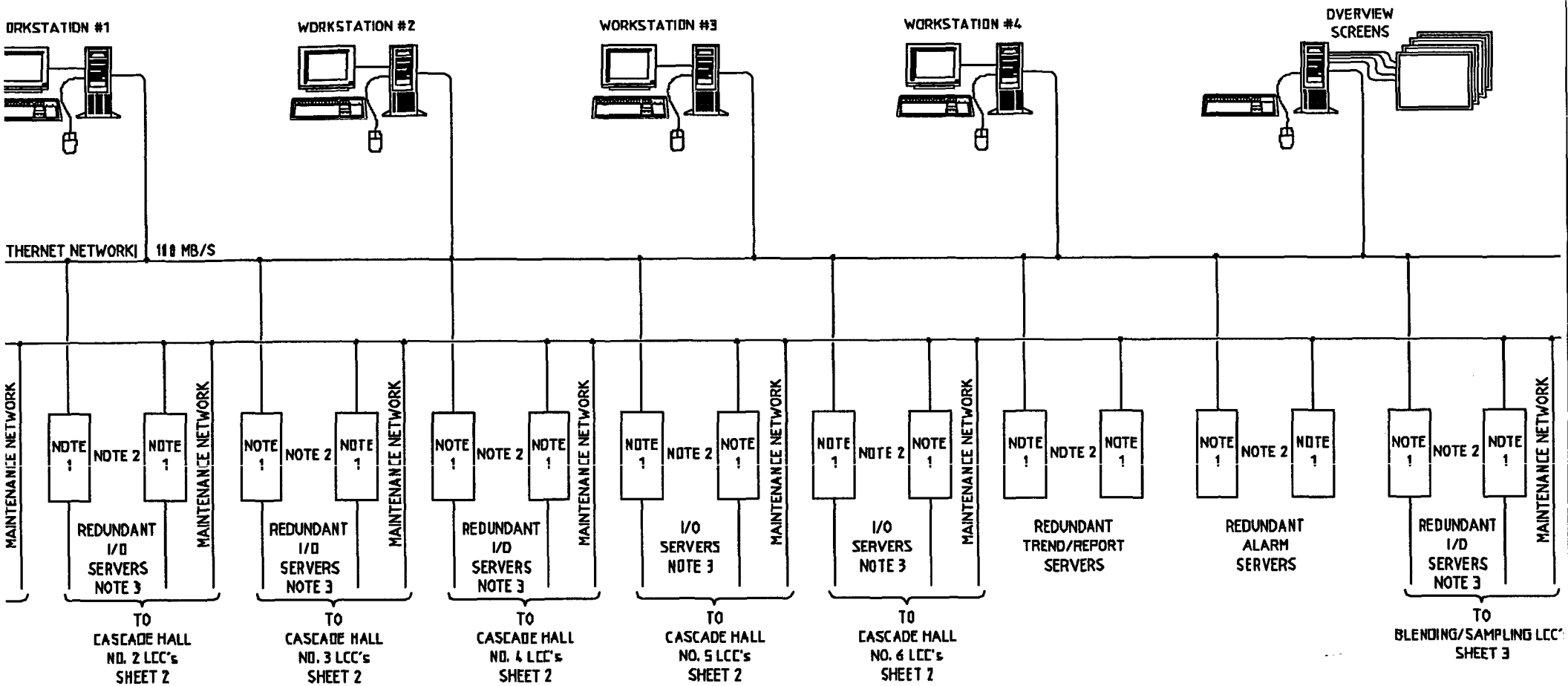
TO
CASCADE
NO. 4

TO
CASCADE
NO. 5

TO
CASCADE
NO. 6

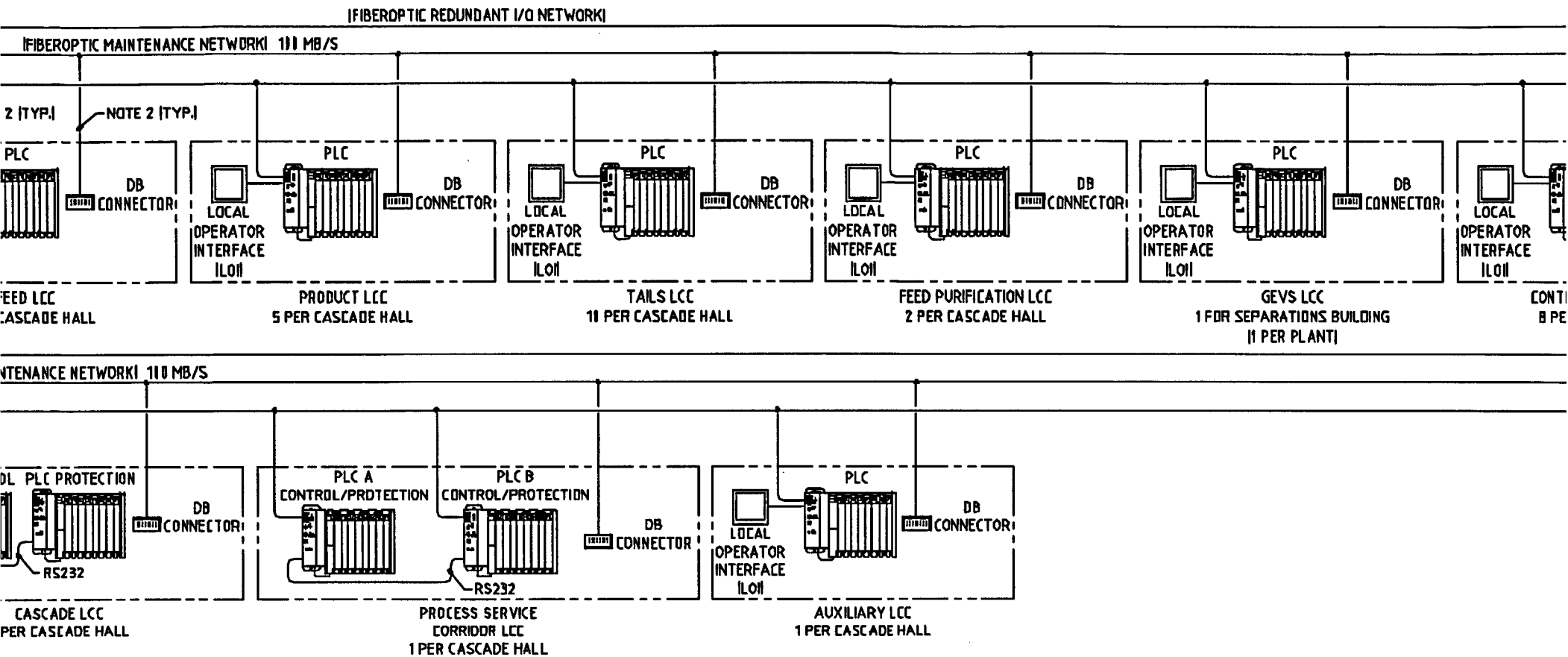
CENTRIFUGE COOLING WATER SUPPLY
FOR CASCADE HALL NO. 3 AND 4

CENTRIFUGE COOLING WATER SUPPLY
FOR CASCADE HALL NO. 5 AND 6



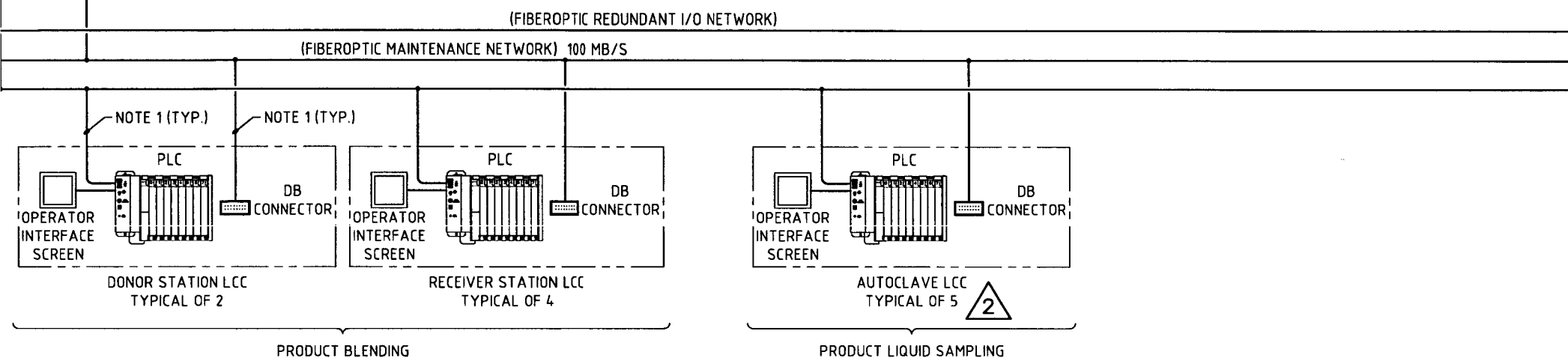
NOTES

1. EACH SERVER AND NETWORK
2. THERE IS NO PARITY CHECK BETWEEN REDUNDANT ETHERNET NETWORKS
3. PROCESS NETWORK INSTALLATION
4. REFERENCE TO FIGURE 3.5-27

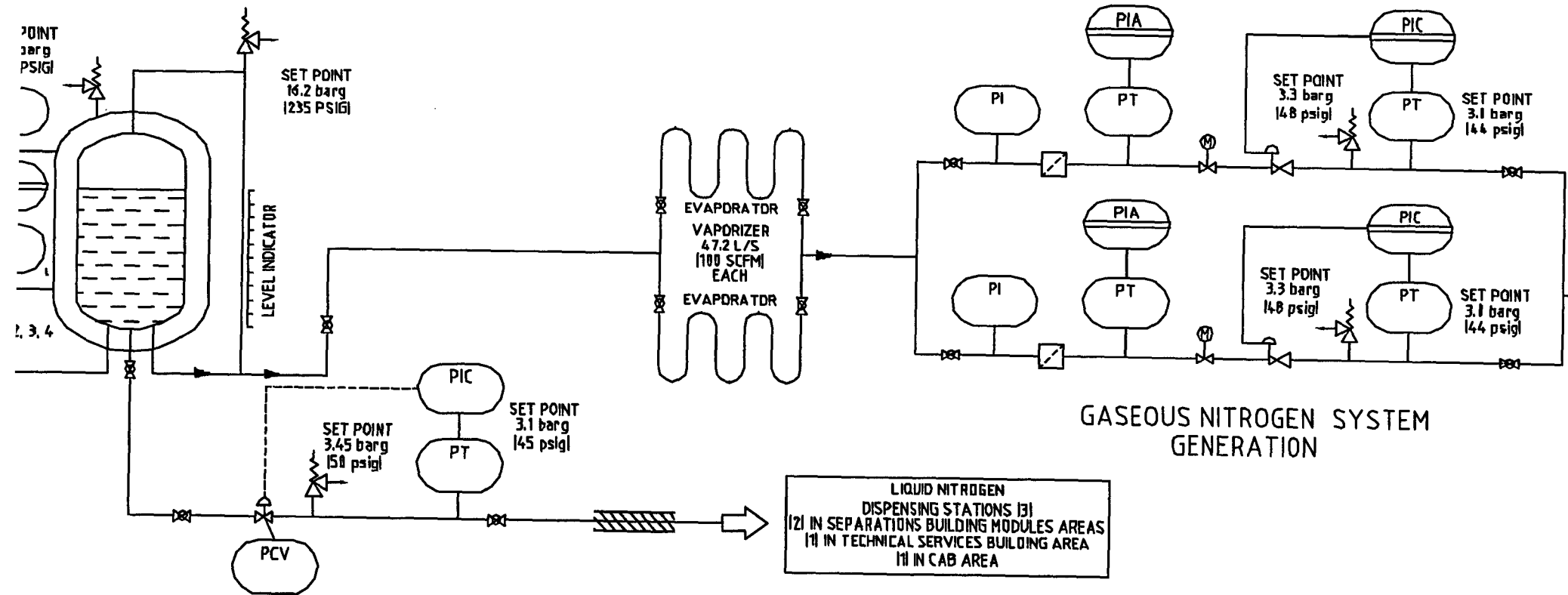


NOTES

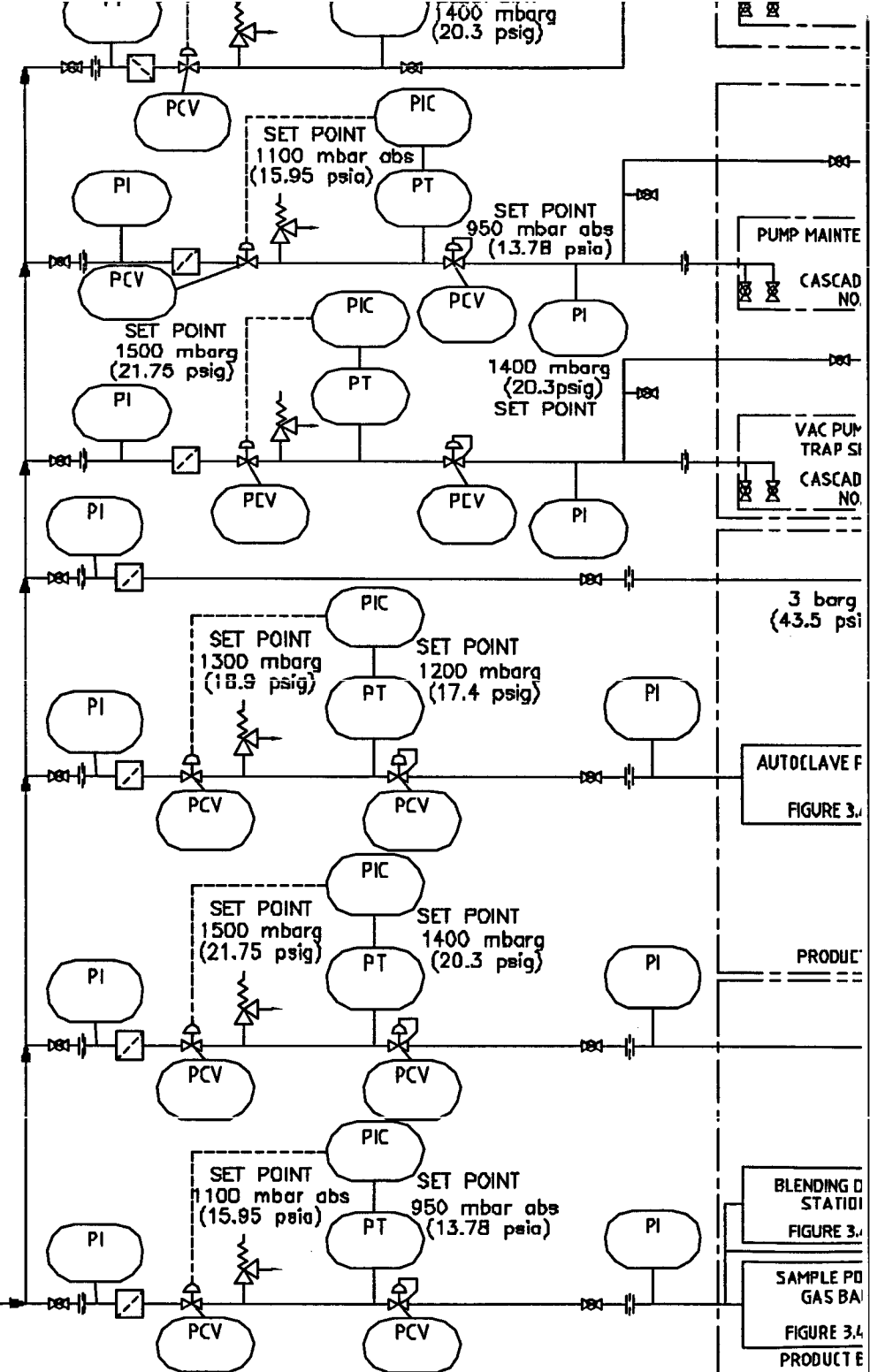
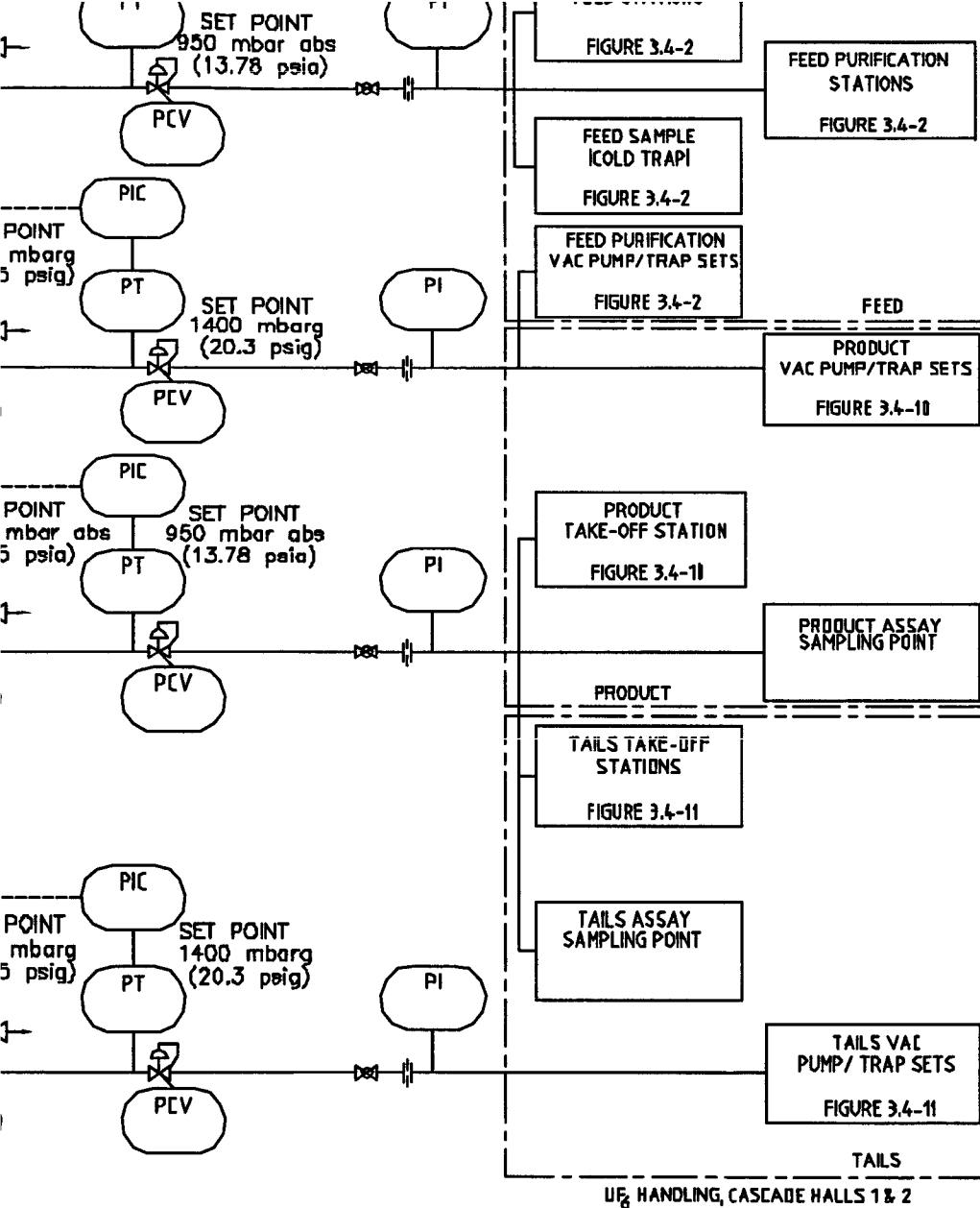
1. THIS DRAWING
2. CONNECTION I
NETWORKS A
MANUFACTUR
3. REFERENCE TI
FIGURE 3.5-2



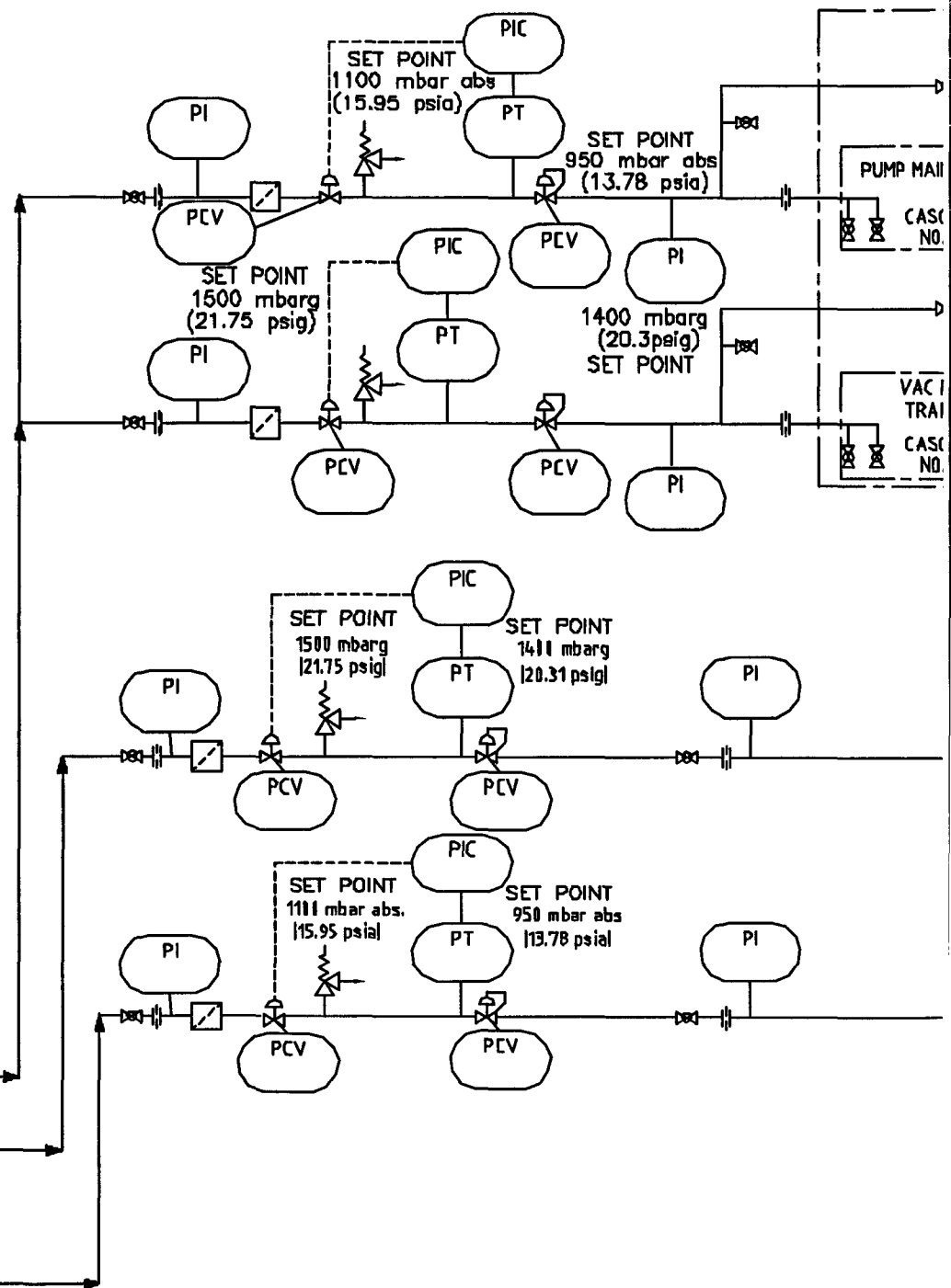
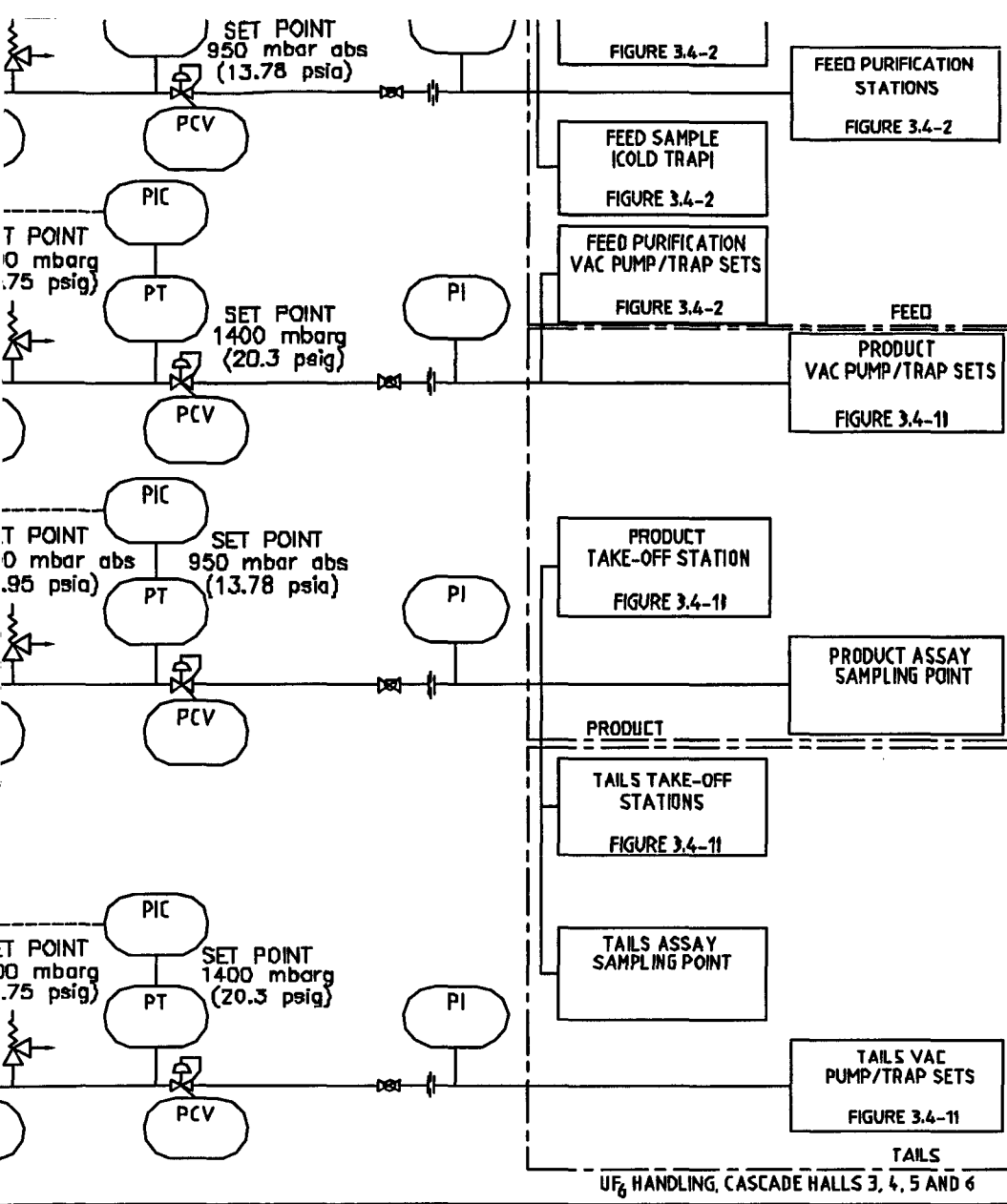
NOTE
1. CONNECT
NETWORK
MANUFA

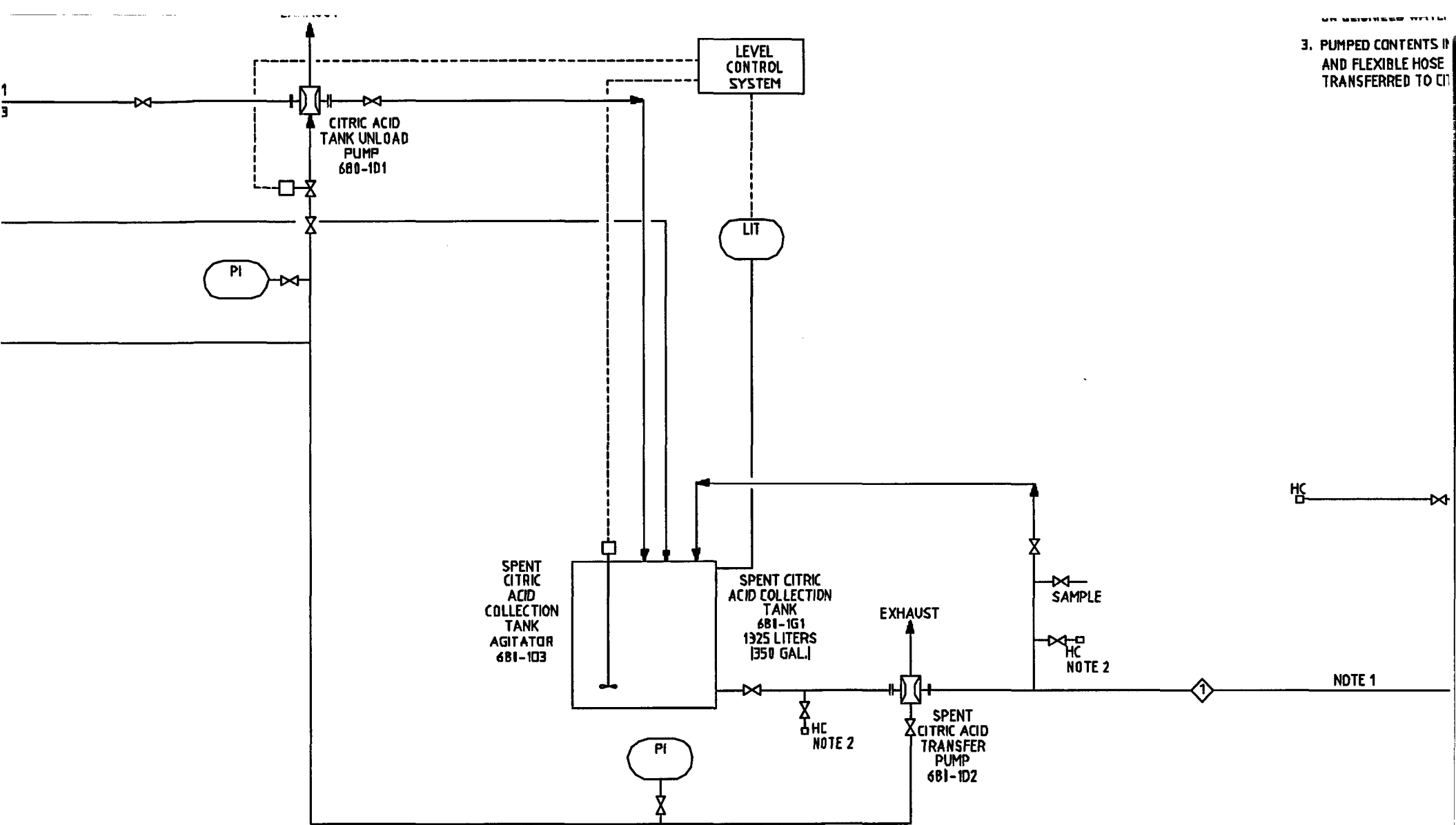


NITROGEN SYSTEM
(TYPICAL OF FOUR SYSTEMS)



SETPOINTS, DUCT OR LINE SIZES ARE PRELIMINARY. QUANTITIES, VALUES AND SIZES WILL BE ESTABLISHED IN DESIGN PHASE IN ACCORDANCE WITH U.S.





OR DESIGNER WITH
3. PUMPED CONTENTS IN
AND FLEXIBLE HOSE
TRANSFERRED TO CH

3. TOTAL
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1126 LBS

4. URANIC
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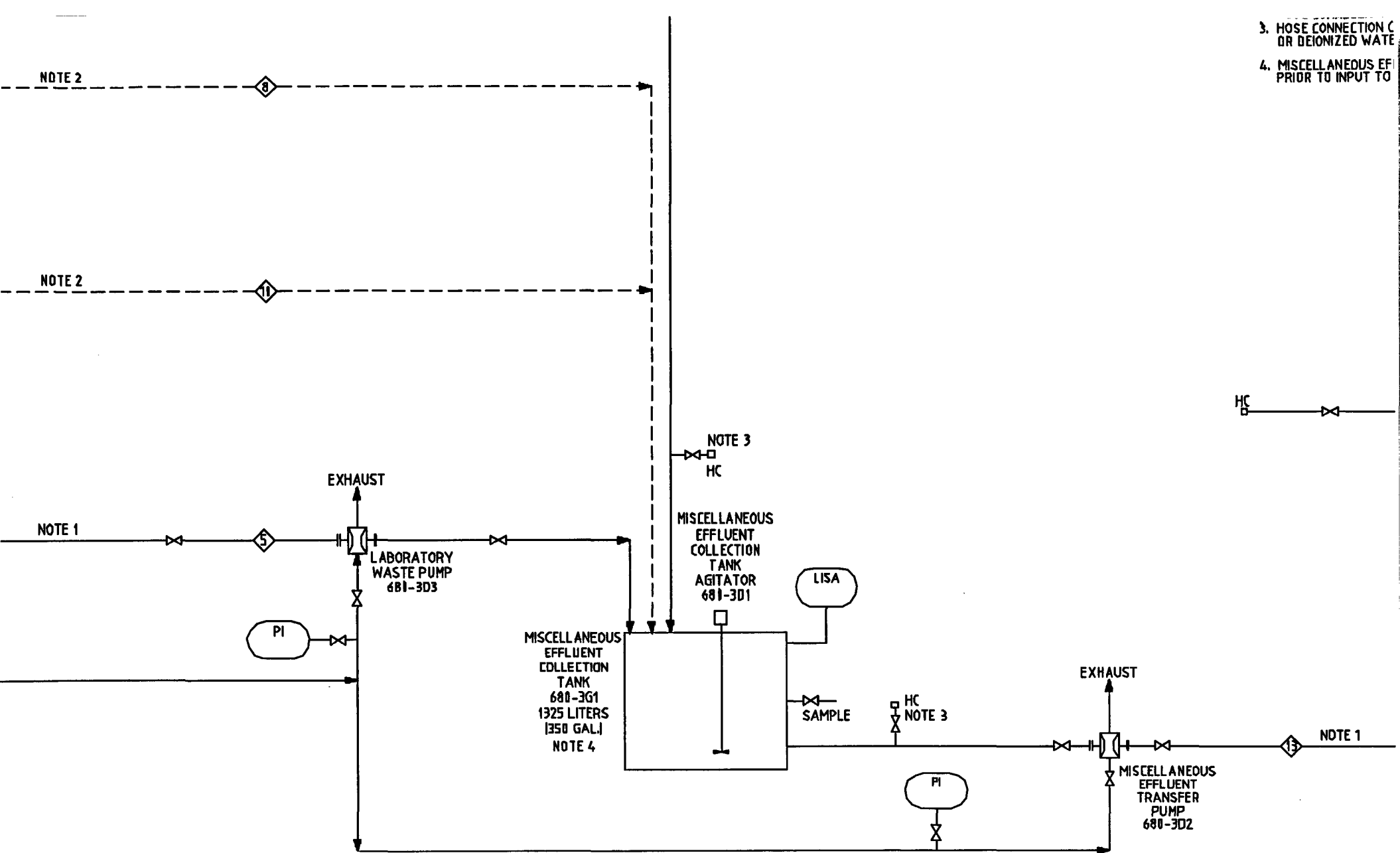
NOTE 408

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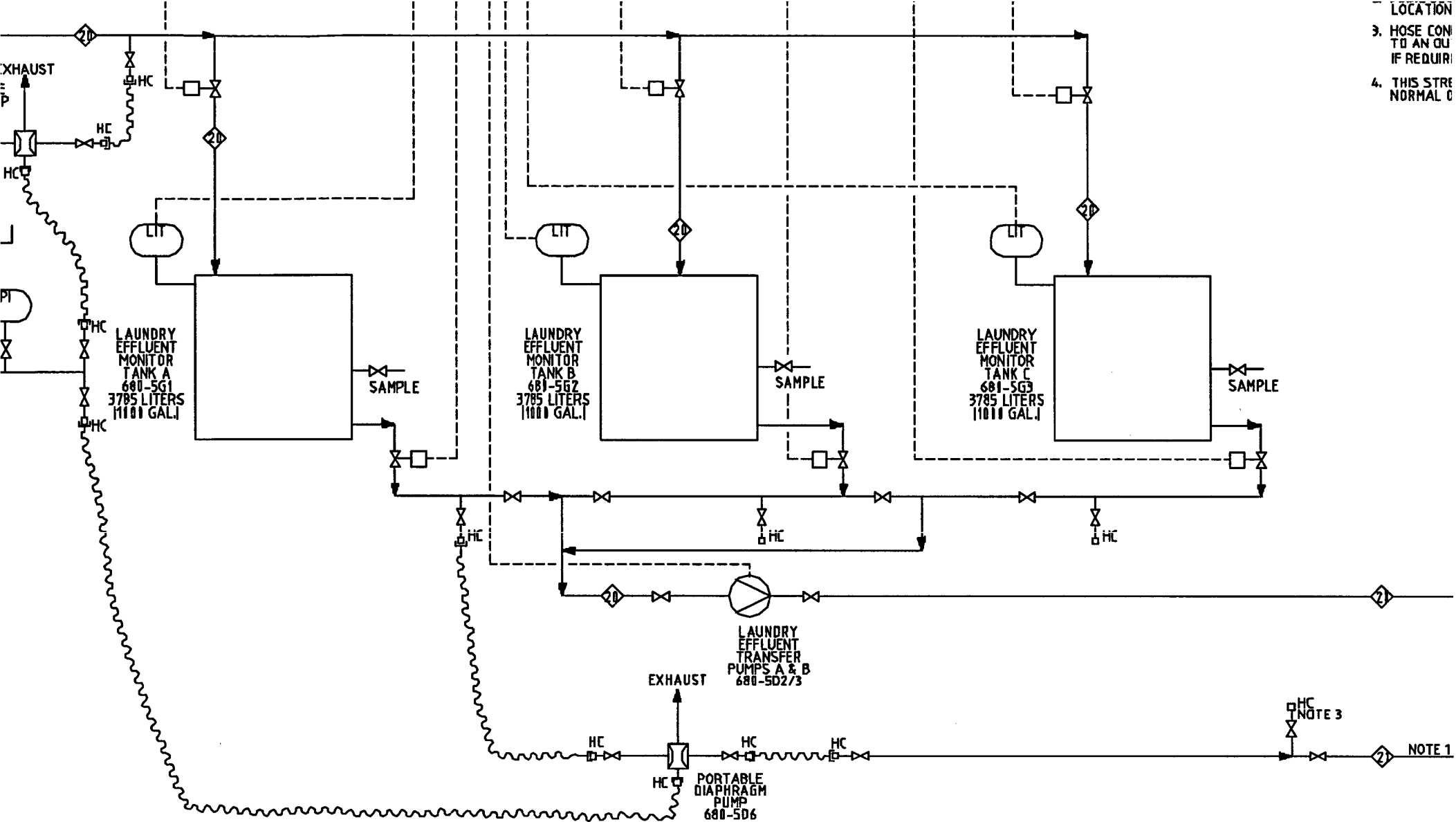
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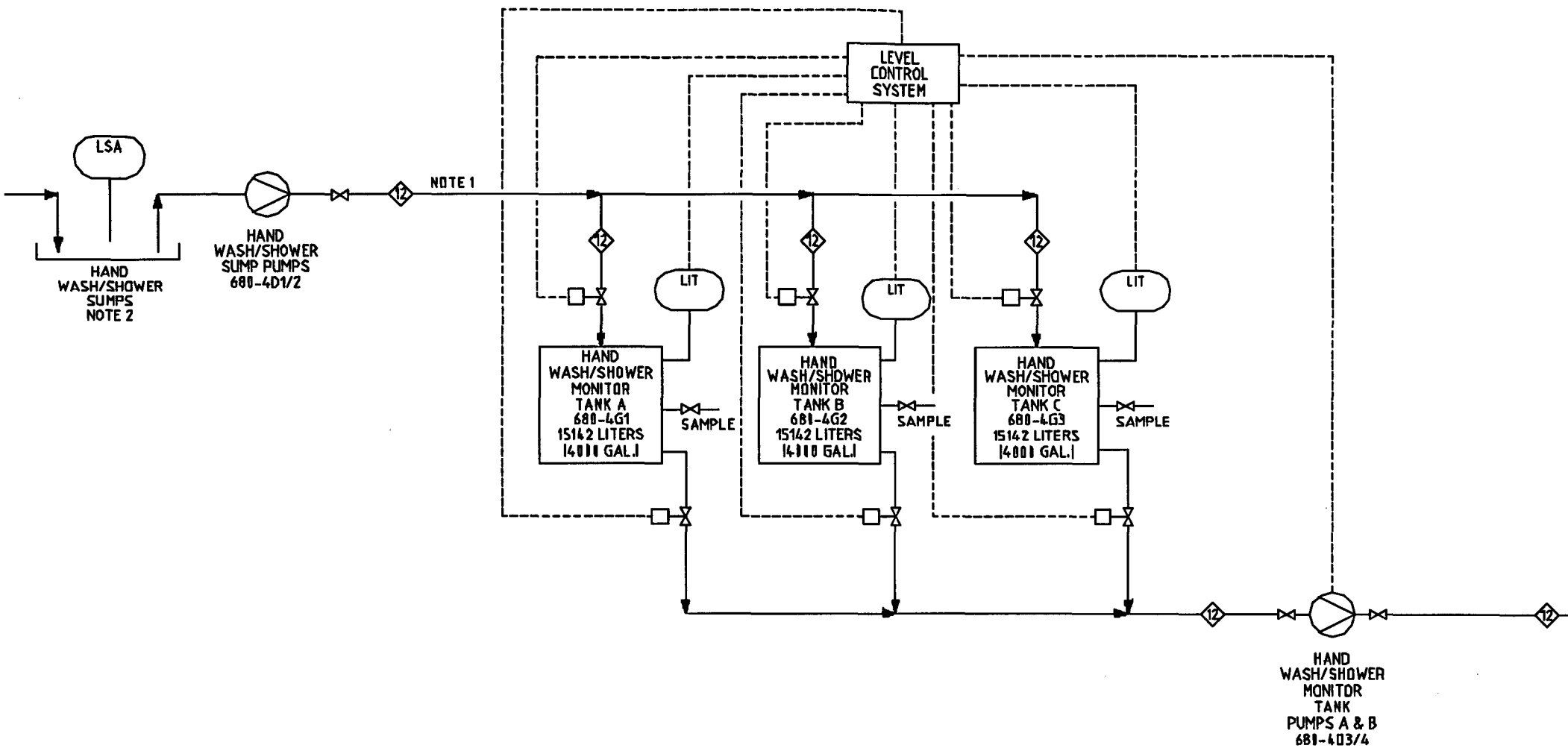
3. HOSE CONNECTION C
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4. MISCELLANEOUS EF
PRIOR TO INPUT TO

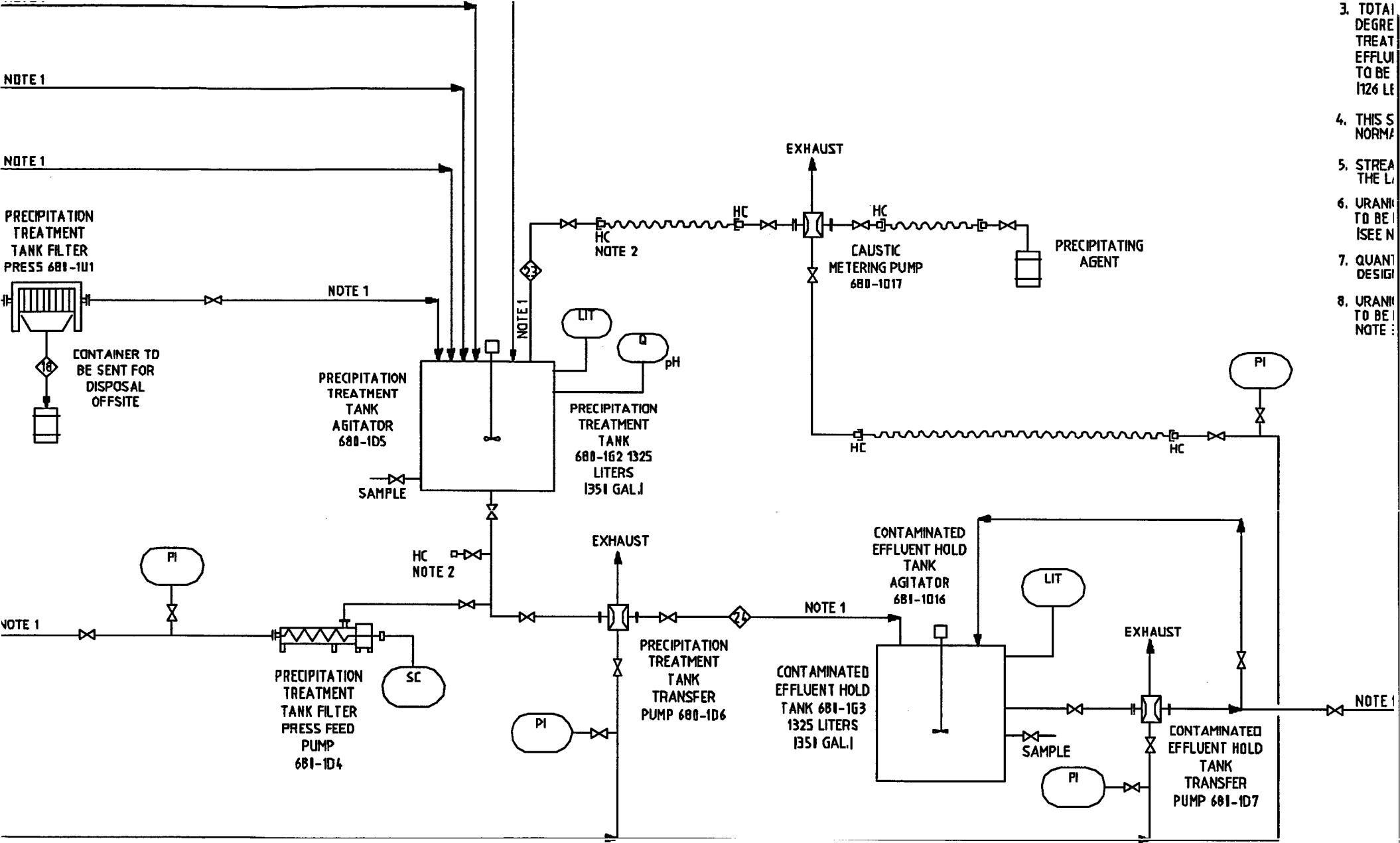


6	8	10	13
2401	41	81	23135
251	41.2	91.4	2342



- LOCATION
- HOSE CONNECTED TO AN OUTLET IF REQUIRED
 - THIS SYSTEM IS NORMAL

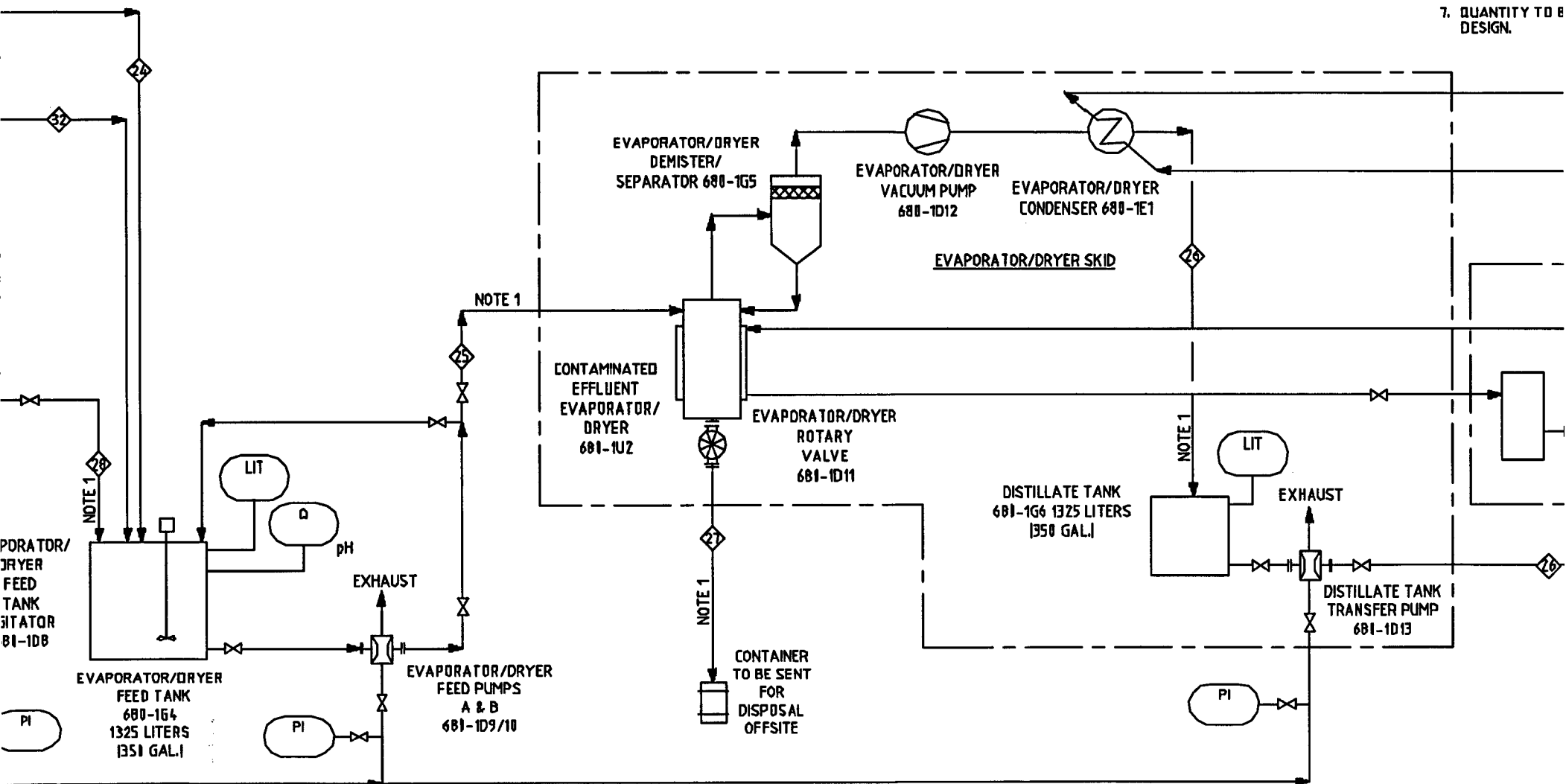




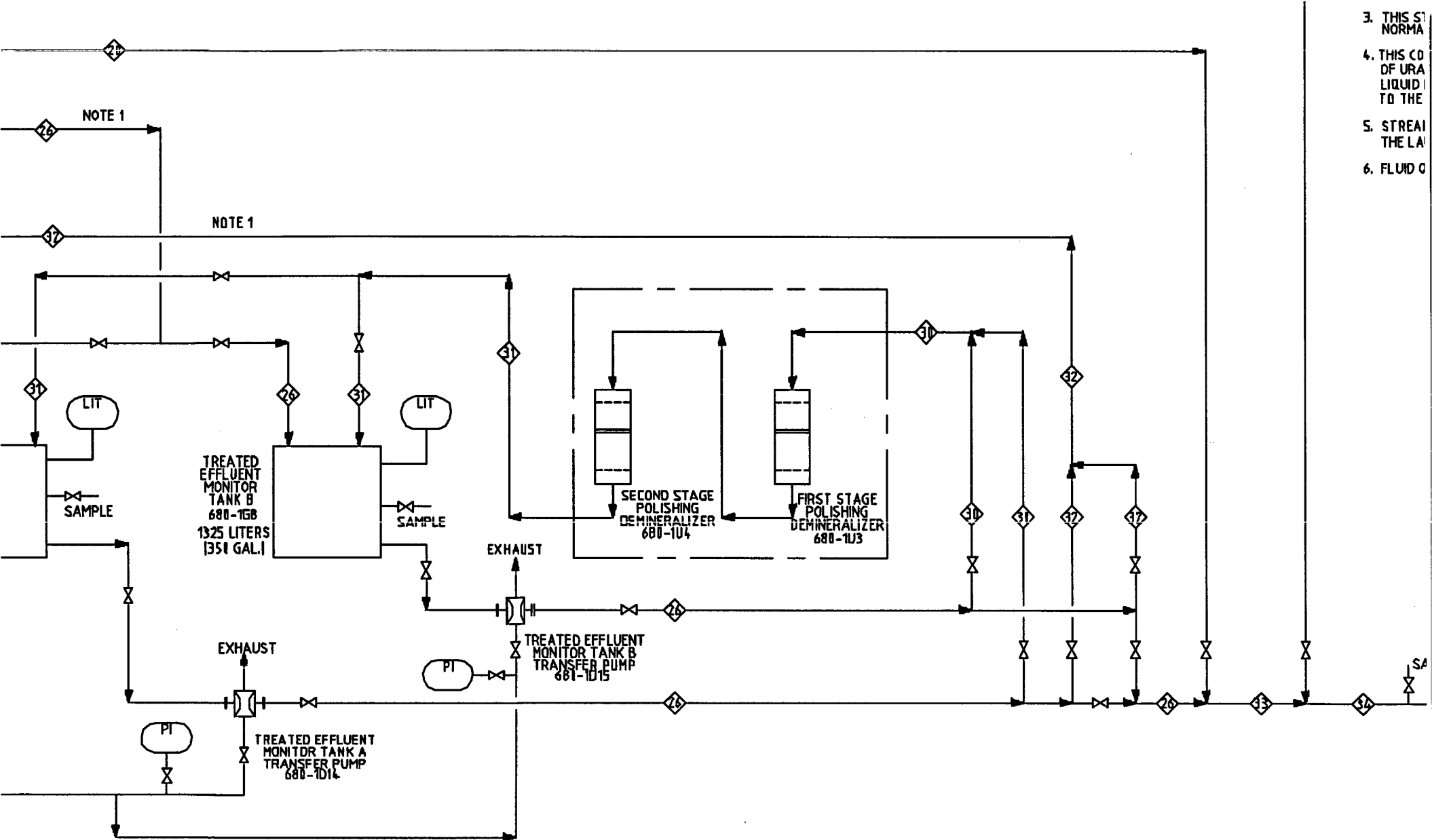
3. TOTAL DEGRE TREAT EFFLUI TO BE 1126 L
4. THIS S NORMA
5. STREA THE L
6. URANI TO BE I SEE N
7. QUANT DESIG
8. URANI TO BE I NOTE :

4	15	16	21	23	24
3711	23135		I	NOTE 7	29,565
981	6112		I		7811

- 1126 LBI OF URA
3. URANIC CONTENT TO BE DETERMINED (SEE NOTE 2 ABOVE)
 4. STREAM DATA THE LAUNDRY
 5. URANIC CONTENT TO BE DETERMINED (SEE NOTE 2 ABOVE)
 6. THIS STREAM IS NORMAL OPERATION
 7. QUANTITY TO BE DESIGNED

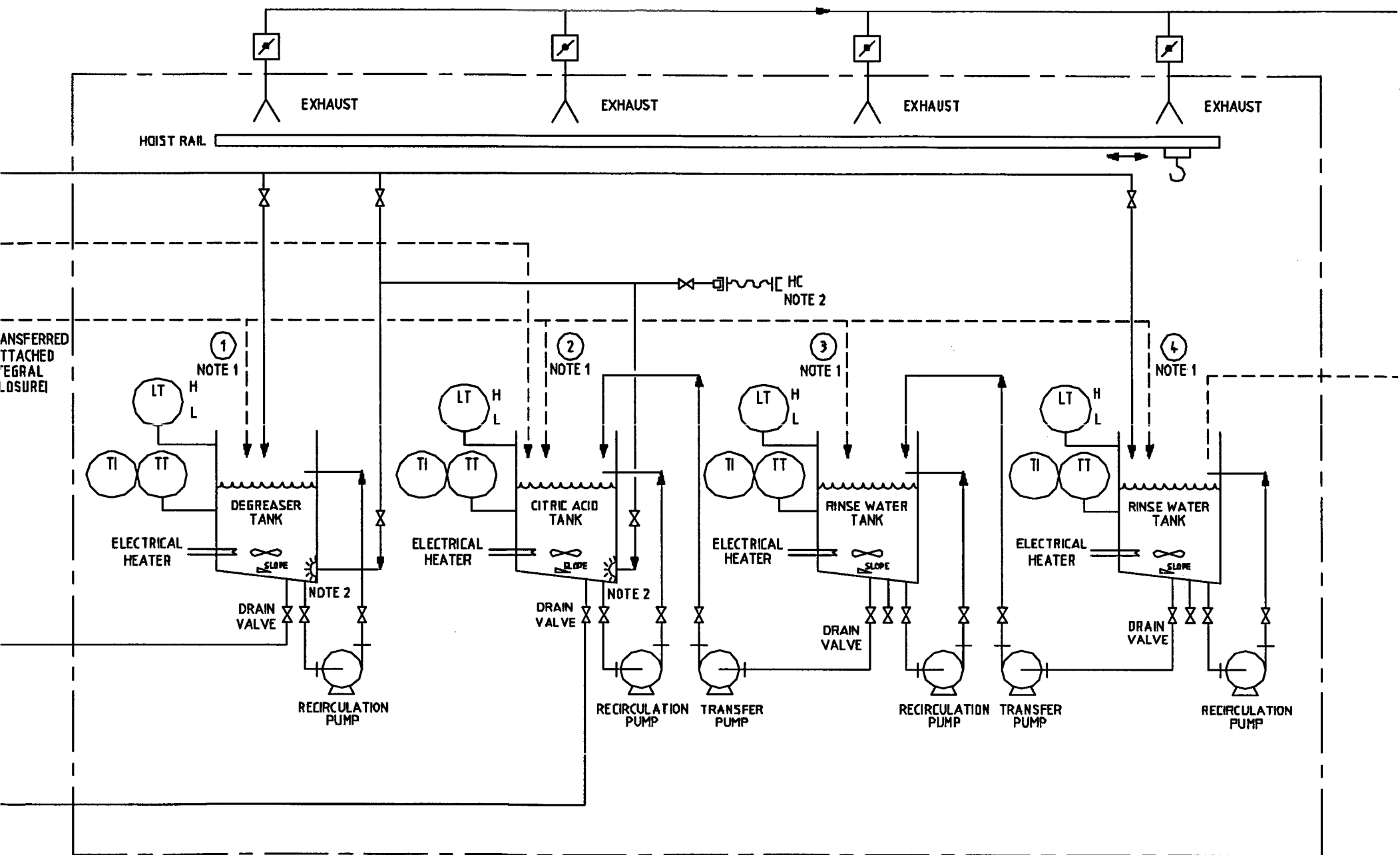


25	26	27	28	29
29,565	29,565		NOTE 7	1
7811	7811		NOTE 7	1

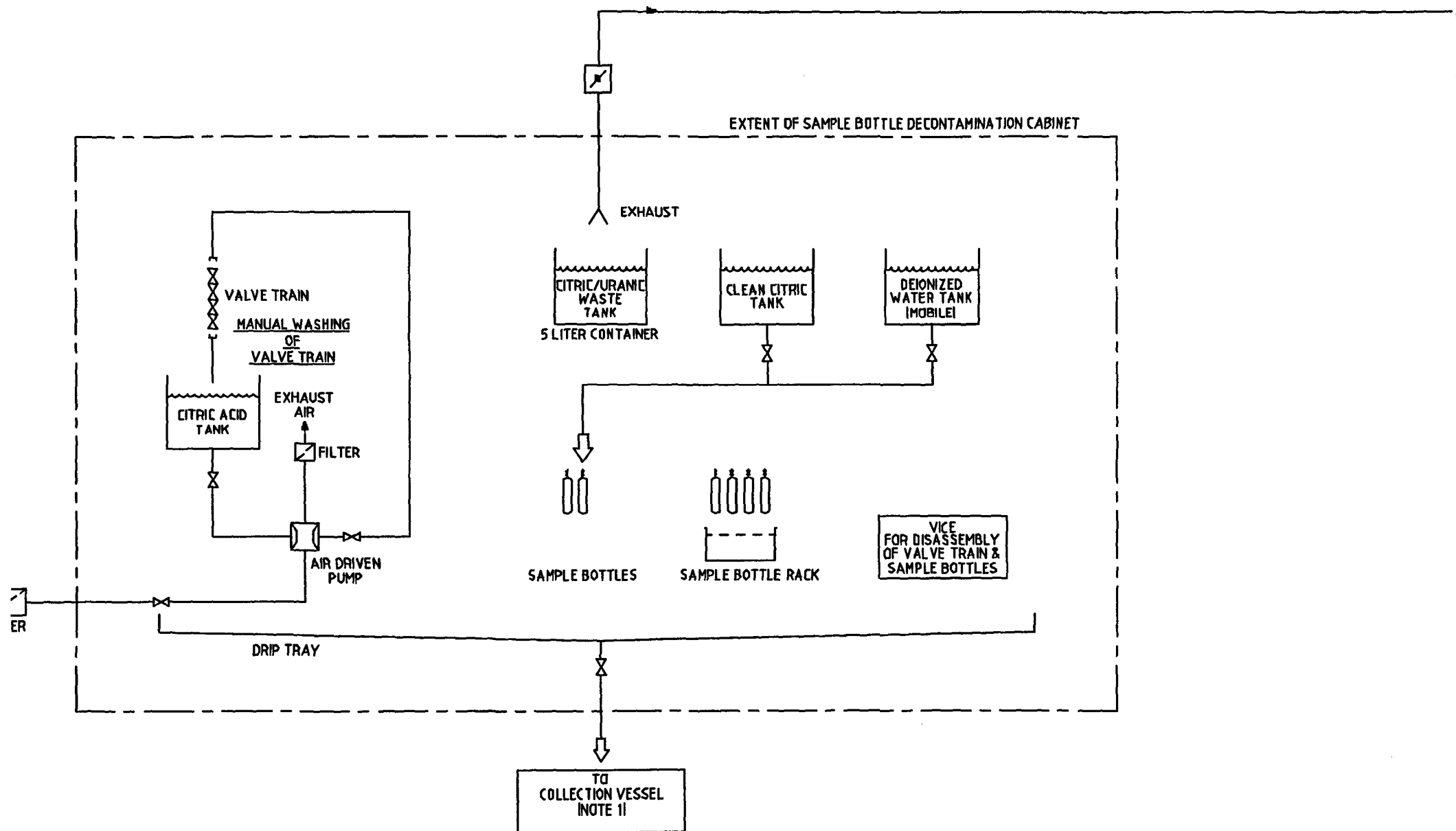


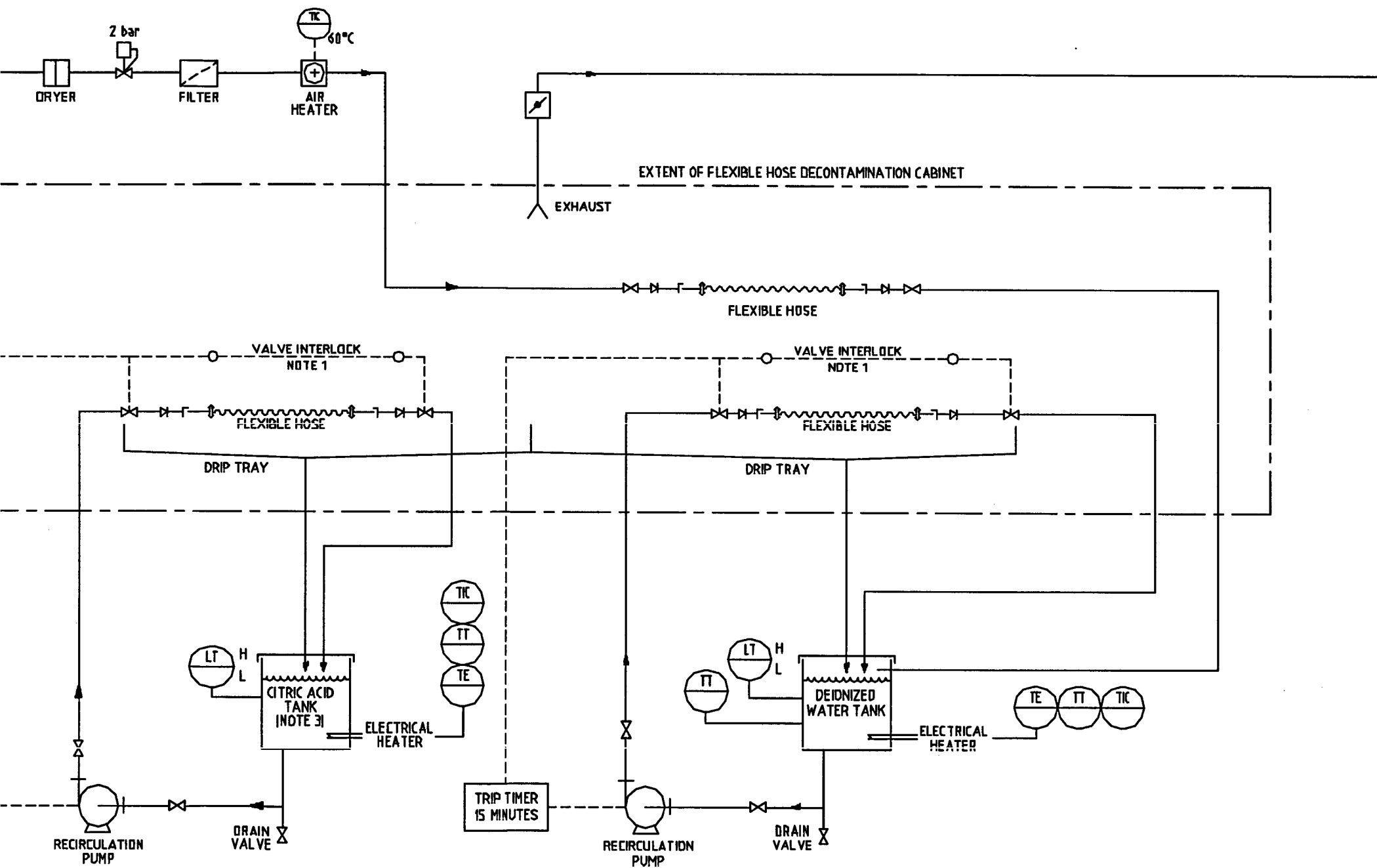
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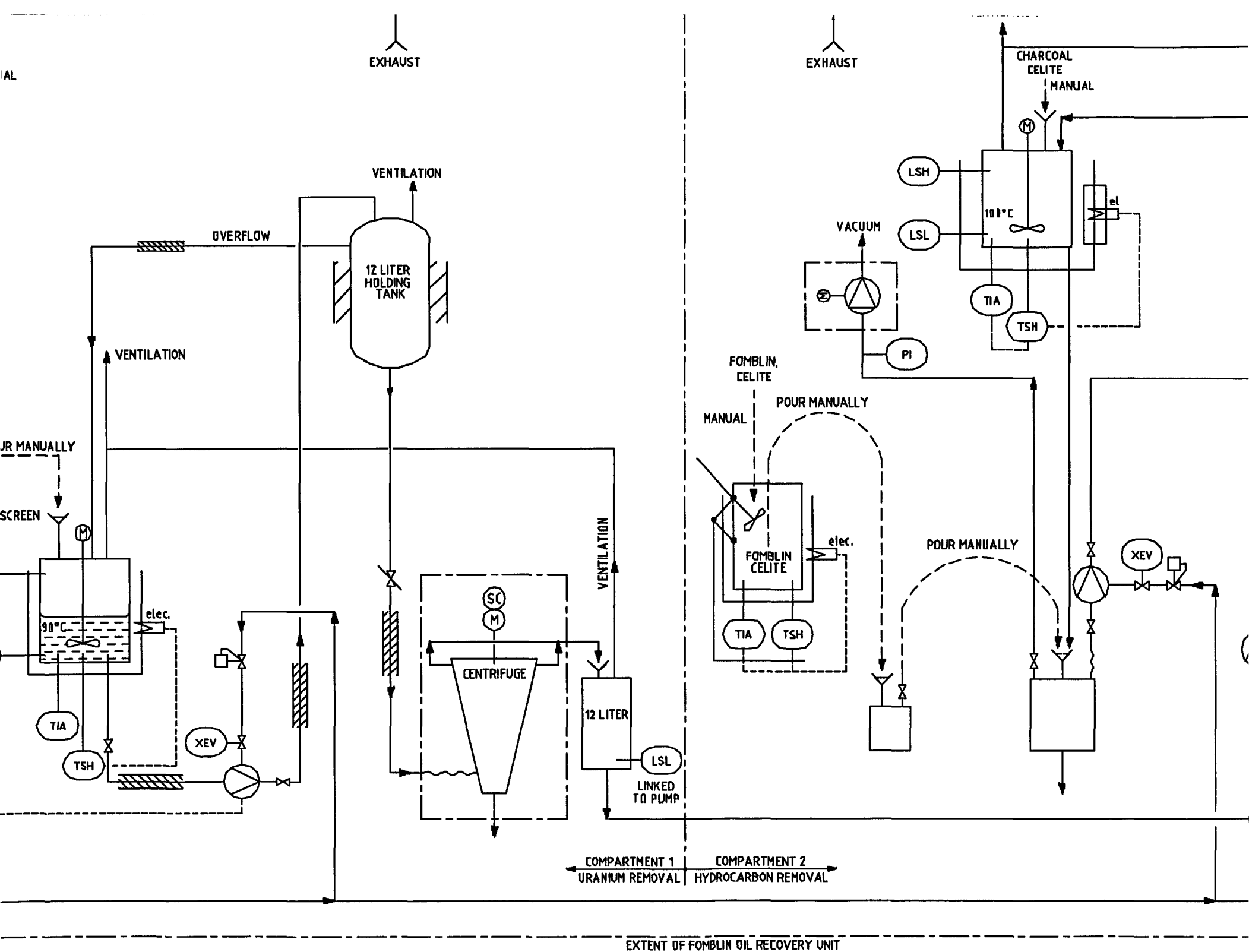
20	26	30	31	32	33	34
405,012	29,565	1	0	1	435,410	2,535,400
107,213	7811	1	0	1	115,033	669,853

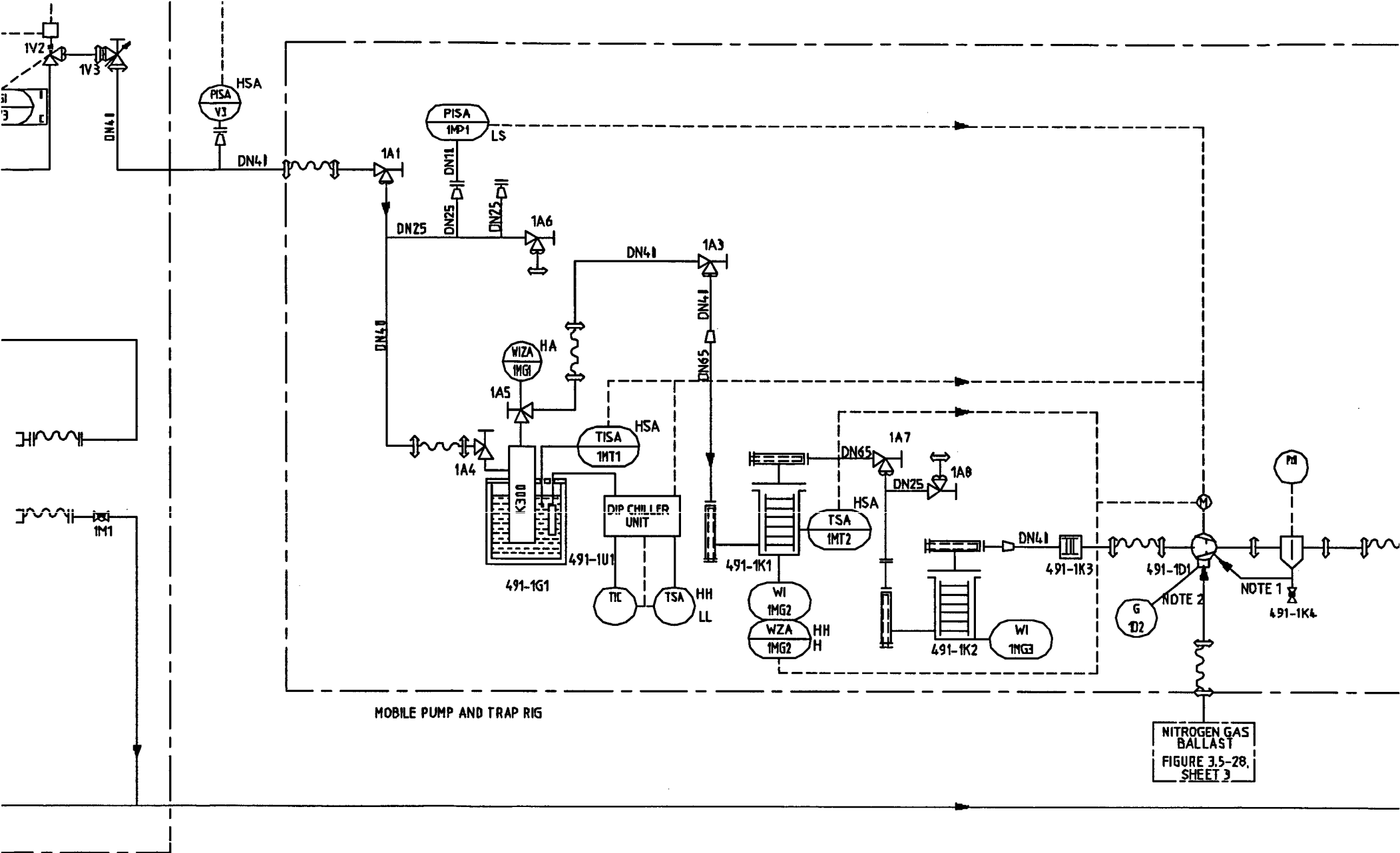


EXTENT OF EQUIPMENT DECONTAMINATION CABINET



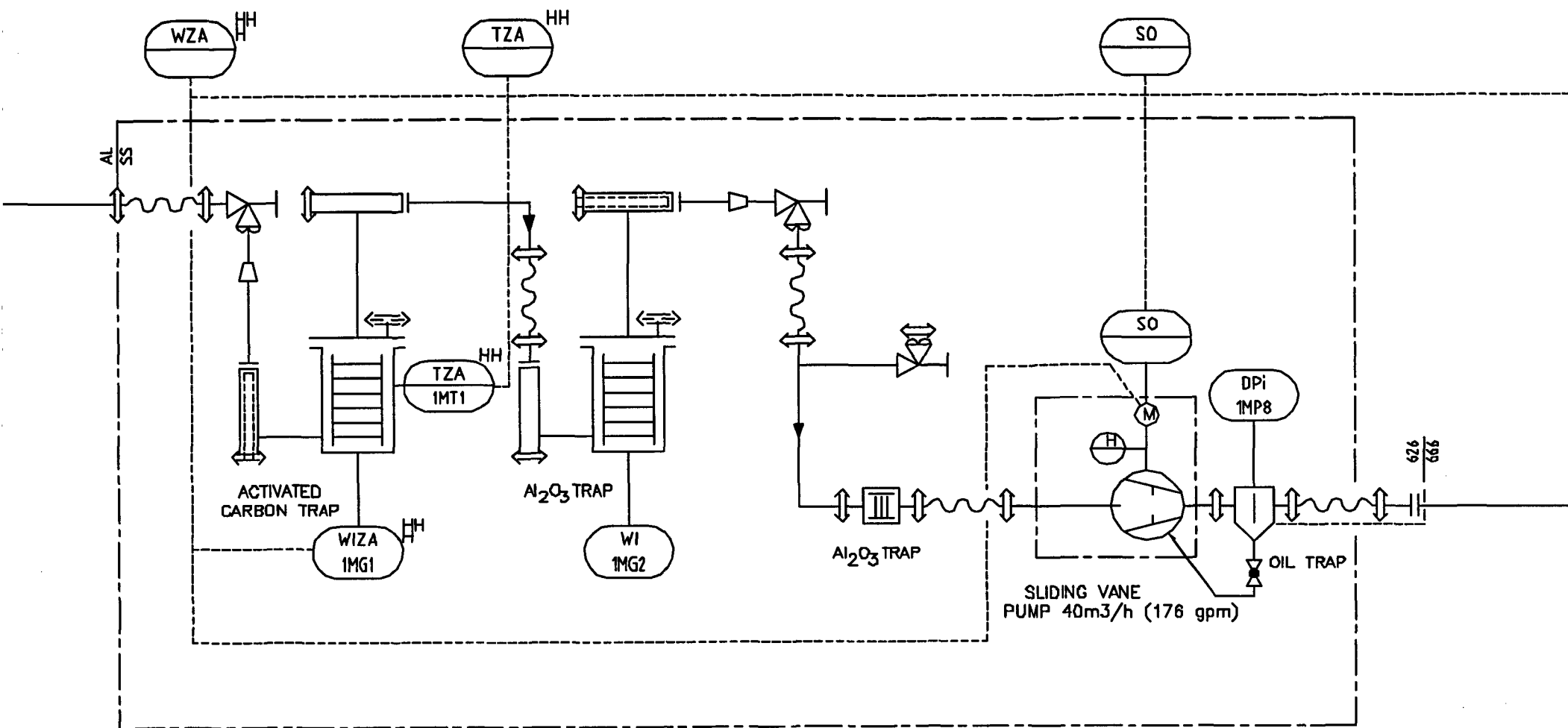






NOTES:

1. OIL RETURN
2. NITROGEN



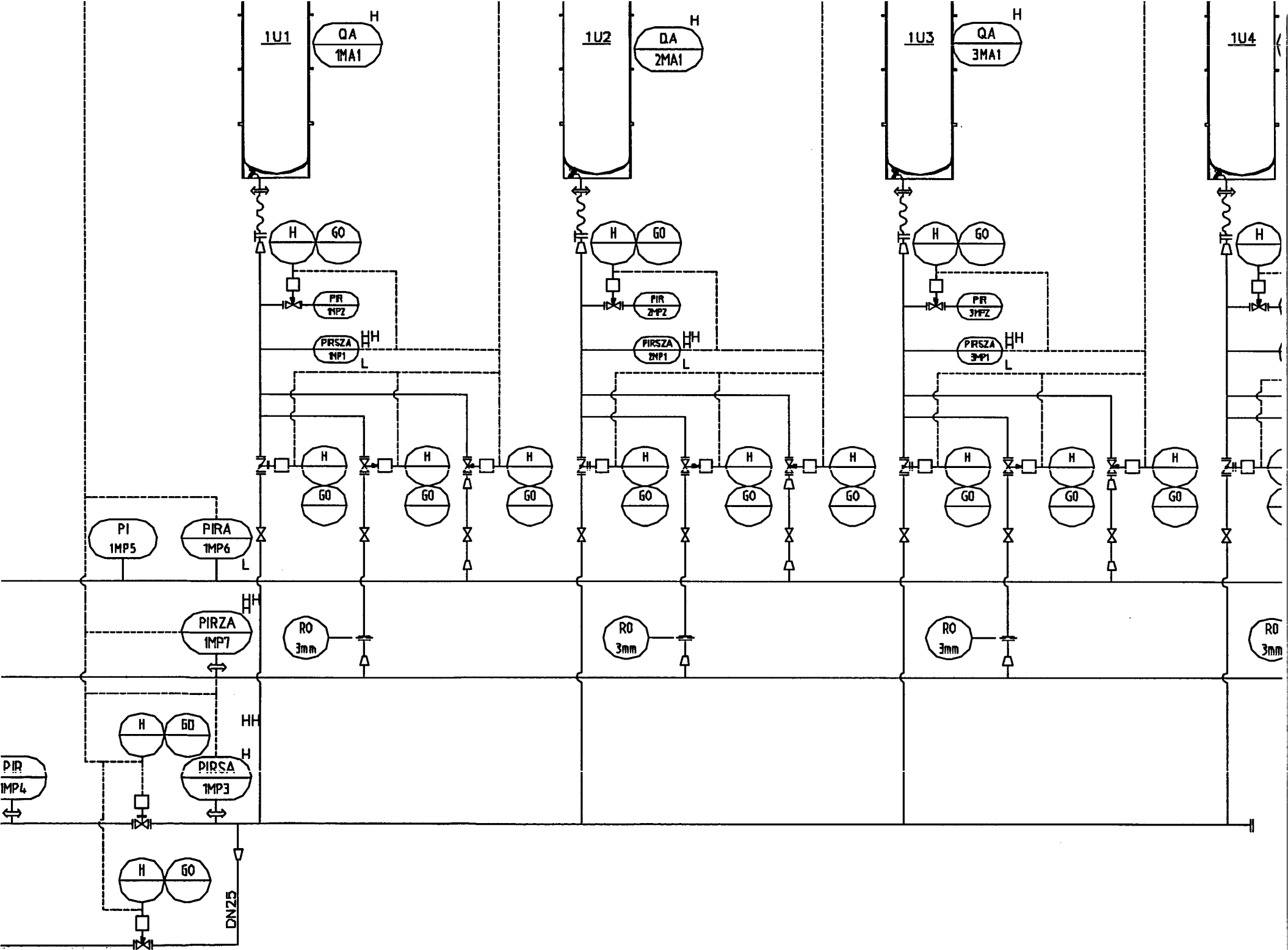


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3.6 PROCESS HAZARDS

The separation of uranium isotopes is a physical rather than chemical process. Natural uranium hexafluoride (UF_6) arrives at the National Enrichment Facility (NEF) in the solid phase in a 48-inch diameter cylinder. To begin the enrichment process, the 48-inch diameter feed cylinder is placed into a Solid Feed Station. The Solid Feed Station consists of an insulated enclosure, which is heated by electric heaters to 53°C (127°F).^{*} At this temperature and pressure (sub-atmospheric), the solid UF_6 sublimates into a gas. The gaseous UF_6 is fed to the cascades for enriching to a maximum of 5 % ^{235}U . An important safety feature of the feed system is that at no time does the UF_6 go into a liquid phase. Enriched and depleted UF_6 streams are withdrawn from the cascades by pumps and returned to the solid phase in Product and Tails Low Temperature Take-off Stations, respectively. These stations consist of insulated enclosures that are maintained at -25°C (-13°F) ^{*} by electrically operated chiller units. As the gaseous UF_6 enters the cylinder (either product or tails), desublimation into solid UF_6 occurs. No process chemical reactions are initiated.

Although the separation of isotopes is a physical rather than chemical process, chemical principles play an important role in the design of the facility. The phase behavior of UF_6 is critical to the design of all aspects of the facility. Chemical reactions include the undesirable reaction between UF_6 and water, which produces the toxic reaction products uranyl fluoride (UO_2F_2) and hydrogen fluoride (HF). Maintaining the UF_6 process piping at sub-atmospheric pressures minimizes this reaction in the event of a pipe leak. Other chemical reactions are controlled by utility systems that decontaminate equipment and remove contaminants from effluent streams and lubricating oil.

The process hazards associated with the NEF were identified in the Integrated Safety Analysis (ISA). These process hazards include radioactivity, toxicity of UF_6 and breakdown products, and criticality. The hazards from radioactivity were evaluated in the ISA and found to be low consequence. Some of the hazards associated with UF_6 release or criticality were found to be intermediate and high consequence. The potential accident sequences and consequences are discussed in greater detail in Section 3.7, General Types of Accident Sequences.

^{*}NOTE: Design process parameter values are specified with a datum of standard atmospheric pressure at sea level. These values will be finalized to reflect the site-specific National Enrichment Facility elevation during the design phase and the ISA Summary will be revised accordingly.

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3.7 GENERAL TYPES OF ACCIDENT SEQUENCES

Table 3.7-1, Accident Sequence and Risk Index, lists the potential accident sequences that were identified that could have consequences that exceed the performance criteria of 10 CFR 70.61 (CFR, 2003). The accident sequences identified in Table 3.7-1 include those from the classified and non-classified Integrated Safety Analysis (ISA). The likelihood, consequence, and risk ratings are also provided. The measures to reduce the risk to acceptable levels (Items Relied on for Safety (IROFS)) by either reducing the frequency of occurrence of the events or mitigating the consequences of the events are also identified. Additional details/descriptions of the accident sequences presented in Table 3.7-1 are provided in Table 3.7-2, Accident Sequence Descriptions. Again, these descriptions include the classified ISA results.

The results presented in Tables 3.7-1 and 3.7-2 are for the hazards identified for the process systems. The fire (external to the process systems) and external events (e.g., severe weather, seismic, transportation and industrial) hazards were assessed on a facility-wide basis and the results summarized in Tables 3.7-3, External Events and Fire Accident Sequences and Risk Index and 3.7-4, External Events and Fire Accident Descriptions. These are discussed in additional detail later in the text. Table 3.7-5, Uranic Material Assumptions for Criticality Accident Sequences, provides the assumed mass and enrichment values for ^{235}U for each of the criticality accident sequences presented in Tables 3.7-1 through 3.7-4.

The accident sequence risk assessment demonstrates that credible high-consequence events are highly unlikely and credible intermediate-consequence events are unlikely. IROFS necessary to prevent or mitigate event sequences that exceed 10 CFR 70.61 (CFR, 2003) criteria have been identified.

The definitions for the contents of each column in the accident summary tabulation in Table 3.7-1 and Table 3.7-3 are provided below. The ISA methodology is described in Section 3.1, General ISA Information.

Accident Identifier

This column identifies the accident sequence being analyzed. The ISA will have all accident sequences for each uniquely identified facility process. The accident sequence identifier has the format AAB-C where AA is the system/area from the table below, B is the Hazard and Operability (HAZOP) Analysis node number and C is the accident sequence number.

Accident Sequence System Identifier	
Identifier (AA)	System/Area
CL	Chemical Laboratory
CH	Technical Services Building (TSB) Contaminated Workshop and Laboratories HVAC
CP	Cylinder Preparation Room
DC	Contingency Dump
DS	Decontamination
EC	Cascade
FR	Fomblin Oil Recovery
LR	Laundry
LT	Liquid Effluent Treatment
LW	Liquid Effluent Collection
MS	Mass Spectrometry Laboratory
PB	Product Blending and Liquid Sampling
PT	Product Take-Off
RD	Cylinder Receipt and Dispatch
SV	Separations Building Gaseous Effluent Vent
SW	Solid Waste Collection
TP	Centrifuge Test/Centrifuge Post Mortem
TT	Tails Take-Off
TV	TSB Gaseous Effluent Vent
UF	UF ₆ Feed
VR	Ventilated Room

Initiating Event Index (Column a)

This column lists initiating events or IROFS failures that are typically identified in the Process Hazard Analysis (PHA) phase of the ISA and that may lead to consequences exceeding those identified in 10 CFR 70.61 (CFR, 2003). Initiating events are of several distinct types: (1) external events, such as hurricanes and earthquakes; (2) facility events external to the node being analyzed (e.g., fires, explosions, failures of other equipment, flooding from facility water sources); (3) deviations from normal operations of the process in the node (i.e., credible abnormal events); and (4) failures of IROFS of the node. The tabulated initiating events consist of those that involve an actual or assumed failure of IROFS or that cause a demand requiring IROFS to function to prevent consequences exceeding 10 CFR 70.61 (CFR, 2003) levels. The frequency index number for initiating events is given in the table in column (a)." Table 3.1-9, Failure Frequency Index Numbers, provides criteria for assigning a value to the frequency index.

Preventive Safety Parameter 1 or IROFS 1 Failure Index (Column b)

This column addresses the failure or success of the safety parameter designated to prevent consequences exceeding 10 CFR 70.61 (CFR, 2003) criteria. Specific IROFS that are needed to maintain the safety parameter are included in the table. The failure duration of the first IROFS is assigned using Table 3.1-11, Failure Duration Index Numbers. Accident sequences

where two IROFS must simultaneously be in a failed state require assignment of the three index numbers (1) the failure frequency of the first IROFS, (2) the duration of this failure and (3) the failure frequency of the second IROFS. Except where identified on Table 3.7-3, External Events And Fire Accident Sequences And Risk Index, failure duration index numbers are zero (zero corresponds to an average failure duration and test frequency of one year) and are therefore not explicitly shown on Table 3.7-1 and Table 3.7-3. Reverse sequences are not identified in Table 3.7-1 since the failure frequencies and the duration of outages of the first and second IROFS of accident sequences with multiple IROFS are the same. Accident sequences may be more easily described as an occurrence of an initiating event followed by a failure of the IROFS on demand. In these cases, the failure probability index number is assigned using Table 3.1-10, Failure Probability Index Numbers and the failure duration is assigned using Table 3.1-11.

Preventive Safety Parameter 2 or IROFS 2 Failure Index (Column c)

This column is provided in case a second preventive Safety Parameter or IROFS is designated. The failure probability on demand is assigned in the same manner as for preventive IROFS 1.

Mitigation IROFS Failure Index (Column d)

This column is provided in case IROFS are available to mitigate the consequences of the accident sequence. That is, they reduce, but do not eliminate, the consequences of an accident sequence. An IROFS that eliminates all adverse consequences is considered preventive.

Likelihood Index T Uncontrolled (U)/Controlled (C) (Column e) and Likelihood Category (Column f)

Column (f) lists the likelihood category number for the risk matrix, which is based on the total likelihood index for an accident sequence. Column (e) is the total likelihood index, T, is the sum of the indices for those events that comprise an accident sequence, which normally consists of the initiating event and failure of one or more IROFS, including any failure duration indices. Based on the sum of these indices, the likelihood category number for the risk matrix is assigned using Table 3.1-8, Determination of Likelihood Category.

Consequence Category (Type of Accident) (Column g)

This column is provided to assign the consequence category numbers based on estimating the consequences of all types (i.e., radiological, criticality, chemical, and environmental) of accident sequences that may occur. Accident sequences having IROFS to mitigate consequences are divided into two cases, one where the mitigation succeeds, and one where it fails, each with different consequences. The type of accident is also listed in parenthesis where T indicates chemical and CR indicates criticality.

Risk Index ($h = f \times g$) Uncontrolled(U)/Controlled (C) (Column h)

This column is provided to list the risk index, which is calculated as the product of the likelihood category and consequence category numbers. This is shown in the column heading by the formula " $h = f \times g$." Sequences with values of "h" less than or equal to 4 are acceptable. (See Table 3.1-6, Risk Matrix with Risk Index Values).

Comments and Recommendations

This column records ISA team conclusions.

3.7.1 Process Risk Assessment

The results of the risk assessment performed for each accident sequence are summarized in Table 3.7-1, Accident Sequence and Risk Index. The following information is provided for each accident sequence, including the inclusion of any events which were screened as not credible:

- Consequences for each general type of uncontrolled accident sequence
- Comparison of the accident consequences to the performance requirements of 10 CFR 70.61 (CFR, 2003) and designation of each as a 'high consequence event' (10 CFR 70.61(b)) (i.e., Consequence Category 3), an 'intermediate consequence event' (10 CFR 70.61(c)) (i.e., Consequence Category 2) or neither (i.e. an event of no regulatory concern (low consequence event)) (i.e., Consequence Category 1)
- Likelihood of occurrence of each accident sequence, expressed in terms of the likelihood category (3=not unlikely, 2=unlikely, 1=highly unlikely)
- Classification of the risk of each uncontrolled accident sequence
- Classification of the likelihood of occurrence of each accident sequence (following application of IROFS)
- Classification of the risk of each controlled accident sequence

The detailed descriptions for the accident sequences are provided in Table 3.7-2, Accident Sequence Descriptions.

3.7.2 Fire and External Events Risk Assessment

As discussed previously, facility fires (FF) and external events (EE) were assessed on a facility-wide basis. The results of this assessment are presented in Tables 3.7-3, External Events and Fire Accident Sequences and Risk Index, and 3.7-4, External Events and Fire Accident Descriptions. The ISA methodology utilized for external events and facility fires is described in Section 3.1, General Integrated Safety Analysis (ISA) Information. The information contained in the columns in Table 3.7-3, External Events and Fire Accident Sequences and Risk Index is defined in Section 3.7.1, Process Risk Assessment.

3.7.3 Selected Consequence Analysis

To support the classification of ISA events and sequences by the National Enrichment Facility Emergency Plan, consequence analyses have been performed for the postulated events identified in the ISA Summary for which protective actions may be necessary. The only

postulated events are nuclear criticality and loss of containment leading to a very large release of UF₆. These analyses have been performed for a Nuclear Criticality scenario and for a Blending Donor Station Heater Controller Failure and Heater Run Away scenario. For both of these scenarios, IROFS have been designated which result in acceptable risk results for these accidents. However, to support the classification of ISA events and sequences by the Emergency Plan, no credit for these IROFS is taken in the results presented in this section.

3.7.3.1 Nuclear Criticality

A conservative public consequence calculation for a criticality event has been completed. The consequence analysis methodology is based on NUREG/CR-6410 (NRC, 1998). The calculations were performed using the following assumptions:

- The criticality was assumed to occur in a vented vessel of unfavorable geometry containing a 400 L (105.6 gal) solution of uranium enriched in ²³⁵U
- The criticality produces an initial burst of 1.0E+18 fissions, followed by 47 bursts of 1.92E+17 fissions per burst, for a total of 1.0E+19 fissions in 8 hours
- The event terminates when 100 L (26.4 gal) of the initial 400 L (105.6 gal) of solution is evaporated.

The consequence calculations included dose contributions from:

- Prompt gamma rays produced by the criticality event
- Fission products produced by the criticality event
- The uranium isotopes.

The off-site radiological impacts considered:

- Direct shine doses from prompt gamma radiation emitted during the criticality event
- Submersion, inhalation, and ground shine doses from radioactive material released to the atmosphere as a result of the criticality event.

For the prompt gamma radiation, the source was assumed to be shielded by a 20.3 cm (8 inch) thick concrete wall, and receptors were assumed to be at 340 m from the criticality site and at a number of other distances out to 1.61 km (one mile). Ensuing doses were calculated through use of a point-kernel shielding code, for a 2-hr exposure interval and for the duration of the criticality event (8 hrs).

For the atmospheric releases, 100 % of the noble gases produced by the criticality events and 25 % of the halogens (iodines) produced by the criticality events, and 0.05 % of the particulates and uranium isotopes in the evaporated solution (i.e., 0.0125 % of the totals) were assumed to be released from the vessel where the criticality takes place and released to the atmosphere without mixing or decay within the building. The atmospheric releases were assumed to be at uniform rates representative of the actual airborne releases from the criticality events during the 0 to 2 hr interval and the 2 to 8 hr interval. Credit for deposition within the building and ductwork was conservatively ignored.

Dispersion and ground-deposition of the released radioactivity was based on a computer code, which implements the methodology in Regulatory Guide 1.145 (NRC, 1982) and uses a finite-cloud-correction capability for cloud shine.

Dispersion/deposition calculations were performed for the 5th percentile meteorology to represent adverse dispersion conditions (i.e., better dispersion conditions prevail 95 % of the time), and 50th percentile meteorology to represent the realistic-case analyses.

The ensuing radiological consequences (submersion, inhalation and ground-shine pathways) were calculated at the critical receptor on the site boundary and at a number of distances out to 1.61 km (one mile), using a computer code for radiological impact evaluations. The exposure intervals were assumed to be 2 hrs and 8 hrs, the latter representing the end of the criticality event.

The 2-hr and 8-hr Total Effective Dose Equivalent (TEDE) doses at the site boundary were determined to be 3.1 mSv (310 mRem) and 8.0 mSv (800 mRem), respectively; these doses include the prompt gamma radiation and the released cloud contributions under accident meteorology (5th percentile). The corresponding doses as a function of distance from the criticality site are presented in Figure 3.7-1, TEDE Doses from Postulated Criticality, for both accident (5 %) and average meteorology. These results indicate that the consequences of a postulated criticality event upon members of the public at or beyond the site boundary would be considerably below the threshold for an intermediate consequence event, as defined by 10 CFR 70.61 (CFR, 2003).

This calculation conservatively bounds the various locations in the facility where a criticality event is possible.

3.7.3.2 Blending Donor Station Heater Controller Failure and Heater Run Away (No IROFS Credited)

The initiating event for this scenario is the failure of the Blending Donor Station heater controller causing the blending donor heater within the station to remain on.

For the uncontrolled accident sequence, the product cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the liquid UF₆. Upon cylinder rupture, the product cylinder content of UF₆ is released within the Blending Donor Station. Since the station enclosure is not air tight, the UF₆ is released to the Blending and Liquid Sampling Area. The UF₆, when in contact with air, will produce HF gas and UO₂F₂. The release into the building is then released to the outside. The HVAC is conservatively assumed to be operating at the maximum ventilation flow rate. HF and UO₂F₂ are further transported to outside the site boundary.

Atmospheric dispersion factors were generated for various distances downwind using the algorithms presented in Regulatory Guide 1.145 (NRC, 1982). Two sets of meteorological conditions were evaluated: F stability class with a wind speed of 0.6 m/sec (2.0 ft/s) (representing conservative case consequences) and D stability class with a wind speed of 2.0 m/sec (6.6 ft/s) (representing typical or average case consequences). These conditions are consistent with those used in the consequence analysis for criticality. The results for this scenario are presented in Figures 3.7-2 through 3.7-5. The detailed discussion of the consequence analysis methodology is provided in the ISA documentation.

3.7.4 References

CFR, 2003. Title 10, Code of Federal Regulations, Section 70.61, Performance Requirements, 2003.

NRC, 1982. Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, Regulatory Guide 1.145, Revision 1, U.S. Nuclear Regulatory Commission, 1982.

NRC, 1998. Nuclear Fuel Cycle Accident Analysis Handbook, NUREG/CR-6410, U.S. Nuclear Regulatory Commission, March 1998.

TABLES

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
TT2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
TT2-1	-2	(IROFS1) -2	(IROFS2) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
TT2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
TT2-2	-2	(IROFS38) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
TT3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
TT3-1	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
TT3-1	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
TT3-1	-2	(IROFS3) (Success)	N/A	(IROFS47b) (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
UF1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
UF1-1	-2	(IROFS4) -2	(IROFS5) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
UF2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
UF2-1	-2	(IROFS1) -2	(IROFS2) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
UF2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
UF2-2	-2	(IROFS38) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
UF3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
UF3-1	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
UF3-1	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
UF3-1	-2	(IROFS3) (Success)	N/A	(IROFS47a) (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PT2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PT2-1	-2	(IROFS1) -2	(IROFS2) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
PT2-2	(IROFS6a) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
PT2-2	(IROFS6a) -1	(IROFS7) -3	(IROFS6b) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PT2-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PT2-3	-2	(IROFS16c) -2	(IROFS16d) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PT2-4	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PT2-4	-2	(IROFS38) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PT2-5	(IROFS30a) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
PT2-5	(IROFS30a) -1	(IROFS30b) -2	(IROFS30c) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PT3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PT3-1	-2	(IROFS3) -2	(IROFS8a) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PT3-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PT3-2	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
PT3-2	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
PT3-2	-2	(IROFS3) (Success)	N/A	(IROFS47a) (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PT3-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PT3-3	-2	(IROFS8a) -2	(IROFS9) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PT3-5	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PT3-5	-2	(IROFS15) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB1-1	-2	(IROFS4) -2	(IROFS5) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
PB1-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB1-3	-2	(IROFS45) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB2-1	-2	(IROFS1) -2	(IROFS2) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB2-2	-2	(IROFS16a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB2-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB2-3	-2	(IROFS3) -2	(IROFS8a) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB2-4	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB2-4	-2	(IROFS38a) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB2-5	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB2-5	-2	(IROFS16c) -2	(IROFS16d) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB2-6	(IROFS30a) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
PB2-6	(IROFS30a) -1	(IROFS30b) -2	(IROFS30c) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB3-1	-2	(IROFS3) -2	(IROFS8a) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
PB3-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB3-2	-2	(IROFS9) -2	(IROFS8a) -2	N/A	-6 (C)	1	3 (CR)	3 (U)	Acceptable Risk
PB3-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB3-3	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB3-3	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47a) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
PB3-3	-2	(IROFS3)	N/A	(IROFS47a)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
		(Success)		(Failure, -3)					
PB4-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB4-1	-2	(IROFS10) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB4-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB4-2	-2	(IROFS11) -2	(IROFS12) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB4-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB4-3	-2	(IROFS10) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB4-4	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
PB4-4	-2	(IROFS42) -2	(IROFS10) -3	N/A	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
PB4-5	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
PB4-5	-2	(IROFS13) -2	(IROFS8b) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
VR1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
VR1-1	-2	(IROFS3) -2	(IROFS21) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
VR1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
VR1-2	-2	(IROFS22) -2	(IROFS21) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
VR1-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
VR1-3	-2	(IROFS23a) -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
VR1-5	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
VR1-5	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
VR1-5	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
VR1-5	-2	(IROFS3) (Success)	N/A	(IROFS47b) (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
VR2-1	-2	N/A	N/A	N/A	-2 (U)	3	2 (T)	6 (U)	IROFS Required
VR2-1	-2	(IROFS23b)	N/A	N/A	-4 (C)	2	2 (T)	4 (C)	Acceptable

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
		-2							Risk
VR2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
VR2-2	-2	(IROFS23b) -2	(IROFS24a) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
VR2-7	(IROFS31a) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
VR2-7	(IROFS31a) -1	(IROFS31b) -2	(IROFS31c) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
FR1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
FR1-1	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
FR1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
FR1-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
FR2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
FR2-1	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
FR2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (C)	IROFS Required
FR2-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS1-1	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS1-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS1-3	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
DS1-3	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS2-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS2-1	-2	(IROFS14a)	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
		-3							Risk
DS2-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS2-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS2-3	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
DS2-3	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS3-1	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DS3-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
DS3-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
CL3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
CL3-1	-2	(IROFS20) -2	(IROFS21) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
CL3-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
CL3-2	-2	(IROFS24b) -2	(IROFS46) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
CL3-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
CL3-3	-2	(IROFS43) -2	(IROFS24b) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
CP1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
CP1-1	-2	(IROFS3) -2	(IROFS21) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
CP1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
CP1-2	-2	(IROFS16a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
CP1-4	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
CP1-4	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Failure, -3)	-7 (C)	1	3 (T)	3 (C)	Acceptable Risk
CP1-4	-2	(IROFS3) (Failure, -2)	N/A	(IROFS47b) (Success)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
CP1-4	-2	(IROFS3) (Success)	N/A	(IROFS47b) (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
SW1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
SW1-1	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
SW1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
SW1-2	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW1-1	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
LW1-1	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
LW1-2	-2	(IROFS14a) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW1-3	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
LW1-3	-2	(IROFS14b) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW2-1	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
LW2-1	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW3-1	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
LW3-1	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
LW5-1	(IROFS19c) -1	N/A	N/A	N/A	-1 (U)	3	3 (CR)	9 (U)	IROFS Required
LW5-1	(IROFS19c) -1	(IROFS19a) -2	(IROFS19d) -2	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
RD1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
RD1-1	-2	(IROFS45) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
DC1-1	0	N/A	N/A	N/A	0 (U)	3	3 (T)	9 (U)	IROFS Required
DC1-1	0	(IROFSC1b) -2	(IROFS3) -2,	N/A	-6 (U)	1	3 (T)	3 (C)	Acceptable Risk

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
			(IROFSC18) -2						
DC1-2	0	N/A	N/A	N/A	0 (U)	3	2 (T)	6 (U)	IROFS Required
DC1-2	0	(IROFSC1b) -2	(IROFS3) -2	N/A	-4 (U)	2	2 (T)	4 (C)	Acceptable Risk
DC1-3	0	N/A	N/A	N/A	0 (U)	3	3 (T)	9 (U)	IROFS Required
DC1-3	0	(IROFSC1b) -2	(IROFS3) -2, (IROFSC18) -2	N/A	-6 (U)	1	3 (T)	3 (C)	Acceptable Risk
DC1-4	0	N/A	N/A	N/A	0 (U)	3	2 (T)	6 (U)	IROFS Required
DC1-4	0	(IROFSC1b) -2	(IROFS3) -2	N/A	-4 (U)	2	2 (T)	4 (C)	Acceptable Risk
DC1-5	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
DC1-5	-2	(IROFS3) -2	(IROFSC18) -2	N/A	-6 (U)	1	3 (T)	3 (C)	Acceptable Risk
DC1-6	-2	N/A	N/A	N/A	-2	3	2 (T)	6 (U)	IROFS Required
DC1-6	-2	(IROFS3) -2	N/A	N/A	-4	2	2 (T)	4 (C)	Acceptable Risk
DC1-7	-2	N/A	N/A	N/A	-2	3	3 (T)	9 (U)	IROFS Required
DC1-7	-2	(IROFS3) -2	(IROFSC18) -2	N/A	-6	1	3 (T)	3 (C)	Acceptable Risk
DC1-8	-2	N/A	N/A	N/A	-2	3	2 (T)	6 (U)	IROFS Required
DC1-8	-2	(IROFS3) -2	N/A	N/A	-4	2	2 (T)	4 (C)	Acceptable Risk
EC3-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
EC3-1	-2	(IROFSC6) -3	N/A	N/A	-5 (C)	1	3 (CR)	3 (C)	Acceptable Risk
EC4-1	-2	N/A	N/A	N/A	-2	3	3 (T)	9 (U)	IROFS Required
EC4-1	-2	(IROFS3) -2	(IROFSC18) -2	N/A	-6	1	3 (T)	3 (C)	Acceptable Risk
EC4-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
EC4-2	-2	(IROFS3) -2	(IROFS8a) -2	N/A	-6 (C)	1	3 (CR)	3 (C)	Acceptable Risk
TP8-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required

Table 3.7-1 Accident Sequence and Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Conseq. Category (Type of Accident)	Risk Index (h=f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
TP8-1	-2	(IROFSC15) -2	(IROFSC16) -2	N/A	-6 (C)	1	3 (T)	3 (C)	Acceptable Risk
TP8-2	-2	N/A	N/A	N/A	-2	3	3 (T)	9 (U)	IROFS Required
TP8-2	-2	(IROFS3) -2	(IROFSC18) -2	N/A	-6	1	3 (T)	3 (C)	Acceptable Risk
CHEM RELEASE-WORKER EVAC	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
CHEM RELEASE-WORKER EVAC	-2	N/A	N/A	IROFS39c -3	-5 (U)	1	1 (T)	1 (C)	Acceptable Risk
LOSS OF SAFE-BY-DESIGN ATTRIBUTE	-5	N/A	N/A	N/A	-5 (U)	1	3(CR)	3(U)	Acceptable Risk

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: TT2-1

The initial failure (initiating event) is the tails low temperature take-off station cold box defrost heater controller failure, causing the cold box heater within the tails low temperature take-off station to remain on.

For the uncontrolled accident sequence, the tails cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF_6 . Upon tails cylinder rupture, the tails cylinder content of UF_6 is released within the tails low temperature take-off station. Since the station enclosure is not air tight, the UF_6 is released to the UF_6 Handling Area. This sequence, if uncontrolled, would require a significant time to cause a UF_6 release since the heat up rate is limited by heater capacity. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of defrost heater and fan on high air return temperature to ensure cylinder integrity (IROFS1) and (2) an automatic trip of defrost heater and fan on high station internal air temperature to ensure cylinder integrity (IROFS2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS1. This corresponds to single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS2. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: TT2-2

The initial failure (initiating event) is the failure of the tails low temperature take-off station load cell causing the tails cylinder to be over filled.

The over filled tails cylinder is then warmed to ambient and ruptures in the tails low temperature take-off station.

Upon tails cylinder rupture UF_6 is released to the tails low temperature take-off station. Since the station enclosure is not air tight, UF_6 is released to the UF_6 Handling Area. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is administratively limit the cylinder fill mass to ensure cylinder integrity by verifying cylinder weight is within specified trending limits once per shift during filling of the cylinder (IROFS38). If the acceptance criterion is not met, then fill of the associated cylinder shall be terminated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 years, and have not had a failure of this type.

The failure probability index of (-3) was selected for IROFS38. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS38 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: TT3-1

The initial failure (initiating event) is the tails carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through various process valves.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge of the tails vacuum pump, causing high pressure and thus failing the tails vacuum pump discharge flange seal, causing a release of UF_6 to the UF_6 Handling Area. This event was calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measure is an automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47b). As a result of IROFS47b, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 years, and have not had a failure of this type.

The failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

The failure probability index of (-3) was selected for IROF47b. This corresponds to a single passive engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: UF1-1

The initial failure (initiating event) is the solid feed station heater controller failure, causing the solid feed station heater within the solid feed station to remain on.

For the uncontrolled accident sequence, the feed cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF_6 . Upon cylinder rupture, the feed cylinder content of UF_6 is released within the solid feed station. Since the station enclosure is not air tight, the UF_6 is released to the UF_6 Handling Area. This sequence, if uncontrolled, would require a significant time to cause a UF_6 release since the heat up rate is limited by the heater capacity. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of station heaters on high cylinder temperature to ensure cylinder integrity (IROFS4) and (2) an automatic trip of station heaters on high station internal air temperature to ensure cylinder integrity (IROFS5).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index of (-2) was selected for IROFS4. This corresponds to a single active engineered IROFS per NUREG-1520.

The failure probability index of (-2) was selected for IROFS5. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: UF2-1

The initial failure (initiating event) is the feed purification low temperature take-off station defrost heater controller failure, causing the defrost heater within the feed purification low temperature take-off station to remain on.

For the uncontrolled accident sequence, the feed purification cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF₆. Upon cylinder rupture, the feed purification cylinder content of UF₆ is released within the feed purification station. Since the station enclosure is not air tight, the UF₆ is released to the UF₆ Handling Area exposing workers and the public. This sequence, if uncontrolled, would require a significant time to cause a UF₆ release since the heat up rate is limited by heater capacity. This event is assumed to have a high consequence to the worker and to the public.

For the controlled accident sequence, the preventive measures are: (1) an automatic trip of the defrost heater and fan on high air return temperature to ensure cylinder integrity (IROFS1), and (2) an automatic trip of the defrost heater and fan on high station internal air temperature to ensure cylinder integrity (IROFS2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index of (-2) was selected for IROFS1. This corresponds to a single active engineered IROFS per NUREG-1520.

The failure probability index of (-2) was selected for IROFS2. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: UF2-2

The initial failure (initiating event) is the failure of the feed purification low temperature take-off station load cell causing the cylinder to be over filled.

For the uncontrolled accident sequence, the over filled cylinder is warmed up to ambient and ruptures in the feed purification low temperature take-off station. Upon cylinder rupture, UF₆ is released to the feed purification low temperature take-off station. Since the station enclosure is not air tight, the UF₆ is released to the UF₆ Handling Area. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is administratively limit the cylinder fill mass to ensure cylinder integrity by verifying cylinder weight is within specified trending limits once per shift during filling of the cylinder (IROFS38). If the acceptance criterion is not met, then fill of the associated cylinder shall be terminated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 years, and have not had a failure of this type.

The failure probability index of (-3) was selected for IROFS38. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS38 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: UF3-1

The initial failure (initiating event) is the feed purification carbon trap becomes saturated with UF₆ caused by a small UF₆ leak through a cold trap outlet isolation valve.

For the uncontrolled accident sequence, a UF₆ plug forms on the discharge of the feed purification vacuum pump, causing high pressure and thus failing the feed purification vacuum pump discharge flange seal, causing a release of UF₆ to the UF₆ Handling Area. This event was calculated to have a high consequence to the worker.

For the controlled accident sequence, the preventive measure is an automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF₆ (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47a). As a result of IROFS47a, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

The failure probability index of (-3) was selected for IROFS47a. This corresponds to a single passive engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT2-1

The initial failure (initiating event) is the product low temperature take-off station cold box defrost heater controller failure, causing the cold box heater within the product low temperature take-off station to remain on.

For the uncontrolled accident sequence, the product cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF₆. Upon product cylinder rupture, the product cylinder content of UF₆ is released within the product low temperature take-off station. Since the station enclosure is not air tight, the UF₆ is released to the UF₆ Handling Area. This sequence, if uncontrolled, would require a significant time to cause a UF₆ release since the heat up rate is limited by heater capacity. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of defrost heater and fan on high air return temperature to ensure cylinder integrity (IROFS1), (2) an automatic trip of defrost heater and fan on high station internal air temperature to ensure cylinder integrity (IROFS2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS1. This corresponds to single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS2. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT2-2

The initial failure (initiating event) is a failure of IROFS6a, administrative verification of distinguishing visual markings/identification of 48X and 48Y cylinders within the UF₆ area to ensure that filled product cylinders are not placed on-line to the cascade. This failure could result in an operator attempting to insert a full 48Y product cylinder into a solid feed station with the potential of a criticality event.

For the uncontrolled accident sequence, a product cylinder (48Y) is placed in a feed station thus causing enrichment higher than licensed limits. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) a design feature to physically prevent product cylinder within the UF₆ area from being placed in a Solid Feed Station (IROFS7) and (2) administrative verification of ²³⁵U concentration in feed cylinders to ensure that product material is not used as feed material by sampling and assay analysis (IROFS6b) before the cylinder is placed on-line to the cascade. If the acceptance criterion from the sampling and assay analysis is not met, the cylinder shall not be placed on-line to the cascade.

The frequency index number for the initiating event (failure of IROFS6a) was determined to be (-1). This frequency probability index number corresponds to failure of an administrative IROFS with large margin per NUREG-1520.

The failure probability index number of (-2) was selected for IROFS6b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

The failure probability index number for (IROFS7) was determined to be (-3), a single passive engineered IROFS consistent with NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT2-3

The initial failure (initiating event) is excessive moderator being introduced into a product cylinder after the cylinder is put into the product take-off station with the potential for a criticality event. This excessive moderator is assumed to be a result of moisture laden air in-leakage to the process system.

For the uncontrolled accident sequence, moderator ingress (moisture in-leakage) via the product take-off system enters a product cylinder. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit addition of moderator from system venting to ensure subcriticality using an independent means of monitoring system venting from that used for IROFS16d (IROFS16c), administratively limit addition of moderator from system venting to ensure subcriticality (IROFS16d) using an independent means of monitoring system venting from that used for IROFS16c. For these preventive measures, if the acceptance criterion is not met, then venting of the associated cylinder shall be stopped and the cylinder filling processed terminated. Excessive venting is indicative of process system air in-leakage that may result in excessive moderator being introduced into a product cylinder.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index number of (-2) was selected for IROFS16c. This frequency probability index number corresponds to an administrative IROFS per NUREG-1520.

The failure probability index number of (-2) was selected for IROFS16d. This frequency probability index corresponds to an administrative IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT2-4

The initial failure (initiating event) is the failure of the product low temperature take-off station load cell causing the cylinder to be over filled.

For the uncontrolled accident sequence, the over filled cylinder is then warmed up to ambient and ruptures in the product low temperature take-off station. Upon cylinder rupture, UF₆ is released to the product low temperature take-off station. Since the station enclosure is not air tight, the UF₆ is released to the UF₆ Handling Area. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is administratively limit the cylinder fill to ensure cylinder integrity by verifying cylinder weight is within specified trending limits once per shift during filling of the cylinder (IROFS38). If the acceptance criterion is not met, then fill of the associated cylinder shall be terminated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 years, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS38. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS38 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: PT2-5

The initial failure (initiating event) is hydrocarbon oil (a moderator) is used in place of perfluorinated polyether (PFPE) oil during maintenance of vacuum pumps associated with Product, Cylinder Preparation, Ventilated Room and Assay Sampling Systems. The hydrocarbon oil is assumed to enter the process stream and is deposited in a product cylinder.

The condition that needs to be fulfilled to result in a criticality event due to moderator ingress introduced in a product cylinder in the product take-off station is excessive moderator (hydrocarbon oil) is introduced in the product cylinder. The introduction of excessive moderator is due to a vacuum pump improperly filled with hydrocarbon oil.

For the uncontrolled accident sequence, the failure of IROFS30a, administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by controlling the type of oil used in process vacuum pumps, is assumed. Excess moderator is deposited in a product cylinder in the product take-off station. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and the public.

For the controlled accident sequence, the preventive measures are (1) administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by verifying, through test prior to addition of oil, that process vacuum pump oil is not hydrocarbon oil (IROFS30b) and (2) administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderator control assumptions are maintained by verifying, through test after oil addition prior to placing vacuum pumps in the process system, that process vacuum pump oil is not hydrocarbon oil (IROFS30c). If acceptance criterion is not met, then for IROFS30b, oil shall not be added to the associated process vacuum pump, and for IROFS30c, the associated vacuum pump shall not be placed in the process system.

The frequency index number for the initiating event (IROFS30a failure) was determined to be (-1) which is based on failure of an administrative IROFS with large margin per NUREG-1520.

A failure probability index of (-2) was selected for IROFS30b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS30c. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT3-1

The initial failure (initiating event) is the product vent system carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through a product cold trap outlet valve. Continued UF_6 leakage to the product vent system carbon trap results in UF_6 being released into the Separations Building (SB) Gaseous Effluent Vent System (GEVS). The leak into the SB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters or electrostatic precipitators to form a critical mass.

The combination of these conditions, is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) an automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8a).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT3-2

The initial failure (initiating event) is the product vent subsystem carbon trap becoming saturated with UF₆ caused by a small UF₆ leak through a product cold trap valve.

For the uncontrolled accident sequence, a UF₆ plug forms on the discharge of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF₆ to the UF₆ Handling Area. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measure is an automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF₆ (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47a). As a result of IROFS47a, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 years, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

The failure probability index of (-3) was selected for IROF47a. This corresponds to a single passive engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PT3-3

The initial failure (initiating event) is the UF_6 cold trap outlet valve fails open during the back gas mode and results in high UF_6 flow through the carbon trap. A high UF_6 flow through the carbon trap results in high temperature in the carbon trap and release of excessive UF_6 into the SB GEVS. The leak into the SB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters or electrostatic precipitators to form a critical mass.

The combination of these conditions, is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of the vacuum pump on carbon trap high temperature to ensure the carbon trap does not pass excessive UF_6 (IROFS9) and (2) an automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8a).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS9. This corresponds to single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Accident Identifier: PT3-5

The initial condition is initial transfer of enriched uranic material during decontamination/waste disposal into a non-safe-by-design container. The worker is required to initially transfer enriched uranic material into safe-by-design containers.

Note that subsequent liquid waste transfers between non-safe-by-design containers are addressed by accident sequences DS1-3, DS2-3, LW1-1, LW2-1, LW3-1, and LW5-1 and subsequent solid waste bulking operations are addressed by accident sequence VR2-7.

The description of this sequence (i.e., the uncontrolled sequence) is the following:

- (1) The worker transfers enriched uranic material during decontamination/waste disposal (i.e., from washing flex hose, emptying carbon trap, draining oil from product pump, scraping breakdown materials from product pump internals) into a non-safe-by-design container.
- (2) Multiple inappropriate decontamination/waste disposal activities and/or failures occur (e.g., multiple occurrences of failure to use safe-by-design containers).

For the controlled accident sequence, the preventive measure is administratively restrict an independent parameter of the criticality sequence to ensure subcritical configuration by preventing additional transfer of enriched uranic material to another container if that container contains enriched uranic material and is a non-safe-by-design container (IROFS15) prior to the transfer of the enriched uranic material into a container. If the acceptance criterion are not met, then the transfer of enriched uranic material to the container shall not be initiated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS15, an enhanced administrative IROFS consistent with NUREG-1520. IROFS15 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB1-1

The initial failure (initiating event) is the blending donor station heater controller fails causing the heater within the blending donor station to remain on.

For the uncontrolled accident sequence, the donor cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF₆. Upon cylinder rupture, the donor cylinder content of UF₆ is released within the donor station. Since the station enclosure is not air tight, the UF₆ is released to the Blending and Liquid Sampling Area. This sequence, if uncontrolled, would require significant time to cause a UF₆ release since the heat up rate is limited by the heater capacity. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of station heaters on high cylinder temperature to ensure cylinder integrity (IROFS4), (2) an automatic trip of station heaters on high station internal air temperature to ensure cylinder integrity (IROFS5).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index of (-2) was selected for IROFS4. This corresponds to a single active engineered IROFS per NUREG-1520.

The failure probability index of (-2) was selected for IROFS5. This corresponds to a single active engineered IROFS per NUREG-1520.

Accident Identifier: PB1-2

This sequence was removed.

Sequence PB1-2 described a product blending donor cylinder and the moderator control by tracking venting operations. Donor cylinders are not vented.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB1-3

The initiating event allows placing product 48Y and 30B cylinders into a non-safe criticality interaction arrangement (i.e., a non-analyzed condition). The initial condition is an operator would have stacked a product cylinder on another product cylinder in the Blending and Liquid Sampling Area

For the uncontrolled accident sequence, product cylinders are stacked more than one high next to another product cylinder . A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is (IROFS45) to ensure subcritical geometry, prior to moving a cylinder containing enriched uranium in the CRDB or the Blending and Liquid Sampling Area, verify that the stored cylinders containing enriched uranium in these areas are in a horizontal, co-planar (i.e., non-stacked), condition and that no other cylinder containing enriched uranium is in movement in the associated area. If the acceptance criterion are not met, then the cylinder containing enriched uranium shall not be moved.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS45. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS45 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB2-1

The initial failure (initiating event) is the blending receiver station cold box defrost heater controller failure, causing the heater within the receiver station to remain on.

For the uncontrolled accident sequence, the product cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF₆. Upon product cylinder rupture, the product cylinder content of UF₆ is released within the receiver station. Since the station enclosure is not air tight, the UF₆ is released to the Blending and Liquid Sampling Area. This sequence, if uncontrolled, would require a significant time to cause a UF₆ release since the heat up is limited by heater capacity. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of defroster heater and fan on high air return temperature to ensure cylinder integrity (IROFS1), (2) an automatic trip of defroster heater and fan on high station internal air temperature to ensure cylinder integrity (IROFS2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS1. This corresponds to single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS2. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB2-2

The initial failure (initiating event) is excessive moderator introduced into the receiver cylinder before being put in the blending receiver station.

The condition that needs to be fulfilled to result in a criticality event due to moderator ingress introduced in a receiver cylinder before and subsequently placed into the blending receiver station is excessive moderator (hydrocarbon oil and water) present in the receiver cylinder.

For the uncontrolled accident sequence, excessive moderator (hydrocarbon and water) is present in the receiver cylinder before placed into a blending receiver station. This could be due to excessive hydrocarbon oil and water present in new or cleaned cylinders. The receiver cylinder is placed into the blending receiver station and placed online. This event is assumed to result in a high consequence to the worker and the public.

For the controlled sequence, the preventive measure is administratively limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality by allowing no visible oil and by limiting cylinder vapor pressure prior to introducing product (IROFS16a). If the acceptance criteria are not met, then product shall not be introduced into the associated cylinder.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index number of (-3) was selected for IROFS16a. This frequency probability index number corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS16a is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB2-3

The initial failure (initiating event) is the Blending and Sampling Vent carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through the cold trap valve. Continued UF_6 leakage to the Blending and Sampling Vent carbon trap results in UF_6 being released into the SB GEVS. The leak into the SB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters or electrostatic precipitator to form a critical mass.

The combination of these conditions is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) an automatic trip on ^{235}U selective gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8a).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Accident Identifier: PB2-4

The initial failure (initiating event) is the failure of the blending receiver low temperature take-off station load cell causing the cylinder to be over filled.

For the uncontrolled sequence, the over filled cylinder is then warmed up to ambient and ruptures in the blending receiver low temperature take-off station. Upon cylinder rupture, UF₆ is released to the blending receiver low temperature take-off station. Since the station enclosure is not air tight, the UF₆ is released to the Blending and Liquid Sampling Area. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is administratively limit the cylinder fill mass to ensure cylinder integrity by verifying cylinder weight is within specified trending limits once per shift during filling of the cylinder (IROFS38). If the acceptance criteria is not met, then fill of the associated cylinder shall be terminated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index of (-3) was selected for IROFS38. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS38 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB2-5

The initial failure (initiating event) is excessive moderator being introduced into a product cylinder after the cylinder is put into the station with the potential for a criticality event. The excessive moderator is assumed to be a result of moisture laden air in-leakage to the process system.

For the uncontrolled accident sequence, moderator ingress (moisture in-leakage) via the product take-off system enters a product cylinder. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit addition of moderator from system venting to ensure cylinder subcriticality using an independent means of monitoring system venting from that used for IROFS16d (IROFS16c) and (2) administratively limit addition of moderator from system venting to ensure cylinder subcriticality (IROFS16d) using an independent means of monitoring system venting from that used for IROFS16c. For these preventive measures, if the acceptance criterion is not met, then venting of the associated cylinder shall be stopped and the cylinder filling process stopped. Excessive venting is indicative of process system air in-leakage that may result in excessive moderator being introduced into a product cylinder.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index number of (-2) was selected for IROFS16c. This frequency probability index number corresponds to an administrative IROFS per NUREG-1520.

The failure probability index number of (-2) was selected for IROFS16d. This frequency probability index corresponds to an administrative IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB2-6

The initial failure (initiating event) is hydrocarbon oil (a moderator) is used in place of perfluorinated polyether (PFPE) oil during maintenance of Cylinder Preparation, Ventilated Room and Blending and Liquid Sampling System vacuum pumps. The hydrocarbon oil is assumed to enter the process stream and is deposited in a product cylinder.

The condition that needs to be fulfilled to result in a criticality event due to moderator ingress introduced in a product cylinder in the product take-off station is excessive moderator (hydrocarbon oil) is introduced in the product cylinder. The introduction of excessive moderator is due to a vacuum pump improperly filled with hydrocarbon oil.

For the uncontrolled accident sequence, the failure of IROFS30a, administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by controlling the type of oil used in process vacuum pumps, is assumed. Excess moderator is deposited in a product cylinder in plant into a product take-off station. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and the public.

For the controlled accident sequence, the preventive measures are (1) administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by verifying, through test prior to addition of oil, that process vacuum pump oil is not hydrocarbon oil (IROFS30b) and (2) administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderator control assumptions are maintained by verifying, through test (after oil addition) prior to placing vacuum pumps in the process system, that process vacuum pump oil is not hydrocarbon oil (IROFS30c). If the acceptance criteria is not met, then for IROFS30b, oil shall not be added to the associated process vacuum pump, and for IROFS30c, the associated vacuum pump shall not be placed in the process system.

The frequency index number for the initiating event (IROFS30a failure) was determined to be (-1) which is based on failure of an administrative IROFS with large margin per NUREG-1520.

A failure probability index of (-2) was selected for IROFS30b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS30c. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB3-1

The initial failure (initiating event) is the blending vent system carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through the cold trap valve. Continued UF_6 leakage to the blending vent system carbon trap results in UF_6 being released into the SB GEVS. The leak into the SB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters or electrostatic precipitator to form a critical mass.

The combination of these conditions is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected as UO_2F_2 on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter or within the precipitator over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated (IROFS3) and (2) automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8a).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB3-2

The initial failure (initiating event) is the UF_6 cold trap outlet valve fails open during the back gas mode and results in high UF_6 flow through the carbon trap. A high UF_6 flow to the carbon trap results in high temperature in the carbon trap, and release of excessive UF_6 into the SB GEVS. The leak into the SB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters or electrostatic precipitator to form a critical mass.

The combination of these conditions is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected as UO_2F_2 on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter or within the precipitator over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of the vacuum pump on carbon trap high temperature to ensure the carbon trap does not pass excessive UF_6 (IROFS9) and (2) an automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS9. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB3-3

The initial failure (initiating event) is the Blending and Sampling Vent carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through a blending system cold trap valve.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF_6 to the Blending and Liquid Sampling Area. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measure is an automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47a). As a result of IROFS47a, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

The failure probability index of (-3) was selected for IROF47a. This corresponds to a single passive engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB4-1

The initial failure (initiating event) is the product liquid sampling autoclave heater failure (heat off) followed by reheat. Solidification of UF_6 in the sampling manifold isolates pressure trips. Upon reheat, the sampling manifold ruptures.

For the uncontrolled accident sequence, (autoclave pressure boundary not credited) UF_6 from the sampling manifold and the liquid UF_6 in the product cylinder is released to the Blending and Liquid Sampling Area. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is a design feature to maintain Product Liquid Sampling Autoclave leak tight integrity (IROFS10).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS10. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: PB4-2

The initial failure (initiating event) is the product liquid sampling autoclave heater controller failure causing the heater to remain on.

For the uncontrolled accident sequence (autoclave pressure boundary credited), the product cylinder over heats and the cylinder hydraulically ruptures due to the expansion of the UF_6 . Upon cylinder rupture, the product cylinder content of UF_6 is released within the liquid sampling autoclave pressure boundary. The heater continues to input heat into the liquid sampling autoclave causing the autoclave pressure boundary to rupture. HF is released to the Blending and Liquid Sampling Area. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of the autoclave heater and fan on autoclave high internal air temperature to ensure Product Liquid Sampling Autoclave integrity (IROFS11) and (2) an automatic trip of the autoclave heater and fan on autoclave high internal air pressure to ensure Product Liquid Sample Autoclave integrity (IROFS12).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS11. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS12. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB4-3

The initial failure (initiating event) is the operator error of leaving the sampling manifold purge valve open and blind flange not fitted. Upon liquid sample heat up and tipping of the liquid sampling autoclave, the sampling manifold releases liquid UF₆ into the autoclave.

For the uncontrolled accident sequence (autoclave pressure boundary not credited), UF₆ from the sampling manifold and the liquid UF₆ in the product cylinder is released to the Blending and Liquid Sampling Area. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is a design feature to maintain Product Liquid Sampling Autoclave leak tight integrity (IROFS10).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from operator error history at similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS10. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: PB4-4

The initial failure (initiating event) is an over filled product cylinder heated in the sampling autoclave.

For the uncontrolled accident sequence (autoclave pressure boundary not credited), the over filled product cylinder is heated in the sampling autoclave followed by cylinder rupture. Upon cylinder rupture, the product content of UF₆ cylinder is released to the Blending and Liquid Sampling Area. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the cylinder fill mass to ensure cylinder integrity of a product cylinder prior to placement and heating of the associated cylinder in the Product Liquid Sampling Autoclave (IROFS42) and (2) design feature to maintain Product Liquid Sampling Autoclave leak tight integrity (IROFS10). If the acceptance criteria are not met, then the associated product cylinder shall not be heated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS42. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520.

A failure probability index of (-3) was selected for IROFS10. This corresponds to a single passive engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: PB4-5

The initial failure (initiating event) is a release of UF_6 from the product cylinder at the end of the liquid sampling cycle into the autoclave. Upon UF_6 release, HF and UO_2F_2 are generated. The flow path from the autoclave to the SB GEVS is then manually opened using the GEVS vent valve resulting in a release into the SB GEVS. The release to the SB GEVS is assumed to allow a sufficient amount of accumulation on the filters or electrostatic precipitator to form a critical mass. The combination of these conditions is assumed to lead to an accumulation of fissile material on the SB GEVS filters or electrostatic precipitator resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the SB GEVS and is collected as UO_2F_2 on the SB GEVS HEPA filters or electrostatic precipitator forming a critical mass of fissile material on the filter or within the precipitator. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic inhibit opening of GEVS vent valve on high-high HF in the autoclave to ensure no more than a subcritical mass deposited on SB GEVS filter (IROFS13) and (2) automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter (IROFS8b).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS8b. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS13. This corresponds to a single active engineered IROFS per NUREG-1520.

Accident Identifier: VR1-1

The initial failure (initiating event) is the carbon trap becomes saturated with UF_6 caused by a small UF_6 leak through a process valve in the vessel pressure test/valve change rig. Continued UF_6 leakage to the carbon trap results in UF_6 released into the Technical Services Building (TSB) GEVS. The leak into the TSB GEVS system is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filters to form a critical mass.

The combination of these conditions is assumed to lead to an accumulation of fissile material on the TSB GEVS filters resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the TSB GEVS and is collected UO_2F_2 on the TSB GEVS HEPA forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) an automatic trip of the TSB GEVS on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the filter (IROFS21).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS21. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Accident Identifier: VR1-2

The initial failure (initiating event) is an operator error in excessively opening the cold trap outlet throttle valve in the cylinder vent system which results in high UF_6 flow through the carbon trap. A high UF_6 flow to the carbon trap results in high temperature in the carbon trap and release of excessive UF_6 into the TSB GEVS. The leak into the TSB GEVS is assumed to exist for a significant period of time to allow a sufficient amount of accumulation on the filter to form a critical mass. The combination of these conditions is assumed to lead to an accumulation of fissile material on the TSB GEVS filter resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the TSB GEVS and is collected on the TSB GEVS HEPA filters forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) an automatic trip of the vacuum pump on carbon trap high temperature to ensure the carbon trap does not pass excessive UF_6 (IROFS22) and (2) an automatic trip of the TSB GEVS on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the filter (IROFS21).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS22. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS21. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: VR1-3

The initial failure (initiating event) is the failure of a cylinder superior valve or the flexible piping of a cylinder containing UF_6 undergoing a cylinder pressure test after repair/replacement of a leaking cylinder component.

For the uncontrolled accident sequence, a slight over pressure release of UF_6 exposes the worker. This event was calculated to result in a high intermediate consequence to the worker and low consequence to the public.

For the controlled accident sequence, the preventive measure is administrative use of personnel respiratory protection to ensure that inhalation of uranic material and HF consequences are low when performing positive pressure testing of a UF_6 cylinder after repair/replacement of a leaking cylinder component (IROFS23a). If personnel respiratory protection is not used, then the positive pressure testing of the UF_6 cylinder shall not be performed.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS23a. This corresponds to an enhanced administrative IROFS per NUREG-1520 criteria. IROFS23a is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: VR1-5

The initial failure (initiating event) is the vent subsystem carbon trap becoming saturated with UF_6 caused by a small UF_6 leak through a ventilated room mobile pump and trap rig cold trap valve.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF_6 to the Ventilated Room. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measure is an automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47b). As a result of IROFS47b, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria - no failures of this type in this facility in 30 yrs - applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

The failure probability index of (-3) was selected for IROF47b. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: VR2-1

The initial failure (initiating event) is a loss of containment of a chemical trap and pouring of the contents of the trap into the Ventilated Room. The cause could be operator error in unloading a carbon trap or impact to a carbon trap.

For the uncontrolled accident sequence, a release of carbon fines containing uranic material from the trap exposes the worker through inhalation of uranic material. This event was calculated to result in an intermediate consequence to the worker and low consequence to the public.

For the controlled accident sequence, the preventive measure is administrative use of personnel respiratory protection to ensure that inhalation of uranic material consequence are low when handling carbon trap material containing uranic material (IROFS23b). If personnel respiratory protection is not used, then carbon trap material containing uranic material shall not be handled.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS23b. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: VR2-2

The initial failure (initiating event) is a loss of containment of a chemical dump trap and pouring of the contents of the trap into the ventilated room. The cause could be operator error in unloading a chemical dump trap or impact to a chemical dump trap.

For the uncontrolled accident sequence, a release of sodium fluoride (NaF) fines containing uranic material from the trap exposes the worker through inhalation of uranic material. This event was calculated to result in a high consequence to the worker and low consequence to the public.

For the controlled accident sequence, the preventive measures are (1) administrative use of personnel respiratory protection to ensure that inhalation of uranic material consequence is low when handling NaF trap material containing uranic material (IROFS23b) and (2) administrative establishment of airflow away from the worker to ensure inhalation of uranic material consequences are low when handling NaF trap material containing uranic material (IROFS24a). If personnel respiratory protection is not used or if air flow away from the worker is not established, then NaF trap material containing uranic material shall not be handled.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS23b. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS24a. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

Accident Identifier: VR2-7

The initiating event allows the accumulation of sufficient uranic mass to cause criticality in a solid waste container. The initial condition is that the operator would transfer carbon containing enriched uranic material to a non-safe-by design solid waste container and fails to control the uranic matter in the waste container, (i.e., failure of IROFS31a: administratively limit ^{235}U mass in non-safe-by-design solid waste containers to ensure subcriticality by performing independent sampling and analysis).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the solid waste container through transfer of carbon containing enriched uranic material from the carbon chemical traps. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are: (1) administratively limit ^{235}U mass in non-safe-by-design solid waste containers to ensure a subcritical mass (IROFS31b, i.e., by independent sample and assay analysis to determine ^{235}U mass prior to transferring and bulk storing enriched uranic material in solid waste containers) and (2) administratively limit the calculated ^{235}U mass waste storage to ensure a subcritical mass (IROFS31c, i.e., using bookkeeping procedures to determine the ^{235}U mass prior to transferring and bulk storing enriched uranic material in solid waste containers). For each preventive measure, if the acceptance criterion is not met, the transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event (IROFS31a) was determined to be (-1). This frequency probability index corresponds to a failure of redundant IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS31c. This corresponds to an administrative IROFS for planned routine operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS31b. This corresponds to an administrative IROFS for planned routine operation per NUREG-1520.

Accident Identifier: FR1-1

The accident sequence is the combination of numerous conditions assumed to lead to a criticality in a waste container being transported. This description of this sequence is the following:

- (1) The fissile material in the waste container and interacting components would be a uranyl fluoride/water mixture at an H/U atomic ratio near optimum moderation,
- (2) The waste container, as well as other interacting components, would be nearly or completely filled with the above material at a high enough enrichment to achieve a configuration favorable for criticality (Urenco European experience is that less than 10% of waste container enrichment is at product enrichment levels), and
- (3) The waste container would have to interact (i.e., proximity limit not maintained) with greater than one component containing fissile material, as interaction of the waste container and one other component is subcritical.

The movement of waste containers is part of normal operations; the abnormal operating condition pertaining to the waste container concerns the assumption that the waste container and interacting component are filled with product UF_6 breakdown material at optimum moderation conditions. This would be extremely unlikely for a single waste container and even more unlikely for more than one component.

For the uncontrolled accident sequence, conditions (1) through (3) above must be met to result in a potential criticality event. For this accident sequence, a criticality event was assumed. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is to administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration by verifying the use of a safe-by-design transfer frame prior to movement of the associated waste container containing enriched uranic material (IROFS14a). If the acceptance criteria is not met, then the associated waste container containing enriched uranic material shall not be moved.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS14a. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS14a is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: FR1-2

The accident sequence is the combination of numerous conditions assumed to lead to a criticality in a waste container being stored. This description of this sequence is the following:

- (1) The fissile material in the waste container and interacting components would be a uranyl fluoride/water mixture at an H/U atomic ratio near optimum moderation,
- (2) The waste container, as well as other interacting components, would be nearly or completely filled with the above material at a high enough enrichment to achieve a configuration favorable for criticality (Urenco European experience is that less than 10% of waste container enrichment is at product enrichment levels), and
- (3) The waste container would have to interact (i.e., proximity limit not maintained) with greater than one component containing fissile material, as interaction of the waste container and one other component is subcritical.

For the uncontrolled accident sequence, conditions (1) through (3) above, above must be met to result in a potential criticality event. For this accident sequence, a criticality event was assumed. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration by verifying, prior to moving a waste container containing enriched uranic material within 180 cm of the associated storage array, associated storage array condition is acceptable for storage of the waste container and no component containing enriched uranic material is in movement in the designated area (IROFS14b). If the acceptance criteria are not met, then the associated waste container shall not be moved.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS14b. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS14b is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: FR2-1

This accident sequence is identical to sequence FR1-1, except it is located in the hydrocarbon removal portion of Fomblin Oil Recovery System.

Accident Identifier: FR2-2

This accident sequence is identical to sequence FR1-2, except it is located in the hydrocarbon removal portion of Fomblin Oil Recovery System.

Accident Identifier: DS1-1

This accident sequence is identical to sequence FR1-1, except it is located in the Equipment Decontamination System.

Accident Identifier: DS1-2

This accident sequence is identical to sequence FR1-2, except it is located in the Equipment Decontamination System.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DS1-3

The initial failure (initiating event) is the accumulation of sufficient uranium mass to cause criticality in the decontamination tank.

The initial set of conditions, or combination of conditions, that needs to be fulfilled to result in a criticality event in the decontamination tanks include the following:

- (1) A significant number of components containing uranium with product enrichments would need to be processed to provide the uranium levels needed to create favorable conditions for criticality, and
- (2) The operator would have to fail to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the decontamination tank. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit measured uranic mass inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank). For each preventive measure, if the acceptance criterion is not met, then transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c was determined to be (-1). This is based on failure of a redundant administrative IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DS2-1

This accident sequence is identical to sequence FR1-1, except it is located in the Flexible Hose Decontamination System.

Accident Identifier: DS2-2

This accident sequence is identical to sequence FR1-2, except it is located in the Flexible Hose Decontamination System.

Accident Identifier: DS2-3

The initial failure (initiating event) is the accumulation of sufficient uranium mass in the first rinse tank to cause criticality.

The initial set of conditions, or combination of conditions, that needs to be fulfilled to result in a criticality event in the first rinse tank include the following:

- (1) A significant number of components containing uranium with product enrichments would need to be processed to provide the uranium levels needed to create favorable conditions for criticality, and
- (2) The operator would have to fail to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the first rinse tank. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit measured uranic mass inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material of the associated tank). For each preventive measure, if the acceptance criteria is not met, the transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c was determined to be (-1). This is based on failure of a redundant administrative IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520.

Accident Identifier: DS3-1

This accident sequence is identical to sequence FR1-1.

Accident Identifier: DS3-2

This accident sequence is identical to sequence FR1-2.

Accident Identifier: CL3-1

The initial failure (initiating event) is an operator error, no liquid nitrogen in the Dewar cold trap of the sub-sampling System in the chemical laboratory which results in a cold trap temperature above the UF_6 desublimation temperature. During evacuation of the sub-sampling System in this condition, liquid UF_6 desublimates to gas and is pumped by the vacuum pump and is transferred to the TSB GEVS with the potential for a criticality event. The transfer of UF_6 into the TSB GEVS system must exist for a significant period of time to allow a sufficient amount of accumulation on the filters to form a critical mass. The combination of these conditions is assumed to lead to accumulation of fissile material on the TSB GEVS filters resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the TSB GEVS and is collected on the TSB GEVS HEPA filters forming a critical mass of fissile material on the filter over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic isolation of cold trap on cold trap high temperature to ensure no more than a subcritical mass deposited on the TSB GEVS filter (IROFS20) and (2) an automatic trip of the TSB GEVS on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the filter (IROFS21).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS20. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS21. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: CL3-2

The initial failure (initiating event) is an operator error, no liquid nitrogen in the UF_6 cold trap which results in a cold trap temperature above the UF_6 desublimation temperature. During the process of transferring product samples for assay analysis, liquid UF_6 flashes to gas. This leads to a release of UF_6 to the atmosphere exposing the worker.

For the uncontrolled accident sequence, the release of liquid UF_6 (product) results in exposure of the worker. This event was calculated to result in a high consequence to the worker and low consequence to the public.

For the controlled accident sequence, the preventive measures are (1) the administrative establishment of airflow away from worker to ensure inhalation of uranic material and HF consequences are low during transfer of product samples for assay analysis (IROFS24b) and (2) the administrative verification that product samples are in a solid state, prior to transfer of product samples for assay analysis, to ensure worker consequences of inhalation of uranic material and HF are low (IROFS46). For these preventive measures, if the acceptance criteria are not met, then the transfer of product samples for assay analysis shall not be initiated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS24b. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

The failure probability index of (-2) was selected for IROFS46. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: CL3-3

The initial failure (initiating event) is the UF₆ sub-sampling unit heater controller failure, causing the heater within the UF₆ sub-sampling unit to remain on.

For the uncontrolled accident sequence, the sample bottle over heats and the bottle hydraulically ruptures due to the expansion of the UF₆. Upon bottle rupture, the sample bottle content of UF₆ is released within chemical laboratory hood. HF and uranic material are released to the chemical laboratory exposing workers. This event is calculated to result in a low consequence to the public and a high consequence to the worker.

For the controlled accident sequence, the preventive measures are (1) automatic trip of UF₆ sub-sampling unit hotbox heater or high hotbox internal temperature to ensure sample bottle integrity (IROFS43) and (2) administrative establishment of air flow away from the worker to ensure inhalation of uranic material and HF consequences are low during heating of a sample bottle(s) within the UF₆ sub-sampling unit (IROFS24b). If air flow from the worker is not established, then sample bottle(s) in the UF₆ sampling unit shall not be heated.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index number for IROFS43 was determined to be (-2), a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS24b. This corresponds to an administrative IROFS for routine planned operations per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: CP1-1

The initial failure (initiating event) is that a full product cylinder is used erroneously in the cylinder preparation process and UF_6 is released to the TSB GEVS during the pump out of the cylinder with the potential for a criticality event in the TSB GEVS. The release of UF_6 into the TSB GEVS system must exist for a significant period of time to allow a sufficient amount of accumulation on the filters to form a critical mass. The combination of these conditions is assumed to lead to accumulation of fissile material on the TSB GEVS filters resulting in a criticality event.

For the uncontrolled accident sequence, UF_6 (product) is discharged to the TSB GEVS and is collected as UO_2F_2 on the TSB GEVS HEPA filter forming a critical mass of fissile material on the filter. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated (IROFS3) and (2) automatic trip of the TSB GEVS on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the filter (IROFS21).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS21. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Accident Identifier: CP1-2

The initial failure (initiating event) is that a product cylinder arrives at the plant with excess moderator inside the cylinder. This failure results in the potential for a criticality event.

The combination of conditions, that needs to be fulfilled to result in a potential criticality event due to moderator being present in a cylinder include the following:

- (1) During vacuum testing of the cylinder, after connection to the plant, the operator must fail to recognize the increased pressure in the cylinder due to the presence of moderator in the cylinder is within acceptable limits, and
- (2) Visual inspection has failed to detect the presence of oil in the cylinder.

For the uncontrolled accident sequence, failures (1) or (2) occur (IROFS16a: administratively limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality). A criticality event is assumed to result for this accident sequence when the cylinder is connected to the plant. This event is assumed to result in a high consequence to the worker and public.

For the controlled sequence, the preventive measure is administratively limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality by allowing no visible oil and by limiting cylinder vapor pressure prior to introducing product (IROFS16a). If the acceptance criteria is not met, then product shall not be introduced into the associated cylinder.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index number of (-3) was selected for IROFS16a. This frequency probability index number corresponds to an enhanced administrative IROFS per NUREG-1520. IROFS16a is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: CP1-4

The initial failure (initiating event) is the cylinder preparation vent system carbon trap becomes saturated with UF₆ caused by a small UF₆ leak through the cold trap valve.

For the uncontrolled accident sequence, a UF₆ plug forms on the discharge of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF₆ to the cylinder preparation room. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measure is automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF₆ (IROFS3) and the mitigative measure is a flow restriction to ensure, in the event of a postulated release, worker consequences of inhalation of uranic material and HF are low (IROFS47b). As a result of IROFS47b, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-3) was selected for IROF47b. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: SW1-1

This accident sequence is identical to sequence FR1-1.

Accident Identifier: SW1-2

This accident sequence is identical to sequence FR1-2.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: LW1-1

The initial failure (initiating event) is the accumulation of sufficient uranium mass in the degreaser water collection tank.

The initial condition that needs to be fulfilled to result in a criticality event in the degreaser water collection tank is that the operator would have to fail to control the uranium mass in the tank, including the operator failing to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the degreaser tank to cause criticality. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit the measured tank uranic inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank). For each preventive measure, if the acceptance criterion is not met, then transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c, was determined to be (-1). This is based on failure of a redundant IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Accident Identifier: LW1-2

This accident sequence is identical to sequence FR1-1.

Accident Identifier: LW1-3

This accident sequence is identical to sequence FR1-2.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: LW2-1

The initial failure (initiating event) is the accumulation of sufficient uranium mass in the spent citric acid tank to cause criticality.

The initial condition that needs to be fulfilled to result in a criticality event in the spent citric acid tank is that the operator would have to fail to control the uranium mass in the tank, including the operator failing to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the spent citric acid tank. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit the measured tank uranic inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank). For each preventive measure, if the acceptance criterion is not met, then transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c was determined to be (-1). This is based on failure of a redundant IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: LW3-1

The initial failure (initiating event) is the accumulation of sufficient uranium mass in the miscellaneous effluent collection tank to cause criticality.

The initial condition that needs to be fulfilled to result in a criticality event in the miscellaneous effluent collection tank is that the operator would have to fail to control the uranium mass in the tank, including the operator failing to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the miscellaneous effluent collection tank. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit the measured tank uranic inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank). For each preventive measure, if the acceptance criterion is not met, then transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c, was determined to be (-1). This is based on failure of a redundant IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: LW5-1

The initial failure (initiating event) is the accumulation of sufficient uranium mass in the precipitation treatment tank to cause criticality.

The initial condition that needs to be fulfilled to result in a criticality event in the precipitation treatment tank is that the operator would have to fail to control the uranium mass in the tank, including the operator failing to notice the incremental rise in uranium concentration from the sampling of the tank (failure of IROFS19c, administratively limit the measured uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement).

For the uncontrolled accident sequence, sufficient uranium mass accumulates in the precipitation treatment tank. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass (IROFS19a, i.e., using bookkeeping procedures to determine calculated tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank) and (2) administratively limit the measured tank uranic inventory to ensure a subcritical mass (IROFS19d, i.e., by independent sampling and measurement to determine tank uranic mass inventory prior to transfer of enriched uranic material to the associated tank). For each preventive measure, if the acceptance criterion is not met, then transfer of enriched uranic material shall not be initiated.

The frequency index number for the initiating event, failure of IROFS19c was determined to be (-1). This is based on failure of a redundant IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19a. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS19d. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

Accident Identifier: RD1-1

The initiating event allows the placement of product 48Y and 30B cylinders into a non-safe criticality interaction arrangement (i.e., a non-analyzed condition). The initial condition is an operator would have stacked a product cylinder on another product cylinder in the CRDB

For the uncontrolled accident sequence, product cylinders are stacked more than one high next to another product cylinder. A criticality event is assumed to result for this accident sequence. This event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is (IROFS45) to ensure subcritical geometry, prior to moving a cylinder containing enriched uranium in the CRDB or the Blending and Liquid Sampling Area, verify that the stored cylinders containing enriched uranium in these areas are in a horizontal, co-planar (i.e., non-stacked), condition and that no other cylinder containing enriched uranium is in movement in the associated area. If the acceptance criteria are not met, then the cylinder containing enriched uranium shall not be moved.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFS45. This corresponds to an enhanced administrative IROFS for routine operation per NUREG-1520. IROFS45 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DC1-1

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System dumping to sodium fluoride (NaF) traps, which have not been filled correctly, coincident with a worker located near the contingency dump vacuum pump.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in a high consequence to the worker. Impact to the public is evaluated in accident sequence DC1-2.

For the controlled accident sequence, the preventive measures are (1) administratively maintain contingency dump NaF trap fill and use to ensure carbon trap does not saturate on operation of contingency dump by maintaining appropriate fill of the NaF traps prior to placing the associated NaF trap in service after filling (IROFSC1b), (2) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3), and (3) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18). For IROFSC1b, if the acceptance criterion is not met, then the associated NaF trap shall not be placed in service.

The frequency index number for the initiating event was determined to be (0). This frequency index is based on an annual frequency of one for the Contingency Dump System discharge to the NaF traps. This assumption is based on an assessment of the NEF annual Contingency Dump System actuation potential.

The failure probability index of (-2) was selected for IROFSC1b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DC1-2

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System dumping to sodium fluoride (NaF) traps which have not been filled correctly.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in an intermediate consequence to the public.

For the controlled accident sequence, the preventive measures are (1) administratively maintain contingency dump NaF trap fill and use to ensure carbon trap does not saturate on operation of contingency dump by maintaining appropriate fill of the NaF traps prior to placing the associated NaF trap in service after filling (IROFSC1b) and (2) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3). For IROFSC1b, if the acceptance criterion is not met, then the associated NaF trap shall not be placed in service.

The frequency index number for the initiating event was determined to be (0). This frequency index is based on an annual frequency of one for the Contingency Dump System discharge to the NaF traps. This assumption is based on an assessment of the NEF annual Contingency Dump System actuation potential.

The failure probability index of (-2) was selected for IROFSC1b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DC1-3

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System dumping to sodium fluoride (NaF) traps which have been saturated through excessive use coincident with a worker located near the contingency dump vacuum pump.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in a high consequence to the worker. Impact to the public is evaluated in accident sequence DC1-4.

For the controlled accident sequence, the preventive measures are (1) administratively maintain contingency dump NaF trap fill and use to ensure carbon trap does not saturate on operation of contingency dump by replacement of the NaF trap prior to the NaF fill becoming spent due to excessive dump operation (IROFSC1b), (2) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3), and (3) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18). For IROFSC1b, if the acceptance criterion is not met, then the NaF trap shall be isolated from the associated cascade.

The frequency index number for the initiating event was determined to be (0). This frequency index is based on an annual frequency of one for the Contingency Dump System discharge to the NaF traps. This assumption is based on an assessment of the NEF annual Contingency Dump System actuation potential.

The failure probability index of (-2) was selected for IROFSC1b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Accident Identifier: DC1-4

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System dumping to sodium fluoride (NaF) traps which have been saturated through excessive use.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to process services corridor. This event was calculated to result in an intermediate consequence to the public.

For the controlled accident sequence, the preventive measures are (1) administratively maintain contingency dump NaF trap fill and use to ensure carbon trap does not saturate on operation of contingency dump by replacement of the NaF trap prior to the NaF fill becoming spent due to excessive dump operation (IROFSC1b), and (2) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3). For IROFSC1b, if the acceptance criterion is not met, then the NaF trap shall be isolated from the associated cascade.

The frequency index number for the initiating event was determined to be (0). This frequency index is based on an annual frequency of one for the Contingency Dump System discharge to the NaF traps. This assumption is based on an assessment of the NEF annual Contingency Dump System actuation potential.

The failure probability index of (-2) was selected for IROFSC1b. This corresponds to an administrative IROFS for routine planned operation per NUREG-1520.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

Accident Identifier: DC1-5

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System bypassing the NaF traps due to operation of the bypass valve coincident with a worker located near the contingency dump vacuum pump.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in a high consequence to the worker. Impact to the public is evaluated in accident sequence DC1-6.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Accident Identifier: DC1-6

The initial failure (initiating event) is the carbon traps become saturated with UF_6 caused by the operation of Contingency Dump System bypassing the NaF traps due to operation of the bypass valve.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in an intermediate consequence to the public.

For the controlled accident sequence, the preventive measure is automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DC1-7

The initial failure (initiating event) is the occurrence of a dump operation following a period of time where the contingency dump valve has been exhibiting a small continuous leak. The leak would cause UF_6 from the cascade to enter the dump system, causing the NaF traps and the pump's carbon trap to become spent. Contingency dump operation is assumed to occur coincident with a worker located near the contingency dump vacuum pump.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in a high consequence to the worker. Impact to the public is evaluated in accident sequence DC1-8.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: DC1-8

The initial failure (initiating event) is the occurrence of a dump operation following a period of time where the contingency dump valve has been exhibiting a small continuous leak. The leak would cause UF_6 from the cascade to enter the dump system, causing the NaF traps and the pump's carbon trap to become spent.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the contingency dump vacuum pump discharge flange seal, causing high pressure and thus failing the contingency dump vacuum pump discharge flange seal, causing a release of UF_6 to the process services corridor. This event was calculated to result in an intermediate consequence to the public.

For the controlled accident sequence, the preventive measure is automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: EC3-1

The initial failure (initiating event) is failure of criticality enrichment control by failing to properly control the UF₆ enrichment process. The maximum enrichment of a single cascade is limited by mechanical enrichment control devices. This failure is initiated by the improper setting of the cascade enrichment control devices. In addition, other failures are assumed to occur such as (1) a leak must exist within the product system to cause breakdown build-up in an otherwise safe by geometry component, or allow moderator into the product cylinder and (2) a significant period of time is required to allow a significant build-up of product, breakdown and/or moderator. The combination of these conditions is assumed to result in a criticality event.

For the uncontrolled accident sequence there is a failure of criticality enrichment control by failing to properly control the UF₆ enrichment process. A criticality event is assumed to result for this accident sequence. A criticality event is assumed to result in a high consequence to the worker and public.

For the controlled accident sequence, the preventive measure is: calculate and set the cascade enrichment control device in accordance with the calculation to ensure $\leq 5\%$ ²³⁵U enrichment to ensure subcriticality within the designed process (IROFSC6). If the acceptance criterion is not met and the cascade enrichment control device setting has not been changed, then the cascade enrichment control device setting shall not be changed. If the acceptance criterion is not met and the cascade enrichment control device setting has been changed, then the associated cascade shall be isolated such that no additional UF₆ can enter or exit the cascade.

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-3) was selected for IROFSC6. This corresponds to an enhanced administrative IROFS per NUREG-1520. IROFSC6 is enhanced by requiring independent verification of the IROFS safety function. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: EC4-1

The initial failure (initiating event) is an operator error that results in an incorrect sampling sequence. This causes excessive flow of UF_6 resulting in the evacuating rig carbon trap becoming saturated.

For the uncontrolled accident sequence, a UF_6 plug forms on the discharge line of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF_6 to the process services corridor. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: EC4-2

The initial failure (initiating event) is inadvertent alignment of the cascade sampling rig to the cascade product header when performing cascade sampling. The carbon trap would fill up with UF_6 and eventually overflow to the vacuum pump where it may get pumped into the SB GEVS, mixing with moist air, forming solid UO_2F_2 that collects on the SB GEVS filters. The release of UF_6 to the SB GEVS is assumed to exist for a significant period of time to allow a sufficient amount of accumulation of the filters to form a critical mass. The combination of these conditions is assumed to lead to an accumulation of fissile material of the SB GEVS filters resulting in a criticality event.

In the uncontrolled accident sequence, it is assumed that an operator error occurs related to the sampling sequence and the vacuum pump, rather than evacuating rig, is connected to the cascade product header. UF_6 is released into the SB GEVS and is collected on the SB GEVS HEPA filters forming a critical mass of fissile material on the filters over a long period of time. A criticality event is assumed to result for this accident sequence. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF_6 (IROFS3) and (2) automatic trip signal on ^{235}U selective high-high gamma monitor to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator (IROFS8a).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFS8a. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: TP8-1

The initial failure (initiating event) is a one of the two Centrifuge Test Facility UF₆ vessels heater controller failure, causing a vessel high temperature.

For the uncontrolled accident sequence, the UF₆ test vessel overheats and the vessel hydraulically ruptures due to the expansion of UF₆. Upon vessel rupture, the UF₆ content is released into the Centrifuge Test Facility. This sequence, if uncontrolled, would require significant time to cause a UF₆ release since the heat up rate is limited by the heater capacity. In addition, failure of a single heating circuit is not sufficient to cause the temperatures required for a hydraulic rupture. This event is assumed to have a high consequence to the worker and public.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the centrifuge Test Facility Feed/take-off vessel heat tracing on high temperature to ensure feed/take-off vessel integrity (IROFSC15) and (2) automatic trip of the Centrifuge Test Facility Feed/take-off vessel heat tracing on high temperature to ensure feed/take-off vessel integrity (IROFSC16).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFSC15. This corresponds to a single active engineered IROFS per NUREG-1520.

A failure probability index of (-2) was selected for IROFSC16. This corresponds to a single active engineered IROSF per NUREG-1520.

Accident Identifier: TP8-2

The initial failure (initiating event) is the Centrifuge Test Facility vent carbon trap becomes saturated with UF₆ caused by operator mis-alignment of the vacuum pump to the feed vessel.

For the uncontrolled accident sequence, a UF₆ plug forms on the discharge of the vacuum pump, causing high pressure in the vacuum pump and thus failing seals leading to a release of UF₆ to the Centrifuge Test Facility. This event has been calculated to result in a high consequence to the worker.

For the controlled accident sequence, the preventive measures are (1) automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF₆ (IROFS3) and (2) automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release (IROFSC18).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

A failure probability index of (-2) was selected for IROFS3. This corresponds to a single active engineered IROFS per NUREG-1520 criteria.

A failure probability index of (-2) was selected for IROFSC18. This corresponds to a single active engineered IROFS per NUREG-1520.

Table 3.7-2 Accident Sequence Descriptions

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Accident Identifier: CHEM RELEASE-WORKER EVAC

The initial failure is a release of UF_6 of a magnitude that would require worker evacuation. The systems involved in the associated accident sequences that may lead to this magnitude of release are as follows.

Tails, Feed, Feed Purification, Product, Blending and Sampling, Ventilated Room, UF_6 Sub-sampling Unit, Cylinder Preparation Room, UBC Storage Pad, Decontamination Workshop, and CRDB.

The uncontrolled event is a release of a magnitude that results in worker consequences of inhalation of uranic material and HF that are greater than a low category (1). The subsequent release from this event is assumed to have high consequences to the worker present in the area.

For the controlled event, the mitigative measure is to administratively limit exposure by requiring worker action to evacuate the area(s) of concern during a chemical release to ensure that the consequences of inhalation of uranic material and HF are low (IROFS39c). Sufficient time is available for the worker to detect and to evacuate the area(s) of concern. As a result of IROFS39c, the consequence analysis shows that the consequence has been mitigated to a low category (1).

The frequency index number for each initiating event of the associated accident sequences was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was selected based on evidence from history of similarly designed Urenco European plants, which have a combined plant history of greater than 30 yrs, and have not had a failure of this type.

The failure probability index for the administrative controls/procedures of IROFS39c was determined to be (-3). This corresponds to an administrative IROFS that must be performed in response to a rare unplanned demand per NUREG-1520. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: LOSS OF SAFE-BY-DESIGN ATTRIBUTE

The accident sequence is a criticality resulting from loss of a feature associated with safe-by-design components containing enriched Uranium material. The criticality event is assumed to have a high consequence to the worker and the public. The safe-by-design components addressed in this accident sequence are as follows.

Safe-by-design components in the following systems, Cascade, Product, Tails, Product Blending, Product Liquid Sampling, Contingency Dump, Centrifuge Test, Centrifuge Post Mortem, Liquid Effluent Collection and Treatment, Solid Waste, Decontamination Workshop, Fomblin Oil Recovery, Ventilated Room, Chemical Laboratory, Mass Spectrometry, and Cylinder Preparation Room Systems. These safe-by-design components are identified in Tables 3.7-6 through 3.7-21.

The passive, safe-by-design features of these components do not rely on human interface to perform the criticality safety function. These features also meet the criterion that the only potential means to effect a change that might result in a failure to function, would be to implement a design change (i.e., geometry deformation as a result of a credible process deviation or event does not adversely impact the performance of the safety function). The evaluation of the potential to adversely impact the safety function of the passive design features (which includes consideration of potential mechanisms to cause bulging, corrosion, and breach of confinement/leakage and subsequent accumulation of material) is presented in Tables 3.7-6 through 3.7-21, and includes consideration of adequate controls to ensure the double contingency principle is met. For the identified components, Tables 3.7-6 through 3.7-21 summarize the rationale for the conclusion that there is no credible means to effect a change to the safe-by-design feature that might result in a failure of the safety function. Tables 3.7-6 through 3.7-21 also support the conclusion that significant margin exists. For components that are safe-by-volume, safe-by-diameter, or safe-by-slab thickness, significant margin is defined as a margin of at least 10%, during both normal and upset conditions, between the actual design parameter value of the component and the value of the corresponding critical design attribute. For components that require a more detailed criticality analysis, significant margin is defined as $k_{eff} < 0.95$, where $k_{eff} = k_{calc} + 3\sigma_{calc}$. These passive, safe-by-design features are considered items which may affect IROFS. As a result, QA level 1 requirements apply to these features. In addition, the configuration management system required by 10 CFR 70.72 (implemented by the NEF Configuration Management Program) adequately ensures maintaining the safety function of the subject component features and assures compliance with the double contingency principle, as well as the defense-in-depth criterion required by 10 CFR 70.64(b).

Conclusion: Based on 1) the lack of credible means to effect an adverse change to the safe-by-design feature of these passive design components, 2) the significant margins of safety that exist, 3) the application of the 10 CFR 70.72 configuration management system to preserve the safety design features, and 4) the relative low risk of a criticality event at low enriched uranium enrichment facilities, the frequency for the criticality initiating event was determined to be "highly unlikely." Therefore, an initiating event index of (-5) is appropriate, the risk of such an event is judged to be low and no IROFS are needed.

Table 3.7-3 External Events and Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
EE-Aircraft	-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not Credible Event
EE-Pipeline	-5	N/A	N/A	N/A	-5 (U)	1	3 (T)	3 (U)	Acceptable Risk
EE-Highway	-5	N/A	N/A	N/A	-5 (U)	1	3 (T)	3 (U)	Acceptable Risk
EE-Other Nearby Facilities	-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not Credible Event
EE-Railroad	-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not Credible Event
EE-CUB-GAS	-5	N/A	N/A	N/A	-5 (U)	1	3 (T)	3 (U)	Acceptable Risk
EE-Flood	-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not Credible Event
EE-LP-BLD(T)	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
EE-LP-BLD(T)	-5	IROFS27c-3	N/A	N/A	-8 (C)	1	3 (T)	3 (C)	Acceptable Risk
EE-LP-BLD (CR)	-2	N/A	N/A	N/A	-2 (U)	3	3 (CR)	9 (U)	IROFS Required
EE-LP-BLD (CR)	-5	IROFS27a-3	IROFS27b-3	N/A	-11 (C)	1	3 (CR)	3 (C)	Acceptable Risk
EE-LP-PAD	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
EE-LP-PAD	-5	IROFS27d-3	N/A	N/A	-8 (C)	1	3 (T)	3 (C)	Acceptable Risk
EE-Snow	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
EE-Snow	-5	IROFS27c-3	N/A	N/A	-8 (C)	1	3 (T)	3 (C)	Acceptable Risk
EE-Tornado, Tornado Missile & High Wind	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
EE-Tornado, Tornado Missile & High Wind	-5	IROFS27c -3	N/A	N/A	-8 (C)	1	3 (T)	3 (C)	Acceptable Risk
EE-SEISMIC-WORKER EVAC	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
EE-SEISMIC-X WORKER EVAC	-2	N/A	N/A	IROFS39a -3	-5 (U)	1	1 (T)	1 (C)	Acceptable Risk
SEISMIC-1a (UF ₆ Areas)	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
SEISMIC-1b (UF ₆ Areas)	-2	N/A	N/A	IROFS27c	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
SEISMIC-1c (UF ₆ Areas)	-2	N/A	N/A	IROFS27c IROFS26 (Success)	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
SEISMIC-1d (UF ₆ Areas)	-2	N/A	N/A	IROFS27c IROFS26 (Failure, -3)	-5 (C)	1	2 (T)	2 (C)	Acceptable Risk
SEISMIC-1e (UF ₆ Areas)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Success)	-2 (C)	3	1 (T)	3 (C)	Acceptable Risk

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
SEISMIC-1f (UF ₆ Areas)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Failure, -2)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
SEISMIC-2a (Cascades)	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
SEISMIC-2b (Cascades)	-2	N/A	N/A	IROFS27c	-2 (C)	3	3 (T)	9 (C)	Additional IROFS Required
SEISMIC-2c (Cascades)	-2	N/A	N/A	IROFS27c IROFS26 (Success)	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
SEISMIC-2d (Cascades)	-2	N/A	N/A	IROFS27c IROFS26 (Failure, -3)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
SEISMIC-2e (Cascades)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Success)	-2 (C)	3	1 (T)	3 (C)	Acceptable Risk

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
SEISMIC-2f (Cascades)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Failure, -2)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
SEISMIC-3a (Blending & Liquid Sampling)	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
SEISMIC-3b (Blending & Liquid Sampling)	-2	N/A	N/A	IROFS27c	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
SEISMIC-3c (Blending & Liquid Sampling)	-2	N/A	N/A	IROFS27c IROFS26 (Success)	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
SEISMIC-3d (Blending & Liquid Sampling)	-2	N/A	N/A	IROFS27c IROFS26 (Failure, -3)	-5 (C)	1	2 (T)	2 (C)	Acceptable Risk
SEISMIC-3e (Blending & Liquid Sampling)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Success)	-2 (C)	3	1 (T)	3 (C)	Acceptable Risk

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
SEISMIC-3f (Blending & Liquid Sampling)	-2	N/A	N/A	IROFS27c IROFS26 (Success) IROFS41 (Failure, -2)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
SEISMIC -5 (Liquid Sampling Autoclave)	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
SEISMIC -5 (Liquid Sampling Autoclave)	-5	IROFS28 -3	N/A	N/A	-8 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF1-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF1-1	-2	IROFS35 -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF1-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF1-2	-2	IROFS36a -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF5-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF5-1	-2	IROFS36b -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF5-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF5-2	-2	IROFS36h -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF6-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF6-1	-2	IROFS35 -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
FF6-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF6-2	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF7-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF7-1	-2	IROFS36c-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF8-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF8-1	-2	IROFS35-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF8-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF8-2	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF11-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF11-1	-2	IROFS35-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF11-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF11-2	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF15-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF15-1	-2	IROFS35-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF16-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF16-1	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF16-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF16-2	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF21-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
FF21-1	-2	IROFS35 -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF21-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF21-2	-2	IROFS36d -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF23-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF23-1	-2	IROFS35 -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF23-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF23-2	-2	IROFS36d -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF24-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF24-1	-2	IROFS35 -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF25-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF25-1	-2	IROFS36d -3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF25-2a	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF25-2b	-2	IROFS36d (Success)	N/A	N/A	-2 (C)	3	2 (T)	6 (C)	Additional IROFS Required
FF25-2c	-2	IROFS36d (Success)	N/A	IROFS37 (Success)	-2 (C)	3	1 (T)	3 (C)	Acceptable Risk
FF25-2d	-2	IROFS36d (Success)	N/A	IROFS37 -2 (Failure)	-4 (C)	2	2 (T)	4 (C)	Acceptable Risk
FF25-2e	-2	IROFS36d (Failure, -3)	N/A	IROFS37 (Success)	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF25-2f	-2	IROFS36d (Failure, -3)	N/A	IROFS37 (Failure, -2)	-7 (C)	1	3 (T)z	3 (C)	Acceptable Risk

Table 3.7-3 External Events And Fire Accident Sequences And Risk Index

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Accident Identifier	Initiating Event Index	Preventive Safety Parameter 1 or IROFS 1 Failure Index	Preventive Safety Parameter 2 or IROFS 2 Failure Index	Mitigation IROFS Failure Index	Likelihood Index T Uncontrolled (U) / Controlled (C)	Likelihood Category	Consequence Category (Type of Accident)	Risk Index (h= f x g) Uncontrolled (U) / Controlled (C)	Comments and Recommendations
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
FF38-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF38-1	-2	IROFS35-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF38-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF38-2	-2	IROFS36a-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF42-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF42-1	-2	IROFS36c-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF43-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF43-1	-2	IROFS36e-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF43-2	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF43-2	-2	IROFS36f-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF44-1	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF44-1	-2	IROFS36g-3	N/A	N/A	-5 (C)	1	3 (T)	3 (C)	Acceptable Risk
FF-WORKER EVAC	-2	N/A	N/A	N/A	-2 (U)	3	3 (T)	9 (U)	IROFS Required
FF-WORKER EVAC	-2	N/A	N/A	IROFS39b-3	-5 (U)	1	1 (T)	1 (C)	Acceptable Risk

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-AIRCRAFT

Aircraft crash into facility from local airport traffic and commercial or military routes in the vicinity of the facility meets the definition of not credible. Based on detailed probabilistic analysis, the annual probability of an aircraft crash onto the site is less than $1.0\text{E-}6$ (see Section 3.2.1.2.4). This yields an initiating event index of (-6). This probability meets definition of "not credible;" therefore, no IROFS are needed.

Accident Identifier: EE-PIPELINE

Oil industry pipelines located near the facility. Based on detailed probabilistic analyses, the hazards due to thermal radiation, missile generation and plant contamination by gas and/or explosion were shown to have an annual probability less than $1.0\text{E-}5$ (see Section 3.2.2.4) and an initiating event index of (-5) is appropriate. This meets the definition of "highly unlikely," therefore, no IROFS are needed. Consequence category conservatively assumed as high.

Accident Identifier: EE-HIGHWAY

Potential adverse impact to the facility from chemical releases or explosions from trucks on nearby highway was evaluated. Detailed probabilistic analyses show the annual probability of an explosion adversely impacting the plant is less than $1.0\text{E-}5$ (see Section 3.2.1.2) and an initiating event index of (-5) is appropriate. This meets the definition of "highly unlikely," therefore, no IROFS are needed. Consequence category conservatively assumed as high.

Accident Identifier: EE-OTHER NEARBY FACILITIES

Potential adverse impact to the facility from chemical releases/explosions from nearby industrial or military facilities. No such facilities identified within proximity to enrichment plant. Therefore, an initiating event index of (-6) is appropriate which meets the definition of "not credible" and no IROFS are needed.

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-RAILROAD

Potential adverse impact to the facility from chemical releases/explosions from nearby railroad traffic. Rail spur to the Waste Control Specialists facility along north side of NEF site does not transport explosive materials. No other railroads identified within proximity to the facility (see Section 3.2.1.2.2). Therefore, an initiating event index of (-6) is appropriate which meets the definition of "not credible" and no IROFS are needed.

Accident Identifier: EE-CUB-GAS

Potential adverse impact to the facility from natural gas release in the Central Utilities Building (CUB) and subsequent explosion. Natural gas used to fire plant boiler.

The initiating event is an assumed explosion in the CUB that could potentially impact nearby UF_6 areas in nearby adjacent buildings. Hazard shown by probabilistic analysis to be less than $1E-05$ which meets definition of "highly unlikely," therefore, an initiating event index of (-5) is appropriate and no IROFS are needed. Consequence category conservatively assumed as high.

Accident Identifier: EE-FLOOD

No credible sources of river or upstream dam flooding exist at the site. This yields an initiating event index of (-6). This probability meets definition of "not credible," therefore, no IROFS are needed.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: EE-LP-BLD (T)

Flooding due to local intense precipitation of areas containing UF₆ process systems and potential UF₆ release from process systems. Scenarios include: (1) excessive roof ponding beyond design capacity of roof and (2) interior building flooding from flood waters flowing and/or ponded around plant structures.

The initiating event is an uncontrolled flood with assumed high consequences to the worker and public. Without explicit design basis, conservatively assumed initiating event index of (-2) which would be typical of normal building code requirements.

For the controlled accident sequence, the preventive measure is a design feature of buildings containing UF₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and roof ponding and site flooding due to local intense precipitation, to ensure UF₆ process systems integrity (IROFS27c)

The frequency index number for the controlled accident initiating frequency was assigned a (-5) to meet the definition of "highly unlikely." The design basis will demonstrate the highly unlikely frequency of the associated local intense precipitation (see Section 3.2.3.4.4).

The failure probability index of (-3) was selected for IROFS27c. This corresponds to a single passive engineered IROFS per NUREG-1520.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: EE-LP-BLD (CR)

Flooding due to local intense precipitation of areas containing enriched uranic material and a potential criticality event. Scenarios include: (1) excessive roof ponding beyond design capacity of roof and (2) interior building flooding from flood waters flowing and/or ponded around plant structures.

The initiating event is an uncontrolled flood with assumed high consequences to the worker and public. Without explicit design basis, conservatively assumed initiating event index of (-2) which would be typical of normal building code requirements.

For the controlled accident sequence, the preventive measures are (1) a design feature of buildings containing enriched uranic material for roof ponding and site flooding due to local intense precipitation, to ensure associated building area subcriticality (IROFS27a) and (2) a design feature of buildings containing enriched uranic material for roof ponding and site flooding due to local intense precipitation, to ensure associated building area subcriticality (IROFS27b).

The frequency index number for the controlled accident initiating frequency was assigned a (-5) to meet the definition of "highly unlikely." The design basis will demonstrate the highly unlikely frequency of the associated local intense precipitation (see Section 3.2.3.4.4).

The failure probability index of (-3) was selected for IROFS27a. This corresponds to a single passive engineered IROFS per NUREG-1520.

The failure probability index of (-3) was selected for IROFS27b. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: EE-LP-PAD

Flooding due to local intense precipitation of the UBC storage pad and potential for impact with a UF₆ release.

The initiating event is an uncontrolled flood with assumed high consequences to the worker and public. Without explicit design basis, conservatively assumed initiating event index of (-2) which is typical of normal design requirements.

For the controlled accident sequence, the preventive measure is a design feature of the UBC storage pad for site flooding due to local intense precipitation to ensure UBC integrity (IROFS27d)

The frequency index number for the controlled accident initiating frequency was assigned a (-5) to meet the definition of "highly unlikely." The design basis will demonstrate the highly unlikely frequency of the associated local intense precipitation (see Section 3.2.3.4.4).

The failure probability index of (-3) was selected for IROFS27d. This corresponds to a single passive engineered IROFS per NUREG-1520.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SNOW

Excessive snow load on roofs of areas containing UF₆ process systems leading to roof failures and potential UF₆ release from process systems.

The uncontrolled event is an excessive snow load above normal building code design loads leading to roof failure and impacts on UF₆ process systems leading to UF₆ release. The event is assumed to have high consequences to the worker and public. Without explicit design basis, conservatively assumed initiating event index of (-2) which is appropriate for normal building code design.

For the controlled accident sequence, the preventive measure is a design feature of buildings containing UF₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and roof ponding and site flooding due to local intense precipitation, to ensure UF₆ process systems integrity (IROFS27c).

The frequency index number for the controlled accident initiating frequency was assigned a (-5) to meet the definition of "highly unlikely." The design basis will demonstrate the highly unlikely frequency of the associated local snow loading (see Section 3.2.3.3).

The failure probability index of (-3) was selected for IROFS27c. This corresponds to a single passive engineered IROFS per NUREG-1520.

Accident Identifier: EE-TORNADO, TORNADO MISSILE & HIGH WIND

Excessive tornado, tornado missile and high wind loads leading to building failure at areas containing UF₆ process systems and potential UF₆ release from process systems.

The uncontrolled event is excessive tornado loads, tornado missile loads and high wind loads above normal building code design levels leading to building failure and impacts on UF₆ process systems leading to UF₆ release. The event is assumed to have high consequences to the worker and public. Without explicit design basis, conservatively assumed initiating event index of (-2) which is appropriate for normal building code design.

For the controlled event, buildings are designed to tornado, tornado missile and wind loads shown to be "highly unlikely." Details on the development of the tornado, tornado missile and high wind loads are provided in Section 3.2.3.4.1. These loads have an annual probability of exceedance of 1E-05 and an initiating event index of (-5) is appropriate. The design basis for tornado, tornado missiles and high wind is IROFS27c.

The failure probability index of (-3) was selected for IROFS27c. This corresponds to a single passive engineered IROFS per NUREG-1520.

Type of Accident – T for Chemical
CR for Criticality

Accident Identifier: EE-SEISMIC-1 (UF₆ Areas)

Excessive seismic motions imposed on non-seismically qualified buildings, beyond normal building code design, and beyond the capacity of UF₆ piping systems could lead to building collapse, breaching of UF₆ systems, and ultimately a UF₆ release.

The UF₆ cascades and piping systems do not have an explicit seismic design basis. An initiating event index of (-2) has been conservatively assumed. Information on the annual frequency of earthquakes is provided in Section 3.2.6.4. The peak horizontal ground acceleration at an annual frequency of 1E-02 is approximately 0.01g. The peak horizontal ground acceleration at an annual frequency of 1E-03 is approximately 0.05g. The seismic capacity of the UF₆ piping systems is assumed to be capable of maintaining UF₆ confinement to at least a 0.01g earthquake. Actual seismic capacity of the piping is likely to be higher than 0.01g. Therefore, it is conservative to assign an initiating event index to UF₆ piping failure of (-2).

The uncontrolled event is for the UF₆ Areas. The seismic event leads to building failure and impacts on UF₆ process systems leading to UF₆ release. The event is assumed to have high consequences.

For the controlled event, buildings are designed to a seismic level with an annual probability of 1.0E-4. Details of the development of the seismic design basis are provided in Section 3.2.6. The seismic design basis selected for the facility is based on a site-specific seismic hazard assessment for the NEF site.

The design basis earthquake (DBE) has been selected as the 10,000-yr (1.0E-4 mean annual probability) earthquake. This DBE will be used in the detailed design process to demonstrate compliance with the overall ISA performance requirements. This will be accomplished by confirmatory seismic performance calculations for the seismic IROFS during detailed design. The objective will be to demonstrate that use of this DBE will achieve a likelihood of unacceptable performance of less than approximately 1.0E-5 per year. The difference between the mean annual probabilities for design (1.0E-4) and performance (1.0E-5) is achieved through conservatism in the design (factors of safety), elasticity in the structures, and conservatism in the evaluation of the design. Use of this approach will result in a "highly unlikely" event likelihood for exceeding the seismic capacity of the buildings and an initiating event index of (-5) is appropriate.

Since the initiating event index for the UF₆ piping (-2) is more limiting than the seismic capacity of the buildings (-5), the (-2) is used as the initiating event index for all seismic cases.

Accident Identifier SEISMIC-1a: Uncontrolled case; initiating event index (-2) as described above. As discussed above, this is a high consequence category of (3). Risk index becomes (9). Therefore, IROFS required.

Design feature of buildings containing UF₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and roof ponding and site flooding due to local intense precipitation, to ensure UF₆ process systems integrity (seismic portion, 1.0E-4 and likelihood of unacceptable performance 1.0E-5) is IROFS27c.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: EE-SEISMIC-1 (UF₆ Areas) (continued)

Accident Identifier SEISMIC-1b: Add IROFS27c, initiating event index (-2) as described above. As a result of IROFS27c, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2). The risk index is (6), therefore, additional IROFS are required.

The HVAC system will also be designed to automatically trip on a seismic event. Automatic Building HVAC system trip on detection of seismic event to ensure offsite exposures from building outflow maintain consequence low is IROFS26.

Accident Identifier SEISMIC-1c: Add IROFS26, initiating event index (-2) as described above. As a result of the addition of IROFS26, consequence analysis shows that the consequences have been further mitigated but still at an intermediate category (2). The resulting risk index is (6), therefore, additional IROFS are required.

Accident Identifier SEISMIC-1d: Evaluate failure of IROFS26. A failure probability index of (-3) was selected for IROFS26. This corresponds to a single active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3. Consequence category is intermediate (2), same as for Accident Identifier SEISMIC-1b. The resulting risk index is (4) which is acceptable risk.

Building leakage to outside following HVAC trip is limited by design features. Design features to ensure building leak integrity is IROFS41.

Accident Identifier SEISMIC-1e: Add IROFS41, initiating event index (-2) as described above. As a result of the addition of IROFS41, consequence analysis shows that consequences have been further mitigated to low (1), yielding a risk index of (3). This is acceptable risk.

Accident Identifier SEISMIC-1f: Evaluate failure of IROFS41 with success of IROFS26. A failure probability index of (-2) was conservatively selected for IROFS41, which is a single passive engineered IROFS per NUREG-1520. The resulting consequence category is intermediate (2), same as for Accident Identifier SEISMIC-1c. Risk index is (4) which is acceptable.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SEISMIC-2 (Cascades)

Excessive seismic motions imposed on non-seismically qualified buildings, beyond normal building code design, and beyond the capacity of UF₆ piping and cascade systems could lead to building collapse, breaching of UF₆ systems, and ultimately a UF₆ release.

The UF₆ cascades and piping systems do not have an explicit seismic design basis. An initiating event index of (-2) has been conservatively assumed. Information on the annual frequency of earthquakes is provided in Section 3.2.6.4. The peak horizontal ground acceleration at an annual frequency of 1E-02 is approximately 0.01g. The peak horizontal ground acceleration at an annual frequency of 1E-03 is approximately 0.05g. The seismic capacity of the UF₆ piping systems is assumed to be capable of maintaining UF₆ confinement to at least a 0.01g earthquake. Actual seismic capacity of the piping is likely to be higher than 0.01g. Therefore, it is conservative to assign an initiating event index to UF₆ piping failure of (-2).

The uncontrolled event is for the Cascade Halls. The seismic event leads to building failure and impacts on centrifuges leading to UF₆ release. The event is assumed to have high consequences.

For the controlled event, buildings are designed to a seismic level with an annual probability of 1.0E-4. Details of the development of the seismic design basis are provided in Section 3.2.6. The seismic design basis selected for the facility is based on a site-specific seismic hazard assessment for the NEF site.

The design basis earthquake (DBE) has been selected as the 10,000-yr (1.0E-4 mean annual probability) earthquake. This DBE will be used in the detailed design process to demonstrate compliance with the overall ISA performance requirements. This will be accomplished by confirmatory seismic performance calculations for the seismic IROFS during detailed design. The objective will be to demonstrate that use of this DBE will achieve a likelihood of unacceptable performance of less than approximately 1.0E-5 per year. The difference between the mean annual probabilities for design (1.0E-4) and performance (1.0E-5) is achieved through conservatism in the design (factors of safety), elasticity in the structures, and conservatism in the evaluation of the design. Use of this approach will result in a "highly unlikely" event likelihood for exceeding the seismic capacity of the buildings and an initiating event index of (-5) is appropriate.

Since the initiating event index for the UF₆ piping (-2) is more limiting than the seismic capacity of the buildings (-5), the (-2) is used as the initiating event index for all seismic cases.

Accident Identifier SEISMIC-2a: Uncontrolled case; initiating event index (-2) as described above. As discussed above, this is a high consequence category of (3). Risk index becomes (9). Therefore, IROFS required.

Design feature of buildings containing UF₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and roof ponding and site flooding due to local intense precipitation, to ensure UF₆ process systems integrity (seismic portion, 1.0E-4 and likelihood of unacceptable performance 1.0E-5) is IROFS27c.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: EE-SEISMIC-2 (Cascades) (continued)

Accident Identifier SEISMIC-2b: Add IROFS27c, initiating event index (-2) as described above. As a result of IROFS27c, the consequence analysis shows that the consequences remain high category (3). The risk index is (9), therefore, additional IROFS are required.

The HVAC system will also be designed to automatically trip on a seismic event. Automatic Building HVAC system trip on detection of seismic event to ensure offsite exposures from building outflow maintain consequence low is IROFS26.

Accident Identifier SEISMIC-2c: Add IROFS26, initiating event index (-2) as described above. As a result of the addition of IROFS26, consequence analysis shows that the consequences have been mitigated to an intermediate category (2). The resulting risk index is (6), therefore, additional IROFS are required.

Accident Identifier SEISMIC-2d: Evaluate failure of IROFS26. A failure probability index of (-3) was selected for IROFS26. This corresponds to a single active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3. Consequence category is high (3), same as for Accident Identifier SEISMIC-2b. The resulting risk index is (3) which is acceptable risk.

Building leakage to outside following HVAC trip is limited by design features. Design features to ensure building leak integrity is IROFS41.

Accident Identifier SEISMIC-2e: Add IROFS41, initiating event index (-2) as described above. As a result of the addition of IROFS41, consequence analysis shows that consequences have been further mitigated to low (1), yielding a risk index of (3). This is acceptable risk.

Accident Identifier SEISMIC-2f: Evaluate failure of IROFS41 with success of IROFS26. A failure probability index of (-2) was conservatively selected for IROFS41, which is a single passive engineered IROFS per NUREG-1520. The resulting consequence category is intermediate (2), same as for Accident Identifier SEISMIC-2c. Risk index is (4) which is acceptable.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SEISMIC-3 (Blending & Liquid Sampling)

Excessive seismic motions imposed on non-seismically qualified buildings, beyond normal building code design, and beyond the capacity of UF₆ piping systems could lead to building collapse, breaching of UF₆ systems, and ultimately a UF₆ release.

The UF₆ cascades and piping systems do not have an explicit seismic design basis. An initiating event index of (-2) has been conservatively assumed. Information on the annual frequency of earthquakes is provided in Section 3.2.6.3. The peak horizontal ground acceleration at an annual frequency of 1E-02 is approximately 0.01g. The peak horizontal ground acceleration at an annual frequency of 1E-03 is approximately 0.05g. The seismic capacity of the UF₆ piping systems is assumed to be capable of maintaining UF₆ confinement to at least a 0.01g earthquake. Actual seismic capacity of the piping is likely to be higher than 0.01g. Therefore, it is conservative to assign an initiating event index to UF₆ piping failure of (-2).

The uncontrolled event is for the Blending & Liquid Sampling Area. The seismic event leads to building failure and impacts on UF₆ process systems leading to UF₆ release. The event is assumed to have high consequences.

For the controlled event, buildings are designed to a seismic level with an annual probability of 1.0E-4. Details of the development of the seismic design basis are provided in Section 3.2.6. The seismic design basis selected for the facility is based on a site-specific seismic hazard assessment for the NEF site.

The design basis earthquake (DBE) has been selected as the 10,000-yr (1.0E-4 mean annual probability) earthquake. This DBE will be used in the detailed design process to demonstrate compliance with the overall ISA performance requirements. This will be accomplished by confirmatory seismic performance calculations for the seismic IROFS during detailed design. The objective will be to demonstrate that use of this DBE will achieve a likelihood of unacceptable performance of less than approximately 1.0E-5 per year. The difference between the mean annual probabilities for design (1.0E-4) and performance (1.0E-5) is achieved through conservatism in the design (factors of safety), elasticity in the structures, and conservatism in the evaluation of the design. Use of this approach will result in a "highly unlikely" event likelihood for exceeding the seismic capacity of the buildings and an initiating event index of (-5) is appropriate.

Since the initiating event index for the UF₆ piping (-2) is more limiting than the seismic design of the buildings (-5), the (-2) is used as the initiating event index for all seismic cases.

Accident Identifier SEISMIC-3a: Uncontrolled case; initiating event index (-2) as described above. As discussed above, this is a high consequence category of (3). Risk index becomes (9). Therefore, IROFS required.

Design feature of buildings containing UF₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and roof ponding and site flooding due to local intense precipitation, to ensure UF₆ process systems integrity (seismic portion, 1.0E-4 and likelihood of unacceptable performance 1.0E-5) is IROFS27c.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SEISMIC-3 (Blending & Liquid Sampling) (continued)

Accident Identifier SEISMIC-3b: Add IROFS 27c, initiating event index (-2) as described above. As a result of IROFS27c, the consequence analysis shows that the consequences have been mitigated to an intermediate category (2). The risk index is (6), therefore, additional IROFS are required.

The HVAC system will also be designed to automatically trip on a seismic event. Automatic Building HVAC system trip on detection of seismic event to ensure offsite exposures from building outflow maintain consequence low is IROFS26.

Accident Identifier SEISMIC-3c: Add IROFS26, initiating event index (-2) as described above. As a result of the addition of IROFS26, consequence analysis shows that the consequences have been further mitigated but still at an intermediate category (2). The resulting risk index is (6), therefore, additional IROFS are required.

Accident Identifier SEISMIC-3d: Evaluate failure of IROFS26. A failure probability index of (-3) was selected for IROFS26. This corresponds to a single active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3. Consequence category is intermediate (2), same as for Accident Identifier SEISMIC-3b. The resulting risk index is (4) which is acceptable risk.

Building leakage to outside following HVAC trip is limited by design features. Design features to ensure building leak integrity is IROFS41.

Accident Identifier SEISMIC-3e: Add IROFS41, initiating event index (-2) as described above. As a result of the addition of IROFS41, consequence analysis shows that consequences have been further mitigated to low (1), yielding a risk index of (3). This is acceptable risk.

Accident Identifier SEISMIC-3f: Evaluate failure of IROFS41 with success of IROFS26. A failure probability index of (-2) was conservatively selected for IROFS41, which is a single passive engineered IROFS per NUREG-1520. The resulting consequence category is intermediate (2), same as for Accident Identifier SEISMIC-3c. Risk index is (4) which is acceptable.

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SEISMIC-5 (Liquid Sampling Autoclave)

Excessive seismic motions beyond the seismic capacity of the liquid sampling autoclave in the horizontal or tipped position containing liquified UF_6 could lead to liquid sampling autoclave failure and a liquid UF_6 release.

For the uncontrolled case, the liquid sampling autoclave is assumed not to have an explicit seismic design basis. An initiating event index of (-2) has been conservatively assumed. Information on the annual frequency of earthquakes is provided in Section 3.2.6.4. The peak horizontal ground acceleration at an annual frequency of $1E-02$ is approximately $0.01g$. The peak horizontal ground acceleration at an annual frequency of $1E-03$ is approximately $0.05g$. The seismic capacity of the liquid sampling autoclave is assumed to be capable of maintaining UF_6 confinement to at least a $0.01g$ earthquake. Actual seismic capacity of the liquid sampling autoclave is likely to be higher than $0.01g$. Therefore, it is conservative to assign an initiating event index to the liquid sampling autoclave failure of (-2). The uncontrolled event is a seismic-induced loss of containment for a liquid sampling autoclave containing liquified UF_6 . The event is assumed to have high consequences.

For the controlled event, the liquid sampling autoclave is seismically designed in both operating positions (i.e., cylinder horizontal and cylinder tipped) to a seismic level with an annual probability of $1.0E-4$. Details of the development of the seismic design basis are provided in Section 3.2.6. The seismic design basis selected for the facility, including the liquid sampling autoclave, is based on a site-specific seismic hazard assessment for the NEF site.

The design basis earthquake (DBE) has been selected as the 10,000-yr ($1.0E-4$ mean annual probability) earthquake. This DBE will be used in the detailed design process to demonstrate compliance with the overall ISA performance requirements. This will be accomplished by confirmatory seismic performance calculations for the seismic IROFS during detailed design. The objective will be to demonstrate that use of this DBE will achieve a likelihood of unacceptable performance of less than approximately $1.0E-5$ per year. The difference between the mean annual probabilities for design ($1.0E-4$) and performance ($1.0E-5$) is achieved through conservatism in the design (factors of safety), elasticity in the components, and conservatism in the evaluation of the design. Use of this approach will result in a "highly unlikely" event likelihood for exceeding the seismic capacity of the liquid sampling autoclave and an initiating event index of (-5) is appropriate.

The liquid sampling autoclave seismic design is IROFS28. Seismic design level considers the duration that the liquid sampling autoclave is in a particular position (horizontal or tipped). For the horizontal position, the seismic design is based on the $1.0E-4$ annual probability DBE ($0.15g$) peak horizontal and vertical acceleration and likelihood of unacceptable performance ($1.0E-5$). An initiating event index of (-5) is appropriate.

Seismic design in the tipped position is adjusted for the short exposure period to maintain "highly unlikely" likelihood. Based on a detailed analysis considering the number of annual liquid sampling evolutions, duration while the liquid sampling autoclave is in the tipped position, and the seismic hazard for the site (see Section 3.2.6.4), a seismic design basis for the liquid sampling autoclave of $0.04g$ (peak horizontal and vertical acceleration) while in the tipped position is appropriate. This design applies to all positions except for full horizontal. The $0.04g$ tipped design level was determined based on an initiating event index of (-5).

The failure probability index of (-3) was selected for IROFS28. This corresponds to a single passive engineered IROFS per NUREG-1520.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: EE-SEISMIC-WORKER EVAC

The initial failure (initiating event) is excessive seismic motions imposed beyond the capacity of UF₆ piping systems leading to breaching of UF₆ systems, and ultimately a UF₆ release exposing workers in the area.

The uncontrolled event is the seismic event that leads to failure of the UF₆ process systems and UF₆ release. The event is assumed to have high consequences to the worker present in the area.

For the controlled event, the mitigative measure is to administratively limit exposure by requiring worker action to evacuate the area(s) of concern during a seismic event to ensure that the consequences of inhalation of uranic material and HF are low (IROFS39a). Sufficient time is available for the worker to detect and to evacuate the area(s) of concern. As a result of IROFS39a, the consequence analysis shows that the consequence has been mitigated to a low category (1).

The index number for the initiating event was conservatively assumed to be (-2). The UF₆ cascades and piping systems do not have an explicit seismic design basis. Information on the annual frequency of earthquakes is provided in Section 3.2.6.4. The peak horizontal ground acceleration at an annual frequency of 1E-02 is approximately 0.01g. The seismic capacity of the UF₆ piping systems is assumed to be capable of maintaining UF₆ confinement to at least a 0.01g earthquake. Actual seismic capacity of the piping is likely to be higher than 0.01g. Therefore, it is conservative to assign an initiating event index to UF₆ piping failure of (-2).

The failure probability index for the administrative controls/procedures of IROFS39a was determined to be (-3). This corresponds to an administrative IROFS that must be performed in response to a rare unplanned demand per NUREG-1520. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF1-1 (Centrifuge Test Facility)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was based on evidence from similarly designed Urenco European plants which have a combined plant history of greater than 30 yrs in which no fire events have occurred in any uranium areas.

The uranium inventory in the area is 50 kg (110 lb) of UF_6 contained in sealed stainless steel components and piping.

The uncontrolled event is fire propagating into this area from other areas within the Centrifuge Assembly Building that could result in a release of the UF_6 inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material.

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Accident Identifier: FF1-2 (Centrifuge Test Facility)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory in the area is 50 kg (110 lb) which is contained in sealed stainless steel components and piping.

The uncontrolled event is a fire involving excessive transient combustibles within the room that could result in a release of the UF_6 inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF_6 inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of sealed stainless steel components used in the test assembly and test piping. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF5-1 (CRDB Loading Dock)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is UF₆ contained in 48Y, 48X, and/or 30B cylinders located on the loading dock and scales adjacent to the CRDB Truck Unloading Bay and Dock.

The uncontrolled event is a fire involving excessive transient combustibles in the adjacent truck bay that could result in a release of the UF₆ inventory (failure of IROFS36b: administratively limit storage of UF₆ cylinders in the CRDB to ensure ≥ 1 m (3 ft) setback from the edge of the loading dock). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of the cylinders. In order to prevent exposure to a potential service vehicle fire in the drive through bay, preventive measures are to administratively limit storage of UF₆ cylinders in the CRDB to ensure ≥ 1 m (3 ft) setback from the edge of the loading dock.

The failure probability index for administrative controls/procedures of IROFS36b was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF5-2 (CRDB Truck Bay)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is UF₆ contained in 48Y and/or 30B cylinders located on the semi-tractor trailers during receipt of incoming feed cylinders, shipment of outgoing product cylinders, or shipment of outgoing UBCs while on the semi-tractor trailer or being transported to/from the loading dock.

The uncontrolled event is a fire involving the transient combustibles and fuel load of a truck located in the truck bay that could result in a release of the UF₆ inventory (failure of IROFS36h: administratively limit fire exposure to feed cylinders, product cylinders, and UBCs containing ≥ 0.1 kg of UF₆ due to a semi-tractor trailer fire during the receipt and shipping process). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of the cylinders. In order to prevent cylinder exposure to a semi-tractor trailer fire in the drive through bay, preventive measures are to receive UF₆ feed cylinders in their U.S. Department of Transportation (DOT) required protective assemblies and to offload the cylinder/protective assemblies to the loading dock. Outgoing product cylinders will be placed into their DOT required overpacks on the loading dock or in the CRDB prior to the cylinder/overpacks being placed on the semi-tractor trailer. Similarly, the DOT required protective assemblies would be installed on outgoing UBCs on the loading dock or in the CRDB prior to the cylinder/protective assemblies being placed on the semi-tractor trailer.

A theoretical truck fire in the CRDB loading bay was analyzed and shown to not pose a threat of rupturing cylinders in the building or on the loading dock applying a minimum of 1 meter (3 feet) spatial separation. This theoretical truck fire aggregated the cumulative combustible load of the vehicle (i.e., 500 liters (132 gallons) of diesel fuel and 744 liters (196 gallons) of fuel equivalent to other content) into a pool fire of 5 meters (16 feet) in diameter. The duration of this fire was calculated to be approximately 22 minutes. This fire severity is less than that required by 10 CFR 71.73(c)(4) for qualification of the cylinder thermal overpack/protective assemblies (i.e., full engulfment of the cylinder in an 800°C (1475°F) hydrocarbon fire for 30 minutes). Additionally, there are conservative assumptions in the analysis that make exposure from this theoretical fire more severe than would be expected to realistically occur (e.g., the bulk fuel load of the tractor is actually spatially separated from the trailer holding the cylinders, three-fifths of the fuel load cannot physically “pool,” and cylinders would not be “engulfed”). As a result, the cylinder handling practices, including use of cylinder overpack/thermal protective assemblies, of IROFS36h will ensure that cylinders containing UF₆ on a semi-tractor trailer will be protected from a theoretical truck fire.

The failure probability index for administrative controls/procedures of IROFS36h was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF6-1 (CRDB General Areas)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 9.43E6 kg (2.08E7 lb) and consists of UF₆ contained in 48Y, 48X, and 30B cylinders located in storage or transit into and out of the area via overhead crane or on a cylinder transporter (to and from the UF₆ Handling Area).

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the UF₆ inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Accident Identifier: FF6-2 (CRDB General Areas)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 9.43E6 (2.08E7 lb) and consists of UF₆ contained in 48Y, 48X, and 30B cylinders located in storage or transit into and out of the area via overhead crane or on a cylinder transporter (to and from the UF₆ Handling Area).

The uncontrolled event is a fire involving excessive transient combustibles within the CRDB that could result in a release of the UF₆ inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic materials at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of a cylinder. Preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic materials at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Accident Identifier: FF7-1 (Cylinder Transporters/Movers)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory would be one UF₆ cylinder (a 48X, 48Y, or a 30B) in transit.

The uncontrolled event is a fire involving excessive combustibles on any onsite cylinder transporter/mover that could result in a release of the UF₆ inventory (failure of IROFS36c: administratively limit onsite UF₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of a cylinder. Cylinder transporter/mover design will be limited to be either electric drive or diesel drive with a fuel capacity of less than 280 L (74 gallons). Diesel driven onsite UF₆ cylinder transporters/movers are not used for cylinder transport inside NEF buildings. Since filled 30B cylinders are stored inside the NEF buildings, only electric driven onsite UF₆ cylinder transporters/movers are used for transport of filled 30B product cylinders inside NEF buildings. When filled 30B product cylinders are transported outside of NEF buildings, they are in DOT required overpacks as described in accident sequence FF5-2. Empty 30B cylinders may be stored outside NEF buildings and, as a result, may be transported by diesel driven onsite UF₆ cylinder transporters/movers. The preventive measure is to administratively limit onsite UF₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal) (IROFS36c).

The failure probability index for administrative controls/procedures of IROFS36c was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: FF8-1 (Cascade Hall Inside Assay Thermal Enclosure - typical for 6 halls)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory consists of UF₆ in piping and centrifuges. The inventory in an assay (8 cascades) is 128 kg (282 lb).

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the UF₆ inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF8-2 (Cascade Hall Inside Assay Thermal Enclosure - typical for 6 halls)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The inventory consists of UF₆ in piping and centrifuges. The inventory in an assay (8 cascades) is 128 kg (282 lb).

The uncontrolled event is a fire involving excessive transient combustibles within the Cascade Hall inside the assay enclosure that could result in a release of the UF₆ inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The fire presumes that ignition occurs in cabling feeding the centrifuge drive motors. It was conservatively presumed that this fire could result in the release of 1.3 kg (2.87 lb) of UF₆. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: FF11-1 (Process Services Area)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is 13.8 kg (30.4 lb) which consists of UF₆ in feed, product, and tails piping manifolds. Additionally, there is a possibility of uranic material being present in the sodium fluoride traps which are part of the contingency dump system. Assuming this system has been charged to capacity, there could be up to 2400 kg (5290 lb) (16 cascades with three traps per cascade – 50 kg/trap (110 lb/trap)).

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the uranium inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF11-2 (Process Services Area)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is 13.8 kg (30.4 lb) which consists of UF₆ in feed, product, and tails piping manifolds. Additionally, there is a possibility of uranic material being present in the sodium fluoride traps which are part of the contingency dump system. Assuming this system has been charged to capacity, there could be up to 2400 kg (5290 lb) (16 cascades with three traps per cascade – 50 kg/trap (110 lb/trap)).

The uncontrolled event is a fire involving excessive transient combustibles within the area that could result in a release of the uranium inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. It is assumed that fire could cause failures in the aluminum piping manifolds and that 50% of the inventory of the manifolds (6.88 kg) (15.2 lb) would be released even though this piping is at subatmospheric pressure. Continuing release from these manifolds was not considered since the cascade centrifuges and connected cylinders are at lower elevations and gravity pouring would be necessary for additional UF₆ to escape. The remaining uranic material inventory that could potentially be present was discounted as not being released during this fire due to insufficient combustibles being present to cause failure of the sealed aluminum chemical traps. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF15-1 (UF₆ Handling Area - typical for 3 modules/ Blending and Liquid Sampling Area)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 4.00E5 kg (8.82E5 lb) in the UF₆ Handling Area and 1.46E5 kg (3.22E5 lb) in the Blending and Liquid Sampling Area and consists of UF₆ contained in cylinders, piping, manifolds, and hoses. Additional uranic material/HF inventory could be present on the carbon/alumina traps that capture UF₆ from the various feed, product, and tails system cold traps.

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the uranium inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF16-1 (UF₆ Handling Area - typical for 3 modules/ Blending and Liquid Sampling Area)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 4.00E5 kg (8.82E5 lb) in the UF₆ Handling Area and 1.46E5 kg (3.22E5 lb) in the Blending and Liquid Sampling Area and consists of UF₆ contained in cylinders, piping, manifolds, and hoses. Additional uranic material/HF inventory could be present on the carbon/alumina traps that capture residual traces of UF₆ from the various feed, product, and tails system cold traps.

The uncontrolled event is a fire involving excessive transient combustibles within the area could result in a release of the uranium inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. It is assumed that a fire in improperly placed transient combustibles could cause failure of a single cylinder hose. This could result in a pouring feed cylinder release (feed selected as bounding – highest pressure) of 1.3 kg of UF₆ over a 30-minute period. The remaining uranic material/HF inventory was discounted as not being released during this fire due to insufficient combustibles being present to cause failures of adjacent hoses, cylinders, piping, manifolds, or stainless steel chemical traps. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF16-2 (UF₆ Handling Area – typical for 3 modules/ Blending and Liquid Sampling Area)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 4.00E5 kg (8.82E5 lb) in the UF₆ Handling Area and 1.46E5 kg (3.22E5 lb) in the Blending and Liquid Sampling Area and consists of UF₆ contained in cylinders, piping, manifolds, and hoses. Additional uranic material/HF inventory could be present on the carbon/alumina traps that capture residual traces of UF₆ from the various feed, product, and tails system cold traps.

The uncontrolled event is a fire involving excessive transient combustibles within the area could result in a release of the uranium inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. It is assumed that fire could cause failures in the aluminum piping manifold and that 50% of the inventory feeding one assay (3.44 kg) (7.6 lb) would be released even though this piping is at subatmospheric pressure. Continuing release from these manifolds was not considered since connected cylinders are at lower elevations and gravity pouring would be necessary for additional UF₆ to escape. The remaining uranic material/HF was discounted as not being released during this fire due to insufficient combustibles being present to cause failure of the cylinders or stainless steel chemical traps. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF21-1 (TSB Solid Waste Collection Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 500 kg (1100 lb) of uranic material contained in 12 L (3.2 gal) metal containers and 210 L (55 gal) metal drums.

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the uranium inventory (failure of IROFS35: automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF21-2 (TSB Solid Waste Collection Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 years – applies. (See FF1-1 for justification.)

The uranium inventory is up to 500 kg (1100 lb) of uranic material contained in 12 L (3.2 gal) metal containers and 210 L (55 gal) metal drums.

The uncontrolled event is a fire involving excessive transient combustibles within the room that could result in a release of the uranium inventory (failure of IROFS36d: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The fire presumes that up to 4 kg (8.8 lb) worth of uranic material (no HF) could be present in open 12 L (3.2 gal) containers or drums during transfer/packing operations and driven off in the event of a fire even though this material is typically bound on other material. The remaining uranic material inventory in the sealed metal drums and waste containers was discounted as not being released during this fire due to insufficient combustibles being present to cause failure of the metal containers. Preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d).

The failure probability index for administrative controls/procedures of IROFS36d was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF23-1 (TSB Decontamination Workshop)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 48 kg (106 lb) contained in up to three 12 L (3.2 gal) metal containers and three steel tanks.

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the uranium inventory (failure of IROFS35: automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF23-2 (TSB Decontamination Workshop)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 48 kg (106 lb) contained in up to three 12 L (3.2 gal) metal containers and three steel tanks.

The uncontrolled event is a fire involving excessive transient combustibles within the room that could result in a release of the uranium inventory (failure of IROFS36d: *administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low*). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The fire presumes that up to 4 kg (8.8 lb) worth of uranic material (no HF) could be present in open 12 L (3.2 gal) containers during transfer/charging operations and driven off in the event of a fire. The remaining uranic material inventory is in closed metal tanks, sealed metal containers, and/or is suspended in liquid and was discounted as not being released during this fire due to insufficient combustibles being present to cause failures/release.

Preventive measures are to *administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d)*.

The failure probability index for administrative controls/procedures of IROFS36d was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF24-1 (TSB Ventilated Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 500 kg (1100 lb) contained in 12 L (3.2 gal) metal containers and 210 L (55 gal) drums. Additional uranium inventory is present (periodically) in the form of a single 48Y, 48X, or 30B cylinder present in the room for valve maintenance/change-out.

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the uranium inventory (failure of IROFS35: automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due to automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF25-1 (TSB Ventilated Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

TSB Ventilated Room – The uranium inventory is up to 500 kg (1100 lb) contained in 12 L (3.2 gal) metal containers and 210 L (55 gal) drums. Additional uranium inventory is present (periodically) in the form of a single 48Y, 48X, or 30B cylinder present in the room for valve maintenance/change-out.

The uncontrolled event is a fire involving excessive transient combustibles within the area that could result in a release of the uranium inventory (failure of IROFS36d: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. It is assumed that a fire in improperly placed transient combustibles could cause failure of the nitrogen hose or vent line piping used to bleed gas from cylinders during valve servicing and/or subsequent nitrogen pressure test. The resulting release would be bounded by a feed or tails cylinder (48Y has the largest inventory) which results in a puff release at the 1.4 bar (20.3 psia) valve test pressure with a subsequent pouring cylinder release at room temperature. The puff releases 3.83 kg of UF₆ and the continuing release is a cumulative 0.42 kg of UF₆ over 30 minutes. The remaining uranic material/HF inventory in the cylinder, sealed metal drums, chemical traps, and waste containers was discounted as not being released during this fire due to insufficient combustibles being present to cause failure of the cylinder or metal containers. Preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d).

The failure probability index for administrative controls/procedures of IROFS36d was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF25-2 (TSB Ventilated Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 500 kg (1100 lb) contained in 12 L (3.2 gal) metal containers and 210 L (55 gal) drums. Additional uranium inventory is present (periodically) in the form of a single 48Y, 48X, or 30B cylinder present in the room for valve maintenance/change-out.

The uncontrolled event is a fire involving excessive transient combustibles within the area that could result in a release of the uranium inventory (failure of IROFS36d: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be an intermediate consequence event. The fire presumes that up to 50 kg (110 lb) of uranic material/HF could be present in open 12 L (3.2 gal) containers and the bulking drum during transfer/bulking operations and driven off in the event of a fire. In order to mitigate the severity to low consequence, the IROFS required is smoke detection (area-wide in the room or in the ventilation system) interlocked to isolate the room ventilation systems with limited leakage from the building (IROFS37).

The remaining uranic material/HF inventory in the cylinder, sealed metal drums, chemical traps, and waste containers was discounted as not being released during this fire due to insufficient combustibles being present to cause failure of the cylinder or metal containers. The preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d).

Accident Identifier FF25-2a: The uncontrolled case is initiating event index (-2) with a consequence category (3). Risk index is (9) and IROFS are needed.

Accident Identifier FF25-2b: Preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS 36d). The controlled case consequences analysis shows that the resulting consequence is intermediate category (2). Risk index is (6) and additional IROFS are needed.

Accident Identifier FF25-2c: Preventive measures are (1) to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d) and (2) automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low (IROFS37). This is a controlled event with a mitigation to reduce the severity of the consequence (smoke detection trip of the room ventilation with limited leakage) with a failure probability of (-2). The resulting risk index is (3) which is acceptable risk.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF25-2 (TSB Ventilated Room) (continued)

Accident Identifier FF25-2d: Preventive measures are (1) to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d) and (2) automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low (IROFS37). However, in this event, the failure of IROFS37 is evaluated. This is a controlled event without mitigation to reduce the severity of the consequence. The resulting likelihood index is (-4) which is combined with the intermediate consequence (the controlled case consequences analysis shows that the resulting consequence is intermediate) and results in a risk index of (4) which is acceptable risk.

Accident Identifier FF25-2e: Preventive measures are (1) to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d) and (2) automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low (IROFS37). However, in this event, the failure of IROFS36d is evaluated. This is an evaluation of the event with mitigation. The initiating event is -2 with a failure probability index of -3. The event is assumed to have high consequences (category 3). This results in a risk index of (3) which is acceptable risk.

Accident Identifier FF25-2f: Preventive measures are (1) to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36d) and (2) automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low (IROFS37). However, in this event, the failure of both IROFS36d and IROFS37 are evaluated. This is an evaluation of the event with a failure of mitigation. The initiating event is -2 with a failure probability index of -3 combined with a failure probability of -2. The event is assumed to have high consequences (category 3). This results in a risk index of (3) which is acceptable risk.

The failure probability index for smoke detection trip of the room ventilation and limited building leakage was determined to be (-2). The NUREG-1520 criteria – a single active engineered IROFS – applies.

The failure probability index for administrative controls/procedures of IROFS36d was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF38-1 (TSB Chemical Lab Sample Storage Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 250 kg (550 lb) of UF₆.

The uncontrolled event is fire propagating into this area from other areas that could result in a release of the UF₆ inventory (failure of IROFS35: automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire barriers prevents fires from propagating into areas containing uranic material). This event was assumed to have a high consequence.

For the controlled event, fire would not propagate into the area due automatic closure of fire-rated barriers opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fire barriers prevents fires from propagating into areas containing uranic material (IROFS35).

The failure probability index for fire barriers was determined to be (-3). This corresponds to an active engineered IROFS per NUREG-1520. The IROFS justification for high availability is discussed in Section 3.8.3.

Accident Identifier: FF38-2 (TSB Chemical Lab Sample Storage Room)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 250 kg (550 lb) of UF₆ (up to 0.5 kg (1.1 lb) in 500 1S sample cylinders)

The uncontrolled event is a fire involving excessive transient combustibles within the room that could result in a release of the UF₆ inventory (failure of IROFS36a: administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of a sample cylinder. Preventive measures are to administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low (IROFS36a).

The failure probability index for administrative controls/procedures of IROFS36a was determined to be (-3). The NUREG-1520 criteria – a administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions
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Accident Identifier: FF42-1 (UBC Storage Pad Transporter/Mover)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory would be one UF₆ cylinder (a 48Y) in transit.

The uncontrolled event is a fire involving excessive combustibles on any UBC storage pad cylinder transporter/mover that could result in a release of the UF₆ inventory (failure of IROFS36c: administratively limit onsite UF₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of a cylinder. Onsite cylinder transporter/mover design will be limited to be either electric drive or diesel drive with a fuel capacity of less than 280 L (74 gal). The preventive measure is to administratively limit onsite UF₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal) (IROFS36c).

The failure probability index for administrative controls/procedures of IROFS36c was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: FF43-1 (Uranium Byproduct Cylinders (UBC) Storage Pad)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 1.97E8 kg (4.34E8 lb) of UF₆ contained in 48Y cylinders located on the UBC Storage Pad.

The uncontrolled event is a fire involving excessive transient combustibles on the UBC Storage Pad (failure of IROFS36e: administratively limit transient combustible loading on the UBC Storage Pad to ensure cylinder integrity). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of the cylinders. In order to prevent exposure to pooled flammable fuel fire on the pad, vehicles to be driven onto the storage pad itself will be limited in fuel capacity to less than 280 L (74 gal) of flammable or combustible fuel. The preventive measure is to administratively limit transient combustible loading on the UBC Storage Pad to ensure cylinder integrity (IROFS36e).

The failure probability index for administrative controls/procedures of IROFS36e was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical
CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF43-2 (UBC Storage Pad)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 1.97E8 kg (4.34E8 lb) of UF₆ contained in 48Y cylinders located on the UBC Storage Pad.

The uncontrolled event is a fire involving excessive transient combustibles adjacent to the UBC Storage Pad (failure of IROFS36f: administratively limit designated routes for bulk fueling vehicles onsite to ensure UBC cylinder integrity). This event was assumed to have a high consequence.

For the controlled event, a fire considering expected in-situ and transient combustibles would be a low consequence event. The UF₆ inventory was discounted as not being released during a fire due to insufficient combustibles being present to cause failure of the cylinders. A typical service vehicle fire on the UBC Storage Pad perimeter road was evaluated and shown to not result in failure of the UBC cylinders. The preventive measure is to administratively limit designated routes for bulk fueling vehicles onsite to ensure UBC cylinder integrity (IROFS36f).

The failure probability index for administrative controls/procedures of IROFS36f was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Accident Identifier: FF44-1 (UBC Storage Pad)

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. (See FF1-1 for justification.)

The uranium inventory is up to 1.97E8 kg (4.34E8 lb) of UF₆ contained in 48Y cylinders located on the UBC Storage Pad.

The uncontrolled event is a wildland fire spreading onto the property and exposing the UBC Storage Pad (failure of IROFS36g: administratively limit onsite vegetation fire sources to ensure integrity of important targets). This event was assumed to have a high consequence.

For the controlled event, a fire would be a low consequence event. Off property vegetation is of a low density and the fenceline is over 100 m (328 ft) away. An off-property wildland fire will not cause failure of cylinders. The preventive measure is to administratively limit onsite vegetation fire sources to ensure integrity of important targets (IROFS36g).

The failure probability index for administrative controls/procedures of IROFS36g was determined to be (-3). The NUREG-1520 criteria – a routine administrative IROFS - applies. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-4 External Events and Fire Accident Descriptions

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Accident Identifier: FF-WORKER EVAC

The initial failure (initiating event) is a fire of sufficient magnitude to result in a release of UF₆ or uranic material.

The uncontrolled event is a fire that leads to failure of the mechanical systems or components containing UF₆ or uranic material. The subsequent release from this event is assumed to have high consequences to the worker present in the area.

For the controlled event, the mitigative measure is to administratively limit exposure by requiring worker action to evacuate the area(s) of concern during a fire to ensure that the consequences of inhalation of uranic material and HF are low (IROFS39b). Sufficient time is available for the worker to detect and to evacuate the area(s) of concern. As a result of IROFS39b, the consequence analysis shows that the consequence has been mitigated to a low category (1).

The frequency index number for the initiating event was determined to be (-2). The NUREG-1520 criteria – no failures of this type in this facility in 30 yrs – applies. This failure frequency index was based on evidence from similarly designed Urenco European plants which have a combined plant history of greater than 30 yrs in which no fire events have occurred in any uranium areas.

The failure probability index for the administrative controls/procedures of IROFS39b was determined to be (-3). This corresponds to an administrative IROFS that must be performed in response to a rare unplanned demand per NUREG-1520. The IROFS justification for enhanced administrative control is discussed in Section 3.8.3.

Type of Accident – T for Chemical

CR for Criticality

Table 3.7-5 Uranic Material Assumptions for Criticality Accident Sequences

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Accident Sequences	Assumed Mass of ^{235}U (kg)	Assumed ^{235}U Enrichment (w/o)
PT2-2	600.1	6.0
PT2-3	600.1	6.0
PT2-5	600.1	6.0
PT3-1	1.6	6.0
PT3-3	1.6	6.0
PT3-5	1.6	6.0
PB1-3	(1)	6.0
PB2-2	92.9	6.0
PB2-3	1.6	6.0
PB2-5	600.1	6.0
PB2-6	600.1	6.0
PB3-1	1.6	6.0
PB3-2	1.6	6.0
PB4-5	1.6	6.0
VR1-1	1.6	6.0
VR1-2	1.6	6.0
VR2-7	1.6	6.0
FR1-1	22.1	6.0
FR1-2	22.1	6.0
FR2-1	22.1	6.0
FR2-2	22.1	6.0
DS1-1	22.1	6.0
DS1-2	22.1	6.0
DS1-3	7.2	6.0
DS2-1	22.1	6.0
DS2-2	22.1	6.0
DS2-3	7.2	6.0
DS3-1	22.1	6.0
DS3-2	22.1	6.0
CL3-1	1.6	6.0
CP1-1	1.6	6.0
CP1-2	600.1	6.0
SW1-1	22.1	6.0
SW1-2	22.1	6.0
LW1-1	6.7	6.0
LW1-2	22.1	6.0
LW1-3	22.1	6.0
LW2-1	6.7	6.0
LW3-1	6.7	6.0

Table 3.7-5 Uranic Material Assumptions for Criticality Accident Sequences

Page 2 of 2

Accident Sequences	Assumed Mass of ^{235}U (kg)	Assumed ^{235}U Enrichment (w/o)
LW5-1	6.7	6.0
RD1-1	(1)	6.0
EC3-1	(2)	(2)
EC4-2	1.6	6.0
EE-LP-BLD (CR)	(3)	6.0

Notes:

- (1) 38 cylinders, each with 600.1 kg ^{235}U
- (2) Accident sequence EC3-1 considers the potential for a criticality in the facility resulting from the enrichment control being lost. In the accident sequence, it is assumed that all enrichment controls have failed, allowing enrichments in excess of the normal 5 w/o ^{235}U limit. An exact upper bound enrichment and ^{235}U mass are not calculated. Instead, it is assumed that:
 - previously geometrically favorable components no longer can be relied upon to prevent criticality; and
 - moderation controls used to prevent criticality in the product cylinder may be inadequate, given the reduced levels of moderator that could result in criticality if enrichment levels were higher.

While the availability of moderating materials is not certain, the accident sequence conservatively assumes that operating with product enrichment in excess of 5 w/o ^{235}U will result in a criticality somewhere within the facility. Criticality is considered in all cases to be a high consequence event. The identified IROFS are considered to provide adequate protection against this high consequence event.
- (3) Sufficient mass of ^{235}U was assumed to be available to cause a criticality event.

Table 3.7-6 Cascade System
(Note 1)
Page 1 of 2

Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cascade Piping				
Cascade Piping Arrangement				
Cascade Centrifuge				
Cascade Valve Frame Piping				
Cascade Valve Frame Piping Arrangement				
Cascade Evacuation Roots Vacuum Pump				
Cascade Evacuation Rotary Vane Evacuation Pump				
Cascade Evacuation Cold Trap				
Cascade Evacuation Carbon Trap				
Cascade Evacuation Chemical Absorber Oil Trap				
Cascade Evacuation Oil Trap				
Cascade Evacuation Pump/Chemical Trap Set				
Cascade Sampling Gravimetric Sample Bottle				
Cascade Sampling Finger Type Sample Bottle				
Cascade Sampling Roots Vacuum Pump				
Cascade Sampling Evacuation Rotary Vane Pump				
Cascade Sampling Carbon Trap				
Cascade Sampling Chemical Absorber Oil Trap				

Table 3.7-6 Cascade System
(Note 1)
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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cascade Sampling Oil Trap				
Cascade Sampling Pump/Chemical Trap Set				
Pump Transport Device				
Chemical Trap Transport Device				
Mobile Rig				
Vacuum Cleaner				

Table 3.7-6 Note:

1. The system is considered classified. As such, specific information regarding design of components has been intentionally excluded to protect the classified nature of the information.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-7 Product System
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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Piping (largest pipe ID in system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Pump Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Product Pump Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Product Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion / Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Product Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Cold Trap	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of component diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of cold trap confinement or leakage and will not result in any appreciable accumulation of material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

Table 3.7-7 Product System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Carbon Trap (Product Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Aluminum Oxide Trap (Product Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Aluminum Oxide Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Aluminum Oxide Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Absorber Oil Trap (Product Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Product Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Evacuation Pump/Chemical Trap Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Product Evacuation Pump/Chemical Trap Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is critically safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Assay Sampling Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Assay Sampling Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Assay Sampling Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Assay Sampling Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Assay Sampling Rig confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Carbon Trap (Assay Sampling Rig)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Absorber Oil Trap (Assay Sampling Rig)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Assay Sampling Rig)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Catch Pot confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Assay Sampling Piping (largest pipe ID in system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Assay Sampling Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Mobile UF ₆ Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Mobile UF ₆ Rig confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Finger Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Finger Sample Bottle diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Finger Sample Bottle confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Tails Piping (largest piping diameter in the system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Tails Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Tails Pump Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Tails Pump Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Tails Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Tails Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Tails Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Carbon Trap (Tails Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Aluminum Oxide Trap (Tails Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Aluminum Oxide Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Aluminum Oxide Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Absorber Oil Trap (Tails Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Tails Evacuation)	LOSS OF SAFE-BY- DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY- DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ^{235}U . As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above- Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Tails Evacuation Pump/Chemical Trap Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Tails Evacuation Pump/Chemical Trap Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Mobile UF ₆ Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Mobile UF ₆ Rig confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Finger Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Finger Sample Bottle diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Finger Sample Bottle confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Blending Piping (largest pipe ID in the system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Blending Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cold Trap (Product Blending Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of component diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of cold trap confinement or leakage and will not result in any appreciable accumulation of material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Blending Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Product Blending Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Product Blending Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Carbon Trap (Product Blending Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Aluminum Oxide Trap (Product Blending Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Aluminum Oxide Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Aluminum Oxide Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Chemical Absorber Oil Trap (Product Blending Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Product Blending Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Blending Evacuation Pump/ Chemical Trap Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Product Blending Evacuation Pump/ Chemical Trap Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Mobile UF ₆ Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Mobile UF_6 Rig confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
1S Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of 1S Sample Bottle diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.

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Criticality Assessment of Passive Safe By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 1S Sample Bottle confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Liquid Sampling Piping (largest pipe ID in the system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Product Liquid Sampling Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Mobile UF ₆ Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Mobile UF ₆ Rig confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
1S Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

Table 3.7-10 Product Liquid Sampling

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 1S Sample Bottle confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Table 3.7-10 Product Liquid Sampling

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Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-11 Contingency Dump System
(Note 1)
Page 1 of 2

Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Contingency Dump Trap				
Contingency Dump Piping				
Contingency Dump Piping Arrangement				
Contingency Dump Buffer Volume Arrangement				
Contingency Dump Roots Pump				
Carbon Trap (Contingency Dump)				
Aluminum Oxide Trap (Contingency Dump)				
Chemical Absorber Oil Trap (Contingency Dump)				
Rotary Vane Vacuum Pump (Contingency Dump)				
Oil Trap (Contingency Dump)				
Contingency Dump Pump/Chemical Trap Set				
Vacuum Cleaner				
Pump Transport Device				
Chemical Trap Transport Device				
Mobile UF ₆ Rig				

Table 3.7-11 Note:

1. The system is considered classified. As such, specific information regarding design of components has been intentionally excluded to protect the classified nature of the information.

Table 3.7-11 Contingency Dump System
(Note 1)
Page 2 of 2

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-12 Centrifuge Test System
(Note 1)
Page 1 of 2

Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Centrifuge Test System Piping (largest pipe ID in system)				
Centrifuge Test System Piping Arrangement				
Centrifuge Test System Test Centrifuge				
1S Sample Bottle				
Centrifuge Test System Carbon Trap				
Centrifuge Test System Aluminum Oxide Trap				
Centrifuge Test System Chemical Absorber Oil Trap				
Centrifuge Test System Evacuation Rotary Vane Pump				
Centrifuge Test System Evacuation System Oil Trap				
Centrifuge Test System Pump/Chemical Trap Set				
Centrifuge Test System Pump Transport Device				
Centrifuge Test System Chemical Trap Transport Device				
Vacuum Cleaner				

Table 3.7-12 Note:

1. The system is considered classified. As such, specific information regarding design of components has been intentionally excluded to protect the classified nature of the information.

Table 3.7-12 Centrifuge Test System
(Note 1)
Page 2 of 2

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-13 Centrifuge Post Mortem
(Note 1)
Page 1 of 1

Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Component Description (A)	Component Description (A)	Component Description (A)	Component Description (A)
Centrifuge Post Mortem Centrifuge				
Vacuum Cleaner				

Table 3.7-13 Note:

1. The system is considered classified. As such, specific information regarding design of components has been intentionally excluded to protect the classified nature of the information.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-14 Liquid Effluent Collection and Treatment System
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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Waste Container Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Waste Container	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Waste Container volume and the conservative design/analysis value for this parameter assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Waste Container confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Waste Container Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Centrifuge	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Degreaser Water Centrifuge volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Degreaser Water Centrifuge shall be protected from loss of confinement or leakage with a curbed area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Tank Unloading Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Degreaser Water Unloading Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Degreaser Water Tank Unloading Pump shall be protected from loss of confinement or leakage with a curbed area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above- Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Transfer Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Degreaser Water Transfer Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Degreaser Water Transfer Pump shall be protected from loss of confinement or leakage with a curbed area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above- Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is critically safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Centrifuge Feed Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Degreaser Water Centrifuge Feed Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Degreaser Water Centrifuge Feed Pump shall be protected from loss of confinement or leakage with a curbed area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Piping (largest pipe ID in subsystem)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Degreaser Water Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Spent Citric Acid Piping (largest pipe ID in subsystem)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Spent Citric Acid Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Spent Citric Acid Transfer Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24. liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Spent Citric Acid Transfer Pump volume, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Spent Citric Acid Transfer Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Spent Citric Acid Unloading Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Spent Citric Acid Unloading Pump volume, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Spent Citric Acid Unloading Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Laboratory Waste Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Laboratory Waste Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Laboratory Waste Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above- Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Miscellaneous Effluent Transfer Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Miscellaneous Effluent Transfer Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Miscellaneous Effluent Transfer Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is critically safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Miscellaneous Effluent Piping (largest pipe ID in system))	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Miscellaneous Effluent Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Piping system shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Precipitation Treatment Tank Filter Press Feed Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Precipitation Treatment Tank Filter Press Feed Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Precipitation Treatment Tank Filter Press Feed Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Precipitation Treatment Tank Transfer Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Precipitation Treatment Tank Transfer Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Precipitation Treatment Tank Transfer Pump shall be protected from loss of confinement or leakage with a confinement area to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of volume is not adversely impacted.

Table 3.7-14 Liquid Effluent Collection and Treatment System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of volume is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the Criticality Design is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of volume is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Curbed Area, Liquid Effluent Collect and Treatment Room	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of the curb area shape, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of the curbed area confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of the robust construction of the curbed area.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above- Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
12 Liter Container Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
12 Liter Canister	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of 12 Liter Canister volume and the conservative design/analysis value for this parameter assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 12 Liter Canister confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
12 Liter Container Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Fomblin Oil Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Pump Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Drip Tray	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Oil Drip Tray volume and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Drip Tray confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
6 Liter Residue Container	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of 6 Liter Residue Container volume and the conservative design/analysis value for this parameter assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 6 Liter Residue Container confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments: (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
6 Liter Residue Container Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Flexible Hoses Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Citric Acid Holding Tank (Decon System for Flexibles)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Citric Acid Holding Tank (Decontamination System for Flexibles) shape, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape. Materials are corrosion/erosion resistant.
			Loss of Confinement or Leakage	Citric Acid Holding Tank (Decontamination System for Flexibles) shall be protected from loss of confinement or leakage with a confinement area (Flexible Hose Decontamination Cabinet) to ensure the critical design.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Sample Bottle Wash Drip Tray	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Sample Bottle Wash Drip Tray shape, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape. Materials are corrosion/erosion resistant.
			Loss of Confinement or Leakage	Sample Bottle Wash Drip Tray shall be protected from loss of confinement or leakage with a confinement area (Sample Bottle Decontamination Cabinet) to ensure subcriticality.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Fomblin Oil 6 Liter Container	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of 6 Liter Residue Container volume and the conservative design/analysis value for this parameter assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 6 Liter Residue Container confinement or leakage will not result in any appreciable accumulation of ^{235}U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Product Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Residue Container Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Flexible Hose Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments: (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Flexible Hose Decontamination Cabinet	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Flexible Hose Decontamination Cabinet shape, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape. Materials are corrosion/erosion resistant.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of the Flexible Hose Decontamination Cabinet or leakage will not result in any appreciable accumulation of ²³⁵ U material because of the robust construction of the curbed area.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments: (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Sample Bottle Decontamination Cabinet	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Sample Bottle Decontamination Cabinet shape, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape. Materials are corrosion/erosion resistant.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of the Sample Bottle Decontamination Cabinet or leakage will not result in any appreciable accumulation of ^{235}U material because of the robust construction of the curbed area.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Contaminated Components Hydraulic Bench	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments: (E)
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-17 Fomblin Oil Recovery System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Fomblin Oil Recovery Rig	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Fomblin Oil Recovery Rig shall be protected from loss of confinement or leakage with a confinement area, the Fomblin Oil Recovery Rig Cabinet, to ensure the critical design.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Fomblin Oil Recovery Rig Cabinet	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	SLAB 11.5 cm Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Fomblin Oil Recovery Rig Cabinet shape and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe shape and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe shape. Materials are corrosion/erosion resistant.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of the Fomblin Oil Recovery Rig Cabinet or leakage will not result in any appreciable accumulation of ²³⁵ U material because of the robust construction of the Fomblin Oil Recovery Rig Cabinet.
			Fire	Components shall be protected from fire to ensure the critical design attribute of shape is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of shape.
			Impact/Drop	Components shall be protected from impact/drop to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the criticality design attribute of shape is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the criticality design attribute of shape is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cylinder Pressure Test & Pump Out Piping (largest pipe ID in the system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cylinder Pressure Test & Pump Out Piping Arrangement		PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cold Trap (Cylinder Pressure Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of component diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of cold trap confinement or leakage and will not result in any appreciable accumulation of material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cylinder Pressure Test & Pump Out Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Cylinder Pressure Test & Pump Out Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Cylinder Pressure Test & Pump Out Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Carbon Trap (Cylinder Pressure Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Aluminum Oxide Trap (Cylinder Pressure Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Aluminum Oxide Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Aluminum Oxide Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Absorber Oil Trap (Cylinder Pressure Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Cylinder Pressure Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cylinder Pressure Test & Pump Out Evacuation Pump/ Chemical Trap Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Cylinder Pressure Test & Pump Out Evacuation Pump/ Chemical Trap Set confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is critically safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
1S Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of 1S Sample Bottle diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 1S Sample Bottle confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Dump Trap Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Dump Trap Interlocks	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Dump Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
12 Liter Canister Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
12 Liter Canister	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of 12 Liter Canister volume and the conservative design/analysis value for this parameter assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 12 liter canister confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
12 Liter Canister Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
1S Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of 1S Sample Bottle diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of 1S Sample Bottle confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
1S Sample Bottle Storage Array	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cold Trap	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of component diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of cold trap confinement or leakage and will not result in any appreciable accumulation of material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
UF ₆ Sampling System Pump	LOSS OF SAFE-BY- DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of UF ₆ Sampling System Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of UF_6 Sampling System Pump confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
P10 Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of P10 Sample Bottle diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of P10 Sample Bottle confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

Table 3.7-20 Mass Spectrometry

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Mass Spectrometry	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Mass Spectrometry volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Mass Spectrometry confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Table 3.7-20 Mass Spectrometry

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Finger Sample Bottle	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Finger Sample Bottle diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Finger Sample Bottle confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cylinder Preparation Test & Pump Out Piping (largest pipe ID in system)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of pipe diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
Cylinder Preparation Test & Pump Out Piping Arrangement	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of piping system confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cylinder Preparation Test & Pump Out Evacuation Pump	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Cylinder Pressure Test & Pump Out Evacuation Pump volume, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Cylinder Pressure Test & Pump Out Evacuation Pump confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Carbon Trap (Cylinder Preparation Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Carbon Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Carbon Trap confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Aluminum Oxide Trap (Cylinder Preparation Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Aluminum Oxide Trap diameter, amount of ²³⁵ U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ²³⁵ U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Aluminum Oxide Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Absorber Oil Trap (Cylinder Preparation Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	VOLUME 24 liters Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Chemical Absorber Oil Trap volume, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe volume and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe volume. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe volume.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Chemical Absorber Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of volume is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of volume.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Oil Trap (Cylinder Preparation Test & Pump Out Evacuation)	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter values at normal operating conditions of Oil Trap diameter, amount of ^{235}U and enrichment and the conservative design/analysis values for these parameters assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Oil Trap confinement or leakage will not result in any appreciable accumulation of ^{235}U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Vacuum Cleaner	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	DIAMETER 24.4 cm (ID) Keff = 1.0 @ 6 wt %		Based on qualitative assessment, there is margin between the parameter value at normal operating conditions of Vacuum Cleaner diameter and the conservative design/analysis value for this parameter assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would cause an approach to the critical safe diameter and to adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter value.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would cause an approach to the critical safe diameter. Materials are corrosion/erosion resistant and postulated complete wall erosion would not exceed the critical safe diameter.
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Vacuum Cleaner confinement or leakage will not result in any appreciable accumulation of ²³⁵ U. As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of diameter is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of diameter.
			Impact/Drop	Components shall be protected from Impact/Drop to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from Construction on Site to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Tanks)	Components shall be protected from Failure of Above-Ground Liquid Tanks to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from Hurricane events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Seismic)	Components shall be protected from Seismic events to ensure the critical design attribute of diameter is not adversely impacted.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Tornado)	Components shall be protected from Tornado events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from Local Intense Precipitation events to ensure the critical design attribute of diameter is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from Snow/Ice events to ensure the critical design attribute of diameter is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Cylinder Preparation Test & Pump Out Evacuation Pump/ Chemical Trap Set	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			More Heat	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more heat condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			More Pressure	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a more pressure condition that would adversely affect the maintenance of margin to criticality associated with design and maximum operating parameter values for amount of ^{235}U and enrichment.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments: (E)
			Loss of Confinement or Leakage	Based on qualitative assessment, postulated loss of Cylinder Pressure Test & Pump Out Evacuation Pump/ Chemical Trap Set confinement or leakage will not result in any appreciable accumulation of ²³⁵ U material because of physical limitations of the process (sub-atmospheric). As a result, loss of confinement does not result in a potential for criticality and therefore its consequence is low.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.

Table 3.7-21 Cylinder Preparation System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Pump Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/ Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.

Table 3.7-21 Cylinder Preparation System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.
Chemical Trap Transport Device	LOSS OF SAFE-BY-DESIGN ATTRIBUTE	PHYSICAL ARRANGEMENT		Based on qualitative assessment, there is margin between the normal operating conditions and the conservative design/analysis conditions assumed for criticality.
			Corrosion/Erosion	Based on qualitative assessment, it is highly unlikely for a process deviation to result in a corrosion/erosion condition that would affect the maintenance of margin to criticality associated with design and maximum operating parameter values for physical arrangement.
			Fire	Components shall be protected from fire to ensure the critical design attribute of physical arrangement is not adversely impacted.
			Maintenance	Configuration Management shall ensure that maintenance does not adversely impact the critical design attribute of physical arrangement.
			Impact/Drop	Components shall be protected from impact/drop to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Construction on Site)	Components shall be protected from construction on-Site to ensure the critical design attribute of physical arrangement is not adversely impacted.

Table 3.7-21 Cylinder Preparation System

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Criticality Assessment of Passive Safe-By-Design Components				
Component Description (A)	Sequence ID (B)	Critical Design Attribute (C)	Review of Up-Set Conditions to Change Geometry (Applicable HAZOP Guidewords) (D)	Notes/Comments (E)
			External Events (Failure of Above-Ground Liquid Storage Tanks)	Components shall be protected from external flooding (Failure of Above-Ground Liquid Storage Tanks) to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Hurricane)	Components shall be protected from hurricane events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Seismic)	Components shall be protected from seismic events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Tornado)	Components shall be protected from tornado events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Local Intense Precipitation)	Components shall be protected from local intense precipitation events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (External Fire)	Components shall be protected from external fire events to ensure the critical design attribute of physical arrangement is not adversely impacted.
			External Events (Snow/Ice)	Components shall be protected from external ice/snow events to ensure the critical design attribute of physical arrangement is not adversely impacted.
				Double Contingency Principle is satisfied as follows. The geometry is criticality safe and no single credible event or failure has been identified whereby the geometry could become unsafe. The enrichment is also controlled such that no single credible failure could result in loss of enrichment control.

Column Descriptions:

Column A: This column provides a brief description of each component.

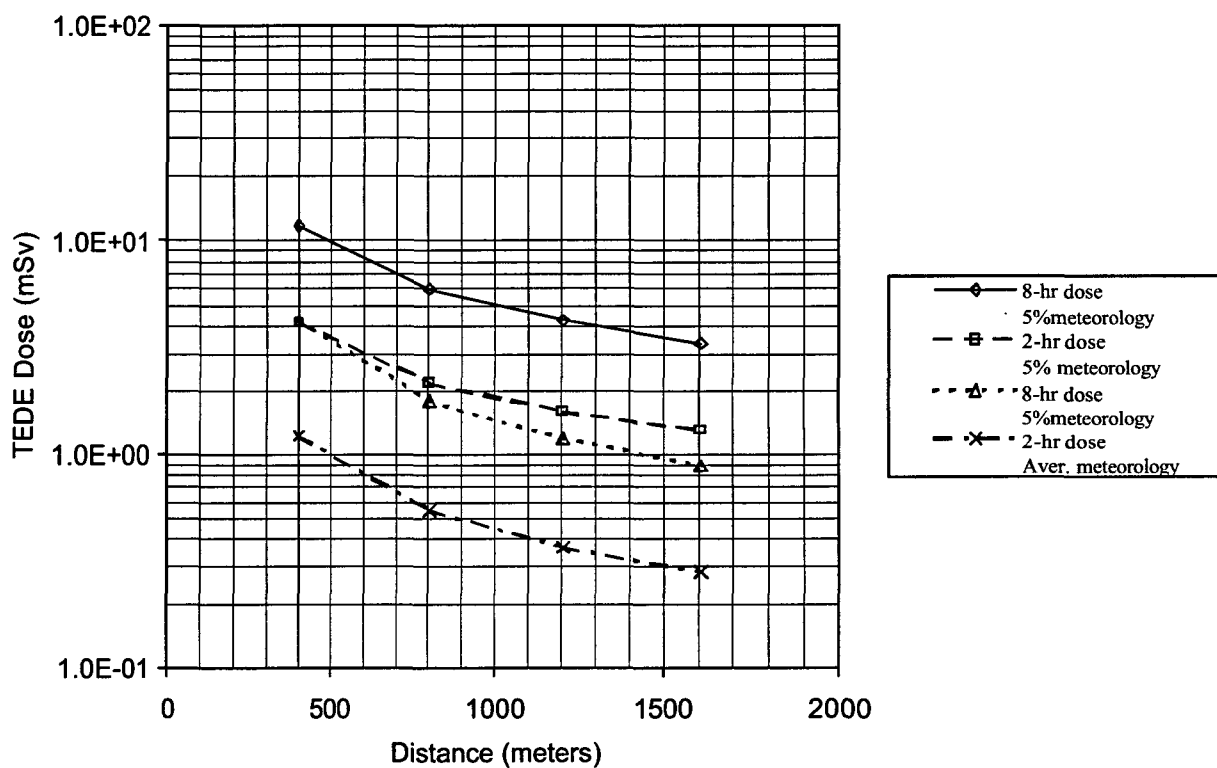
Column B: This column identifies the accident sequence associated with the passive component.

Column C: This column identifies the critical design attribute under consideration along with the conservative values used in the criticality analysis.

Column D: This column identifies the applicable guidewords from the ISA HAZOP procedure that are used to assess the criticality design margin. Additional guidewords are addressed as applicable in the detailed assessment.

Column E: This column provides any notes, comments and concluding statements.

FIGURES



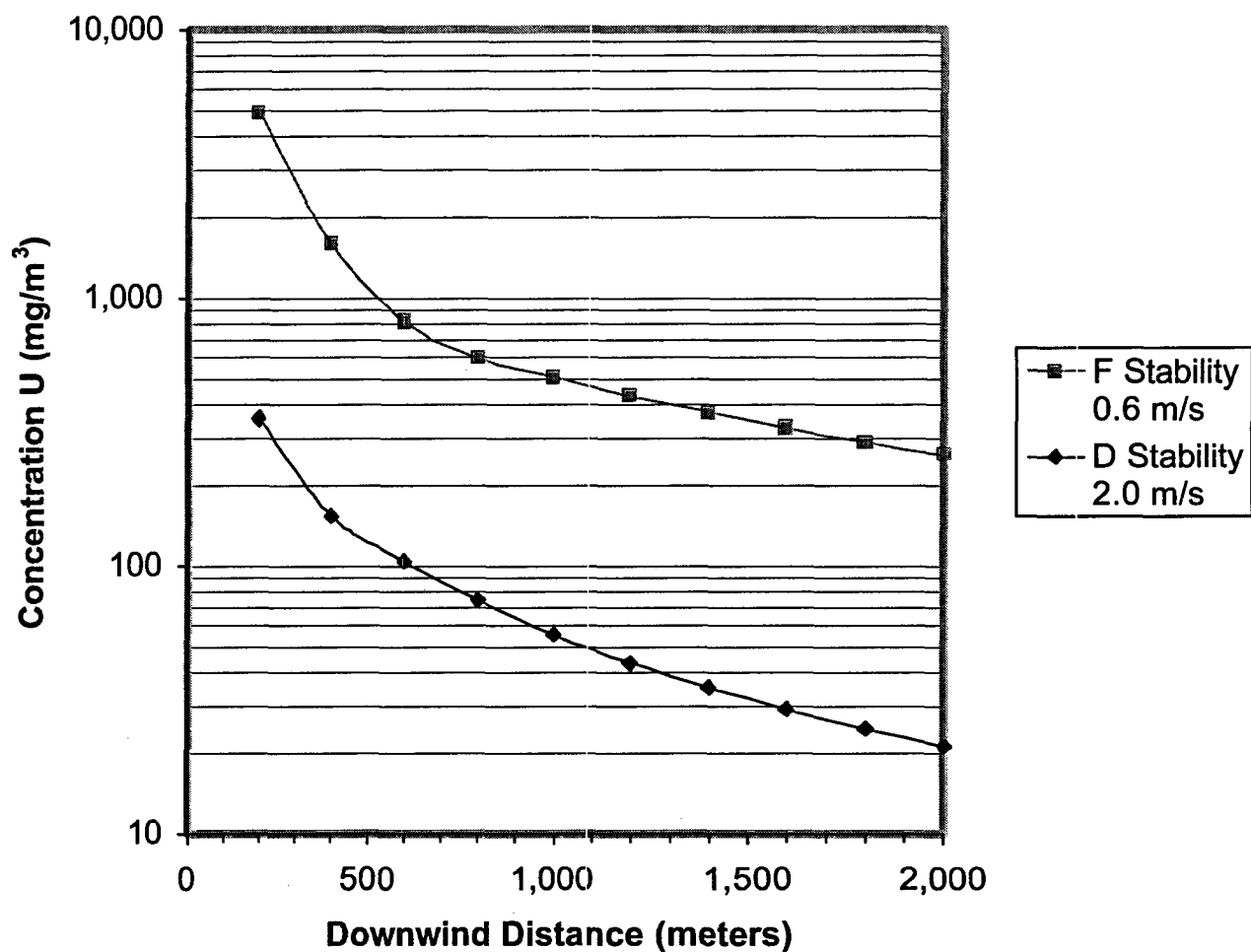
(Prompt Radiation + Released Cloud; 5% and Average Meteorology)

REFERENCE NUMBER
Figures 3.7.doc



FIGURE 3.7-1
TEDE DOSES FROM
POSTULATED CRITICALITY ACCIDENT

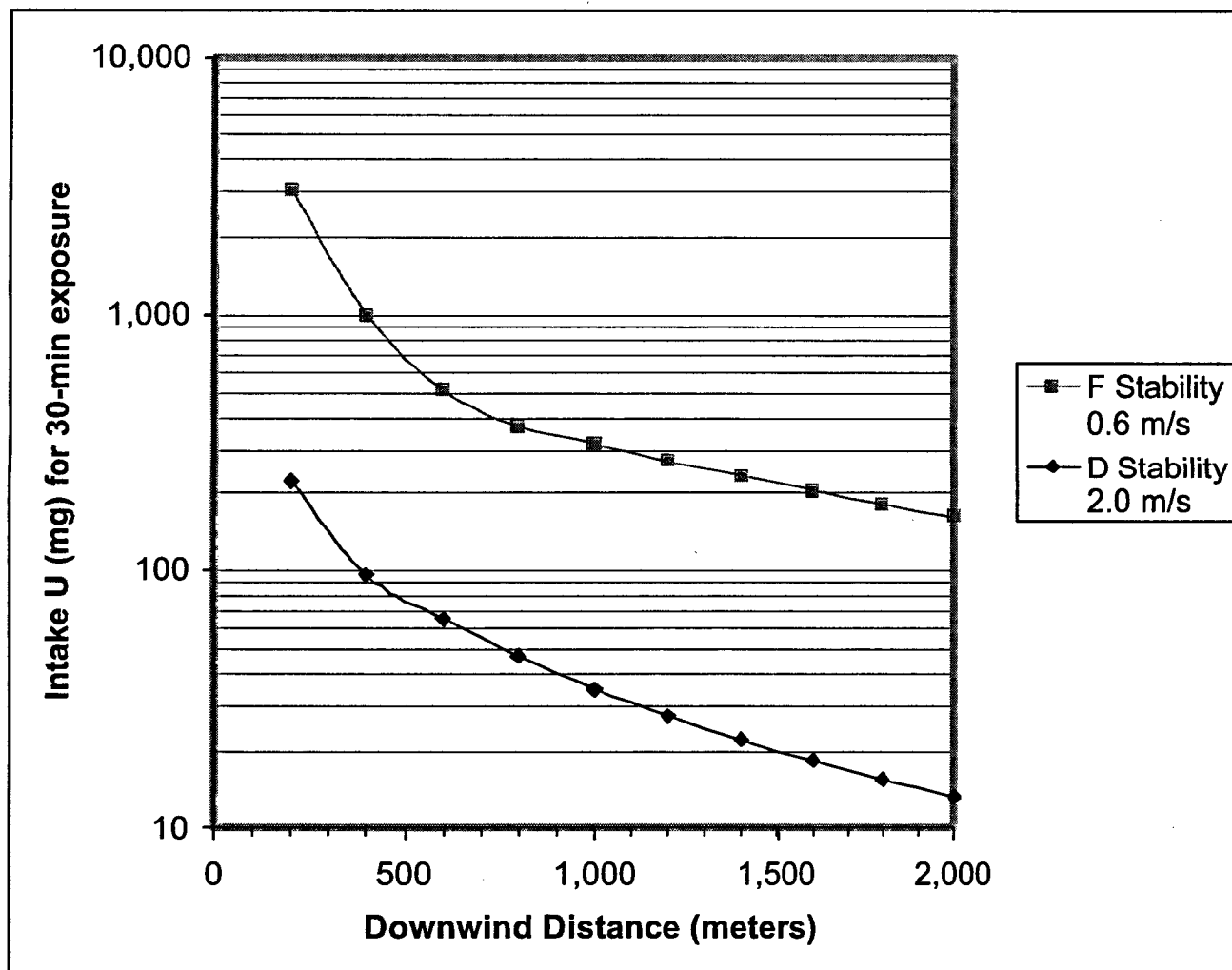
REVISION DATE: DECEMBER 2003



REFERENCE NUMBER
Figures 3.7.doc



FIGURE 3.7-2
AIRBORNE URANIUM CONCENTRATIONS DUE TO
A HEATER RUNAWAY RELEASE
REVISION DATE: DECEMBER 2003

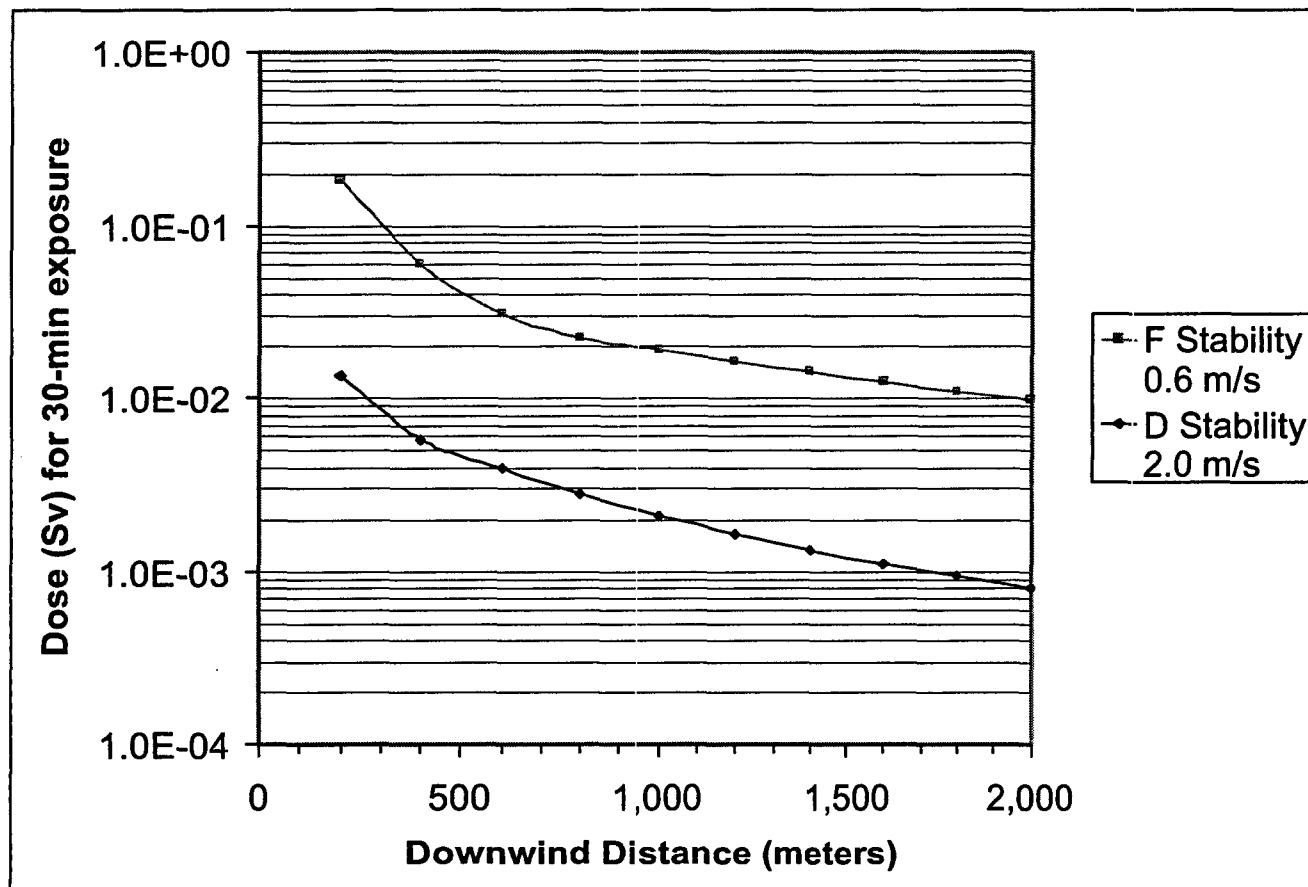


REFERENCE NUMBER
Figures 3.7.doc



FIGURE 3.7-3
AIRBORNE URANIUM INTAKE DUE TO
A HEATER RUNAWAY RELEASE

REVISION DATE: DECEMBER 2003

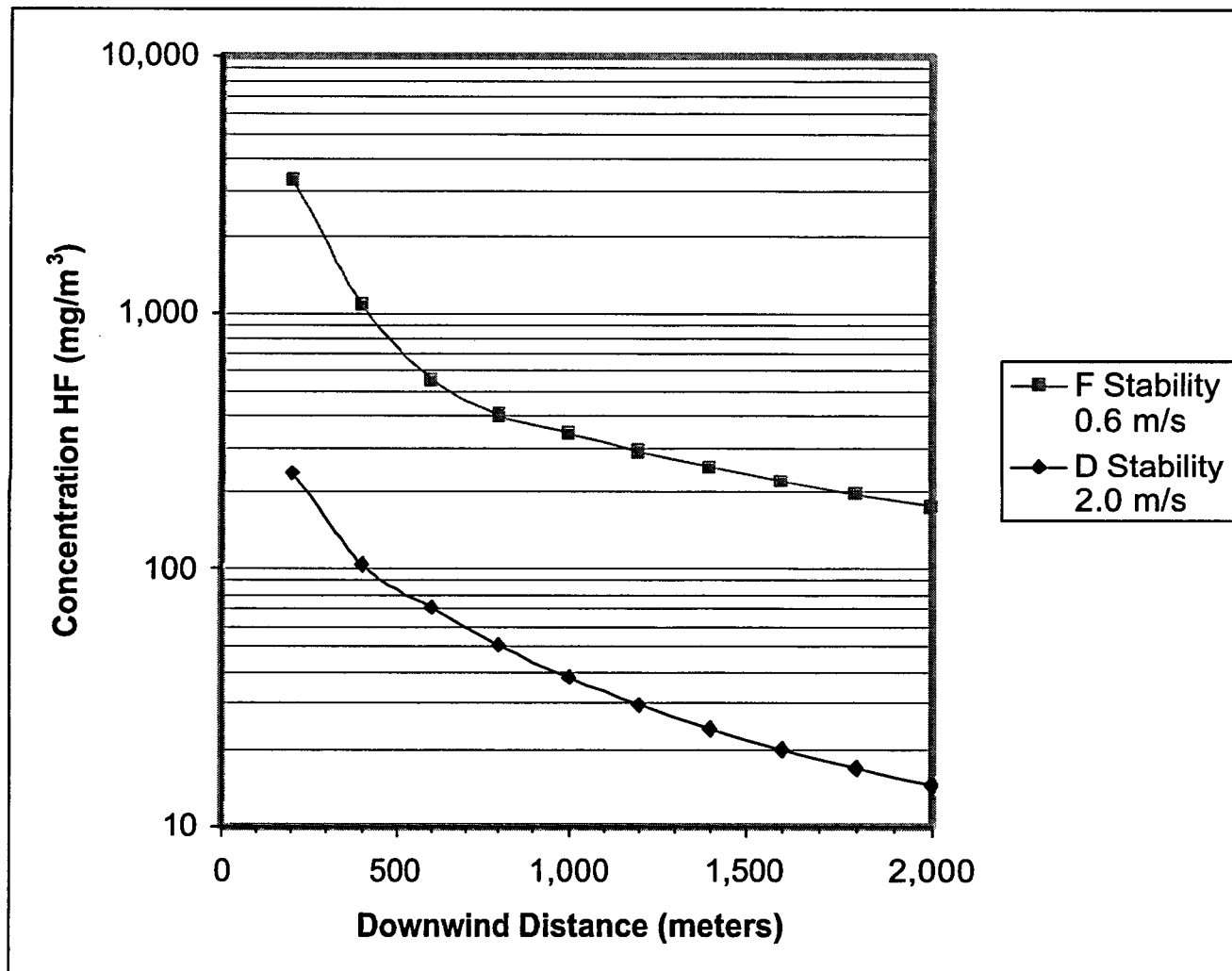


REFERENCE NUMBER
Figures 3.7.doc



FIGURE 3.7-4
TEDE DOSES DUE TO A HEATER
RUNAWAY RELEASE

REVISION DATE: DECEMBER 2003



REFERENCE NUMBER
Figures 3.7.doc



FIGURE 3.7-5
AIRBORNE HYDROGEN FLUORIDE CONCENTRATIONS
DUE TO A HEATER RUNAWAY RELEASE

REVISION DATE: DECEMBER 2003

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LIST OF TABLES

Table 3.8-1	Items Relied On For Safety (IROFS)
Table 3.8-2	Sole Items Relied On For Safety (IROFS)

3.8 ITEMS RELIED ON FOR SAFETY (IROFS)

This section of the Integrated Safety Analysis (ISA) Summary lists all of the Items Relied On For Safety (IROFS) designated for high-and intermediate-consequence accident sequences.

3.8.1 IROFS

Table 3.8-1, Items Relied On For Safety (IROFS), provides the IROFS designated for the National Enrichment Facility (NEF). Those IROFS designated with "C" (e.g., IROFSC1) are from the classified ISA. All other IROFS (e.g., IROFS1) are from the non-classified ISA. These IROFS either reduce the likelihood of occurrence, or the consequences, of the accident scenarios such that the associated risks are acceptable. The IROFS, which reduce the likelihood of occurrence, are termed "preventive" whereas the IROFS, which reduce the consequences, are termed "mitigative." The majority of the IROFS designated for this facility are preventive. The IROFS designated for the NEF ensure that the hazards identified for this facility result in potential accident sequences that are of acceptable risk, as defined in Table 3.1-6, Risk Matrix with Risk Index Values. There are no IROFS that are frequently or continuously challenged.

Table 3.8-1, describes each IROFS, identifies its expected safety function, and references the accident sequence (as found in Table 3.7-2, Accident Sequence Descriptions and Table 3.7-4, External Events and Fire Accident Descriptions) that describes the conditions needed for the IROFS to reliably perform its function and the effects of its failure. The Table 3.8-1 description of each IROFS also identifies the Failure Probability Index Numbers. For indices that are more negative than the lower absolute value nominally assigned to the type of IROFS indicated from Table 3.1-10, a reference is made to Section 3.8.3, Basis for Enhanced or High Availability Failure Probability Index Number, to justify the index value used. The reliability for an IROFS is proportionate to the amount of risk reduction relied on in the ISA. Thus, the level of the reliability management measures applied to an IROFS is commensurate with the required reliability. Management measures will ensure that IROFS are designed, implemented, and maintained, as necessary, to be available and reliable to perform their safety function when needed. The degree of reliability and availability of IROFS ensured by these measures are consistent with the evaluations of accident likelihood in the ISA. As described in Section 3.8.1.3, general high-quality Management Measures are applied to all IROFS. However, certain IROFS evaluated in the ISA may require "enhanced" administrative controls or may require automatic engineered controls to have "high availability." The basis for these evaluations is presented in Section 3.8.3, as referenced from Table 3.8-1.

For accident sequences postulated to result in nuclear criticality, IROFS are specified to ensure subcriticality under all normal and credible abnormal conditions. In order to identify IROFS, it was conservatively assumed that initiating events would result in criticality. The IROFS associated with criticality accident sequences have been specified consistent with the definition of "Items relied on for safety" in 10 CFR 70.4, "Definitions" (CFR, 2003a).

IROFS will be designed, constructed, tested and maintained to QA Level 1. IROFS will comply with design requirements established by the ISA and the applicable codes and standards (current approved version at the time of design). IROFS components and their designs will be of proven technology for their intended application. These IROFS components and systems will

be qualified to perform their required safety functions under normal and accident conditions, e.g., pressure, temperature, humidity, seismic motion, electromagnetic interference, and radio-frequency interference, as required by the ISA. IROFS components and systems will be qualified using the applicable guidance in Institute of Electrical and Electronics Engineers (IEEE) standard IEEE-323, 1983, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" (IEEE, 1983). Furthermore, IROFS components and systems will be designed, procured, installed, tested, and maintained using the applicable guidance in Regulatory Guide 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," Revision 1, dated October 2003 (NRC, 2003). IROFS systems will be designed and maintained consistent with the reliability assumptions in the ISA. Redundant IROFS systems will be separate and independent from each other. IROFS systems will be designed to be fail-safe. In addition, IROFS systems will be designed such that process control system failures will not affect the ability of the IROFS systems to perform their required safety functions. Plant control systems will not be used to perform IROFS functions. Installation of IROFS systems will be in accordance with engineering specifications and manufacturer's recommendations. Required testing and calibration of IROFS will be consistent with the assumptions of the ISA and setpoint calculations, as applicable. For hardware IROFS involving instrumentation which provides automatic prevention or mitigation of events, setpoint calculations are performed in accordance with a setpoint methodology, which is consistent with the applicable guidance provided in Regulatory Guide 1.105, "Setpoints for Safety-Related Instrumentation," Revision 3, dated December 1999 (NRC, 1999).

In addition, for those IROFS requiring operator actions, a human factors engineering review of the human-system interfaces shall be conducted using the applicable guidance in NUREG-0700, "Human-System Interface Design Review Guidelines," Revision 2, dated May 2002 (NRC, 2002), and NUREG-0711, "Human Factors Engineering Program Review Model," Revision 2, dated February 2004 (NRC, 2004).

For IROFS and IROFS with Enhanced Failure Probability Index Numbers (i.e., enhanced IROFS) that require "independent verification" of a safety function, the independent verification shall be independent with respect to personnel and personnel interface. Specifically, a second qualified individual, operating independently (e.g., not at the same time or not at the same location) of the individual assigned the responsibility to perform the required task, shall, as applicable, verify that the required task (i.e., safety function) has been performed correctly (e.g., verify a condition), or re-perform the task (i.e., safety function), and confirm acceptable results before additional action(s) can be taken which potentially negatively impact the safety function of the IROFS. The required task and independent verification shall be implemented by procedure and documented by initials or signatures of the individuals responsible for each task. In addition, the individuals performing the tasks shall be qualified to perform, for the particular system or process (as applicable) involved, the tasks required and shall possess operating knowledge of the particular system or process (as applicable) involved and its relationship to facility safety. The requirements for independent verification are consistent with the applicable guidance provided in ANSI/ANS-3.2-1994 (ANSI, 1994).

The following information related to IROFS will be available onsite in the ISA documentation once final design is completed.

- Hardware IROFS design details, such as system schematics and/or descriptive lists, sufficient to determine the structures, system, equipment or component included within the hardware IROFS' boundary
- Identification of essential utilities and support systems on which the IROFS depends to perform the intended safety functions
- Operating ranges and limits for measured process variables, e.g., temperature, pressure, associated with IROFS
- Basis for establishing the average vulnerable outage time to maintain acceptable IROFS availability
- Safety limits and safety margins, as applicable.

3.8.2 Sole IROFS List

The sole IROFS for the NEF are provided in Table 3.8-2, Sole Items Relied On For Safety (IROFS). Table 3.8-2 identifies the sole IROFS titles, IROFS identifier, and references the accident sequence (in Table 3.7-2, Accident Sequence Descriptions, and Table 3.7-4, External Events and Fire Accident Descriptions) that describes the conditions needed for the IROFS to reliably perform its function and effects of its failure. The description of the sole IROFS associated safety functions is provided in Table 3.8-1. Sole IROFS are those designated as Class A on Table 3.8-1.

A sole IROFS is a single item or feature that is relied upon to prevent or mitigate an accident for which the consequences could exceed the performance requirements in 10 CFR 70.61 (CFR, 2003b). It is acceptable to rely on these sole IROFS for non-criticality accident sequences because these IROFS will reliably provide sufficient preventive and mitigative features to ensure that the associated accident sequence results in an acceptable risk.

3.8.3 Basis for Enhanced or High Availability Failure Probability Index Number

For Failure Probability Index Number (FPIN) indices that are more negative than the lower absolute value nominally assigned to the type of IROFS indicated from Table 3.1-10, the following bases are provided. These IROFS reflect "enhanced" administrative controls and/or active engineered controls with "high availability." The following Sections are referenced from Table 3.8-1 for these IROFS. The nominal Management Measures outlined in Section 3.1.8.3 that apply to all IROFS, continue to also provide high quality assurance that these IROFS will be maintained, however, the following additional Management measures provided the basis for assigning the more negative value.

(Note subsection numbering is not contiguous. Subsections numbered to correspond to applicable IROFS number.)

3.8.3.14a IROFS14a Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration by verifying the use of a safe-by-design transfer frame is based on the following factors:

The failure to use a safe-by-design transfer frame will be precluded by independent verification prior to the movement of associated vessels containing enriched uranic material. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.14b IROFS14b Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration by verifying the associated storage array condition is acceptable for storing the vessel and no other component containing enriched uranic material is in movement in the designated area is based on the following factors:

The failure to ensure that the required conditions are met for subcritical configuration will be precluded by independent verification prior to the movement of associated vessel containing enriched uranic material. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.15 IROFS15 Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to restrict an independent parameter of the criticality sequence to ensure subcritical configuration by preventing additional transfer of enriched uranic material to another container if that container contains enriched uranic material and is a non-safe-by-design container is based on the following factors:

Transfer of enriched uranic material into another container that contains enriched uranic material and is a non-safe-by-design container will be precluded by independent verification prior to the transfer of the enriched uranic material into a container. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.16a IROFS16a Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality by allowing no visible oil and limiting cylinder vapor pressure is based on the following factors:

The presence of visible oil in a cylinder and cylinder vapor pressure above required limits will be precluded by independent verification prior to the introducing product into a cylinder. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.23a IROFS23a Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control for use of personal respiratory protection to ensure that inhalation of uranic material and HF consequences are low is based on the following factors:

The failure to use personal respiratory protection will be precluded by independent verification prior to the performing positive pressure testing of UF₆ cylinder after repair/replacement of a

leaking cylinder component. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.26 IROFS26 Basis for High Availability FPIN

The high availability (i.e., Index of "-3") of the seismic trip of building area HVAC is based on a requirement for increased frequency of functional testing of the trip function. To limit the potential duration of unavailability of the trip function, a monthly functional test is required.

3.8.3.35 IROFS35 Basis for Enhanced FPIN

The high availability (i.e., Index of "-3") of the fire barriers, which include active engineered control associated with automatic closure of fire doors and dampers, is based on the following factors:

- (1) Barriers shall be designed with adequate safety margin such that the total combustible loading (in situ and transients) allowed to expose the barrier will not exceed 80% of the hourly fire resistance rating of the barrier.
- (2) Doors shall be automatic, self-closing and maintained in the closed position during normal operation or they will be provided with passive actuation mechanisms (e.g., fusible links) to affect closure in the event of a fire.
- (3) Fire dampers in openings or HVAC duct penetrations shall be provided with passive actuation mechanisms (e.g., fusible links) to affect closure in the event of a fire.
- (4) Routine (at least weekly) visual inspection of accessible areas ensures fire doors are closed or not inhibited from closing and latching in the closed position.
- (5) Periodic visual inspection of dampers and through-penetration seal systems and functional testing of doors and dampers equipped with passive actuation devices confirms functionality.
- (6) Spatial separation of not less than 3 meters (10 feet) is provided between interim storage of transient combustibles and critical components. The separation criteria will not apply during an individual operation or maintenance activity in this area due to the presence of personnel in the area performing the operation or activity. These personnel would be able to readily detect a fire in the proximity. This provides added margin to potential fire loading that is not credited in transient combustible allowance.

3.8.3.36a IROFS36a Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit transient combustible loading is based on the following factors:

- (1) Routine (at least weekly) visual inspection of accessible areas ensures no transient combustibles (other than may be appropriately labeled as accepted by Fire Safety Review) stored within any areas of concern.
- (2) Areas of concern shall be appropriately posted to require consideration of entry with transient combustibles only in accordance with approved procedures, including a permitting system as appropriate.

3.8.3.36b IROFS36b Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit storage of UF₆ cylinders in the CRDB to ensure a minimum 1 m (3 ft) setback from the edge of the loading dock is based on the following factors:

- (1) Routine (at least daily) visual inspection to verify appropriate cylinder storage.
- (2) Visual markings on loading dock floor to designate non-storage area.
- (3) Additional verification prior to truck entering CRDB that cylinders are properly stored at > 1 m (3 ft).

3.8.3.36c IROFS36c Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit onsite UF₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal) is based on the following factors:

- (1) The designed cylinder transporters/movers shall be electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal).
- (2) Transportation of cylinders by means other than the designed transporters/ movers will be precluded by independent verification.

3.8.3.36d IROFS36d Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit transient combustible loading in the fire area of concern to ensure integrity of uranic material containers and to ensure the quantity of uranic material at risk results in consequences to the public that are low, is based on the following factors:

- (1) Routine (at least weekly) visual inspection of accessible areas ensures no transient combustibles (other than may be appropriately labeled as accepted by Fire Safety Review) stored within any areas of concern.
- (2) Routine (at least daily) visual inspection verifies no excessive open containers and that all stored waste is contained in metal containers.
- (3) Areas of concern shall be appropriately posted to require consideration of entry with transient combustibles only in accordance with approved procedures, including a permitting system as appropriate.

3.8.3.36e IROFS36e Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit transient combustible loading on the UBC pad to ensure the presence of only electric drive vehicles or diesel powered vehicles with a fuel capacity of less than 280 L (74 gal), is based on the following factors:

- (1) Routine (at least weekly) visual inspection ensures no transient combustibles (other than may be appropriately labeled as accepted by Fire Safety Review) stored on the UBC pad.
- (2) The designed cylinder transporters/movers shall be electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal).

- (3) Access to the UBC pad with vehicles other than the designed cylinder transporters/movers will require verification that vehicle fuel capacity is less than 280 L (74 gal).

3.8.3.36f IROFS36f Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit bulk fueling vehicles onsite to ensure UBC cylinder integrity is based on the following factors:

- (1) Diesel fuel deliveries shall require escort to diesel fuel offload station following designated route that ensures adequate distance from UBC pad and buildings of concern.
- (2) NEF site design shall provide surface gradient at the diesel fuel offload station away from UBC pad, or shall provide appropriate containment features.
- (3) Design location for diesel fuel offloading will assure adequate distance from UBC to preclude challenge to cylinder integrity.

3.8.3.36g IROFS36g Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit onsite vegetation fire sources to ensure integrity of important targets, is based on the following factors:

- (1) Routine landscaping upkeep results in potential fire loading margins to cylinder and building wall fire ratings of such magnitude as to make this event highly unlikely.
- (2) Routine (at least daily) visual inspection by security personnel provides enhanced monitoring.

3.8.3.36h IROFS36h Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit fire exposure to feed cylinders, product cylinders, and UBCs containing ≥ 0.1 kg of UF_6 due to a semi-tractor trailer fire during the receipt and shipping process, is based on the following factors:

- (1) Routine (at least daily) visual inspection to verify appropriate cylinder load/unload practices, including installation of required U.S. Department of Transportation (DOT) cylinder overpacks/protective assemblies.
- (2) Additional verification, through manifest/shipping inspection of receipt/delivery vehicles at CRDB entry and departure, that incoming and outgoing cylinders have the required DOT protective assemblies properly installed or are in the required DOT overpacks.

3.8.3.38 IROFS38 Basis for Enhanced FPIN

The enhanced (i.e., Index of "-3") administrative control to limit the cylinder fill mass to ensure cylinder integrity is based on the following factors:

Exceeding the cylinder fill mass limit will be precluded by independent verification (i.e., second verification) performed on the next shift following the completion of the IROFS38 periodic

verification on the previous shift (i.e., first verification). This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.39a IROFS39a Bases for Enhanced FPIN

The enhanced (i.e., Index of "3") administrative control to limit worker exposure by requiring evacuation of area(s) of concern in the event of a seismic event, is based on the following factors:

- (1) Worker detection of ground motion associated with a seismic event is immediate (i.e., the worker will immediately sense and recognize ground motion associated with the seismic event of concern).
- (2) Heightened awareness will allow immediate response to the seismic event. Training recall is greatly enhanced. Worker response for any release is expected to be immediate.
- (3) Any release from UF₆ systems/cylinders at the NEF would predominantly consist of HF with some potential entrainment of uranic particulate. An HF release would predominately cause a visible cloud and a pungent odor which is detectable at concentrations less than 1 ppm. This odor threshold is well below the concentration that could cause permanent injury or produce escape-impairing symptoms. Inhalation of HF causes an intolerable prickling, burning sensation in the nose and throat, with cough and pain beneath the sternum. Ocular exposure to HF causes a burning sensation, redness and secretion. As a result, worker desire to promptly vacate the area will be high.
- (4) Workers away from the immediate area of release would detect the release by the vapor cloud produced. The release will involve both white UF₆ (solid) and yellow uranyl fluoride reaction products. Visual clues as well as odor gradient will provide adequate assurance that the worker exposure time is less than that used in the consequence calculation.
- (5) Sufficient time is available for the worker to reliably detect the event and evacuate the area(s) of concern.

3.8.3.39b IROFS39b Bases for Enhanced FPIN

The enhanced (i.e., Index of "3") administrative control to limit worker exposure by requiring evacuation of area(s) of concern in the event of a fire, is based on the following factors:

- (1) Worker detection of a fire in the area is prompt and will occur prior to the fire reaching the magnitude necessary to cause a release (i.e., visual clues and odor are sufficient to allow prompt detection of a fire by workers in the area).
- (2) Heightened awareness will allow immediate worker response to the fire. Training recall is greatly enhanced.

- (3) Any release from UF₆ systems/cylinders at the NEF would predominantly consist of HF with some potential entrainment of uranic particulate. An HF release, in the event of a fire, would have a pungent odor which is detectable even in the presence of products of combustion. The odor threshold is well below the concentration that could cause permanent injury or produce escape-impairing symptoms. Inhalation of HF causes an intolerable prickling, burning sensation in the nose and throat, with cough and pain beneath the sternum. Ocular exposure to HF causes a burning sensation, redness and secretion. As a result, worker desire to promptly vacate the area will be high.
- (4) Workers away from the immediate area of release would detect the release by the visible products of combustion, the odor from the products of combustion, and/or the odor of HF from the release. Visual clues as well as odor will provide adequate assurance that the worker exposure time is less than that used in the consequence calculation.
- (5) Sufficient time is available for the worker to reliably detect the event and evacuate the area(s) of concern.

3.8.3.39c IROFS39c Bases for Enhanced FPIN

The enhanced (i.e., Index of "3") administrative control to limit worker exposure by requiring evacuation of area(s) of concern in the event of a release, is based on the following factors:

- (1) Worker detection of a release is immediate (i.e., the local worker will immediately sense and recognize a release, the worker elsewhere in the area will promptly detect the release by visual clues and odor associated with the release).
- (2) Heightened awareness will allow immediate response to an event resulting from a release. Training recall is greatly enhanced. Worker response for any release is expected to be immediate.
- (3) Any release from UF₆ systems/cylinders at the NEF would predominantly consist of HF with some potential entrainment of uranic particulate. An HF release would predominately cause a visible cloud and a pungent odor which is detectable at concentrations less than 1 ppm. This odor threshold is well below the concentration that could cause permanent injury or produce escape-impairing symptoms. Inhalation of HF causes an intolerable prickling, burning sensation in the nose and throat, with cough and pain beneath the sternum. Ocular exposure to HF causes a burning sensation, redness and secretion. As a result, worker desire to promptly vacate the area will be high.
- (4) Workers away from the immediate area of release would detect the release by the vapor cloud produced. The release will involve both white UF₆ (solid) and yellow uranyl fluoride reaction products. Visual clues as well as odor gradient will provide adequate assurance that the worker exposure time is less than that used in the consequence calculation.
- (4) Sufficient time is available for the worker to reliably detect the event and evacuate the area(s) of concern.

3.8.3.45 IROFS45 Basis for Enhanced FPIN

The enhanced (i.e., Index of “-3”) administrative control to ensure subcritical geometry, by verifying that the stored cylinders containing enriched uranium in the CRDB and Blending and Liquid Sampling Areas are in a horizontal, co-planar (i.e., non-stacked), condition and that no other cylinder containing enriched uranium is in movement in the associated area, is based on the following factors:

The failure to ensure that the required conditions are met for subcritical geometry will be precluded by independent verification prior to moving a cylinder containing enriched uranium in the CRDB or the Blending and Liquid Sampling Area. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.3.C6 IROFSC6 Basis for Enhanced FPIN

The enhanced (i.e., Index of “-3”) administrative control to calculate and set the cascade enrichment control device in accordance with the calculation to ensure ^{235}U enrichment $\leq 5\%$ to ensure subcriticality within the designed process and analyzed activities is based on the following factors:

Exceeding the ^{235}U enrichment license limit of 5% will be precluded by independent verification of the cascade enrichment control device setting calculation prior to changing the cascade enrichment control device setting and independent verification of implementation of the enrichment control device setting within 1 hour after changing the cascade enrichment control setting. This enhancement shall meet the requirements for independent verification identified in Section 3.8.1.

3.8.4 References

ANSI, 1994. Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants, ANSI/ANS-3.2-1994, American National Standards Institute/American Nuclear Society, 1994.

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NRC, 1999. Setpoints for Safety-Related Instrumentation, Regulatory Guide 1.105, U.S. Nuclear Regulatory Commission, Revision 3, December 1999.

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NRC, 2004. Human Factors Engineering Program Review Model, NUREG-0711, U.S. Nuclear Regulatory Commission, Revision 2, February 2004.

TABLES

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS1	TT2-1 UF2-1 PT2-1 PB2-1	Chemical	AEC	B	<p>Automatic trip of defrost heater and fan on high air return temperature to ensure cylinder integrity.</p> <p>This is implemented with a hardwired temperature sensor for automatic, fail-safe, high air return temperature trip of defrost heaters and fans at Tails Low Temperature Take-off Stations, Feed Purification Low Temperature Take-off Stations, Product Low Temperature Take-off Stations, and Product Blending Receiver Stations. Setpoint conservative with respect to assuring cylinder integrity.</p>	-2	N/A
IROFS2	TT2-1 UF2-1 PT2-1 PB2-1	Chemical	AEC	B	<p>Automatic trip of defrost heater and fan on high station internal air temperature to ensure cylinder integrity.</p> <p>This is implemented with a capillary temperature sensor for automatic, hardwired, fail-safe, high station internal air temperature trip (independent and diverse from IROFS1) of defrost heaters and fans at Tails Low Temperature Take-off Stations, Feed Purification Low Temperature Take-off Stations, Product Low Temperature Take-off Stations and Product Blending Receiver Stations. Setpoint conservative with respect to assuring cylinder integrity.</p>	-2	N/A

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS3	DC1-6 DC1-8	Chemical	AEC	A	Automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF ₆ . This is implemented with an automatic hardwired, fail-safe, trip of the vacuum pump on high weight of the evacuation skid carbon trap in the Tails Evacuation System, Feed Purification Subsystem, Product Vent Subsystem, Blending and Sampling Vent Subsystem, Ventilated Room Cylinder Pressure Test & Pump Out Rig, Cylinder Preparation Vacuum Pump and Trap Set System, and Contingency Dump System. Setpoint conservative with respect to saturated carbon trap weight.	-2	N/A
IROFS3	TT3-1 UF3-1 PB3-3 CP1-4 PT3-2 VR1-5 EC4-1 DC1-1 DC1-2 DC1-3 DC1-4 DC1-5 DC1-7 TP8-2	Chemical	AEC	B	Automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF ₆ . This is implemented with an automatic hardwired, fail-safe, trip of the vacuum pump on high weight of the evacuation skid carbon trap in the Cascade Sampling Rig, the Contingency Dump System and the Centrifuge Test Facility Vent Subsystem. Setpoint conservative with respect to saturated carbon trap weight.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS3	PB2-3 PB3-1 VR1-1 CP1-1 EC4-2 PT3-1	Criticality	AEC	B	<p>Automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF₆.</p> <p>This is implemented with an automatic hardwired, fail-safe, trip of the vacuum pump on high weight of the evacuation skid carbon trap in the Product Vent Subsystem, Blending and Sampling Vent Subsystem, Ventilated Room Cylinder Pressure Test & Pump Out Rig, Cylinder Preparation Vacuum Pump and Trap Set System, Cascade Sampling Rig and Contingency Dump. Setpoint conservative with respect to saturated carbon trap weight.</p>	-2	N/A
IROFS4	UF1-1 PB1-1	Chemical	AEC	B	<p>Automatic trip of station heaters on high cylinder temperature to ensure cylinder integrity.</p> <p>This is implemented with a hardwired temperature sensor for automatic, fail-safe, trip on high cylinder temperature of Solid Feed Station and Blending Donor Station heaters. Setpoint conservative with respect to assuring cylinder integrity.</p>	-2	N/A
IROFS5	UF1-1 PB1-1	Chemical	AEC	B	<p>Automatic trip of station heaters on high station internal air temperature to ensure cylinder integrity.</p> <p>This is implemented with a capillary temperature sensor for automatic, fail-safe, trip (independent and diverse from IROFS4) on high internal air temperature of Solid Feed Station and Blending Donor Station heaters. Setpoint conservative with respect to assuring cylinder integrity.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS6a	PT2-2	Criticality	AC	N/A	Administrative verification of distinguishing visual markings/ identification of 48X and 48Y cylinders within the UF ₆ area to ensure that cylinders containing product are not placed on-line to the cascade. Each 48X and 48Y cylinder will have distinguishing feature(s) that identifies product cylinders as not feed cylinders.	N/A	N/A
IROFS6b	PT2-2	Criticality	AC	B	Administrative verification of ²³⁵ U concentration in feed cylinders to ensure that product material is not used as feed material by sampling and assay analysis. This is implemented by sampling and assay analysis of feed cylinder contents for uranic enrichment and verification that it is not a product cylinder before being placed on-line to the cascade consistent with the assumptions in the Nuclear Criticality Safety Analyses. If the established acceptance criterion is not met, the cylinder shall not be placed on-line to the cascade.	-2	N/A
IROFS7	PT2-2	Criticality	PEC	B	Design feature to physically prevent product cylinder within the UF ₆ area from being placed in a Solid Feed station. This is implemented by design features unique to feed cylinders and unique to product cylinders to preclude inter-changing feed and product cylinders.	-3	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS8a	PT3-1 PT3-3 PB2-3 PB3-1 PB3-2 EC4-2	Criticality	AEC	B	Automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter or precipitator. Upon detection of ^{235}U selective high-high gamma levels in the SB GEVS filter by hardwired, fail-safe, instrumentation, the operating SB GEVS train trips. Upon detection of high-high gamma levels in the SB GEVS precipitator, the trip realigns dampers to bypass and isolate the electrostatic precipitator. Setpoint conservative with respect to assuring subcritical mass as determined from Nuclear Criticality Safety Analyses.	-2	N/A
IROFS8b	PB4-5	Criticality	AEC	B	Automatic trip on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the SB GEVS filter. Upon detection of ^{235}U selective high-high gamma levels in the SB GEVS filter by hardwired, fail-safe, instrumentation, the operating SB GEVS train trips. Setpoint conservative with respect to assuring subcritical mass as determined from Nuclear Criticality Safety Analyses.	-2	N/A
IROFS9	PT3-3 PB3-2	Criticality	AEC	B	Automatic trip of the vacuum pump on carbon trap high temperature to ensure the carbon trap does not pass excessive UF_6 . This is implemented with a hardwired, fail-safe, temperature sensor for automatic trip of the Product Vent Subsystem and Blending and Sampling Vent Subsystem vacuum pumps on carbon trap high temperature. Setpoint conservative with respect to temperatures that reflect excessive UF_6 flowrate.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS10	PB4-1 PB4-3	Chemical	PEC	A	Design feature to maintain Product Liquid Sampling Autoclave leak tight integrity. Total autoclave leakage is limited to that assumed in the consequence analyses.	-3	N/A
IROFS10	PB4-4	Chemical	PEC	B	Design feature to maintain Product Liquid Sampling Autoclave leak tight integrity. Total autoclave leakage is limited to that assumed in the consequence analyses.	-3	N/A
IROFS11	PB4-2	Chemical	AEC	B	Automatic trip of the autoclave heater and fan on autoclave high internal air temperature to ensure Product Liquid Sampling Autoclave integrity. This is implemented with an automatic fail-safe hardwired temperature sensor for trip (independent from IROFS12) of the heater and fan on high internal air temperature for the Product Liquid Sampling Autoclave integrity. Setpoint conservative with respect to assuring cylinder and autoclave integrity.	-2	N/A
IROFS12	PB4-2	Chemical	AEC	B	Automatic trip of the autoclave heater and fan on autoclave high internal air pressure to ensure Product Liquid Sampling Autoclave integrity. This is implemented with an automatic fail-safe hardwired pressure sensor for trip (independent of IROFS11) of the heater and fan on high air pressure for the Product Liquid Sampling Autoclave integrity. Setpoint conservative with respect to assuring autoclave integrity.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS13	PB4-5	Criticality	AEC	B	<p>Automatic inhibit prevents opening of GEVS vent valve on high-high HF in the autoclave to ensure no more than a subcritical mass deposited on SB GEVS filter.</p> <p>This is implemented with a hardwired, fail-safe, HF sensor to automatically inhibit retraction of the shotbolt in the Product Liquid Sampling Autoclave (preventing opening the GEVS vent valve) on high-high HF. Setpoint conservative with respect to assuring subcritical mass as determined from Nuclear Criticality Safety Analyses.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS14a	FR1-1 FR2-1 DS1-1 DS2-1 DS3-1 SW1-1 LW1-2	Criticality	AC	A	<p>Administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration.</p> <p>This is implemented by verifying the use of a safe-by-design transfer frame prior to movement of the associated waste container containing enriched uranic material. The proximity limit, enforced by the safe-by-design transfer frame, is based on assumptions in the Nuclear Criticality Safety Analyses. If the acceptance criterion is not met, then the associated waste container shall not be moved.</p>	-3	3.8.3.14b
IROFS14b	FR1-2 FR2-2 DS1-2 DS2-2 DS3-2 SW1-2 LW1-3	Criticality	AC	A	<p>Administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration.</p> <p>This is implemented by verifying, prior to moving a waste container containing enriched uranic material within 180 cm of the associated storage array, the associated storage array condition is acceptable for storing the associated waste container (i.e., the storage array is the correct array for storage of the associated waste container, no component containing enriched uranic material is stored within 180 cm of the storage array (except in storage array locations), components are correctly stored in the array, and a vacant location is available for storage of the associated waste container) and no component containing enriched uranic material is in movement in the designated area. If the acceptance criteria are not met, then the associated waste container containing enriched uranic material shall not be moved.</p>	-3	3.8.3.14b

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS15	PT3-5	Criticality	AC	A	<p>Administratively restrict an independent parameter of the criticality sequence to ensure subcritical configuration by preventing additional transfer of enriched uranic material to another container if that container contains enriched uranic material and is a non-safe-by-design container.</p> <p>This will be implemented by establishing controls independent from other IROFS in applicable accident sequences. Specifically, IROFS15 will require verification that the associated container, into which enriched uranic material will be transferred, either contains no enriched uranic material or is a safe-by-design container prior to the transfer of the enriched uranic material into a container. If the acceptance criteria are not met, then the transfer of the enriched uranic material to the container shall not be initiated.</p>	-3	3.8.3.15

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS16a	PB2-2 CP1-2	Criticality	AC	A	<p>Administratively limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality by allowing no visible oil and by limiting cylinder vapor pressure.</p> <p>This is implemented by allowing no visible oil and by limiting cylinder vapor pressure prior to introducing product, which is based on moderator limitations in the Nuclear Criticality Safety Analyses for product and receiver cylinders. If the acceptance criteria are not met, then product shall not be introduced into the associated cylinder.</p>	-3	3.8.3.16a
IROFS16c	PT2-3 PB2-5	Criticality	AC	B	<p>Administratively limit addition of moderator from system venting to ensure cylinder subcriticality using an independent means of monitoring system venting from that used for IROFS16d.</p> <p>This is implemented by monitoring instrumentation that provides indication of system vent operations and the operator limiting the total vent-count based on moderator limitations in the Nuclear Criticality Safety Analyses for product and receiver cylinders. This monitoring instrumentation shall be independent of the instrumentation used for IROFS16d and shall monitor a different parameter than is monitored for IROFS16d. If the acceptance criterion is not met, then venting of the associated cylinder shall be stopped and the cylinder filling process terminated.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS16d	PT2-3 PB2-5	Criticality	AC	B	<p>Administratively limit addition of moderator from system venting to ensure cylinder subcriticality using an independent means of monitoring system venting from that used for IROFS16c.</p> <p>This is implemented by a second independent, operator monitoring instrumentation that provides indication of system vent operations and verifying the total vent-count is within required limits based on moderator limitations in the Nuclear Criticality Safety Analyses for product and receiver cylinders. This monitoring instrumentation shall be independent of the instrumentation used for IROFS16c and shall monitor a different parameter than is monitored for IROFS16c. If the acceptance criterion is not met, then venting of the associated cylinder shall be stopped and the cylinder filling process terminated.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS19a	DS1-3 DS2-3 LW1-1 LW2-1 LW3-1 LW5-1	Criticality	AC	B	<p>Administratively limit the calculated tank uranic mass inventory to ensure a subcritical mass using bookkeeping procedures.</p> <p>This is implemented by bookkeeping procedures to limit calculated uranic mass to that assumed in the Nuclear Criticality Safety Analyses for the following Equipment Decontamination and Liquid Effluent Collection and Treatment Systems tanks: degreaser, citric acid, rinse water (2), spent citric acid, degreaser water collection, miscellaneous effluent collection, and the precipitation treatment. The calculated tank uranic mass inventory shall be determined using bookkeeping procedures prior to transfer of enriched uranic material to the associated tank. If the acceptance criterion is not met, then the enriched uranic material shall not be transferred to the associated tank.</p>	-2	N/A
IROFS19c	DS1-3 DS2-3 LW1-1 LW2-1 LW3-1 LW5-1	Criticality	AC	N/A	<p>Administratively limit measured tank uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement.</p> <p>This is implemented by independent sampling and measurement, prior to transfer of enriched uranic material to the associated tank, to limit tank uranic mass to that assumed in the Nuclear Criticality Safety Analyses for the following Equipment Decontamination and Liquid Effluent Collection and Treatment Systems tanks: degreaser, citric acid, rinse water (2), spent citric acid, degreaser water collection, miscellaneous effluent collection, and the precipitation treatment. IROFS19c is independent of IROFS19d. If the acceptance criterion is not met, then enriched uranic material shall not be transferred to the associated tank.</p>	N/A	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS19d	DS1-3 DS2-3 LW1-1 LW2-1 LW3-1 LW5-1	Criticality	AC	B	<p>Administratively limit measured tank uranic mass inventory to ensure a subcritical mass by performing independent sampling and measurement.</p> <p>This is implemented by independent sampling and measurement, prior to transfer of enriched uranic material to the associated tank, to limit tank uranic mass to that assumed in the Nuclear Criticality Safety Analyses for the following Equipment Decontamination and Liquid Effluent Collection and Treatment Systems tanks: degreaser, citric acid, rinse water (2), spent citric acid, degreaser water collection, miscellaneous effluent collection, and the precipitation treatment. IROFS19d is independent of IROFS19c. If the acceptance criterion is not met, then enriched uranic material shall not be transferred to the associated tank.</p>	-2	N/A
IROFS20	CL3-1	Criticality	AEC	B	<p>Automatic isolation of cold trap on cold trap high temperature to ensure no more than a subcritical mass deposited on the TSB GEVS filter.</p> <p>This is implemented with an automatic hardwired, fail-safe, high temperature sensor that will close the Cold Trap No. 2 Valve, which is in line to the sub-sampling rig vacuum pump. This will prevent potential flow of UF₆ product to the TSB GEVS in the event that the associated UF₆ cold trap is above a conservative desublimation temperature. Setpoint conservative with respect to assuring desublimation temperature.</p>	-2	N/A

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS21	VR1-1 VR1-2 CL3-1 CP1-1	Criticality	AEC	B	Automatic trip of the TSB GEVS on ^{235}U selective high-high gamma to ensure no more than a subcritical mass deposited on the filter. Upon detection of ^{235}U selective high-high gamma levels in the TSB GEVS filter by hardwired, fail-safe, instrumentation, the TSB GEVS trips. Setpoint conservative with respect to assuring critical mass as determined from Nuclear Criticality Safety Analyses.	-2	N/A
IROFS22	VR1-2	Criticality	AEC	B	Automatic trip of the vacuum pump on carbon trap high temperature to ensure the carbon trap does not pass excessive UF_6 . This is implemented with an automatic hardwired, fail-safe, trip of the Ventilated Room evacuation skid vacuum pump on carbon trap high temperature. Setpoint conservative with respect to temperatures that reflect excessive UF_6 flowrate.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS23a	VR1-3	Chemical	AC	A	Administrative use of personal respiratory protection to ensure that inhalation of uranic material and HF consequences are low. This is implemented through the use of personal respiratory protection when performing positive pressure testing of UF ₆ cylinder after repair/replacement of a leaking cylinder component such that assumptions of the consequence analysis are maintained. If personnel respiratory protection is not used, then the positive pressure test of the UF ₆ cylinder shall not be performed.	-3	3.8.3.23a
IROFS23b	VR2-1	Chemical	AC	A	Administrative use of personal respiratory protection to ensure that inhalation of uranic material consequence is low. This is implemented through the use of personal respiratory protection when handling carbon trap material containing uranic material, such that assumptions in the consequence analyses are maintained. If personnel respiratory protection is not used, then carbon trap material containing uranic material shall not be handled.	-2	N/A
IROFS23b	VR2-2	Chemical	AC	B	Administrative use of personal respiratory protection to ensure that inhalation of uranic material consequence is low. This is implemented through the use of personal respiratory protection when handling sodium fluoride (NaF) trap material containing Uranic material such that assumptions in the consequence analyses are maintained. If personnel respiratory protection is not used, then NaF trap material containing uranic material shall not be handled.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS24a	VR2-2	Chemical	AC	B	<p>Administrative establishment of airflow away from the worker to ensure inhalation of uranic material consequences are low.</p> <p>This is implemented through the use of the Technical Services Building GEVS connected to the assembly when handling sodium fluoride (NaF) trap material containing uranic material. The TSB GEVS shall be operating during this operation, consistent with assumption of the consequence calculation. If airflow away from the worker is not established, then NaF trap material containing uranic material shall not be handled.</p>	-2	N/A
IROFS24b	CL3-2 CL3-3	Chemical	AC	B	<p>Administrative establishment of airflow away from the worker to ensure inhalation of uranic material and HF consequences are low.</p> <p>This is implemented through TSB GEVS connected to Chemical Lab Hood when UF₆ Sub-sampling Unit is operated during transfer of product samples for assay analysis or during heating of a sample bottle(s) within the UF₆ Sub-sampling Unit. The TSB GEVS shall be operating during this operation, consistent with assumption of the consequence calculation.</p> <p>If airflow away from the worker is not established, then transfer of product samples shall not be initiated and sample bottle(s) in the UF₆ Sub-sampling Unit shall not be heated.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS26	SEISMIC-1 SEISMIC-2 SEISMIC-3	Chemical	AEC	A	Automatic Building HVAC system trip on detection of seismic event to ensure offsite exposures from building out flow maintain consequences low. This is implemented with an automatic hardwired, fail-safe, seismic trip of the HVAC Systems in the following areas: Process Services Area, Link Corridor Area, Above Cascade Area, UF ₆ Handling Area, and Blending and Liquid Sampling Area, consistent with assumptions of the consequence calculation.	-3	3.8.3.26
IROFS27a IROFS27b	LP-BLD (CR)	Criticality	PEC	B	Design feature of buildings containing enriched uranic material for roof ponding and site flooding due to local intense precipitation, to ensure associated building area subcriticality. This is implemented by designing the building structures (IROFS27a and IROFS27b are required to be independent passive design features) to withstand the effects of local intense precipitation, thus ensuring lack of moderation consistent with the assumptions in the Nuclear Criticality Analyses.	-3	N/A
IROFS27c	SEISMIC-1 SEISMIC-2 SEISMIC-3 TORNADO SNOW LP-BLD (T)	Chemical	PEC	A	Design feature of buildings containing UF ₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and for roof ponding and site flooding due to local intense precipitation, to ensure UF ₆ process systems integrity. This is implemented by designing the building structures to withstand the effects of seismic, tornado, tornado missile, high wind, roof snow load, and local intense precipitation, consistent with the assumptions in the bases for the consequence calculations.	-3	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS27d	LP-PAD	Chemical	PEC	A	<p>Design feature of the uranium byproduct cylinders (UBC) storage pad for site flooding due to local intense precipitation, to ensure UBC integrity.</p> <p>This is implemented by designing the UBC storage pad to protect the UBCs from the effects of local intense precipitation, consistent with the assumptions in the bases for the consequence calculations.</p>	-3	N/A
IROFS28	SEISMIC-5	Chemical	PEC	A	<p>Design feature to maintain Product Liquid Sampling Autoclave leak tight integrity.</p> <p>This is implemented by providing a seismic design of the Product Liquid Sampling Autoclave such that post-event total autoclave leakage is limited to that assumed in the consequence analyses.</p>	-3	N/A
IROFS30a	PT2-5 PB2-6	Criticality	AC	N/A	<p>Administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by controlling the type of oil used in process vacuum pumps.</p> <p>This is implemented by controlling the type of oil used in all process vacuum pumps to only perfluorinated polyether (PFPE) oil, consistent with moderation assumptions in the Nuclear Criticality Safety Analyses. If the acceptance criterion are not met, then action shall be initiated to remove the associated vacuum pumps from process systems.</p>	N/A	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS30b	PT2-5 PB2-6	Criticality	AC	B	<p>Administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by verifying, through test prior to addition of oil, that process vacuum pump oil is not hydrocarbon oil.</p> <p>This is implemented by testing the oil prior to addition to any process vacuum pump to verify the oil is not hydrocarbon oil, consistent with moderation assumptions in the Nuclear Criticality Safety Analyses. If the acceptance criteria are not met, then the associated oil shall not be added to the process vacuum pump.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS30c	PT2-5 PB2-6	Criticality	AC	B	<p>Administratively limit hydrocarbon oil (moderator mass) in enriched uranium product to ensure moderation control assumptions are maintained by verifying, through test (after oil addition) prior to placing vacuum pumps in process system, that process vacuum pump oil is not hydrocarbon oil.</p> <p>This is implemented by testing the oil in all process vacuum pumps for hydrocarbons after bench testing, but before placing vacuum pumps in process systems to verify lack of hydrocarbon oil. This assures operation consistent with moderation assumptions in the Nuclear Criticality Safety Analyses. If the acceptance criteria are not met, then the associated vacuum pump shall not be placed in the process system.</p>	-2	N/A
IROFS31a	VR2-7	Criticality	AC	N/A	<p>Administratively limit ^{235}U mass in non-safe-by-design solid waste containers to ensure subcriticality by performing independent sampling and assay analysis.</p> <p>This is implemented by independent sampling and assay analysis of waste container contents for ^{235}U mass and limiting mass to that assumed in the Nuclear Criticality Safety Analyses before enriched uranic material is transferred and bulk stored in solid waste containers. IROFS31a is independent of IROFS31b. If the acceptance criterion is not met, then enriched uranic material shall not be transferred and bulk stored in solid waste containers.</p>	N/A	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS31b	VR2-7	Criticality	AC	B	<p>Administratively limit ^{235}U mass in non-safe-by-design solid waste containers to ensure subcriticality by performing independent sampling and assay analysis.</p> <p>This is implemented by independent sampling and assay analysis of waste container contents for ^{235}U mass and limiting mass to that assumed in the Nuclear Criticality Safety Analyses before enriched uranic material is transferred and bulk stored in solid waste containers. IROFS31b is independent of IROFS31a. If the acceptance criterion is not met, then enriched uranic material shall not be transferred and bulk stored in solid waste containers.</p>	-2	N/A
IROFS31c	VR2-7	Criticality	AC	B	<p>Administratively limit ^{235}U mass in non-safe-by-design solid waste containers to ensure subcriticality using bookkeeping procedures.</p> <p>This is implemented by bookkeeping procedures to limit calculated uranic mass in solid waste containers to that assumed in the Nuclear Criticality Safety Analyses for solid waste bulking operations. The calculated ^{235}U mass in solid waste containers shall be determined using bookkeeping procedures before enriched uranic material is transferred and bulk stored in solid waste containers. If the acceptance criterion is not met, then enriched uranic material shall not be transferred and bulk stored in solid waste containers.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS35	FF1-1 FF6-1 FF8-1 FF11-1 FF15-1 FF21-1 FF23-1 FF24-1 FF38-1	Chemical	AEC	A	Automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fires from propagating into areas containing uranic material. Barriers and protectives will be closed or self-closing (e.g., utilizing fusible links).	-3	3.8.3.35
IROFS36a	FF1-2 FF6-2 FF8-2 FF11-2 FF16-1 FF16-2 FF38-2	Chemical	AC	A	Administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low. Transients will be controlled to limit aggregate combustible load (transient and in-situ) in the area of concern.	-3	3.8.3.36a
IROFS36b	FF5-1	Chemical	AC	A	Administratively limit storage of UF ₆ cylinders in the CRDB to ensure ≥ 1 m (3 ft) setback from the edge of the loading dock.	-3	3.8.3.36b
IROFS36c	FF7-1 FF42-1	Chemical	AC	A	Administratively limit onsite UF ₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal).	-3	3.8.3.36c

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS36d	FF21-2 FF23-2 FF25-1 FF25-2	Chemical	AC	A	<p>Administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low.</p> <p>Transients will be controlled to limit aggregate combustible load (transient and in-situ) in the area of concern. Liquid and solid waste transfer and packing containers (except as noted below) are limited to metal only. Transfer and packing container restriction does not apply to packaging within these containers (e.g., plastic liners), to bags for transporting laundry and similar non- or low-contamination solids, or to laboratory size sample containers (required for maintaining sample purity).</p>	-3	3.8.3.36d
IROFS36e	FF43-1	Chemical	AC	A	<p>Administratively limit transient combustible loading on the UBC Storage Pad to ensure cylinder integrity.</p> <p>This is implemented by limiting vehicles allowed onto the pad to cylinder movers and essential vehicles with a fuel capacity limit of less than 280 L (74 gal) and maintaining storage pad drain-off to ensure no excessive fuel pooling.</p>	-3	3.8.3.36e
IROFS36f	FF43-2	Chemical	AC	A	<p>Administratively limit designated routes for bulk fueling vehicles onsite to ensure UBC cylinder integrity.</p> <p>This is implemented by limiting diesel fuel deliveries to designated routes. Diesel fuel delivery vehicles will be prohibited from entering the UBC Storage Pad perimeter road.</p>	-3	3.8.3.36f

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS36g	FF44-1	Chemical	AC	A	Administratively limit onsite vegetation fire sources to ensure integrity of important targets. This is implemented by requiring clear cutting of vegetation onsite proximate to buildings and cylinders containing uranic material.	-3	3.8.3.36g
IROFS36h	FF5-2	Chemical	AC	A	Administratively limit fire exposure to feed cylinders, product cylinders, and UBCs containing ≥ 0.1 kg of UF_6 due to a semi-tractor trailer fire during the receipt and shipping process. This is implemented by ensuring that all received feed cylinder/protective assemblies are unloaded from the semi-tractor trailer to the loading dock prior to removal of the required DOT protective assemblies, that all outgoing product cylinders are loaded into their required DOT overpacks prior to placement on the semi-tractor trailer, and that all outgoing UBCs have their required DOT protective assemblies installed prior to placement on the semi-tractor trailer.	-3	3.8.3.36h
IROFS37	FF25-2	Chemical	AEC	A	Automatic hardwired, fail-safe, trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS38	TT2-2 UF2-2 PT2-4 PB2-4	Chemical	AC	A	Administratively limit the cylinder fill mass to ensure cylinder integrity. This is implemented at Tails Low Temperature Take-off Stations, Feed Purification Low Temperature Take-off Stations, Product Low Temperature Take-off Stations, and Product Blending Receiver Stations by verifying that cylinder weight is within specified trending limits once per shift during filling of the cylinder. Weight limit conservative with respect to assuring cylinder integrity. If the acceptance criterion is not met, then fill of the associated cylinder shall be terminated.	-3	3.8.3.38
IROFS39a	EE-SEISMIC-WORKER EVAC	Chemical	AC	A	Administratively limit exposure by requiring worker action to evacuate the area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low. This is implemented by worker evacuation from area(s) of concern in the event of a seismic event consistent with assumptions of the consequence analyses.	-3	3.8.3.39a
IROFS39b	FF-WORKER EVAC	Chemical	AC	A	Administratively limit exposure by requiring worker action to evacuate the area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low. This is implemented by worker evacuation from area(s) of concern in the event of a fire consistent with assumptions of the consequence analyses.	-3	3.8.3.39b

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS39c	CHEM RELEASE-WORKER EVAC	Chemical	AC	A	Administratively limit exposure by requiring worker action to evacuate the area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low. This is implemented by worker evacuation from area(s) of concern in the event of a release consistent with assumptions of the consequence analyses.	-3	3.8.3.39c
IROFS41	SEISMIC-1 SEISMIC-2 SEISMIC-3	Chemical	PEC	A	Design features to ensure building leak integrity. This is implemented by design considerations applied to the UF ₆ Area, Cascade Halls and Blending & Liquid Sampling Area that require building integrity during a seismic event (IROFS27c) and limiting building leakage to outside areas (in conjunction with IROFS26 HVAC trip) to ensure offsite exposure from building outflow maintains consequences to the public low.	-3	N/A
IROFS42	PB4-4	Chemical	AC	B	Administratively limit the cylinder fill mass to ensure cylinder integrity. This is implemented by determining the weight of product cylinders before placement and heating in the Product Liquid Sampling Autoclave. Weight limit conservative with respect to assuring cylinder integrity. If the acceptance criterion is not met, then the associated product cylinder shall not be heated.	-2	N/A
IROFS43	CL3-3	Chemical	AEC	B	Automatic trip of UF ₆ sub-sampling unit hotbox heater on high hotbox internal temperature to ensure sample bottle integrity. This is implemented with a temperature switch for automatic, hardwired, fail-safe, high temperature trip of hotbox heater at UF ₆ sub-sampling unit. Setpoint conservative with respect to assuring sample bottle integrity.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS45	PB1-3 RD1-1	Criticality	AC	A	<p>To ensure subcritical geometry, prior to moving a cylinder containing enriched uranium in the CRDB or the Blending and Liquid Sampling Area, verify that the stored cylinders containing enriched uranium in these areas are in a horizontal, co-planar (i.e., non-stacked), condition and that no other cylinder containing enriched uranium is in movement in the associated area.</p> <p>Physical separation as assumed in the Nuclear Criticality Safety Analyses is implemented by only storing Product cylinders in a horizontal co-planar (i.e., one high) array. Maintaining conditions such that only one cylinder could be inadvertently placed on horizontal storage array of other product cylinders provides a subcritical geometry as assumed in the Nuclear Criticality Safety Analyses (which analyzes one stacked cylinder as a subcritical array). This is implemented by restriction of movement and storage of product cylinders such that no more than one product cylinder could be inadvertently or accidentally stacked. If the acceptance criteria are not met, then the cylinder containing enriched uranium shall not be moved.</p>	-3	3.8.3.45
IROFS46	CL3-2	Chemical	AC	B	<p>Administratively verify that product samples are in a solid state, prior to transfer of product samples for assay analysis, to ensure worker consequences of inhalation of uranic material and HF are low.</p> <p>This is implemented by visual inspection of the product sample, prior to transfer from the sample rig, to ensure the sample material is in a solid state. If the acceptance criterion is not met, then the transfer of product samples for assay analysis shall not be initiated.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFS47a	UF3-1 PT3-2 PB3-3	Chemical	PEC	B	Flow restriction to ensure, in the event of postulated release, worker consequences of inhalation of uranic material and HF are low. This is implemented by a valve, on the suction of the vacuum pump, with a maximum flow rate that is less than the flow rate assumption of the consequence analyses.	-3	N/A
IROFS47b	TT3-1 VR1-5 CP1-4	Chemical	PEC	B	Flow restriction to ensure, in the event of postulated release, worker consequences of inhalation of uranic material and HF are low. This is implemented by a valve, on the suction of the vacuum pump, blocked such that the maximum flow rate is less than the flow rate assumption of the consequence analyses.	-3	N/A
IROFSC1b	DC1-1 DC1-2 DC1-3 DC1-4	Chemical	AC	B	Administratively maintain contingency dump NaF trap fill and use to ensure carbon trap does not saturate on operation of contingency dump. This is implemented by maintaining appropriate fill of NaF in the traps, prior to placing the associated NaF trap in service after filling, and replacement of the NaF trap prior to NaF trap fill becoming spent due to excessive dump operation to limit the accumulation of UF ₆ in the contingency dump carbon trap such that assumptions in the consequence analyses are maintained. If the acceptance criteria are not met, then the associated NaF trap shall not be placed in service or, if the NaF trap is in service, the NaF trap shall be isolated from the associated cascade.	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFSC6	EC3-1	Criticality	AC	A	<p>Administratively calculate and set the cascade enrichment control device in accordance with the calculation to ensure ^{235}U enrichment $\leq 5\text{ }^w/\text{o}$ to ensure subcriticality within the designed process and analyzed activities.</p> <p>This is implemented by ensuring the calculation performed accurately, and the associated cascade enrichment control device setting is implemented in accordance with the calculation. The $5\text{ }^w/\text{o}$ limit is based on the NEF Materials License limit and consistent with the Nuclear Criticality Safety Analyses to ensure subcriticality within the designed process and analyzed activities. If the acceptance criterion is not met and the cascade enrichment control device setting has not been changed, then the cascade enrichment control device setting shall not be changed. If the acceptance criterion is not met and the cascade enrichment control device setting has been changed, then the associated cascade shall be isolated such that no additional UF_6 can enter or exit the cascade.</p>	-3	3.8.3.C6
IROFSC15	TP8-1	Chemical	AEC	B	<p>Automatic trip of the Centrifuge Test Facility feed/take-off vessel heat tracing on high temperature to ensure feed/take-off vessel integrity.</p> <p>This is implemented with a capillary temperature sensor for automatic, hardwired, fail-safe, high temperature trip of the Centrifuge Test Facility feed/take-off vessel heat trace. Setpoint based on centrifuge integrity calculation.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)
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IROFS	Accident Sequence	Type of Accident	Type (1)	Class (2)	Description of Safety Function	FPIN (3)	FPIN Basis (4)
IROFSC16	TP8-1	Chemical	AEC	B	<p>Automatic trip of the Centrifuge Test Facility feed/take-off vessel heat tracing on high temperature to ensure feed/take-off vessel integrity.</p> <p>This is implemented with a temperature sensor for automatic, hardwired, fail-safe, high temperature trip of the Centrifuge Test Facility feed/take-off vessel heat trace. Setpoint conservative with respect to assuring feed/take-off vessel integrity.</p>	-2	N/A
IROFSC18	EC4-1 TP8-2 DC1-1 DC1-3 DC1-5 DC1-7	Chemical	AEC	B	<p>Automatic trip of the vacuum pump on high pressure at the vacuum pump set outlet to prevent a release.</p> <p>This is implemented with an automatic hardwired, fail-safe, trip of the vacuum pump on high pressure at the vacuum pump set outlet in the Centrifuge Test Facility, Cascade Sampling Rig and Contingency Dump System. Setpoint conservative with respect to system design pressure.</p>	-2	N/A

Table 3.8-1 Items Relied On For Safety (IROFS)

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NOTES:

1. Type of IROFS:

- PEC – Passive Engineered Control: A device that uses only fixed physical design features to maintain safe process conditions without any required human action.
- AEC – Active Engineered Control: A physical device that uses active sensors, electrical components, or moving parts to maintain safe process conditions without any required human action.
- AC – Administrative Control: A procedural human action that is prohibited or required to maintain safe process conditions.

2. Class of IROFS

- "A" – Sole IROFS. Refer to Section 3.8.2 and Table 3.8-2.
- "B" – An IROFS which is one of two preventive or mitigative IROFS for the identified sequence(s). Refer to the applicable accident sequences in Table 3.7-2 or Table 3.7-4 for identification of other IROFS relied upon.
- "N/A" – IROFS is not expressly associated with a preventive or mitigative control for the identified sequence(s).

3. FPIN – Failure Probability Index Numbers from ISA, based on Risk Indexing Methodology described in Section 3.1. When IROFS is not expressly associated with a preventive or mitigative control for the identified sequence(s), "N/A" is specified. Refer to the applicable accident sequence description in Table 3.7-2 or Table 3.7-4 for initiating event frequency index number.

4. Section referenced provides basis for IROFS Type AC that is considered "enhanced" and for IROFS Type AEC that is considered to have "high availability." "N/A" indicates that the FPIN reflects the lower absolute value nominally assigned to the Type of IROFS as indicated in Table 3.1-10 that is supported by the general Management Measures applicable to all IROFS (refer to Section 3.1.8.3).

Table 3.8-2 Sole Items Relied On For Safety (IROFS)
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IROFS Identifier	Accident Sequence	Type of Accident	Type of IROFS	Title
IROFS3	DC1-6 DC1-8	Chemical	AEC	Automatic trip of the vacuum pump on carbon trap high weight to ensure the carbon trap does not become saturated with UF ₆ .
IROFS10	PB4-1 PB4-3	Chemical	PEC	Design feature to maintain Product Liquid Sampling Autoclave leak tight integrity.
IROFS14a	FR1-1 FR2-1 DS1-1 DS2-1 DS3-1 SW1-1 LW1-2	Criticality	AC	Administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration.
IROFS14b	FR1-2 DS1-2 DS2-2 DS3-2 SW1-2 LW1-3	Criticality	AC	Administratively restrict proximity of vessels in non-designed locations containing enriched uranic material to ensure subcritical configuration.
IROFS15	PT3-5	Criticality	AC	Administratively restrict an independent parameter of the criticality sequence to ensure subcriticality configuration by preventing additional transfer of enriched uranic material to another container if that container contains enriched uranic material and is a non-safe-by-design container.
IROFS16a	PB2-2 CP1-2	Criticality	AC	Administratively limit moderator mass (oil and water) in cylinders containing enriched uranic material to ensure subcriticality by allowing no visible oil and limiting cylinder vapor pressure.
IROFS23a	VR1-3	Chemical	AC	Administrative use of personal respiratory protection to ensure that inhalation of uranic material and HF consequences are low.
IROFS23b	VR2-1	Chemical	AC	Administrative use of personal respiratory protection to ensure that inhalation of uranic material and HF consequences are low.
IROFS26	SEISMIC-1 SEISMIC-2 SEISMIC-3	Chemical	AEC	Automatic Building HVAC system trip on detection of seismic event to ensure offsite exposures from building out flow maintain consequences low.

Table 3.8-2 Sole Items Relied On For Safety (IROFS)

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IROFS Identifier	Accident Sequence	Type of Accident	Type of IROFS	Title
IROFS27c	SEISMIC-1 SEISMIC-2 SEISMIC-3 TORNADO SNOW LP-BLD (T)	Chemical	PEC	Design feature of buildings containing UF ₆ process systems for seismic, tornado, tornado missile, high wind, roof snow load, and for roof ponding and site flooding due to local intense precipitation, to ensure UF ₆ process systems integrity.
IROFS27d	LP-PAD	Chemical	PEC	Design feature of the uranium byproduct cylinders (UBC) storage pad for site flooding due to local intense precipitation, to ensure UBC integrity.
IROFS28	SEISMIC-5	Chemical	PEC	Design feature to maintain Product Liquid Sampling Autoclave leak tight integrity.
IROFS35	FF1-1 FF6-1 FF8-1 FF11-1 FF15-1 FF21-1 FF23-1 FF24-1 FF38-1	Chemical	PEC	Automatic closure of fire-rated barrier opening protectives (e.g., doors, dampers, penetration seals) to ensure the integrity of area fire barriers prevents fires from propagating into areas containing uranic material.
IROFS36a	FF1-2 FF6-2 FF8-2 FF11-2 FF16-1 FF16-2 FF38-2	Chemical	AC	Administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low.
IROFS36b	FF5-1	Chemical	AC	Administratively limit storage of UF ₆ cylinders in the CRDB to ensure ≥ 1 m (3 ft) setback from the edge of the loading dock.
IROFS36c	FF7-1 FF42-1	Chemical	AC	Administratively limit onsite UF ₆ cylinder transporters/movers to ensure only use of electric drive or diesel powered with a fuel capacity of less than 280 L (74 gal).
IROFS36d	FF21-2 FF23-2 FF25-1 FF25-2	Chemical	AC	Administratively limit transient combustible loading in areas containing uranic material to ensure integrity of uranic material components/containers and limit the quantity of uranic material at risk to ensure consequences to the public are low.
IROFS36e	FF43-1	Chemical	AC	Administratively limit transient combustible loading on the UBC Storage Pad to ensure cylinder integrity.

Table 3.8-2 Sole Items Relied On For Safety (IROFS)
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IROFS Identifier	Accident Sequence	Type of Accident	Type of IROFS	Title
IROFS36f	FF43-2	Chemical	AC	Administratively limit designated routes for bulk fueling vehicles onsite to ensure UBC cylinder integrity.
IROFS36g	FF44-1	Chemical	AC	Administratively limit onsite vegetation fire sources to ensure integrity of important targets.
IROFS36h	FF5-2	Chemical	AC	Administratively limit fire exposure to feed cylinders, product cylinders and UBCs containing ≥ 0.1 kg of UF_6 due to a semi-tractor trailer fire during the receipt and shipping process.
IROFS37	FF25-2	Chemical	AEC	Automatic trip of the Ventilated Room HVAC and isolation from TSB GEVS on smoke detection and Ventilated Room design leakage limited to ensure offsite exposure from building out flow maintains consequences to the public low.
IROFS38	TT2-2 UF2-2 PT2-4 PB2-4	Chemical	AC	Administratively limit the cylinder fill mass to ensure cylinder integrity.
IROFS39a	EE- SEISMIC- WORKER EVAC	Chemical	AC	Administratively limit exposure by requiring worker action to evacuate area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low.
IROFS39b	FF- WORKER EVAC	Chemical	AC	Administratively limit exposure by requiring worker action to evacuate area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low.
IROFS39c	CHEM RELEASE- WORKER EVAC	Chemical	AC	Administratively limit exposure by requiring worker action to evacuate area(s) of concern to ensure worker consequences of inhalation of uranic material and HF are low.
IROFS41	SEISMIC-1 SEISMIC-2 SEISMIC-3	Chemical	PEC	Design features to ensure building leak integrity.
IROFS45	PB1-3 RD1-1	Criticality	AC	To ensure subcriticality geometry, prior to moving a cylinder containing enriched uranium in the CRDB or the Blending and Liquid Sampling Area, verify that the stored cylinders containing enriched uranium in these areas are in a horizontal, co-planar (i.e., non-stacked), condition and that no other cylinder containing enriched uranium is in movement in the associated area.

Table 3.8-2 Sole Items Relied On For Safety (IROFS)

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IROFS Identifier	Accident Sequence	Type of Accident	Type of IROFS	Title
IROFSC6	EC3-1	Criticality	AC	Administratively calculate and set the cascade enrichment control device in accordance with the calculation to ensure ^{235}U enrichment $\leq 5\%$ to ensure subcriticality within the designed process and analyzed activities.