ENCLOSURE 2

SHINE TECHNOLOGIES, LLC

SHINE TECHNOLOGIES, LLC APPLICATION FOR AN OPERATING LICENSE SUPPLEMENT NO. 23

FINAL SAFETY ANALYSIS REPORT CHANGE SUMMARY PUBLIC VERSION

Summary Description of Changes	FSAR Impacts
Update to reflect changes to the valve and damper position feedback to the target solution vessel (TSV) reactivity protection system (TRPS) and engineered safety features actuation system (ESFAS) following safety actuation and to clarify the description of the reliability of the process integrated control system (PICS).	Figure 7.4-1, Figure 7.5-1, Section 7.6
Update to correct required isolations of radiological ventilation systems in response to a tritium release.	Section 7.5, Figure 7.5-1, Section 13a2.2
Update to correct the instrument accuracy associated with the wide range neutron flux, correct the response time associated with the molybdenum extraction and purification system (MEPS) heating loop radiation instrumentation, and provide clarification to coincidence logic.	Table 7.4-1, Table 7.5-1
Update to correct errors in TRPS and ESFAS logic diagrams.	Figure 7.4-1, Figure 7.5-1
Update to reflect design progression of PICS architecture.	Figure 7.3-1
Update to clarify the control functions that PICS provides in relation to TRPS and ESFAS.	Section 7.3
Update to correct references to the Tritium Purification System (TPS) Process Vent Actuation and to clarify the safety functions initiated by a MEPS A/B/C Heating Loop Isolation.	Section 7.5, Figure 7.5-1

A markup of the Final Safety Analysis Report (FSAR) changes is provided as Attachment 1.

ENCLOSURE 2
ATTACHMENT 1

SHINE TECHNOLOGIES, LLC

SHINE TECHNOLOGIES, LLC APPLICATION FOR AN OPERATING LICENSE SUPPLEMENT NO. 23

FINAL SAFETY ANALYSIS REPORT CHANGE SUMMARY
PUBLIC VERSION

FINAL SAFETY ANALYSIS REPORT MARKUP

Control Functions

None

Interlocks and Permissives

None

7.3.1.3.11 Target Solution Vessel Reactivity Protection System and Engineered Safety Features Actuation System

The TRPS and ESFAS are the safety-related control systems for the main production facility, as described in Sections 7.4 and 7.5, respectively.

Safety-related radiation monitors are also within the scope of the TRPS and ESFAS, as described in Subsection 7.7.1. These components are used to monitor radiation in the radiological ventilation (RV) system and are discussed in Subsection 7.3.1.4.5

Monitoring and Alarms

The PICS receives input from the TRPS and ESAFS and provides alarms related to the status and functionality of the safety-related control systems (e.g., communication errors, faulted modules, failed power supplies).

Control Functions

~~The PICS provides signals to the TRPS and ESFAS to provide normal control of~~Safety-related components that are capable of being actuated by the TRPS or ESFAS~~. C~~, but also have a nonsafety-related function related to production, achieve their safe state by having power removed. PICS controls these components directly by cycling power through the use of relays and contacts and does not send a signal to the TRPS or ESFAS during these normal operations. Should a safety actuation be required, the TRPS or ESFAS opens a contact in series with the power supply to the component, causing it to achieve its safe state regardless of the control signal~~s~~ from the PICS~~ are only accepted by~~. Following the safety actuation, the PICS provides a nonsafety-related control signal to the TRPS ~~and~~or ESFAS ~~when~~to allow for component repositioning. The actuation and priority logic (APL) in the TRPS or ESFAS processes these signals based upon the position of the ~~associated~~ enable nonsafety switch~~ located on the main control board is in the "enable" position~~. Details of the control signals provided by PICS are described in Subsections 7.4.3.4 and 7.5.3.3.

Safety-related components that are capable of being actuated by the TRPS or ESFAS and do not have a nonsafety-related production function are not controlled directly by PICS. Following the safety actuation, the PICS sends a nonsafety-related control signal to the TRPS or ESFAS and the APL in the TRPS or ESFAS processes this signal based upon the position of the enable nonsafety switch. If not prevented by higher priority inputs to the APL, the TRPS or ESFAS will position the component as requested by the PICS.

Interlocks and Permissives

None

Figure 7.3-1 – Process Integrated Control System Architecture

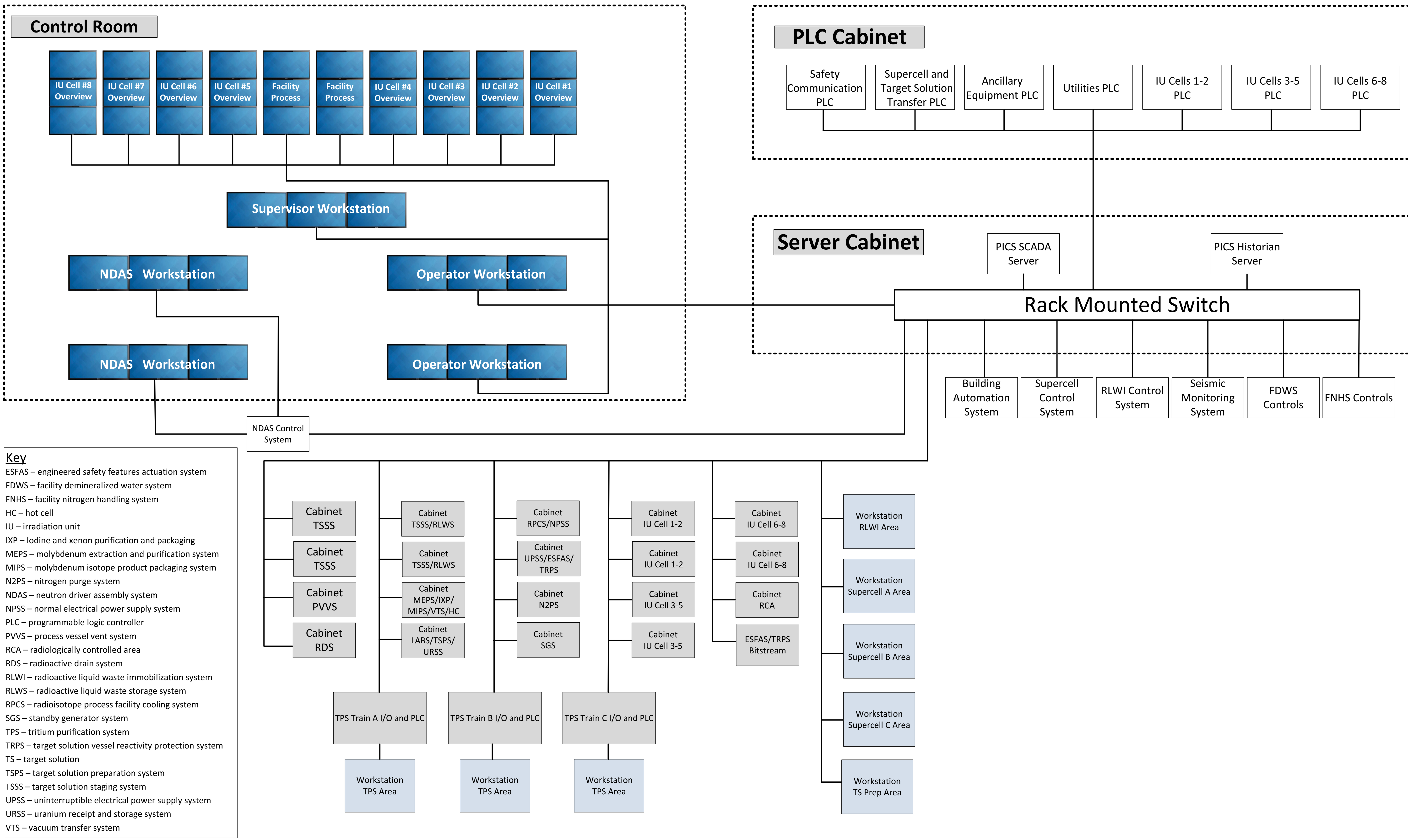

Table 7.4-1 – TRPS Monitored Variables
(Sheet 1 of 2)

Variable	Analytical Limit	Logic	Range	Accuracy	Instrument Response Time
Source range neutron flux	2.52 times the nominal flux at 95 percent volume of the critical fill height	2/3↑	1 to 1.0E+05 cps	2 percent	450 milliseconds
Wide range neutron flux	240 percent	2/3↑	2.5E-~~8~~6 to 250 percent	~~2~~1 percent	450 milliseconds
Power range neutron flux (Low power range limit, driver dropout permissive, and high time-averaged limit)	[ ]PROP/ECI	2/3↓	0 to 125 percent	1 percent	1 second
	40 percent	2/3↑			
	104 percent	2/3↑			
RVZ1e IU cell exhaust radiation	15x background radiation	2/3↑	10^{-7} to 10^{-1} μCi/cc	20 percent	15 seconds
TOGS oxygen concentration	10 percent	2/3↓	0 to 25 percent	1 percent	120 seconds
TOGS mainstream flow	[ ]PROP/ECI	2/3↓	[ ]PROP/ECI	3 percent	1.5 seconds
TOGS dump tank flow	[ ]PROP/ECI	2/3↓	[ ]PROP/ECI	3 percent	1.5 seconds
TOGS condenser demister outlet temperature	25°C	2/3↑	0 to 100°C	0.65 percent	10 seconds
Low-high TSV dump tank level	High level	2/3↑	High level/not high level	Discrete input signal	1.5 seconds
High-high TSV dump tank level	High level	2/3↑	High level/not high level	Discrete input signal	1.5 seconds
PCLS flow	[ ]PROP/ECI	2/3↓	[ ]PROP/ECI	1 percent	1 second
PCLS temperature	15°C	2/3↓	-1 to 121°C	1 percent	10 seconds
	25°C	2/3↑			

Table 7.4-1 – TRPS Monitored Variables
(Sheet 2 of 2)

Variable	Analytical Limit	Logic	Range	Accuracy	Instrument Response Time
TSV fill isolation valve position indication	Not closed	1/2↑	Closed/not closed	Discrete input signal	0.5 seconds
ESFAS loss of external power	Loss of power	1/~~1↑~~2[(a)]↓	Power/loss of power	Discrete input signal	0.5 seconds

(a) The logic for this variable is processed in the ESFAS. The actuation signal is sent redundantly to Division A and Division B of the TRPS.

Figure 7.4-1 TRPS Logic Diagrams
(Sheet 7 of 14)

Figure 7.4-1 TRPS Logic Diagrams
(Sheet 12 of 14)

Figure 7.4-1 TRPS Logic Diagrams
(Sheet 13 of 14)

7.5.3.1.10 Supercell Area 10 (IXP Area) Isolation

Supercell Area 10 (IXP Area) Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenarios 4, 5, 6, and 7).

A Supercell Area 10 (IXP Area) Isolation initiates the following safety functions:

- Deenergize RVZ2 supercell area 10 (IXP area) inlet isolation dampers
- Deenergize RVZ1 supercell area 10 (IXP area) outlet isolation dampers
- Supercell Area 6 (extraction area B) Isolation
- Supercell Area 7 (extraction area C) Isolation

The ESFAS initiates a Supercell Area 10 (IXP Area) Isolation based on the following variable or safety actuation:

- High RVZ1 supercell area 10 (IXP) exhaust ventilation radiation
- RCA Isolation

7.5.3.1.11 MEPS A Heating Loop Isolation

MEPS A Heating Loop Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 14).

A MEPS A Heating Loop Isolation initiates the following safety functions:

- Deenergize MEPS heating loop A inlet isolation valves
- Deenergize MEPS heating loop A discharge isolation valves
- Deenergize MEPS A extraction feed pump breakers

The ESFAS initiates a MEPS A Heating Loop Isolation based on the following variables or safety actuation:

- High MEPS heating loop radiation extraction area A
- Radioactive drain system (RDS) liquid detection
- Supercell Area 2 Isolation

7.5.3.1.12 MEPS B Heating Loop Isolation

MEPS B Heating Loop Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 14).

A MEPS B Heating Loop Isolation initiates the following safety functions:

- Deenergize MEPS heating loop B inlet isolation valves
- Deenergize MEPS heating loop B discharge isolation valves
- Deenergize MEPS B extraction feed pump breakers

The ESFAS initiates a MEPS B Heating Loop Isolation based on the following variables or safety actuation:

- High MEPS heating loop radiation extraction area B
- RDS liquid detection
- Supercell Area 6 Isolation

7.5.3.1.13 MEPS C Heating Loop Isolation

MEPS C Heating Loop Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 14).

A MEPS C Heating Loop Isolation initiates the following safety functions:

- Deenergize MEPS heating loop C inlet isolation valves
- Deenergize MEPS heating loop C discharge isolation valves
- Deenergize MEPS C extraction feed pump breakers

The ESFAS initiates a MEPS C Heating Loop Isolation based on the following variables or safety actuation:

- High MEPS heating loop radiation extraction area C
- RDS liquid detection
- Supercell Area 7 Isolation

7.5.3.1.14 Carbon Delay Bed Group 1 Isolation

Carbon Delay Bed Group 1 Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF fire events (Subsection 13b.1.2.5, Scenario 1).

A Carbon Delay Bed Group 1 Isolation initiates the following safety functions:

- Energize PVVS carbon delay bed group 1 three-way valves
- Energize PVVS carbon delay bed group 1 outlet isolation valves

The ESFAS initiates a Carbon Delay Bed Group 1 Isolation based on the following variable:

- High carbon delay bed group 1 exhaust carbon monoxide

7.5.3.1.15 Carbon Delay Bed Group 2 Isolation

Carbon Delay Bed Group 2 Isolation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF fire events (Subsection 13b.1.2.5, Scenario 1).

- Deenergize RVZ2 TPS room supply isolation dampers
- Deenergize RVZ2 TPS room exhaust isolation dampers
- Deenergize RVZ2 main RCA ingress/egress supply isolation dampers
- Deenergize RVZ2 main RCA ingress/egress exhaust isolation dampers
- Deenergize RVZ3 transfer isolation dampers shipping/receiving IF
- Deenergize RVZ3 transfer isolation dampers shipping/receiving RPF
- Deenergize RVZ3 transfer isolation dampers RPF emergency exit
- Deenergize RVZ3 transfer isolation dampers IF emergency exit
- Deenergize RVZ3 transfer isolation dampers mezzanine emergency exit
- Deenergize RVZ1 exhaust train 1 blower breakers
- Deenergize RVZ1 exhaust train 2 blower breakers
- Deenergize RVZ2 exhaust train 1 blower breakers
- Deenergize RVZ2 exhaust train 2 blower breakers
- Deenergize RVZ2 supply train 1 blower breakers
- Deenergize RVZ2 supply train 2 blower breakers
- Supercell Area 1 Isolation
- Supercell Area 2 Isolation
- Supercell Area 3 Isolation
- Supercell Area 4 Isolation
- Supercell Area 5 Isolation
- Supercell Area 6 Isolation
- Supercell Area 7 Isolation
- Supercell Area 8 Isolation
- Supercell Area 9 Isolation
- Supercell Area 10 Isolation
- VTS Safety Actuation
- TPS Train A Isolation
- TPS Train B Isolation
- TPS Train C Isolation
- TPS Process Vent Actuation

The ESFAS initiates an RCA Isolation based on the following variables:

- High RVZ1 RCA exhaust radiation
- High RVZ2 RCA exhaust radiation
- High TPS confinement A tritium
- High TPS confinement B tritium
- High TPS confinement C tritium
- High TPS IU cell 1 target chamber supply pressure
- High TPS IU cell 1 target chamber exhaust pressure
- High TPS IU cell 2 target chamber supply pressure
- High TPS IU cell 2 target chamber exhaust pressure
- High TPS IU cell 3 target chamber supply pressure
- High TPS IU cell 3 target chamber exhaust pressure
- High TPS IU cell 4 target chamber supply pressure
- High TPS IU cell 4 target chamber exhaust pressure
- High TPS IU cell 5 target chamber supply pressure
- High TPS IU cell 5 target chamber exhaust pressure
- High TPS IU cell 6 target chamber supply pressure
- High TPS IU cell 6 target chamber exhaust pressure

- High TPS IU cell 7 target chamber supply pressure
- High TPS IU cell 7 target chamber exhaust pressure
- High TPS IU cell 8 target chamber supply pressure
- High TPS IU cell 8 target chamber exhaust pressure

7.5.3.1.25 Extraction Column A Alignment Actuation

Extraction Column A Alignment Actuation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 15).

An Extraction Column A Alignment Actuation initiates the following safety functions:

- Deenergize MEPS area A extraction column upper three-way valve
- Deenergize MEPS area A extraction column lower three-way valve
- Deenergize MEPS A extraction column eluent valve

The ESFAS initiates the Extraction Column A Alignment Actuation when both of the following conditions are met:

- MEPS area A extraction column upper three-way valve position indication in “supplying”
- MEPS area A extraction column lower three-way valve position indication in “supplying”

7.5.3.1.26 Extraction Column B Alignment Actuation

Extraction Column B Alignment Actuation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 15).

An Extraction Column B Alignment Actuation initiates the following safety functions:

- Deenergize MEPS area B extraction column upper three-way valve
- Deenergize MEPS area B extraction column lower three-way valve
- Deenergize MEPS B extraction column eluent valve

The ESFAS initiates the Extraction Column B Alignment Actuation when both of the following conditions are met:

- MEPS area B extraction column upper three-way valve position indication in “supplying”
- MEPS area B extraction column lower three-way valve position indication in “supplying”

7.5.3.1.27 Extraction Column C Alignment Actuation

Extraction Column C Alignment Actuation is relied upon as a safety-related control in accordance with the SHINE safety analysis described in Chapter 13 for RPF critical equipment malfunction events (Subsection 13b.1.2.3, Scenario 15).

An Extraction Column C Alignment Actuation initiates the following safety functions:

- Deenergize MEPS area C extraction column upper three-way valve

Each division of the ESFAS contains three redundant 125 VDC to 24 VDC converters. The 24 VDC power is distributed to each of three chassis mounting bays, where it is then used to power two redundant 24 VDC to 5 VDC converters located beneath each chassis bay. These provide independent +5-volt (V) A and +5V B power channels to each chassis. This configuration allows for the architecture to handle a single failure of a power supply.

7.5.3.4 Operating Conditions

The ESFAS control and logic functions operate inside of the facility control room where the environment is mild and not exposed to the irradiation process, and is not subject to operational cycling. However, the cables for the ESFAS are routed through the radiologically controlled area to the process areas. The routed cables have the potential to be exposed to more harsh conditions than the mild environment of the facility control room. The sensors are located inside the process confinement boundary; therefore, the terminations of the cables routed to the sensors are exposed to the high radiation environment.

During normal operation, the ESFAS equipment will operate in the applicable normal radiation environments identified in Table 7.2-1 for up to 20 years, replaced at a frequency sufficient such that the radiation qualification of the affected components is not exceeded. The radiation qualification of the affected components is based upon the total integrated dose (TID) identified in Table 7.2-1 being less than the threshold values identified in industry studies.

The environmental conditions for ESFAS components are outlined in Table 7.2-1 through Table 7.2-3. The facility heating, ventilation and air conditioning (HVAC) systems are relied upon to maintain the temperature and humidity parameters in these areas. The facility HVAC systems are described in Section 9a2.1.

7.5.3.5 Seismic, Tornado, Flood

The ESFAS equipment is installed in the seismically qualified portion of the main production facility where it is protected from earthquakes, tornadoes, and floods. The ESFAS equipment is Seismic Category I, tested using biaxial excitation testing and triaxial excitation testing, in accordance with Section 8 of IEEE Standard 344-2013 (IEEE, 2013) (Subsection 7.5.3.12).

7.5.3.6 Human Factors

The ESFAS provides manual actuation capabilities for the safety functions identified in Subsection 7.5.3.1, except for the IU Cell Nitrogen Purge signal which originates in the TRPS, via the following manual push buttons located on the main control board:

- RCA Isolation
- Supercell Isolation (performs Supercell Areas 1 through 10 Isolations and MEPS A/B/C Heating Loop Isolations)
- VTS Actuation
- TPS Isolation (performs TPS Train A/B/C Isolation and TPS Process Vent ~~Isolation~~Actuation)
- Carbon Delay Bed Group 1 Isolation
- Carbon Delay Bed Group 2 Isolation
- Carbon Delay Bed Group 3 Isolation
- Extraction Column A Alignment Actuation

7.5.4.1.7 High PVVS Carbon Delay Bed Exhaust Carbon Monoxide

The high PVVS carbon delay bed group 1/2/3 exhaust carbon monoxide signals protect against a fire in the PVVS delay bed (Subsection 13b.1.2.5, Scenario 1). The signal is generated by ESFAS for the associated carbon delay bed group (Group 1, 2, or 3) when a carbon delay bed group 1/2/3 exhaust carbon monoxide input exceeds the high level setpoint. The PVVS carbon delay bed group 1/2/3 exhaust carbon monoxide is measured with an analog interface on two different channels, one for each Division A and Division B of ESFAS. When one-out-of-two or more PVVS carbon delay bed group 1/2/3 exhaust carbon monoxide channels exceed their setpoint, then a Carbon Delay Bed Isolation for the affected group is initiated.

7.5.4.1.8 VTS Vacuum Header Liquid Detection

The VTS vacuum header liquid detection signal protects against an overflow of the vacuum lift tanks to prevent a potential criticality event as described in Subsection 6b.3.2.5. The VTS vacuum header liquid detection signal is received by the ESFAS as a discrete input from a liquid detection switch on two different channels, one for each Division A and Division B of ESFAS. When one-out-of-two or more (Division A and Division B) VTS vacuum header liquid detection channels indicate liquid is detected, then a VTS Safety Actuation is initiated.

7.5.4.1.9 RDS Liquid Detection

The RDS liquid detection signal detects leakage or overflow from other tanks and piping (Subsection 13b.1.2.3, Scenarios 8, 10, 11, 12, and 16). The RDS liquid detection signal is received by the ESFAS as a discrete input from a liquid detection switch on two different channels, one for each Division A and Division B of ESFAS. When one-out-of-two or more RDS liquid detection channels indicate liquid is detected, then a VTS Safety Actuation is initiated.

7.5.4.1.10 High TPS IU Cell 1/2/3/4/5/6/7/8 Target Chamber Exhaust Pressure

The high TPS IU Cell 1/2/3/4/5/6/7/8 target chamber exhaust pressure signal protects against a break in the tritium exhaust lines in the IU cell (Subsection 13a2.1.6.2, Scenario 3 and Subsection 13a2.1.12.2, TPS Scenario 3). The signal is generated by ESFAS when a target chamber exhaust pressure input exceeds the high level setpoint. The TPS IU Cell 1/2/3/4/5/6/7/8 target chamber exhaust pressure is measured with an analog interface on two different channels, one for each Division A and Division B of ESFAS. When one-out-of-two or more TPS IU Cell 1/2/3/4/5/6/7/8 target chamber exhaust pressure inputs exceed the allowable limit, the appropriate TPS Train A/B/C Isolation ~~is~~and an RCA Isolation are initiated.

7.5.4.1.11 High TPS IU Cell 1/2/3/4/5/6/7/8 Target Chamber Supply Pressure

The high TPS IU Cell 1/2/3/4/5/6/7/8 target chamber supply pressure signal protects against a break in the tritium supply lines in the IU cell (Subsection 13a2.1.6.2, Scenario 3 and Subsection 13a2.1.12.2, TPS Scenario 3). The signal is generated by ESFAS when a target chamber supply pressure input exceeds the high level setpoint. The TPS IU Cell 1/2/3/4/5/6/7/8 target chamber supply pressure is measured with an analog interface on two different channels, one for each Division A and Division B of ESFAS. When one-out-of-two or more TPS IU Cell 1/2/3/4/5/6/7/8 target chamber supply pressure inputs exceed the allowable limit, the appropriate TPS Train A/B/C Isolation ~~is~~and an RCA Isolation are initiated.

7.5.4.1.12 High TPS Exhaust to Facility Stack Tritium

The high TPS exhaust to facility stack tritium signal protects against a release of tritium from the TPS glovebox pressure control exhaust and VAC/ITS process vent exhaust into the facility ventilation systems (Subsection 13a2.1.12.2, TPS Scenario 3 and TPS Scenario 4). The signal is generated by ESFAS when a TPS exhaust to facility stack tritium input exceeds the high level setpoint. The TPS exhaust to facility stack tritium is measured with an analog interface on three different channels, one for each division of ESFAS. When two-out-of-three or more TPS exhaust to facility stack tritium channels exceed their setpoint, then a TPS Process Vent Actuation is initiated.

7.5.4.1.13 High TPS Confinement Tritium

The high TPS confinement A/B/C tritium signals protect against a release of tritium from TPS equipment into the associated TPS glovebox (Subsection 13a2.1.12.2, TPS Scenario 1). A signal is generated by ESFAS when a TPS confinement A/B/C tritium input exceeds its high level setpoint. There is an independent and separate tritium measurement for each of the three TPS trains. TPS confinement tritium concentration is measured using an analog interface on two different channels per glovebox, one for each Division A and Division B of ESFAS. When one-out-of-two or more TPS confinement A/B/C tritium channels exceed their setpoint (for a particular glovebox), then a TPS Train A Isolation, TPS Train B Isolation, or TPS Train C Isolation is initiated for the respective TPS train along with an RCA Isolation.

7.5.4.1.14 TRPS IU Cell 1/2/3/4/5/6/7/8 Nitrogen Purge

The TRPS IU cell 1/2/3/4/5/6/7/8 nitrogen purge signal protects against a loss of hydrogen mitigation capabilities in the irradiation units (Subsection 13a2.1.2.2, Scenario 5 and Subsection 13a2.1.9.2, Scenario 1). The signal is generated by an affected TRPS subsystem and provided to the ESFAS when the TRPS initiates an IU Cell Nitrogen Purge, as described in Subsection 7.4.3.1.2. The TRPS IU cell 1/2/3/4/5/6/7/8 nitrogen purge signal is transmitted as a discrete input from the TRPS on two different channels, one for each Division A and Division B of ESFAS. When a TRPS IU cell 1/2/3/4/5/6/7/8 nitrogen purge indicates purging, then an ESFAS IU Cell Nitrogen Purge is initiated.

7.5.4.1.15 Low PVVS Flow

The PVVS flow signal protects against loss of hydrogen mitigation capabilities in the RPF (Subsection 13a2.1.6.2, Scenario 7). The signal is generated by ESFAS when a PVVS flow input exceeds the low level setpoint. The PVVS flow is measured with an analog interface on three different channels, one for each division of ESFAS. When two-out-of-three or more PVVS flow channels exceed their setpoint, then an RPF Nitrogen Purge is initiated.

7.5.4.1.16 MEPS Area A/B/C Three-Way Valve Position Indication

The MEPS area A/B/C three-way valve position indication signals protect against a misalignment of the extraction column upper and lower three-way valves, degrading one of the barriers preventing misdirection of chemical reagents or target solution (Subsection 13b.1.2.3, Scenario 15). The MEPS extraction column upper and lower three-way valve position indication is received by the ESFAS as a discrete input from redundant position indicating limit switches on two different channels, one for each Division A and Division B of ESFAS, for each three-way

Table 7.5-1 – ESFAS Monitored Variables
(Sheet 2 of 6)

Variable	Analytical Limit	Logic	Range	Accuracy	Response Time
RVZ1 supercell area 10 (IXP) exhaust ventilation radiation	15x background radiation	1/2↑	10^{-7} to 10^{-1} μCi/cc	20 percent	15 seconds
MEPS heating loop radiation extraction area A	2500 mR/hr	1/2↑	0.1 to 10,000 mR/hr	20 percent	~~5~~20 seconds
MEPS heating loop radiation extraction area B	2500 mR/hr	1/2↑	0.1 to 10,000 mR/hr	20 percent	~~5~~20 seconds
MEPS heating loop radiation extraction area C	2500 mR/hr	1/2↑	0.1 to 10,000 mR/hr	20 percent	~~5~~20 seconds
PVVS carbon delay bed group 1 exhaust carbon monoxide	50 ppm	1/2↑	1 to 100 ppm	10 percent	15 seconds
PVVS carbon delay bed group 2 exhaust carbon monoxide	50 ppm	1/2↑	1 to 100 ppm	10 percent	15 seconds
PVVS carbon delay bed group 3 exhaust carbon monoxide	50 ppm	1/2↑	1 to 100 ppm	10 percent	15 seconds
VTS vacuum header liquid detection	Liquid detected	1/2↑	Liquid detected/liquid not detected	Discrete input signal	5.5 seconds
RDS liquid detection	Liquid detected	1/2↑	Liquid detected/liquid not detected	Discrete input signal	5.5 seconds
TPS exhaust to facility stack tritium	1 Ci/m^3	2/3↑	1 to 2,000,000 $\mu Ci/m^3$	10 percent	5 seconds
TPS IU cell 1 target chamber exhaust pressure	8 psia	1/2↑	0 to 19.5 psia	1 percent	10 seconds
TPS IU cell 2 target chamber exhaust pressure	8 psia	1/2↑	0 to 19.5 psia	1 percent	10 seconds

Table 7.5-1 – ESFAS Monitored Variables
(Sheet 4 of 6)

Variable	Analytical Limit	Logic	Range	Accuracy	Response Time
TPS IU cell 7 target chamber supply pressure	8 psia	1/2↑	0 to 19.5 psia	1 percent	10 seconds
TPS IU cell 8 target chamber supply pressure	8 psia	1/2↑	0 to 19.5 psia	1 percent	10 seconds
TPS confinement A tritium	1000 Ci/m^3	1/2↑	1 to 1,000 Ci/m^3	10 percent	5 seconds
TPS confinement B tritium	1000 Ci/m^3	1/2↑	1 to 1,000 Ci/m^3	10 percent	5 seconds
TPS confinement C tritium	1000 Ci/m^3	1/2↑	1 to 1,000 Ci/m^3	10 percent	5 seconds
PVVS flow	5.0 scfm	2/3↓	1-20 scfm	3 percent	0.5 seconds
TSPS dissolution tank 1 level	High level	1/2↑	High level/not high level	Discrete input signal	1 second
TSPS dissolution tank 2 level	High level	1/2↑	High level/not high level	Discrete input signal	1 second
TRPS IU cell 1 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 2 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 3 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 4 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 5 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 6 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms

Table 7.5-1 – ESFAS Monitored Variables
(Sheet 5 of 6)

Variable	Analytical Limit	Logic	Range	Accuracy	Response Time
TRPS IU cell 7 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
TRPS IU cell 8 nitrogen purge	Purging	~~1/1~~2/3[a]↑	Purging/not purging	Discrete input signal	500 ms
MEPS area A lower three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
MEPS area A upper three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
MEPS area B lower three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
MEPS area B upper three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
MEPS area C lower three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
MEPS area C upper three-way valve position indication[b]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second

Table 7.5-1 – ESFAS Monitored Variables
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Variable	Analytical Limit	Logic	Range	Accuracy	Response Time
IXP lower three-way valve position indication[(b)]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
IXP upper three-way valve position indication[(b)]	Supplying	1/2↑ & 1/2↑	Supplying/not supplying	Discrete input signal	1 second
UPSS loss of external power	Loss of power	1/2↓	Power/loss of power	Discrete input signal	1 second

(a) The logic for these variables is processed in the TRPS. The actuation signal is sent redundantly to Division A and Division B of the ESFAS.

(b) A safety actuation is initiated when both the lower and upper three-way valves show one-out-of-two of the redundant position indications are in the “supplying” position.

Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Figure 7.5-1 – ESFAS Logic Diagrams
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Transmission of information between systemsPICS and TRPS or ESFAS is through unidirectional data transfers. Each of the safety system communications to the nonsafety PICS system is through one-way data communications from the safety systems to the nonsafety system. There are no inputs to the TRPS or ESFAS from the PICS that are used in the determination of protective actions, as described in Subsections 7.4.2.1.6 and 7.5.2.1.6. There are no unidirectional communications that allowfrom the nonsafety system to communicate back to the safety systems preventing the ability tothat would propagate a failure from the nonsafety control system displays to the safety control systems. The PICS communication to the FDCS is through a one-way data diode such that no communication from outside of the PICS (other than the inputs from the safety-related control systems) can have an impact on the operation of the PICS. CIn normal use, communications of the indication and diagnostic information of the TRPS and ESFAS to the maintenance workstation are through a unidirectional point-to-point communication bMonitoring and Indication Bus so that the maintenance workstation does not have an effect oninfluence the TRPS or ESFAS. The maintenance workstation is provided with a separate switch-controlled Calibration and Test Bus for performance of inputs to TRPS and ESFAS for updating parameters and testing activities.

A failure in the display systems results in distinct display changes, which directly indicate that depicted plant conditions are invalid.

The PICS is designed in a manner that allows operators to remove static display screens and equipment control displays from service without impacting the operation of the remaining portions of the PICS displays.

The PICS has in-service self-testing capabilities such that the system will alarm if individual points or an entire rack or cabinet loses communications or faults.

7.6.4.6 Technical Specifications and Surveillance

Certain material in this section provides information that is used in the technical specifications. This includes limiting conditions for operation, setpoints, design features, and means for accomplishing surveillances. In addition, significant material is also applicable to, and may be referenced in, the bases that are described in the technical specifications.

7.6.5 CONCLUSION

The SHINE facility control room is located in the non-radiologically controlled area of the main production facility and contains the necessary workstations, displays, and control cabinets needed for the operation of the main production facility. The main control board, PICS operator and supervisor workstations, and associated control cabinets are considered part of the PICS. As part of the PICS, the main control board, operator workstations, and supervisor workstation are not credited with performing safety functions and only assist operators in performance of normal operations or diverse actuations to the safety systems. The PICS interfaces with the safety-related TRPS, ESFAS, NFDS, and safety-related radiation monitors to provide nonsafety-

the holdup volume in RVZ1e to prevent radioactive gases from exiting through RVZ1e prior to isolation.
5. Tritium migrates to the IF through the IU cell plugs and is released to the environment.
6. Detection of high ~~radiation in the RCA~~TPS target chamber supply pressure or high TPS target chamber exhaust pressure actuates ventilation dampers between the RCA and the environment and minimizes the transport of radioactive material to the environment.
7. Personal dosimeters, local radiation alarms, and alarms in the facility control room notify facility personnel of radiation leakage.
8. Facility personnel evacuate the immediate area within 10 minutes upon actuation of the radiation alarms.

Radiation transport is driven primarily by barometric breathing between the IU cell and the IF.

The safety-related SSCs in the IU cell do not fail during a seismic event, but the NDAS and its internal components are not safety-related and cannot be relied upon to remain intact following a design basis earthquake.

No operator actions are taken or required to reach a stabilized condition or to mitigate dose consequences.

Safety Controls

The safety controls credited for mitigation of the dose consequences for this accident are:

- Primary confinement boundary
- TPS Train Isolation on high TPS target chamber supply pressure or high TPS target chamber exhaust pressure
- Ventilation isolation mechanisms
- Holdup volume in the RVZ1e
- Facility personnel evacuate the immediate area within 10 minutes after receipt of electronic dosimeter or local radiation alarms

It is assumed that the primary confinement is intact and performs a mitigation function with respect to radionuclide transport from the IU cells to the IF. The primary confinement boundary components are designed to maintain their integrity under postulated accident conditions and are maintained in accordance with the facility configuration management and maintenance systems.

13a2.2.6.4 Damage to Equipment

Failure of the NDAS vacuum boundary does not cause subsequent damage to equipment. While the NDAS vacuum boundary integrity is not seismically qualified to maintain integrity, the NDAS is designed to maintain structural integrity during and following a design basis earthquake.

After the initial IU cell pressurization has reached equilibrium, leakage between the IU cells and the IF is driven primarily by barometric breathing. The leakage between the cells and the IF is not impacted by the accident sequence.

13a2.2.12.1.1 Initial Conditions

Initial conditions for facility-specific events are described in Subsection 13a2.1.12.1.

13a2.2.12.1.2 Initiating Event

An internal NDAS vacuum boundary component fails and causes a pressurized release of tritium and SF_6 gas into the IU cell. Potential causes of the initiating event are discussed in Subsection 13a2.1.12.2.

13a2.2.12.1.3 Sequence of Events

It is assumed that the primary confinement is intact and performs a mitigation function with respect to radionuclide transport from the IU cell to the IF. The primary confinement is designed to maintain its integrity under postulated accident conditions and is maintained in accordance with the facility configuration management and maintenance programs.

1. The initiating event is a vacuum boundary component failure in the NDAS, which instantaneously releases tritium and SF_6 gas into the IU cell.
2. The IU cell becomes slightly pressurized due to the mass of released SF_6 gas.
3. Tritium is transported into the IF through penetrations in the confinement boundary.
4. Detection of high TPS target chamber supply pressure or high TPS target chamber exhaust pressure actuates the primary confinement boundary isolation valves and an irradiation unit trip within 20 seconds of detection. A sufficient time delay is provided by the holdup volume in RVZ1e to prevent radioactive gases from exiting through RVZ1e prior to isolation.
5. Tritium migrates to the IF through penetrations in the primary confinement boundary and is released to the environment.
6. Detection of high ~~radiation in the RCA~~TPS target chamber supply pressure or high TPS target chamber exhaust pressure actuates ventilation dampers between the RCA and the environment and minimizes the transport of radioactive material to the environment.
7. Personal dosimeters, local radiation alarms, and alarms in the facility control room notify facility personnel of radiation leakage.
8. Facility personnel evacuate the immediate area within 10 minutes upon actuation of the radiation area monitor alarms.

Radiation transport is primarily driven by barometric breathing between the IU cell and the IF.

Safety Controls

The safety controls credited for mitigation of the dose consequences for this accident are:

- Primary confinement boundary (IU cell plugs and seals)
- TPS Train Isolation on high TPS target chamber supply pressure or high TPS target chamber exhaust pressure
- IU cell ventilation isolations
- Holdup volume in the RVZ1e
- Facility personnel evacuate the immediate area within 10 minutes after receipt of electronic dosimeter or local radiation alarms

confinement boundary is described in detail in Section 6a2.2. Potential causes of the initiating event are discussed in Subsection 13a2.1.12.3.

13a2.2.12.2.3 Sequence of Events

It is assumed that the tritium confinement boundary is intact and performs a mitigation function with respect to radionuclide transport from the TPS to the IF. The tritium confinement boundary components are designed to maintain their integrity under postulated accident conditions and are maintained in accordance with the facility configuration management and maintenance programs.

1. The initiating event is a seismic event that causes a break in two TPS trains and instantaneously releases the tritium inventory into their respective TPS gloveboxes.
2. For the first 20 seconds, tritium escapes from each of the gloveboxes to the IF through the glovebox pressure control exhaust process vent to RVZ1.
3. The glovebox ventilation shuts down after 20 seconds due to high TPS confinement A/B/C tritium monitors.
4. During the 30 seconds after the initiating event, the TPS room vents to the IF at an elevated rate due to the facility RVZ2 ventilation system.
5. The RVZ2 ventilation damper from the TPS room isolates after 30 seconds due to high TPS confinement A/B/C tritium monitors.
6. The radioactive material is then dispersed throughout the IF and exits the facility to the environment through building penetrations.
7. Detection of high TPS confinement A/B/C tritium actuates ventilation dampers between the RCA and the environment and minimizes the transport of radioactive material to the environment.
8. Personal dosimeters, local radiation alarms, and alarms in the facility control room notify facility personnel of radiation leakage.
9. Facility personnel evacuate the immediate area within 10 minutes upon actuation of the radiation area monitor alarms.

Throughout the accident sequence, the leakage rate between each TPS glovebox and the TPS room is constant. After the TPS room ventilation is isolated, radiation transport is driven by air exchange between each TPS glovebox and the IF. Transport to the environment occurs through RCA boundary leak paths. The accident duration used in this analysis is 10 days, after which it is assumed that recovery actions will have occurred to stop further release and dispersion of radioactive material.

Safety Controls

The safety controls credited for mitigation of this accident are:

- TPS room ventilation isolations
- Glovebox pressure control and VAC/ITS ventilation isolations
- TPS confinement A/B/C tritium monitors
- Tritium confinement boundary, as described in Section 6a2.2
- Facility personnel evacuate the immediate area within 10 minutes after receipt of electronic dosimeter or local radiation alarms
- Tritium release event recovery actions are completed within 10 days