ENCLOSURE 2

SHINE TECHNOLOGIES, LLC

SHINE TECHNOLOGIES, LLC APPLICATION FOR AN OPERATING LICENSE SUPPLEMENT NO. 25

FINAL SAFETY ANALYSIS REPORT CHANGE SUMMARY PUBLIC VERSION

Summary Description of Changes	FSAR Impacts
Update to revise description of the neutron driver assembly system (NDAS) operating conditions and to reflect design progression of the process integrated control system (PICS) interactions with irradiation unit systems.	Section 4a2.3, Section 7.3
Update to reflect design progression of the PICS interactions with supercell systems.	Section 7.3
Update to reflect design progression of the PICS interactions with ancillary process systems.	Section 7.3
Update to reflect design progression of the building automation system and the PICS interactions with other facility systems.	Section 7.3, Section 7.6, Section 9a2.1

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

ENCLOSURE 2
ATTACHMENT 1

SHINE TECHNOLOGIES, LLC

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FINAL SAFETY ANALYSIS REPORT CHANGE SUMMARY
PUBLIC VERSION

FINAL SAFETY ANALYSIS REPORT MARKUP

As the ion beam is accelerated, its initial divergence and any space charge forces cause it to grow in radius. The ion beam is focused by solenoid electromagnets, which focus the expanding ion beam through the differential pumping stages into the aperture of the target chamber. If the focus elements failed to operate properly, the ion beam size change would cause the neutron yield to drop. If the focus elements failed and caused the ion-beam to diverge or misalign from the target chamber, the ion-beam divergence would cause the neutron yield to drop.

The target gas within the chamber is maintained at low vacuum to provide proper target atom density. The accelerated deuterium ions impinge upon the neutral deuterium and tritium atoms within the target chamber to initiate fusion. Each D-T fusion reaction produces a single high energy neutron (approximately 14.1 million electron volt [MeV]) and a single high energy alpha particle (approximately 3.5 MeV). The neutrons produced radiate outward, with most entering the SCAS. To maintain the high vacuum differential between the accelerator and the target chamber, neutral gas which escapes the target chamber is extracted from the drift tube by a configuration of blowers and turbomolecular pumps. The extracted neutral target gas is then exhausted from the blowers back into the target chamber.

The neutron driver is supplied with high voltage from the remotely placed HVPS. Subsystems of the neutron driver are controlled and powered by the control cabinets. Cooling for the ion source, solenoid magnets, turbo pumps, blowers, and target chamber is accomplished by circulating deionized cooling water from the cooling cabinet. Operators interface with the neutron driver from the control room, and maintenance access is possible using a maintenance control station. Target gas and ion source gas are provided by the TPS which also controls the target gas purity and composition. See Subsection 9a2.7.1 for more details on TPS.

4a2.3.4 CONTROL SYSTEM

The NDAS operates with an internal control system that operates each of the subsystems of NDAS. The NDAS responds to the control signals from the facility PICS to start and stop the neutron generation. Typical NDAS operational conditions include:

1. System Off;
2. Vacuum;
3. Standby; ~~and~~
4. Beam On; and
5. Decontamination.

During System Off, all systems except the control system are de-energized. During Vacuum, the NDAS is at its operating vacuum levels but beam focusing and steering magnets are de-energized. During Standby, all systems are operational and steady state, high voltage lines are de-energized. During Beam On, the neutron driver is fully operational. During Decontamination, the NDAS is evacuated and purged to allow for tritium decontamination before performing maintenance on the NDAS tritium process boundary components and secondary enclosures.

The NDAS neutron yield is normally maintained within 10 percent stability during the irradiation cycle. However, the neutron yield can temporarily decrease to 0 percent, or to any fraction of full output, due to electrical, beam focusing, or other temporary issues in the NDAS. Beam interruptions are considered normal behavior of accelerator technology, and the NDAS control system includes automatic recovery functions. TRPS limits the duration that the NDAS control system can attempt recovery before it is required to ramp up to full source strength using a

7.3 PROCESS INTEGRATED CONTROL SYSTEM

The SHINE facility is provided with nonsafety-related control systems necessary to perform normal operational activities within the facility. The process integrated control system (PICS) is a nonsafety-related digital control system that performs various functions throughout the SHINE facility. The PICS is the primary interface for operators to perform tasks in both the irradiation facility (IF) and the radioisotope production facility (RPF). PICS functions include signal conditioning, system controls, interlocks, and monitoring of the process variables and system status.

Vendor-provided nonsafety-related control systems, which interface and communicate with the PICS, are also present within the SHINE facility and are used to monitor and control specific facility systems.

The main control board and operator workstations in the facility control room are also part of the PICS and are described in Section 7.6.

7.3.1 SYSTEM DESCRIPTION

The PICS is a collection of instrumentation and control equipment located throughout the facility to support monitoring, indication, and control of various systems. A portion of the PICS supports the main control board and operator workstations in the facility control room by receiving operator commands and collecting and transmitting facility information to the operators, as described in Section 7.6. An architecture of the PICS is provided in Figure 7.3-1.

The following vendor-provided nonsafety-related control systems are also provided for the SHINE facility:

- The building automation system is a digital control system capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. It provides control for the facility heating water system (FHWS), the facility chilled water system (FCHS), the process chilled water system (PCHS), the radioisotope process facility cooling system (RPCS), facility ventilation zone 4 (FVZ4) air handling, and radiological ventilation zone 1, 2, and 3 (RVZ1/2/3) air handling. The building automation system ~~receives commands from the PICS to start and stop select control sequences and~~ provides information to the PICS for monitoring.
- The supercell contains a local control system and human system interface equipment for controlling hot cell functions including interior lighting, interior temperature and pressure, and operation of the doors, ports, and waste export system. The supercell control system provides information to PICS for monitoring only.
- The radioactive liquid waste immobilization (RLWI) system contains a local control system and human system interface equipment for controlling RLWI equipment functions including operation of equipment used to handle solidified waste. The RLWI control system provides information to PICS for monitoring only.
- The neutron driver assembly system (NDAS) control system is used to monitor and make adjustments to any of the eight neutron drivers in the eight irradiation unit (IU) cells. Two NDAS control stations are provided in the facility control room as described in Subsection 7.6.1.2, and a portable local station is provided as described in Subsection 7.6.1.6. The NDAS control system is further described in Subsection 4a2.3.4.

The NDAS control system receives permissive signals from the PICS to allow or disable use of the system and provides information to PICS for monitoring.

- The standby generator system (SGS) generator, facility demineralized water system (FDWS) reverse osmosis (RO) unit, facility nitrogen handling system (FNHS) unit, FHWS boilers, and FCHS and PCHS chillers are each provided with integral controllers that interface with the PICS (for the SGS generator, FDWS RO unit, and FNHS unit) or the building automation system (for boilers and chillers).

A description of the PICS process monitoring functions, control functions, interlocks, alarms, and displays is provided for each facility system where the PICS provides these functions. If applicable, the vendor-provided nonsafety-related controls are also described for each facility system. In addition to the variables described below, PICS monitors valve or damper position feedback as needed to perform control functions or implement interlocks and permissives.

7.3.1.1 Irradiation Unit Systems

The PICS is used to monitor parameters and perform manual and automatic actions during each of the operational modes of a subcritical assembly system (SCAS):

Mode 0 – Solution Removed: No target solution in the SCAS
Mode 1 – Startup: Filling the target solution vessel (TSV)
Mode 2 – Irradiation: Operating mode (neutron driver active)
Mode 3 – Post-Irradiation: TSV dump valves open
Mode 4 – Transfer to the RPF: Dump tank drain valve opens to permit solution transfer

The systems associated with SCAS modes of operation include the SCAS itself, the NDAS, the TSV off-gas system (TOGS), the primary closed loop cooling system (PCLS), the light water pool system (LWPS), and the neutron flux detection system (NFDS).

Mode 0 – Solution Removed

In Mode 0, the PICS provides the capability to control equipment needed to transition an IU into Mode 1, including closing the TSV fill valves and dump valves and ~~starting the TOGS blowers as needed~~ verifying system parameters to meet mode transition criteria. ~~The PICS also provides monitoring and controls of the common tritium purification system (TPS), which is integrated with the modes of operation for each IU cell.~~

Mode 1 – Startup Mode

After the operator transitions the IU to Mode 1 using the operating mode input to the TSV reactivity protection system (TRPS), the PICS is used to open the TSV fill valves and operate the vacuum transfer system (VTS) to add target solution to the TSV from the associated target solution hold tank.

The TSV is filled incrementally. The TSV fill increment is determined by 1/M calculations. The operator may use the PICS as a check to calculate the next required fill volume based on the 1/M calculation. The PICS also provides defense-in-depth time limits and interlocks to control the maximum volumetric step addition during the 1/M fill process to prevent challenging the TRPS Fill Stop actuation function described in Section 7.4.

Mode 2 – Irradiation

When the TSV fill has been completed, PICS is used to close the TSV fill valves to meet Mode 2 transition criteria. The PICS provides an interlock with the source range channel of the NFDS to prevent TSV irradiation without sufficient neutron counts on the detectors and, when that permissive is met, PICS is used to close the neutron driver breakers to enable the target solution in the TSV to be irradiated. The PICS interfaces with the NDAS control system to start or stop the driver and is used to control the introduction of tritium into the NDAS target from the tritium purification system (TPS).

During irradiation, PICS is used to monitor neutron flux levels, concentrations of radiolytic gases generated, NDAS performance parameters, and other parameters associated with the irradiation process.

Mode 3 – Post-Irradiation

The neutron driver breakers are opened by the PICS, ending the irradiation period and satisfying the mode transition criteria, allowing the operator to transition from Mode 2 to Mode 3. When transitioning from Mode 2 to Mode 3 during normal operations, the PICS provides the mode transition signal from the TRPS to automatically open the TSV dump valves to drain the target solution to the dump tank. While in Mode 3, the PICS is used to monitor TOGS and SCAS operational parameters while the solution is held for decay.

Mode 4 – Transfer to RPF

After the operator transitions the IU to Mode 4, the PICS is used to open the TSV dump tank drain isolation valve allowing the target solution to be vacuum lifted out of the IU cell, pumped through an extraction column, and drained to a target solution hold tank. The PICS is used to select the flow path for the transfer to the desired extraction cell and to operate the VTS which accomplishes the lift.

When the solution has been removed from the dump tank, the ~~operator uses~~ PICS ~~to~~ verif~~y~~ies that low-high TSV dump tank level is inactive, meeting the Mode 4 to Mode 0 transition criteria.

7.3.1.1.1 Subcritical Assembly System

The SCAS maintains fissile material in a subcritical, but highly multiplying configuration during the irradiation process to produce molybdenum-99 (Mo-99) and other fission products. The SCAS is described in Section 4a2.2.

Monitoring and Alarms

The PICS is used to monitor and provide alarms for TSV level, TSV temperature, and TSV headspace pressure for each IU. TSV dump tank level is monitored using two level switches (low-high and high-high), which are provided to PICS via TRPS (Subsections 7.4.4.1.8 and 7.4.4.1.9).

PICS also provides alarms for automatic or manual actuation of the TRPS safety functions described in Subsection 7.4.3.1 and the TRPS Fill Stop described in Subsection 7.4.4.1.18.

- Allow transition from Mode 3 to Mode 4 only when TSV level is below an allowable level indicating solution has been drained, and the TSV dump tank low-high level signal is present indicating solution is in the TSV dump tank.
- Allow transition from Mode 4 to Mode 0 only when TSV level is below an allowable level indicating solution has been drained, the TSV dump tank low-high level signal is clear indicating solution has been removed from the TSV dump tank, and the TSV fill valves are closed.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.1.2 Target Solution Vessel Off-Gas System

The TOGS is used to manage radiolysis and fission product gases generated in the TSV during irradiation operation and present in the TSV dump tank during target solution cooldown to maintain concentrations within safe limits. The TOGS is described in Section 4a2.8.

Monitoring and Alarms

The PICS receives input from the TRPS and provides alarms for TOGS oxygen concentration (Subsection 7.4.4.1.10), mainstream flow for both train A and B (Subsection 7.4.4.1.11), condenser demister outlet temperatures for both train A and B (Subsection 7.4.4.1.13), and dump tank flow for train A (Subsection 7.4.4.1.12).

The PICS directly monitors and provides alarms for TOGS hydrogen concentration, ~~gas injection flowrate,~~ TOGS blower outlet and sidestream pressures, instrument demister condensate high level switch and condenser demister outlet, sweep gas supply, recombiner inlet, recombiner outlet, zeolite bed inlet, and zeolite bed outlet temperatures.

Control Functions

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by TRPS are controlled by PICS as described in Subsection 7.3.1.3.11.

The following functions are performed while TOGS is running (Mode 1, 2, 3, or 4):

~~PICS automatically controls mainstream flow for each TOGS train based on the median value of the three mainstream flow inputs received from TRPS by adjusting the variable speed motor of the associated train TOGS blower.~~

~~PICS automatically controls the temperature of the recombiners (trains A and B) and the zeolite bed (train A) by energizing or deenergizing the associated heater based on the inlet and outlet temperature of each component.~~

~~PICS automatically opens the TOGS oxygen inlet valve when oxygen concentration is low, based on the median value of the three TOGS oxygen concentration inputs received from TRPS.~~ When manually initiated by the operator, PICS executes a programmed sequence to open the

TOGS oxygen inlet valve to maintain appropriate oxygen flowrate for a predetermined amount of time.

If TSV headspace pressure (Subsection 7.3.1.1.1) increases above the allowable setpoint, PICS opens the TOGS vacuum tank inlet valve. ~~If TSV headspace pressure is too high while TOGS oxygen concentration is low, PICS closes the TOGS oxygen inlet valve prior to opening the TOGS vacuum tank inlet valve.~~ If TSV headspace pressure is too low, PICS opens the TOGS nitrogen inlet valve.

~~PICS automatically controls the position of the TOGS gas inlet flow control valve to maintain a constant gas injection flowrate when either the TOGS oxygen or nitrogen inlet valve is open.~~

The following functions are performed while TOGS is not running (Mode 0):

When manually initiated by the operator, the PICS executes a programmed sequence to evacuate the TOGS vacuum tank by opening and closing the TOGS vacuum tank inlet valve, opening and closing the TOGS vacuum tank outlet valve, and opening and closing the vacuum supply valves in a specific order.

When manually initiated by the operator, the PICS executes a programmed sequence to start the TOGS by ensuring TOGS valves are in their required states~~,~~ and enabling the TOGS pressure control loop~~s, and starting t~~. The TOGS blowers are locally started manually by the operator, separate from the PICS controls. This sequence places the TOGS in a Running state.

Interlocks and Permissives

PICS provides interlocks and permissives to:

- Prevent the TOGS vacuum tank inlet valve and TOGS vacuum tank outlet valve from being open simultaneously.
- Prevent the TOGS oxygen inlet valve and TOGS nitrogen inlet valve from being open simultaneously.
- Prevent the TOGS vacuum tank inlet valve from being open when either the TOGS oxygen inlet valve or the TOGS nitrogen inlet valve is open.
- Allow the transition from Mode 0 to Mode 1 only when TOGS is in a Running state.
- Allow the transition from Mode 1 to Mode 2 only when TOGS is in a Running state.
- Allow transition from a Running state to idle only when associated IU cell is in Mode 0.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.1.3 Primary Closed Loop Cooling System

The PCLS provides forced convection water cooling to the TSV ~~and~~, neutron multiplier, SCAS, and the light water pool during irradiation of the target solution and immediately prior to transferring target solution from the TSV to the TSV dump tank. The PCLS is described in Section 5a2.2.

Monitoring and Alarms

The PICS receives input from the TRPS and provides alarms for PCLS cooling water flow (Subsection 7.4.4.1.7) and PCLS cooling water supply temperature (Subsections 7.4.2.1.5 and 7.4.2.1.6).

The PICS receives direct input and provides alarms for PCLS pressure, PCLS conductivity, PCLS expansion tank level, PCLS cleanup side stream flow, PCLS cooling water temperature (measured separately from safety-related PCLS cooling water supply temperature), and various other system parameters.

PCLS instrumentation is further described in Subsections 5a2.2.3 and 5a2.5.2.

Control Functions

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by TRPS are controlled by PICS as described in Subsection 7.3.1.3.11.

PICS automatically controls the position of the RPCS outlet control valve from the PCLS heat exchanger to maintain the nonsafety-related PCLS cooling water supply temperature indication within an acceptable band.

When manually initiated by the operator, the PICS executes a programmed sequence to start or stop the PCLS by ensuring PCLS valves are in their required states, enabling or disabling the PCLS temperature control loop, and allowing the operator to start or stop the PCLS pump motors. Starting at least one PCLS pump places PCLS in a Running state.

Interlocks and Permissives

PICS provides interlocks and permissives to:

- Prevent the PCLS pumps from starting if the PCLS supply isolation valve or either PCLS return isolation valve is closed.
- Prevent the PCLS pumps from starting if PCLS expansion tank level is low.
- Prevent the PCLS pumps from starting if PCLS suction pressure is low.
- Allow the transition from Mode 0 to Mode 1 only when PCLS is in a Running state.
- Allow the transition from Mode 1 to Mode 2 only when PCLS is in a Running state.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.1.4 Light Water Pool System

The ~~light water pool system (~~LWPS~~)~~ provides neutron moderation and reflection to reduce neutron leakage, radiation shielding, and decay heat removal from target solution following irradiation. The LWPS is described in Subsection 4a2.4.2.

Monitoring and Alarms

The PICS receives input and provides alarms for LWPS pool level and LWPS pool temperature for each IU.

Control Functions

None

Interlocks

None

7.3.1.1.5 Neutron Driver Assembly System

The NDAS is the source of neutrons used to generate the neutron fluxes required to create medical isotopes in the TSV. The NDAS produces neutrons by colliding a deuterium (D) ion beam with tritium (T) gas. The NDAS is directly controlled by a vendor-provided nonsafety-related control system. The NDAS is described in Section 4a2.3.

Monitoring and Alarms

The NDAS is directly monitored by a vendor-provided nonsafety-related control system. The NDAS control system monitors deuterium-tritium (DT) neutron yield, beam current, target pressure, leakage indications, various system voltages, currents and temperatures, and feedback from vacuum pumps and other system components.

The NDAS control system provides a subset of these monitored parameters and the status of the system (System Off, Vacuum, Prepared, Standby, Decontamination, or Beam On) to the PICS for display on the PICS workstations and generation of alarms.

Control Functions

The NDAS control system allows the operator to manually adjust (e.g., focus or direct) the deuterium beam by changing voltages and currents applied to various solenoid magnets. The NDAS control system also allows the operator to control the ion source by adjusting microwave power, current, and voltage to manually start and stop various system auxiliaries (e.g., vacuum pumps, blowers, cooling pumps), and to open and close NDAS system valves.

The local NDAS control station is only used for maintenance and commissioning activities for an NDAS unit installed in an IU, or for an NDAS unit located in the NDAS service cell.

The operator uses PICS to provide signals to manually open or close the neutron driver HVPS breakers to meet TRPS mode transition criteria and allow the beam to be energized. The operator is able to use the PICS to manually open and close individual valves that are capable of being actuated by TRPS as described in Subsection 7.3.1.3.11.

Interlocks and Permissives

The PICS provides permissive signals to the NDAS control system to:

- Allow ~~the use of the~~control of a specific NDAS from a control room NDAS control station~~, specific to each NDAS unit~~.
- Allow ~~the control room NDAS control station to transition~~ a specific NDAS ~~unit~~ to be in Beam On ~~status~~mode.
- Allow ~~the use of the~~control of a specific NDAS from a local NDAS control station.
- Allow the control room to send the Beam On permissive only if TPS has completed decontamination of the target chamber.
- Prevent the transition of an NDAS unit to Beam On when the NFDS source range count rate is below an allowable value.

Removal of the PICS permissive signal for Beam On operation causes the beam to deenergize.

The PICS additionally provides interlocks and permissives to:

- Prevent the transition of an NDAS unit to Beam On when the NFDS source range count rate is below an allowable value.
- Allow the transition from Mode 0 to Mode 1 only when the NDAS is not in Beam On.
- Allow the transition from Mode 1 to Mode 2 only when the NDAS is not in ~~Standby~~Beam On.
- Allow the transition from Mode 2 to Mode 3 only when the NDAS is not in Beam On.
- Allow the transition from Mode 3 to Mode 4 only when the NDAS is not in Beam On.
- Allow the transition from Mode 4 to Mode 0 only when the NDAS is not in Beam On.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.1.6 Neutron Flux Detection System

The NFDS monitors the neutron flux in the IU during ~~TSV fill and irradiation~~all modes of operation. The NFDS is described in Section 7.8.

Monitoring and Alarms

The PICS receives input from the TRPS for monitoring and provides alarms for source range neutron flux (Subsection 7.4.4.1.1), wide range neutron flux (Subsection 7.4.4.1.4), and power range neutron flux (Subsections 7.4.2.1.2 and 7.4.4.1.3), as described in Subsection 7.8.3.9.

The PICS indirectly receives discrete signals from the NFDS for “source range missing,” “wide range missing,” and “power range missing” faults for the generation of alarms (Subsection 7.8.3.10).

Control Functions

None

Interlocks and Permissives

outlet water temperature from the heater. Additionally, the PICS automatically controls the rate of water flow through the heat exchanger based on the temperature of the target solution.

~~When initiated by the operator during a purification operation, the PICS automatically controls the temperature of the MEPS evaporator by energizing and deenergizing the evaporator heater.~~

Other than performance of a target solution extraction sequence and the automatic PICS control functions described above, the tasks performed by the operator for the MEPS are manual. The operator is able to use the PICS local supercell control stations to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by ESFAS are controlled by PICS as described in Subsection 7.3.1.3.11.

The supercell control system is used by the operator to manually control hot cell (non-process) functions.

Interlocks and Permissives

The PICS provides permissives and interlocks to:

- Prevent initiation of a target solution extraction sequence if the associated IU from where solution is being transferred is not in Mode 4.
- Prevent opening of any of the supercell reagent feed isolation valves while a target solution extraction sequence is in progress.
- Prevent opening of any of the supercell reagent feed isolation valves while drawing a vacuum.
- Prevent alignment of MEPS ~~three-way~~ valves in a way that could misdirect fluid and challenge the operation of system check valves.
- Stop or prevent from starting ~~system~~MEPS extraction column and [ ] PROP/ECI feed pumps when discharge pressure is above an allowable limit.
- Stop or prevent from starting MEPS hot water loop pump when suction pressure is below an allowable limit.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.2.2 Molybdenum Isotope Product Packaging System

The MIPS is located in two hot cells of the supercell (packaging areas 1 and 2) and is used to package isotopes received from the MEPS and IXP, as described in Subsection 9b.7.1.

Monitoring and Alarms

PICS monitors the weight of the Mo-99 product from the MEPS and the weight of the Xe-133 and I-131 products from the IXP system. No alarms are provided.

Control Functions

The supercell control system is used by the operator to manually control hot cell (non-process) functions.

7.3.1.2.4 Process Vessel Vent System

The process vessel vent system (PVVS) provides ventilation of tanks and vessels located in the RPF that may contain radioactive solutions in order to mitigate the potential buildup of hydrogen that is generated via radiolysis. A portion of the PVVS equipment is located in a hot cell of the supercell (PVVS area), with other equipment located in the main production facility mezzanine or in below grade vaults. The PVVS is described in Subsection 9b.6.1.

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for PVVS flow (Subsection 7.5.4.1.15) and PVVS carbon delay bed exhaust ~~carbon monoxide~~temperature (Subsection 7.5.4.1.7).

The PICS directly monitors and provides alarms for nonsafety-related PVVS supply flow to individual tanks and vessels serviced by PVVS, PVVS reheater temperatures, PVVS condensate tank level, PVVS condenser cooling water temperature, PVVS carbon guard bed train exhaust temperature and differential pressure, PVVS carbon delay bed temperatures, and other system temperatures, pressures, and flows.

The PICS also provides alarms for automatic or manual Carbon Delay Bed Group 1/2/3 Isolations described in Subsection 7.5.3.1.

Control Functions

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by ESFAS are controlled by PICS as described in Subsection 7.3.1.3.11.

The PICS provides automatic control of PVVS condensate transfer by stopping the condensate discharge pump on low PVVS condensate tank level after the operator has manually selected the destination tank and initiated the transfer.

The PICS provides automatic control of the PVVS makeup air supply valve by monitoring nonsafety-related PVVS return flow (from tanks and vessels serviced by PVVS), to maintain total flow to the PVVS blowers constant.

The PICS automatically controls temperature by energizing and deenergizing the PVVS reheaters based on the PVVS reheater downstream temperature.

The supercell control system is used by the operator to manually control hot cell (non-process) functions.

Interlocks and Permissives

The PICS provides interlocks and permissives to:

- Close the PVVS inlet valve to a carbon guard bed train if differential pressure for the associated carbon guard bed train is above an allowable limit, and open the PVVS inlet and outlet valves and start the PVVS reheater for the redundant carbon guard bed train.
- Close the PVVS inlet and outlet valves for a carbon guard bed train if exhaust temperature for the associated carbon guard bed train is above an allowable limit, and open the PVVS inlet and outlet valves and start the PVVS reheater for the redundant carbon guard bed train.
- Open the carbon guard bed bypass valves if both carbon guard bed train PVVS inlet valves are closed.
- Isolate flow from the PVVS condensate tank on high level in the first uranium liquid waste tank.
- Isolate flow from the PVVS condensate tank on high level in the liquid waste blending tanks.
- Deenergize PVVS reheater(s) if the associated outlet temperature exceeds an allowable limit.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.2.5 Vacuum Transfer System

Target solution transfer activities occur throughout the main production facility in order to remove irradiated solution from the TSV dump tank, extract isotopes, and return target solution to an IU. These activities are accomplished by the VTS and target solution staging system (TSSS). The VTS consists of vacuum pumps and a vacuum buffer tank located in a hot cell of the supercell (co-located with the PVVS in the PVVS area) and lift tanks, as described in Subsection 9b.2.5.

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for the VTS vacuum header liquid detection switches (Subsection 7.5.4.1.8).

The PICS directly monitors and provides alarms for vacuum system pressure, individual VTS lift tank level switches, VTS vacuum buffer tank level switches, target solution sample line level switches, and status feedback information from the VTS vacuum pumps.

The PICS also provides alarms for automatic or manual VTS Safety Actuation described in Subsection 7.5.3.1.

Control Functions

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by TRPS or ESFAS are controlled by PICS as described in Subsection 7.3.1.3.11.

When initiated by the operator, the PICS starts or stops the VTS by enabling or disabling the vacuum system pressure control loop.

The PICS automatically starts and stops the second of two VTS vacuum pumps to maintain vacuum system pressure within an allowable range.

The supercell control system is used by the operator to manually control hot cell (non-process) functions.

Interlocks and Permissives

The PICS provides interlocks and permissives to:

- Close or prevent opening of individual VTS lift tank or target solution sample line vacuum valves when the corresponding VTS lift tank or target solution sample line high level switch signal is active.
- Close or prevent opening VTS vacuum buffer tank vacuum valves, and stop or prevent from starting the VTS vacuum pumps, and open the VTS vacuum buffer tank drain valve on high level in the VTS vacuum buffer tank.
- Prevent the vacuum transfer sequence from starting if level in the destination tank selected is above an allowable limit.
- Prevent VTS vacuum pumps from starting if any buffer tank vacuum valve is open.
- Prevent VTS vacuum valves from energizing if PVVS flow is below an allowable limit.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.2.6 Target Solution Staging System

The TSSS is used in conjunction with the VTS (Subsection 7.3.1.2.5), and consists of hold tanks and storage tanks located in subgrade vaults. The TSSS is described in more detail in Subsection 4b.4.1.1.

Monitoring and Alarms

The PICS monitors and provides alarms for two diverse methods of level indication for the individual TSSS tanks, and temperature indication for the individual TSSS tanks. The PICS additionally provides alarms when tank level or transfer time is outside of expected parameters during a solution transfer sequence.

Control Functions

When manually initiated by the operator, the PICS executes a programmed sequence to transfer solution from one manually selected TSSS tank to another manually selected tank using the VTS. The PICS opens and closes the appropriate system isolation valves based on feedback from VTS lift tank level switches and the selected hold or storage tank level indication to accomplish the solution transfer.

An in-progress solution transfer sequence can be manually aborted by the operator.

When manually initiated by the operator, the PICS executes a programmed sequence to obtain a sample from a manually selected TSSS tank. The PICS opens and closes the appropriate vacuum valves and sampling isolation valves to accomplish the sampling activity.

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences.

Interlocks and Permissives

The PICS provides interlocks to:

- Prevent a vacuum transfer sequence from starting in a hold or storage tank when the temperature in the associated tank is above an allowable limit.
- Stop a vacuum transfer sequence on high level in the destination tank.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.3 Ancillary Process Systems

The PICS provides automated and manual control of systems used to prepare target solution, manage radioactive waste, control tritium provided to the neutron drivers, and perform other facility process monitoring and control functions.

7.3.1.3.1 Uranium Receipt and Storage System

The uranium receipt and storage system (URSS) is used to receive uranium prior to conversion to target solution. The URSS is described in detail in Subsection 4b.4.2.1.

Monitoring and Alarms

The PICS monitors and provides alarms for URSS glovebox pressures, URSS glovebox air flow, ~~and~~ URSS glovebox temperatures, URSS glovebox humidity, and inlet and outlet high efficiency particulate air (HEPA) filter differential pressures.

A single local control station is associated with the URSS and target solution preparation system (TSPS) which is capable of displaying URSS and TSPS indications and alarms to the local operator.

Control Functions

None

Interlocks and Permissives

None

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for the RDS liquid detection switches (Subsection 7.5.4.1.9).

The PICS directly monitors and provides alarms for RDS sump tank temperature and level.

Control Functions

When manually initiated by the operator, the PICS executes a programmed sequence to transfer solution from the RDS sump tanks to another manually selected tank using the VTS. The PICS opens and closes the appropriate system isolation valves based on feedback from VTS lift tank level switches and the RDS sump tank level indication to accomplish the solution transfer.

An in-progress solution transfer sequence can be manually aborted by the operator.

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences.

Interlocks and Permissives

The PICS provides interlocks to prevent a vacuum transfer sequence from starting in the RDS sump tanks when the temperature in the associated tank is above an allowable limit.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.3.4 Radioactive Liquid Waste Storage System

Radioactive liquid waste is stored in the radioactive liquid waste storage (RLWS), described in Subsection 9b.7.4. The PICS is used to monitor tank levels and temperatures, control the operation of system valves, and provide functionality to support administrative controls related to the transfer of radioactive liquid waste between tanks using the VTS.

Monitoring and Alarms

The PICS monitors and provides alarms for ~~two diverse methods of~~ level and temperature indication for the individual RLWS tanks~~, temperature indication for the individual RLWS tanks, and status feedback from the mixers provided in the blending and collection tanks~~.

Control Functions

When manually initiated by the operator, the PICS executes a programmed sequence to transfer solution from a selected RLWS tank to another manually selected tank using the VTS. The PICS opens and closes the appropriate system isolation valves based on feedback from VTS lift tank level switches and RLWS tank and destination tank level indication to accomplish the solution transfer.

An in-progress solution transfer sequence can be manually aborted by the operator.

When manually initiated by the operator, the PICS executes a programmed sequence to obtain a sample from a manually selected RLWS tank. The PICS opens and closes the appropriate vacuum valves and sampling isolation valves to accomplish the sampling activity.

The operator is able to use the PICS to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences.

Interlocks and Permissives

The PICS provides interlocks and permissives to:

- Prevent a vacuum transfer sequence from starting in a RLWS tank when the temperature in the associated tank is above an allowable limit.
- Prevent a vacuum transfer sequence from starting if the selected destination tank indicates level above an allowable limit.
- Allow tank solution transfers to the second uranium liquid waste tank or to the liquid waste blending tanks only when uranium sampling results have been entered and verified to be within allowable limits and when an operations supervisor has verified the results.

Indication to the operator is provided on the PICS operator workstation displays when an interlock or permissive is bypassed.

7.3.1.3.5 Radioactive Liquid Waste Immobilization System

Radioactive liquid waste is immobilized in the RLWI system, described in detail in Subsection 9b.7.3. PICS interfaces with the RLWI vendor-provided nonsafety-related control system for monitoring purposes only.

Monitoring and Alarms

The PICS directly monitors and provides alarms for RLWI immobilization feed tank and column effluent tank levels and temperatures and RLWI feed pump ~~discharge pressure and flow rate~~status.

The RLWI control system directly monitors the status of immobilization drum filling and mixing equipment, and various other system parameters. The RLWI control system provides a subset of these monitored parameters and the status of the system to the PICS for display on the local and control room PICS workstations for generation of alarms.

Control Functions

The RLWI control system is used by the local operator to manually start and stop operations to transfer drums into and out of the enclosure, and to fill and mix drums of liquid waste to be solidified.

The RWLI control system is also used by the operator to manually control RLWI enclosure (non-process) functions.

When manually initiated by the operator, the PICS executes a programmed sequence to transfer solution from a selected RLWS tank to the immobilization feed tank as described in Subsection 7.3.1.3.4.

Interlocks and Permissives

The PICS provides a~~n interlock~~ permissive to prevent the transfer of liquid waste into the RLWI enclosure unless the RLWI control system provides indication that it is in a “ready” status.

Indication to the operator is provided on the PICS local and control room operator workstation displays when an interlock or permissive is bypassed.

7.3.1.3.6 Tritium Purification System

The TPS, which supplies tritium to the neutron drivers located in the IUs, is described in Subsection 9a2.7.1. The TPS consists of three separate, identical trains. Train A serves IU cells 1 and 2; Train B serves IU cells 3, 4, and 5; and Train C serves IU cells 6, 7, and 8.

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for the IU cell (NDAS) target chamber supply and exhaust pressures (Subsections 7.5.4.1.10 and 7.5.4.1.11), TPS exhaust to facility stack tritium (Subsection 7.5.4.1.12), and TPS confinement tritium (Subsection 7.5.4.1.13).

The PICS directly monitors and provides alarms for:

- Glovebox pressure, helium flow, and dew point;
- Target gas exhaust humidity;
- Nonsafety-related tritium concentration at various points in the system;
- Status ~~feedback from~~of TPS heaters; and
- Various other system pressures, temperatures, dew points, and flows.

The PICS also provides alarms for automatic or manual TPS Train A/B/C Isolations and TPS Process Vent Actuations described in Subsection 7.5.3.1.

Control Functions

When initiated by the operator, the PICS executes programmed sequences to start or stop a TPS train. The PICS opens and closes TPS valves to control the flow of gas through the TPS train and between the separation columns. The PICS starts or stops pumps to transport process gas through the TPS and to circulate the TPS glovebox atmosphere. Temperature and pressure control loops, listed below, are also enabled and disabled as applicable as part of the programmed sequence.

The PICS provides automatic temperature control of permeators, depleted uranium storage beds, oxide and hydride beds, and other TPS components by energizing and deenergizing the heater associated with each component.

The PICS provides automatic temperature control of cryopumps and separation columns by controlling the position of liquid nitrogen supply valves and energizing or deenergizing the heater associated with each component.

~~The PICS provides control of glovebox pressures by opening and closing valves to add helium to the glovebox or remove glovebox atmosphere to the zone 1 ventilation system.~~

When initiated by the operator, the PICS executes programmed sequences to start or stop gas supply to an individual NDAS unit. As part of the sequence, automatic control of valve positions is enabled and disabled to maintain gas supply flow to each NDAS unit individually as selected by the operator, and controls gas return flow pressure within an allowable pressure band.

When initiated by the operator, the PICS executes programmed sequences to perform other periodic or maintenance tasks, including the addition of tritium from a depleted uranium storage bed to the process by energizing or deenergizing heaters, and the evacuation of process lines.

The operator is able to use the PICS, either locally or remotely, to manually open and close individual valves and manually start or stop individual components unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by TRPS or ESFAS are controlled by PICS as described in Subsection 7.3.1.3.11.

Interlocks and Permissives

The PICS provides an interlock on the TPS tritium supply valves to prevent the ~~introduction of~~TPS from supplying tritium to ~~an NDAS~~the target chamber ~~when the associated IU is not in Mode 2~~until TPS decontamination of the target chamber from the prior run has been completed and the NDAS is operating in Beam On status with deuterium gas in the target chamber.

The PICS also provides interlocks to prevent the initiation of certain TPS programmed sequences while conflicting sequences are in progress.

7.3.1.3.7 Stack Release Monitoring System

The stack release monitoring system (SRMS) consists of a stack release monitor (SRM) and a carbon delay bed effluent monitor (CDBEM) to monitor gaseous effluents from the main production facility. The SRMS is described in Subsection 7.7.5.

Monitoring and Alarms

The PICS provides monitoring and alarms for SRM noble gas activity, ~~pressure, flow, and mass flow rate, and~~ CDBEM noble gas activity, and ~~mass flow rate~~system status.

Control Functions

None

Interlocks and Permissives

None

7.3.1.4 Other Facility Systems

The PICS provides the automated control and operator interface to manually control aspects of the facility auxiliary and electrical systems.

7.3.1.4.1 Normal Electrical Power Supply System

The normal electrical power supply system (NPSS) is the normal electrical power supply for the SHINE facility, as described in Subsection 8a2.1.3. The NPSS provides normal power to the PICS, and the PICS provides monitoring, control, and alarms for the NPSS as described in this section.

The PICS remains operational through the use of local PICS power supplies upon a loss of off~~‘~~-site power for a minimum of 10 minutes (Subsection 7.3.3.6).

Monitoring and Alarms

The PICS provides monitoring and alarms for voltage, current, and frequency~~, and power~~ for each main electrical service branch for the SHINE facility. The PICS additionally provides status indication (closed, open, or trip) and alarms for main service breakers, switchgear breakers, and tie breakers, as well as safety-related equipment breakers (i.e., NDAS HVPS breakers, VTS vacuum pump breakers, MEPS extraction pump breakers, and RVZ1 exhaust subsystem [RVZ1e] exhaust, RVZ2 exhaust subsystem [RVZ2e] exhaust, and RVZ2 supply subsystem [RVZ2s] supply fan breakers), and alarms for main service breaker undervoltage, overvoltage, phase reversal, loss of phase, ~~out of frequency,~~ or loss of utility power.

Control Functions

The PICS provides the operator the ability to manually open or close the main service breakers, tie breakers, switchgear breakers, and the NDAS HVPS breakers.

~~The PICS automatically disconnects the on-site electric power systems from the utility by opening the affected main service breaker on undervoltage, overvoltage, phase reversal, or loss of phase.~~

Interlocks and Permissives

~~The PICS provides interlocks to prevent a main service breaker and the tie breaker for that same service from being closed simultaneously, to prevent paralleling two AC power sources.~~None

7.3.1.4.2 Uninterruptible Electrical Power Supply System

The uninterruptible electrical power supply system (UPSS) provides safety-related power for the main production facility, as described in Subsection 8a2.2.3.

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for UPSS loss of external power (Subsection 7.5.4.1.19).

The PICS directly monitors and provides alarms for battery room and UPS equipment room temperatures, battery room hydrogen concentration, battery charge level, battery charger current, inverter bypass status, inverter current, and various other system parameters for both divisions of the UPSS. The PICS also provides alarms for fault conditions of UPSS components (e.g., battery fault, battery charger fault, UPS fault, DC bus ground) and unexpected system alignments (e.g., battery charger breakers open, bypass transformer breakers open, inverter bypass breaker closed, load breakers open).

Control Functions

None

Interlocks and Permissives

None

7.3.1.4.3 Standby Generator System

The SGS provides nonsafety-related backup power for the SHINE facility, as described in Subsection 8a2.2.6. The SGS generator includes a vendor-provided nonsafety-related controller.

Monitoring and Alarms

The PICS provides monitoring and alarms for SGS voltage, current, and power. The internal vendor-provided SGS generator controller additionally monitors for generator status and faults, including oil pressure, water temperature, engine temperature, fuel pressure, coolant level, overcrank or overspeed conditions, and other generator parameters. The SGS controller provides a subset of these monitored parameters to the PICS for display and alarming.

Control Functions

The PICS provides the operator the ability to manually start or stop the generator by providing a signal to the SGS automatic transfer switch(es), and to manually transfer loads between the generator and the off-site utility by opening and closing breakers.

The SGS generator controller automatically starts the generator in response to a loss of off-site power event. PICS automatically sequences the loads onto the generator.

Interlocks and Permissives

The generator automatic transfer switch design prevents paralleling the generator with either service entrance.

7.3.1.4.4 Nitrogen Purge System

The nitrogen purge system (N2PS) provides a backup supply of sweep gas to each IU and to all tanks normally ventilated by the PVVS during a loss of normal power or loss of normal sweep gas flow. The off-gas resulting from the nitrogen purge is treated by passive PVVS equipment prior to being discharged to the alternate vent path in the PVVS and the stack. The N2PS is described in Subsections 6b.2.3 and 9b.6.2.

Monitoring and Alarms

The PICS monitors and provides alarms for N2PS storage tube pressures, N2PS flows, and oxygen concentration in the N2PS structure general area.

The PICS also provides alarms for automatic or manual IU Cell Nitrogen Purge and RPF Nitrogen Purge described in Subsection 7.5.3.1.

Control Functions

The operator is able to use the PICS to manually open and close individual valves that are capable of being actuated by TRPS or ESFAS, as described in Subsection 7.3.1.3.11.

Interlocks and Permissives

None

7.3.1.4.5 Radiological Ventilation Systems

The RV systems are constant volume systems that include supply air, recirculating, and exhaust subsystems required to condition the air and provide the confinement and isolation needed to mitigate design basis accidents, as described in Section 9a2.1. The main production facility uses three ventilation zones and five subsystems in the radiologically controlled area (RCA) to maintain the temperature and humidity of the RCA and to maintain a pressure gradient from areas of least potential for contamination to areas with the most potential for contamination:

- RVZ1
- RVZ1 recirculating subsystem (RVZ1r)
- RVZ1e
- RVZ2
- RVZ2e
- RVZ2s
- RVZ2 recirculating subsystem (RVZ2r)
- RVZ3

The RV systems interface with the vendor-provided building automation system.

Monitoring and Alarms

The PICS receives input from the ESFAS and provides alarms for RVZ1 and RVZ2 RCA exhaust radiation (Subsection 7.5.4.1.1)~~,~~ and RVZ1 supercell radiation in all 10 supercell areas (Subsection 7.5.4.1.2 through Subsection 7.5.4.1.5)~~, and~~. The PICS receives input from the TRPS and provides alarms for RVZ1e IU cell radiation for each IU (Subsection 7.4.4.1.5).

The building automation system continuously monitors hot water supply and return temperatures, chilled water supply and return temperatures, unit mixed air temperature, and discharge air temperature for the RVZ2s air handling units. The building automation system also monitors system flow rates and various other system parameters. The building automation system provides a subset of the monitored variables to PICS for display and alarming.

The PICS directly monitors and provides alarms for:

- RVZ1r IU cell and TOGS cell flows, temperatures, differential pressures, and status feedback from blowers,.

The building automation system directly monitors and provides alarms for:

- RVZ1e filter bank differential pressures and status feedback from blowers,
- RVZ2e filter bank differential pressures and status feedback from blowers,
- RVZ2r area temperatures, and status feedback from blowers and fans, and
- RVZ3 differential pressures.

The PICS also provides alarms for automatic or manual Supercell Isolation and RCA Isolation described in Subsection 7.5.3.1.

Control Functions

When manually initiated by the operator, the building automation system provides automatic control of RVZ2s air handling units, RVZ1e and RVZ2e exhaust fans, make-up air supply, and the position of dampers to maintain the air pressure cascade from areas with the least potential for contamination (RVZ3) to the areas with the most potential for contamination (RVZ1). The building automation system controls supply air temperature and humidity by modulating the position of hot water heating and chilled water-cooling control valves.

When manually initiated by the operator, the PICS executes a programmed sequence to start or stop the RVZ1r subsystem for a selected IU by verifying dampersvalves are in the correct position and enabling or disabling RVZ1r automatic temperature control. The PICS maintains temperature within an allowable band by controlling the position of RPCS cooling water valves for the RVZ1r air handling units.

When manually initiated by the operator, the PICSbuilding automation system executes a programmed sequence to start or stop the RVZ1e subsystem by verifying dampers are in the correct position and enabling or disabling RVZ1e automatic pressure control. The PICSbuilding automation system maintains pressure within an allowable band by controlling the operation of the variable speed RVZ1e blowers.

When manually initiated by the operator, the PICSbuilding automation system executes a programmed sequence to start or stop the RVZ2r subsystem by verifying dampers are in the correct position and enabling or disabling RVZ2r automatic temperature control. The PICSbuilding automation system maintains temperatures within an allowable band by controlling the position of RPCS cooling water valves for the RVZ2r air handling units starting and stopping the RVZ2r RPCS pumps.

The operator is able to use the PICS to provide limited start and stop commands to building automation system control sequences. The operator may also use the PICS to manually open and close individual valves and dampers and manually start or stop individual components directly controlled by the PICS unless operation is prevented by interlocks, permissives, or active sequences. Components that are capable of being actuated by TRPS or ESFAS are controlled by PICS as described in Subsection 7.3.1.3.11.

Interlocks and Permissives

The PICS or building automation system, dependent on the component controlled, provides interlocks and permissives to prevent operation of fans or blowers where the associated discharge damper is closed.

The PICS also provides an interlock that ensures that the TOGS air handling unit drip pan heater is operating whenever the associated TOGS blowers are operating to prevent the accumulation of condensate in the drip pan.

7.3.1.4.6 Facility Ventilation System

The facility ventilation system (FVZ4) is a variable air volume system that provides heating, ventilation, and cooling to the non-RCAs of the main production facility, as described in Section 9a2.1. FVZ4 interfaces with the vendor-provided building automation system.

Monitoring and Alarms

The building automation system continuously monitors hot water supply and return temperatures, chilled water supply and return temperatures, unit mixed air temperature, and discharge air temperature for the RVZ2s air handling units. The building automation system also monitors system flow rates and various other system parameters. The building automation system provides a subset of the monitored variables to PICS for display and alarming.

Control Functions

When manually initiated by the operator, the building automation system provides automatic control of FVZ4 air handling units, exhaust fans, make-up air supply, and the position of dampers. The building automation system controls supply air temperature and humidity by modulating the position of hot water heating and chilled water-cooling control valves, or when outdoor conditions allow for free cooling, by adjusting the percentage of outside air supplied as make-up.

~~The operator is able to use the PICS to provide limited start and stop commands to building automation system control sequences.~~

Interlocks and Permissives

None

7.3.1.4.7 Facility Chilled Water System

The FCHS includes air cooled chillers and distribution pumps and provides chilled water to the main production facility RVZ2s and FVZ4 supply air handling units. The FCHS is described in Subsection 9a2.1.3. FCHS interfaces with the vendor-provided building automation system.

Monitoring and Alarms

The building automation system continuously monitors and provides alarms leaving chilled water temperatures of chillers, return chilled water temperature, chiller flow rates, system pressure, and

7.3.1.4.9 Radioisotope Process Facility Cooling Water System

The RPCS includes a heat exchanger cooled by the PCHS and primary RPCS distribution pumps, and provides cooling to various main production facility loads as described in Section 5a2.3. RPCS interfaces with the vendor-provided building automation system.

Monitoring and Alarms

The building automation system continuously monitors and provides alarms for leaving chilled water temperature from the RPCS heat exchanger, return chilled water temperature, system flow rates, system pressure, and control valve positions. The building automation system provides a subset of the monitored variables to PICS for display and alarming in the facility control room.

Control Functions

When manually initiated by the operator, the building automation system maintains RPCS heat exchanger flow within an allowable band by enabling and disabling the primary RPCS distribution pumps and controlling the position of RPCS valves.

~~The operator is able to use the PICS to provide limited start and stop commands to building automation system control sequences.~~

Interlocks and Permissives

None

7.3.1.4.10 Process Chilled Water System

The PCHS includes air cooled chillers and distribution pumps and provides chilled water to the RPCS heat exchanger. The PCHS is described in Section 5a2.4. PCHS interfaces with the vendor-provided building automation system.

Monitoring and Alarms

The building automation system continuously monitors and provides alarms for leaving chilled water temperatures of chillers, return chilled water temperature, chiller flow rates, system pressure, and control valve positions. The building automation system provides a subset of the monitored variables to PICS for display and alarming in the facility control room.

Control Functions

When manually initiated by the operator, the building automation system provides automatic control of the PCHS temperature. Each PCHS chiller is provided with an integral controller that controls all onboard operations (e.g., capacity control and safeties) and requires a signal from building automation system to engage or disable the chiller. If temperature requirements are not met, the building automation system enables or disables redundant chillers as necessary to maintain PCHS temperature.

The building automation system provides automatic control to enable and disable primary pumps as required to maintain loop flow rates between minimum and maximum chiller flow rates while maintaining real-time response to changes in RPCS heat exchanger load.

Interlocks and Permissives

None

7.3.1.4.11 Facility Nitrogen Handling System

The FNHS provides gaseous and liquid nitrogen to various systems in the main production facility, as described in Subsection 9b.7.8. The FNHS unit contains an integral vendor-provided controller.

Monitoring and Alarms

The PICS provides monitoring and alarms for main production facility general area oxygen concentration and nitrogen pressure in nitrogen receivers for end users.

The FNHS unit contains an integral controller that monitors system status (e.g., vaporizer status and tank level) ~~and provides a subset of monitored parameters to the PICS for display and alarming~~.

Control Functions

~~The operator is able to use the PICS to provide limited start and stop commands to the FNHS integral controller and to manually open and close individual valves.~~None

Interlocks and Permissives

None

7.3.1.4.12 Facility Chemical Reagent System

The portion of the facility chemical reagent system (FCRS) that interfaces with the PICS provides gaseous oxygen to the TOGS, as described in Subsection 9b.7.10

Monitoring and Alarms

The PICS provides monitoring and alarms for pressure in oxygen receivers for end users.

Control Functions

None

Interlocks and Permissives

None

7.3.1.4.13 Facility Demineralized Water System

The FDWS provides demineralized water to various systems in the main production facility as described in Section 5a2.6. The FDWS RO unit contains an integral vendor-provided controller.

Monitoring and Alarms

The FDWS RO unit contains an integral controller that monitors system status (e.g., storage tank level) and provides a subset of monitored parameters to the PICS for display and alarming.

Control Functions

The operator is able to use the PICS to provide limited start and stop commands to the RO unit integral controller~~ and to manually open and close individual valves~~.

Interlocks and Permissives

None

7.3.1.4.14 Seismic Monitoring System

The PICS contains a seismic monitoring system, which includes instrumentation, control cabinets, and a dedicated computer for monitoring seismic activity in the safety-related portion of the facility. The seismic monitoring system provides event recording time histories for seismic events and provides indication of a seismic event to the PICS for alarm in the facility control room. Data may be retrieved from the seismic monitoring system by either the dedicated computer or via the operator workstation in the facility control room.

Monitoring and Alarms

The PICS provides monitoring and alarms for the acceleration status of the seismic monitors located in the main production facility.

Control Functions

None

Interlocks and Permissives

None

7.3.2 DESIGN CRITERIA

The SHINE facility design criteria applicable to the PICS are stated in Table 3.1-2. The facility design criteria applicable to the PICS, and the PICS system design criteria, are addressed in this section. Discussion of other vendor-provided nonsafety-related control systems is also provided, where applicable.

Although not a control station, the PICS is provided with an engineering workstation located in the PICS server room, which is used to perform system administrator functions.

The SHINE facility additionally contains local control stations for vendor provided nonsafety-related control systems. The vendor provided nonsafety-related control systems are further described in Subsection 7.3.2.

The building automation system contains ~~two~~one control station~~s~~, ~~one~~ located in the ~~resource building and the other located in~~facility control room. Local access points are available in the nonsafety-related portion of the main production facility~~ mezzanine~~. The local access points are hardwired connections. The control station~~s are~~ is used for normal operation of the systems served by the building automation system while the local access points are used for periodic adjustments and maintenance on systems served by the building automation system and is not used for normal operation.

The supercell contains an operator interface for the supercell control system used for controlling hot cell functions.

The radioactive liquid waste immobilization (RLWI) system contains an operator interface for the RLWI control system for controlling RLWI equipment functions.

A portable NDAS local control station is provided for controlling one NDAS unit at a time during maintenance and commissioning. The station performs the same functions as the control room NDAS control station, but is not normally connected to an NDAS unit, and is not used for normal operation. The NDAS local control station is also used for controlling an NDAS unit located in the NDAS service cell.

7.6.2 DESIGN CRITERIA

The~~re are no~~ SHINE facility design criteria ~~that are uniquely~~ applicable to the control console and display instruments ~~(other than criteria 1-8 identified in Section 3.1, Tables 3.1-1 and 3.1-2, which are generically applicable to the facility as a whole)~~are described in Subsection 7.6.2.1. The system design criteria uniquely applicable to the control console and display instruments are addressed in ~~this section~~Subsection 7.6.2.2.

7.6.2.1 SHINE Facility Design Criteria

There are no SHINE facility design criteria that are uniquely applicable to the control console and display instruments. The control console and display instruments were considered in the evaluation of SHINE facility design criteria that were performed as part of the PICS and described in Subsection 7.3.2.1.

7.6.2.2 System Design Criteria

7.6.2.2.1 Access Control

PICS Criterion 10 – The operator workstation and main control board design shall incorporate design or administrative controls to prevent or limit unauthorized physical and electronic access to critical digital assets (CDAs) during the operational phase, including the transition from development to operations. CDAs are defined as digital systems and devices that are

The RVZ1e and RVZ2e subsystems combine downstream of each subsystem's respective filter bank, RCA isolation bubble-tight dampers, and exhaust fans, as shown in Figure 9a2.1-8. The PVVS delay bed discharge is also combined with the RVZ1e and RVZ2e flow downstream of the exhaust fans and upstream of the stack release monitor. The discharge of the stack is approximately 10 feet above the roofline of the facility and will maintain a minimum discharge velocity of 3,000 fpm.

9a2.1.1.4 Instrumentation and Control

The RV systems are designed such that the process integrated control system (PICS) monitors the system equipment, flow rates, pressures, and temperatures. Instrumentation monitors the ventilation systems for off-normal conditions and signal alarms as required. The PICS starts, shuts down, and operates the RVZ1r system in normal operating modes. The building automation system starts, shuts down, and operates the RVZ1e and RVZ2 systems in normal operating modes. Coordinated controls maintain negative pressurization to create flow patterns that direct air toward areas of increasing contamination potential.

PICS monitors the differential pressures across all the filters in the RVZ1e and RVZ2e filter banks and produces an alarm if the differential pressure of any filter is above its established limit.

9a2.1.1.5 Inspection and Testing

The ventilation systems are balanced upon installation. Control systems are tested to assure that control elements are calibrated and properly adjusted. Safety-related isolation dampers are inspected and tested as required by, and in accordance with, Section DA of ASME AG-1, Code on Nuclear Air and Gas Treatment (ASME, 2009). Safety-related ductwork will be inspected and tested as required by, and in accordance with, Section SA of ASME AG-1 (ASME, 2009).

9a2.1.1.6 Nuclear Criticality Safety

Subsection 6b.3.2.7 provides a discussion related to the nuclear criticality safety requirements for the URSS glovebox ventilation. Subsection 6b.3.2.4 provides discussion related to the nuclear criticality safety requirements for the TSPS glovebox ventilation.

9a2.1.1.7 Technical Specifications

Certain material in this subsection 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 used for, the bases that are described in the technical specifications.

9a2.1.2 NON-RADIOLOGICAL AREA VENTILATION SYSTEM

The non-radiological area ventilation system is the facility ventilation zone 4 (FVZ4) system.

Ventilation zone 4 consists of areas which are located within the main production facility, but outside of the RCA. The FVZ4 system is completely independent of the RV systems described in Subsection 9a2.1.1. The FVZ4 system supply AHUs draw at least 10 percent outside air to make up for air exhausted and exfiltrated. The outside air is mixed with recirculated air and conditioned through the AHUs before being supplied to FVZ4 areas. FVZ4 exhaust streams exhaust directly

A flow diagram of the return air associated with the FVZ4s subsystem is provided in Figure 9a2.1-10. A diagram of the FVZ4s subsystem AHUs is provided in Figure 9a2.1-11.

FVZ4 Exhaust Subsystem (FVZ4e)

FVZ4e serves the following locations of the non-RCA area of the facility:

- Janitor closets
- Chemical storage
- Restrooms
- Battery rooms
- Control room

The FVZ4e subsystem exhausts the battery rooms and UPS rooms within ventilation zone 4 to maintain the hydrogen concentration below 2 percent and the temperature under 120°F. Upon a loss of power, the battery rooms will be exhausted by dedicated fans powered by the standby generator system (SGS).

Dampers are provided to isolate the FVZ4 exhaust air subsystem to each battery room and each UPS room, independently, on an initiation signal from each location's fire suppression system.

The distribution of the FVZ4e subsystem is provided in Figure 9a2.1-12.

FVZ4 Room Cooling Recirculation Subsystem (FVZ4r)

The FVZ4r subsystem recirculates and cools air within the electrical/telephone rooms. The system is made up of two split systems that cool the server space. The FVZ4r subsystem provides equipment status to the PICS.

9a2.1.2.4 Radiation Protection and Criticality Safety

There are no radiation contamination hazards or criticality safety hazards associated with the FVZ4 system.

9a2.1.2.5 Instrumentation and Control

The supply air subsystem HVAC controls operate through the ~~PICS~~building automation system. The FVZ4 system is designed such that the ~~PICS~~building automation system monitors and controls the non-RCA recirculation air subsystem ventilation equipment, flow rates, pressures, and temperatures. Instrumentation monitors the ventilation systems for off-normal conditions and signal alarms as required.

The ~~PICS~~building automation system performs the following functions relative to FVZ4:

- starts, shuts down, and operates FVZ4 in normal operating modes;
- monitors the return and supply temperature from the AHUs; and
- monitors the pressure differential across the filters.

water flow rates in response to signals sent to the load instrumentation. A flow control valve is maintained on the system bypass line and is controlled by input signals from FCHS controller inputs made by chiller supply, RVZ2s, and FVZ4 modulating flow control valves.

Each pump's VFD status is monitored by local chiller equipment for fault status and motor amps. When the FCHS controller registers that a pump is not running, and a stop command has not been issued from the control panel, an alarm is generated at the control panel and the standby pump is automatically started.

Local chiller equipment monitors differential pressures across each chiller and the chillers' running status. Upon communication of a fault alarm, an FCHS controller isolates that chillers' modulating flow control valve and issues a start command to the back-up chiller. System pumps respond accordingly to the loading of the chillers via a local controller. Chiller fault alarms on multiple chillers initiates an automatic shutdown of the system through an FCHS controller.

The system maintains alarms monitored by ~~PICS~~the building automation system and displays them ~~at operator workstations for system volumes out of range~~in the control room.

9a2.1.3.4 Radiation Protection

There are no radiation contamination hazards associated with the FCHS.

9a2.1.3.5 Instrumentation and Controls

Instrumentation monitors the system for off-normal conditions and signal alarms as required. FCHS controls are nonsafety-related.

The FCHS provides the necessary output signal to the PICS for the monitoring of chilled water temperatures, pressures, and flow rates.

9a2.1.3.6 Inspection and Testing

The FCHS testing requirements for water piping, pipe supports, and valves are in accordance with ASME B31.9, Building Services Piping (ASME, 2017). Hydrostatic tests are performed in accordance with Section 937.3 of ASME B31.9 (ASME, 2017). Visual welding inspections are performed on piping and piping supports in accordance with ASME B31.9 (ASME, 2017).

9a2.1.3.7 Technical Specifications

There are no technical specification parameters associated with the FCHS.

9a2.1.4 FACILITY HEATING WATER SYSTEM

The facility heating water system (FHWS) is a hydronic hot water heating system configured in a variable primary flow piping arrangement.