ENCLOSURE 2

SHINE TECHNOLOGIES, LLC

SHINE TECHNOLOGIES, LLC APPLICATION FOR AN OPERATING LICENSE SUPPLEMENT NO. 15 SUBMITTAL OF THE PHASED STARTUP OPERATIONS APPLICATION SUPPLEMENT

SHINE PHASED STARTUP OPERATIONS APPLICATION SUPPLEMENT (PUBLIC VERSION)

84 pages follow

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
ALARA	as low as reasonably achievable
ASAI	application specific action items
CAMS	continuous air monitoring system
CTB	calibration and test bus
DAC	derived air concentrations
DBA	design basis accident
ESF	engineered safety features
ESFAS	engineered safety features actuation system
FAT	factory acceptance test
FCHS	facility chilled water system
FCR	facility control room
FCRS	facility chemical reagent system
FDCS	facility data and communication system
FDWS	facility demineralized water system
FHWS	facility heating water system
FNHS	facility nitrogen handling system
FPGA	field programmable gate array
FPP	fire protection program
FPWS	facility potable water system
FSAR	Final Safety Analysis Report
FSDS	facility sanitary drain system
FVZ4	facility ventilation zone 4
HIPS	highly integrated protection system
HVAC	heating ventilation and air conditioning
I&C	instrumentation and controls

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	**Definition**
ICBS	irradiation cell biological shield
IF	irradiation facility
IU	irradiation unit
IXP	iodine and xenon purification and packaging
LABS	quality control and analytical testing laboratories
LWPS	light water pool system
MATB	material staging building
MEPS	molybdenum extraction and purification system
MHS	material handling system
MIPS	molybdenum isotope product packaging system
MWS	maintenance workstation
N-16	nitrogen-16
N2PS	nitrogen purge system
NDAS	neutron driver assembly system
NFDS	neutron flux detection system
NPSS	normal electrical power supply system
NSC	neutron driver assembly service cell
NVM	non-volatile memory
PCHS	process chilled water system
PCLS	primary closed loop cooling system
PFBS	production facility biological shield
PICS	process integrated control system
PLC	programmable logic controller

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	**Definition**
PVVS	process vessel vent system
RAMS	radiation area monitoring system
RCA	radiologically controlled area
RDS	radioactive drain system
RLWI	radioactive liquid waste immobilization system
RLWS	radioactive liquid waste storage system
RO	reverse osmosis
RPCS	radioisotope process facility cooling system
RPF	radioisotope production facility
RV	radiological ventilation
RVZ1	radiological ventilation zone 1
RVZ1e	radiological ventilation zone 1 exhaust subsystem
RVZ1r	radiological ventilation zone 1 recirculating subsystem
RVZ2	radiological ventilation zone 2
RVZ2r	RVZ2 recirculation subsystem
RVZ3	radiological ventilation zone 3
SAT	site acceptance test
SCAS	subcritical assembly system
SEC	secondary enclosure cleanup
SER	safety evaluation report
SFM	safety function module
SGS	standby generator system
SHINE	SHINE Technologies, LLC
SNM	special nuclear material

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	**Definition**
SRMS	stack release monitoring system
SRWP	solid radioactive waste packaging system
SSA	SHINE Safety Analysis
SSCs	structures, systems, and components
TCAP	Thermal Cycling Adsorption Process
TOGS	target solution vessel off-gas system
TPS	tritium purification system
TRPS	target solution vessel reactivity protection system
TSPS	target solution preparation system
TSSS	target solution staging system
TSV	target solution vessel
UPSS	uninterruptible electrical power supply system
URSS	uranium receipt and storage system
Vac/ITS	vacuum/impurity treatment subsystem
VTS	vacuum transfer system

CHAPTER 1 – THE FACILITY

1.1 INTRODUCTION

This supplement to the Final Safety Analysis Report (FSAR) is submitted in support of the application by SHINE Technologies, LLC (SHINE) to operate a medical isotope production facility.

The information provided in Section 1.1 of the FSAR is not affected by phased startup operations. This supplement describes the phased approach to operation that SHINE is following to facilitate meeting the national need for molybdenum-99 production as soon as possible while also ensuring all requirements related to public health and safety are met.

The phasing has been developed to minimize the complexities of maintaining process isolation and confinement requirements and to limit the number of physical locations where remaining equipment installation is occurring during operation to minimize impacts on the operating portions of the facility.

The phased approach to operation is separated into four phases. The first three phases bring the eight irradiation units (IUs) and molybdenum-99 production capability online, while Phase 4 adds iodine and xenon production capability. The general description of phases is as follows:

Phase 1 consists of the equipment necessary to support operation of IUs 1 and 2. The equipment installed for Phase 1 includes:

- all auxiliary and support systems, except as noted below for the instances of primary closed loop cooling system (PCLS), light water pool system (LWPS), and radiological ventilation zone 1 (RVZ1) equipment located in the cooling room;
- all radioisotope production facility (RPF) systems except the capability of iodine and xenon purification and packaging (IXP) and radioactive liquid waste immobilization (RLWI) selective removal;
- IUs 1 and 2, including the associated instances of the subcritical assembly system (SCAS), neutron flux detection system (NFDS), target solution vessel (TSV) off-gas system (TOGS), PCLS, LWPS, and RVZ1r; and
- tritium purification system (TPS) train A.

Phase 2 adds the equipment necessary to support operation of IUs 3, 4, and 5. The equipment installed for Phase 2 includes:

- IUs 3, 4, and 5, including the associated instances of the SCAS, NFDS, TOGS, PCLS, LWPS, and RVZ1 equipment located in the cooling room; and
- TPS train B.

Phase 3 adds the equipment necessary to support operation of irradiation units 6, 7, and 8. Phase 3 also adds the capability for selective removal in the RLWI system and waste staging. The equipment installed for Phase 3 includes:

- IUs 6, 7, and 8, including the associated instances of the SCAS, NFDS, TOGS, PCLS, LWPS, and RVZ1 equipment located in the cooling room;
- TPS train C;

- RLWI selective removal components; and
- the material staging building.

Phase 4 adds the IXP capability. See Figure 1.1-1 for the physical layout where equipment is located for the four phases.

1.2 SUMMARY AND CONCLUSIONS OF PRINCIPAL SAFETY CONSIDERATIONS

The information provided in Section 1.2 of the FSAR, and associated subsections, is not affected by phased startup operations, with the exception of the listing of locations in which radioactive materials are primarily present provided in Subsection 1.2.1 of the FSAR. The lone exception to the listing is that the material staging building does not contain radioactive materials until it is operational as part of Phase 3.

The SHINE Safety Analysis (SSA) methodology described in Chapter 13 of the FSAR has been used to evaluate whether any new or different hazards are introduced by phased startup operations. The results of this evaluation concluded that there are no new accident categories introduced by phased startup operations, beyond those identified in Subsection 1.2.4 of the FSAR. Additional details on the safety analysis evaluation specific to phased startup operations is provided in Chapter 13a2 and Chapter 13b of this supplement.

1.3 GENERAL DESCRIPTION OF THE FACILITY

The information provided in Section 1.3 of the FSAR, and associated subsections, is not affected by phased startup operations, with the exception of the specific number of IUs that are operational in each phase, as described in Section 1.1.

The design criteria for each system, both general and system specific, is met during all phases of operation for the systems in operation. This includes Criterion 33 (Piping systems penetrating confinement and) Criterion 34 (Confinement isolation). Discussions of isolation locations specific to phased startup operations are provided in Chapter 4a2, Chapter 4b, Chapter 9a2, and Chapter 9b.

Isolations at interface points with uninstalled systems are described throughout the supplement and generally consist of one or more valves and blind flanges or caps. The blind flanges and caps described are not credited controls and are not necessary to meet design criteria for the systems. As system installation progresses in preparation for the next phase of operation, the blind flanges and caps are removed, and the appropriate process connections are made.

Confinement boundaries for operating systems are not impacted by installation activities.

Each IU has a dedicated IU cell, TOGS cell, and primary cooling room. This provides an installation area that is physically separate from operating units. The IU cells and primary cooling rooms are designed to allow access for maintenance or other operational needs while adjacent units are operating, including irradiation cell biological shield (ICBS) design sufficient to minimize dose rates consistent with as low as reasonably achievable (ALARA) principles at the facility.

During the phased approach to initial facility operations, the instrumentation and control (I&C) systems are installed to the extent practicable given the extent of equipment installation. Instrumentation and controls required for the safe operation of the process equipment in each phase are fully tested and operable. Sufficient isolation exists between operable and non-operable portions of the systems to ensure non-operable portions do not impact the safe operation of the active systems during installation or testing activities, for each phase of startup operations.

For systems associated with individual IUs, including the TSV reactivity protection system (TRPS), NFDS, and the radiological ventilation zone 1 exhaust subsystem (RVZ1e) IU cell radiation monitors, the systems are brought online with the associated IU in the applicable phases.

1.4 SHARED FACILITIES AND EQUIPMENT

The information provided in Section 1.4 of the FSAR is not affected by phased startup operations.

In reference to the list of structures that make up the SHINE facility, the material staging building is not operational until Phase 3.

1.5 COMPARISON WITH SIMILAR FACILITIES

The information provided in Section 1.5 of the FSAR is not affected by phased startup operations.

1.6 SUMMARY OF OPERATIONS

The information provided in Section 1.6 of the FSAR, and associated subsections, is not affected by phased startup operations with the exception of the specific number of IUs that are operational in each phase, as described in Section 1.1.

1.7 COMPLIANCE WITH THE NUCLEAR WASTE POLICY ACT OF 1982

The information provided in Section 1.7 of the FSAR is not affected by phased startup operations.

1.8 FACILITY MODIFICATIONS AND HISTORY

The information provided in Section 1.8 of the FSAR is not affected by phased startup operations.

1.9 REFERENCES

None

Figure 1.1-1 – Physical Layout of Phased Approach to Operation

CHAPTER 2 – SITE CHARACTERISTICS

The site characteristics described in Chapter 2 of the FSAR are not affected by phased startup operations. Phased startup operations impacts the sequence of process equipment installation and operation, not the external considerations described in Chapter 2 of the FSAR (i.e., geography, demography, nearby facilities, meteorology, hydrology, geology, seismology, and geotechnical engineering).

CHAPTER 3 – DESIGN OF STRUCTURES, SYSTEMS, AND COMPONENTS

The design of structures, systems, and components described in Chapter 3 of the FSAR is not affected by the phased startup operations. The design criteria and systems and components descriptions provided in Sections 3.1 and 3.5 of the FSAR, respectively, are applied to phased startup operations. The main production facility structure (FSTR) and the nitrogen purge system (N2PS) structure are constructed to support Phase 1 operations. These structures are designed and constructed to withstand meteorological damage, water damage, and seismic damage as described in Sections 3.2, 3.3, 3.4, and 3.6 of the FSAR.

CHAPTER 4a2 – IRRADIATION FACILITY DESCRIPTION

4a2.1 SUMMARY DESCRIPTION

Irradiation unit (IU) descriptions in Chapter 4a2 of the FSAR are not affected by phased startup operations. IU systems, as described in Chapter 4a2 of the FSAR, are designed and operated at the unit level. Each IU includes unit specific instances of the subcritical assembly system (SCAS), neutron driver assembly system (NDAS), light water pool, and irradiation cell biological shield (ICBS). Additionally, each IU is supported by unit specific instances of the primary closed loop cooling system (PCLS), and target solution vessel (TSV) off-gas system (TOGS).

During Phase 1, the equipment necessary to support operation of IUs 1 and 2 are functional and available for operation. During Phase 2, the equipment necessary to support operation of IUs 1 through 5 are functional and available for operation. During Phases 3 and 4, the equipment necessary to support operation of all IUs (i.e., IUs 1 through 8) are functional and available for operation. Tritium purification system (TPS) Trains A, B, and C support the progression of Phases 1, 2, and 3, respectively, as described in Section 9a2.7. Support systems and auxiliary systems are installed prior to Phase 1 operations as described in Chapter 1. Support system and process line interfaces with the IUs are isolated to support phased startup operation (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1 operation, interfaces with IUs 6 through 8 are isolated during Phase 2 operation).

The following isolation points are provided inside IU cells 3 through 8 during Phase 1 and inside IU cells 6 through 8 during Phase 2:

- The vacuum transfer system (VTS) line to fill the TSV includes two isolation valves.
- The VTS line to the TSV dump tank includes one isolation valve inside the IU cell and an additional isolation valve outside of the IU cell.
- The VTS line to the TOGS vacuum tank includes two isolation valves.
- The process vessel vent system (PVVS) line which exits the IU cell includes one locked closed isolation valve.

The following isolation points are provided outside IU cells 3 through 8 or TOGS cells 3 through 8 during Phase 1 and outside IU cells 6 through 8 or TOGS cells 6 through 8 during Phase 2:

- Radioisotope process facility cooling system (RPCS) supply and return lines (see RPCS isolation descriptions in Section 5a2.3).
- Facility nitrogen handling system (FNHS) supply lines include one isolation valve.
- Facility chemical reagent system (FCRS) supply lines include one isolation valve.
- Nitrogen purge system (N2PS) purge lines include one isolation valve and a blind flange or cap.
- Radiological ventilation system zone 1 (RVZ1) exhaust lines (see RVZ1 isolation descriptions in Section 9a2.1).

4a2.2 SUBCRITICAL ASSEMBLY

IU-specific instances of SCAS, as described in Section 4a2.2 of the FSAR, are installed to support phased startup operations.

4a2.3 NEUTRON DRIVER ASSEMBLY SYSTEM

IU-specific instances of the NDAS, as described in Section 4a2.3 of the FSAR, are installed to support phased startup operations.

4a2.4 TARGET SOLUTION VESSEL AND LIGHT WATER POOL

IU-specific instances of the TSV and light water pool, as described in Section 4a2.4 of the FSAR, are installed to support phased startup operations.

4a2.5 IRRADIATION FACILITY BIOLOGICAL SHIELD

The ICBS, other than shield plugs, is installed prior to Phase 1 operations. IU specific instances of the ICBS shield plugs, as described in Section 4a2.5 of the FSAR, are installed to support phased startup operations.

4a2.6 NUCLEAR DESIGN

The nuclear design described in Section 4a2.6 of the FSAR is on a per IU basis and is not affected by phased startup operations.

4a2.7 THERMAL HYDRAULIC DESIGN

The thermal hydraulic design described in Section 4a2.7 of the FSAR is on a per IU basis and is not affected by phased startup operations.

4a2.8 GAS MANAGEMENT SYSTEM

IU-specific instances of TOGS, as described in Section 4a2.8 of the FSAR, are installed to support phased startup operations.

4a2.9 REFERENCES

None.

CHAPTER 4b – RADIOISOTOPE PRODUCTION FACILITY DESCRIPTION

The radioisotope production facility (RPF) structures, systems, and components descriptions provided in Chapter 4b of the FSAR are not affected by phased startup operations, except that the iodine and xenon purification and packaging (IXP) system is not available during Phase 1 through Phase 3, the radioactive liquid waste immobilization system (RLWI) selective removal process (i.e., removal of selective isotopes such as Sr-90, Cs-137 from liquid wastes) is not available during Phase 1 and Phase 2, and the material staging building (MATB) is not available during Phase 1 and Phase 2.

4b.1 FACILITY AND PROCESS DESCRIPTION

The RPF and RPF process descriptions provided in Section 4b.1 of the FSAR are not affected by phased startup operations, except:

- The IXP system described in Subsection 4b.1.3.3 of the FSAR is not available during Phase 1 through Phase 3.
    - Target solution is not directed to the IXP hot cell, as described in Subsection 4b.1.3.2.3.1 of the FSAR, during Phase 1 through Phase 3.
    - Target solution is not processed or adjusted in the IXP system, as described in Subsection 4b.1.3.4.3 of the FSAR, during Phase 1 through Phase 3.
    - The process vessel vent system (PVVS) does not interface with the IXP system, as described in Subsection 4b.1.3.6.2 of the FSAR, during Phase 1 through Phase 3.
    - The radioactive liquid waste storage system (RLWS) does not collect liquid wastes from the IXP system, as described in Subsection 4b.1.3.7.2 of the FSAR, during Phase 1 through Phase 3.
    - The molybdenum isotope product packaging system (MIPS) does not receive product from the IXP system, as described in Subsection 4b.1.3.10.2 of the FSAR, during Phase 1 through Phase 3.
- The RLWI selective removal process described in Subsection 4b.1.3.8.2 of the FSAR is not available during Phase 1 and Phase 2 (see Subsection 9b.7.3 for description of RLWI operations during phased startup operations).
- Solidified waste drums are not transported to the MATB as described in Subsection 4b.1.3.8.2 of the FSAR during Phase 1 and Phase 2 (see Subsection 9b.7.5 for description of solidified waste storage during phased startup operations).

The production facility biological shield (PFBS) hot cells (supercell), including the IXP hot cell, is installed prior to Phase 1, however the IXP system is not installed in the IXP hot cell until Phase 4. The supercell confinement boundary is isolated from the IXP hot cell and the IXP hot cell drain to radioactive drain system (RDS) is plugged during Phase 1 through Phase 3.

Process flow of target solution through the IXP system does not occur during Phase 1 through Phase 3 (the IXP system is not required to perform any safety or process functions). During Phase 1 through Phase 3, there is no pathway for radioactive materials to be introduced into the IXP hot cell because interfacing process and supporting system connections to the IXP system are isolated as described in Section 4b.3.

4b.2 RADIOISOTOPE PRODUCTION FACILITY BIOLOGICAL SHIELD

The PFBS description provided in Section 4b.2 of the FSAR is not affected by phased startup operations; the PFBS is installed prior to Phase 1 operations. The IXP system is not installed within the IXP hot cell, and the IXP hot cell is isolated from the supercell confinement boundary during Phase 1 through Phase 3. The IXP hot cell does not provide a confinement function during Phase 1 through Phase 3. During Phase 1 through Phase 3, the other hot cells are isolated from the IXP hot cell. MIPS does not receive or process product bottles, secondary containers, or shipping casks from IXP during Phase 1 through Phase 3. The IXP hot cell transfer doors to the adjacent hot cell are locked closed during Phase 1 through Phase 3. The IXP hot cell drain to RDS is plugged during Phase 1 through Phase 3. The IXP hot cell is isolated from radiological ventilation systems during Phase 1 through Phase 3 as described in Section 9a2.1. During Phase 1 through Phase 3, there is no pathway for radioactive materials to be introduced into the IXP hot cell.

The solid waste drum storage bore holes description in Section 4b.2 of the FSAR is not affected by phased startup operations. Solidified waste generated within RLWI during Phases 1 and Phase 2 is stored in the solid waste drum storage bore holes in the RPF as described in Subsection 9b.7.5. The solid waste drum storage bore holes shielding materials and shield thicknesses support as low as reasonably achievable (ALARA) goals and compliance with 10 CFR 20 dose limits as described in Section 11.2.

4b.3 RADIOISOTOPE EXTRACTION SYSTEM

The radioisotope extraction process descriptions provided in Section 4b.3 of the FSAR are not affected by phased startup operations, except that the IXP system does not extract iodine and xenon during Phase 1 through Phase 3. Target solution is not directed to the IXP system, as described in Subsection 4b.3.1.4.1 of the FSAR, during Phase 1 through Phase 3. The IXP system process equipment described in Subsection 4b.3.1.4.4 is not available during Phase 1 through Phase 3. The chemical inventories of the IXP system, as described in Subsection 4b.3.2 of the FSAR, are not applicable during Phase 1 through Phase 3. The interfacing process and supporting system connections to the IXP system are isolated during Phase 1 through Phase 3 as follows:

- The process line from molybdenum extraction and purification system (MEPS) is isolated with manual valves and a blind flange or cap.
- The process line to the target solution staging system (TSSS) is isolated with a manual valve and blind flange or cap.
- The vacuum transfer system (VTS) line is isolated with a manual valve and a blind flange or cap.
- Each waste line to RLWS is isolated with a manual valve and a blind flange or cap.
- Each facility nitrogen handling system (FNHS) supply line is isolated with a manual valve and a blind flange or cap.
- Each PVVS vent line is isolated with a manual valve and a blind flange or cap.
- Each facility chemical reagent system (FCRS) supply line is isolated with a manual valve and a blind flange or cap.
- The zone 2 supply air to the IXP elute hold tank (also the nitrogen purge system [N2PS] supply) is isolated with a manual valve and blind flange or cap.
- The radiological ventilation zone 1 (RVZ1) cryotrap exhaust line is isolated with a manual valve and blind flange or cap.

- The MIPS does receive product from IXP during Phase 1 through Phase 3.
- The solid radioactive waste packaging (SRWP) system does not receive waste from IXP during Phase 1 through Phase 3.

4b.4 SPECIAL NUCLEAR MATERIAL PROCESSING AND STORAGE

The special nuclear material processing and storage description provided in Section 4b.4 of the FSAR is not affected by phased startup operations, except that the IXP system is not available during Phase 1 through Phase 3. The IXP system does not extract iodine and xenon, and reagents are not added to target solution by the IXP system, during Phase 1 through Phase 3. The IXP system does not contain the special nuclear material (SNM) identified in Table 4b.4-2 of the FSAR during Phase 1 through Phase 3. TSSS interfaces with the IXP system are isolated as identified in Section 4b.3.

4b.5 REFERENCES

None.

CHAPTER 5a2 – IRRADIATION FACILITY COOLING SYSTEMS

5a2.1 SUMMARY DESCRIPTION

The summary description of cooling systems provided in Section 5a2.1 of the FSAR is not affected by phased startup operations. Each irradiation unit (IU) is supported by an IU specific instance of the primary closed loop cooling system (PCLS) installed to support phase startup operation as described in Section 5a2.2 (i.e., IUs 1 and 2 are operational in Phase 1, IUs 1 through 5 are operational in Phase 2, and IUs 1 through 8 are operational in Phase 3 and Phase 4). The radioisotope process facility cooling system (RPCS) is installed prior to Phase 1 operation, with IU specific interfaces isolated to support phased startup operation as described in Section 5a2.3 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1 operation, interfaces with IUs 6 through 8 are isolated during Phase 2 operation). The process chilled water system (PCHS) is installed prior to Phase 1 operation as described in Section 5a2.4. The primary and secondary cooling systems maintain the capability to provide sufficient heat removal to support phased startup operations. The heat loads described in Chapter 5 of the FSAR remain bounding for phased startup operations.

5a2.2 PRIMARY CLOSED LOOP COOLING SYSTEM

The PCLS description provided in Section 5a2.2 of the FSAR is not affected by phased startup operations. Each IU is supported by an IU specific instance of the PCLS installed to support phase startup operation. Unit specific instances of PCLS are operational for IUs 1 and 2 in Phase 1, unit specific instances of PCLS are operational for IUs 1 through 5 in Phase 2, and unit specific instances of PCLS are operational for IUs 1 through 8 in Phase 3 and Phase 4.

Support system and process line interfaces with PCLS are isolated to support phased startup operation (i.e., interfaces with PCLS supporting IUs 3 through 8 are isolated during Phase 1 operation, interfaces with PCLS supporting IUs 6 through 8 are isolated during Phase 2 operation), as follows:

- The RPCS supply and return interfaces with PCLS are each isolated with a manual valve and a blind flange or cap.
- The facility demineralized water system (FDWS) supply interface with the PCLS is isolated with a manual valve and blind flange or cap.
- The radiological ventilation zone 1 (RVZ1) exhaust from the PCLS expansion tanks is isolated as described in Section 9a2.1.

5a2.3 RADIOISOTOPE PROCESS FACILITY COOLING SYSTEM

The RPCS description provided in Section 5a2.3 of the FSAR is not affected by phased startup operations. RPCS is installed to support Phase 1 operations. The RPCS interfaces with IU specific systems, including IU specific instances of PCLS, neutron driver assembly system (NDAS) cooling cabinets, target solution vessel (TSV) off-gas system (TOGS), and radiological ventilation zone 1 recirculating cooling subsystem (RVZ1r). The RPCS interface points with IU specific systems are isolated to support phased startup operation (i.e., interfaces with unit specific systems supporting IUs 3 through 8 are isolated during Phase 1 operation, interfaces with unit specific systems supporting IUs 6 through 8 are isolated during Phase 2 operation), as follows:

- The RPCS supply and return interfaces with PCLS are each isolated with a manual valve and a blind flange or cap.
- The RPCS supply and return interfaces with NDAS cooling cabinets are each isolated with a manual valve and a blind flange or cap.
- The RPCS supply and return interfaces with TOGS are each isolated with a manual valve and a blind flange or cap.
- The RPCS supply and return interfaces with the RVZ1r IU supplemental cooling are each isolated with a manual valve and a blind flange or cap.

5a2.4 PROCESS CHILLED WATER SYSTEM

The PCHS description provided in Section 5a2.4 of the FSAR is not affected by phased startup operations. PCHS is installed to support Phase 1 operations. Due to the limited number of IUs in operation during Phase 1 and Phase 2, the heat removal capability of PCHS exceeds the heat loads generated.

5a2.5 PRIMARY CLOSED LOOP COOLING SYSTEM CLEANUP SIDE STREAM

The PCLS cleanup side stream description provided in Section 5a2.5 of the FSAR is not affected by phased startup operations. Each IU is supported by an IU specific instance of the PCLS (including a unit specific instance of the PCLS cleanup side stream) installed to support phase startup operation. Phased startup operation of the PCLS is described in Section 5a2.2.

5a2.6 FACILITY DEMINERALIZED WATER SYSTEM

The FDWS description provided in Section 5a2.6 of the FSAR is not affected by phased startup operations. FDWS is installed to support Phase 1 operations. The FDWS interfaces with IU specific instances of PCLS and the light water pool system (LWPS) to provide makeup water. The FDWS interface points with IU specific systems are isolated to support phased startup operation (i.e., interfaces with unit specific systems supporting IUs 3 through 8 are isolated during Phase 1 operation, interfaces with unit specific systems supporting IUs 6 through 8 are isolated during Phase 2 operation); FDWS interfaces with PCLS and LWPS are each isolated with a manual valve and a blind flange or cap.

5a2.7 NITROGEN-16 CONTROL

The nitrogen-16 (N-16) control described in Section 5a2.7 of the FSAR is not affected by phased startup operations. Each IU is supported by a unit specific instance of the PCLS (including N-16 control) installed to support phase startup operation. Phased startup operation of the PCLS is described in Section 5a2.2.

5a2.8 AUXILIARY SYSTEMS USING PRIMARY COOLANT

The description of auxiliary systems using primary coolant in Section 5a2.8 of the FSAR is not affected by phased startup operations.

5a2.9 REFERENCES

None.

CHAPTER 5b – RADIOISOTOPE PRODUCTION FACILITY COOLING SYSTEMS

SHINE cooling systems are integrated throughout the facility, to support Phase 1 through Phase 4 operations of the SHINE facility, as described in Chapter 5a2.

CHAPTER 6a2 – IRRADIATION FACILITY ENGINEERED SAFETY FEATURES

6a2.1 SUMMARY DESCRIPTION

The summary descriptions provided in Section 6a2.1 of the FSAR are not affected by phased startup operations.

6a2.2 DETAILED DESCRIPTIONS

The irradiation facility (IF) design basis accidents (DBAs), the engineered safety features (ESFs) required to mitigate the DBAs, and the location of the bases for these determinations provided in Table 6a2.1-1 of the FSAR are not affected by phased startup operations.

6a2.2.1 CONFINEMENT

The information provided in Subsection 6a2.2.1 of the FSAR is not affected by phased startup operations. The engineered safety features described in Figure 6a2.1-1 of the FSAR are not affected by phased startup operations.

6a2.2.1.1 Primary Confinement Boundary

The information provided in Subsection 6a2.2.1.1 of the FSAR, including Figure 6a2.2-1 of the FSAR, is described on a per irradiation unit (IU) basis and is not affected by phased startup operations.

During Phase 1, the primary confinement boundaries for IUs 1 and 2 are operable. During Phase 2, the primary confinement boundaries for IUs 1 through 5 are operable. The primary confinement boundaries for all 8 IUs are operable during Phases 3 and 4. For the primary confinement boundaries that are not operable in Phases 1 and 2, system isolations are in place to prevent release of radiological or chemical hazards into the uninstalled IU. Refer to Chapter 4a2 for a discussion of isolation points within the IU and Chapter 4b for isolation points in systems located within the below grade confinement.

6a2.2.1.2 Tritium Confinement Boundary

The information provided in Subsection 6a2.2.1.2 of the FSAR is described on a per tritium purification system (TPS) train basis and is not affected by phased startup operations.

For Phase 1 operations, only Train A of the TPS is installed, and supports the operation of IUs 1 and 2. For Phase 2 operations, Trains A and B of the TPS are installed. Train A of the TPS supports the units installed as part of Phase 1 and Train B supports operation of IUs 3 through 5. For Phase 3 and 4 operations, the TPS and IUs are installed in full.

Figure 6a2.2-2 of the FSAR is not impacted by the phased startup operations with the exception of the number of TPS process trains and irradiation units present in each phase. Figure 6a2.2-1 provides an update to Figure 6a2.2-2 of the FSAR to reflect the number of TPS trains and IUs in operation during Phase 1 and Phase 2.

Because of the independence between TPS trains, as described in Subsection 9a2.7.1, no isolations are needed to prevent radiological material from entering TPS trains installed in later phases, prior to each train being functional and available for operation.

6a2.2.2 COMBUSTIBLE GAS MANAGEMENT

The description of combustible gas management provided in Subsection 6a2.2.2 of the FSAR is not affected by phased startup operations. Figure 6a2.2-2 provides an update to Figure 6a2.2-3 of the FSAR to reflect the number of IUs in operation during Phase 1 and Phase 2.

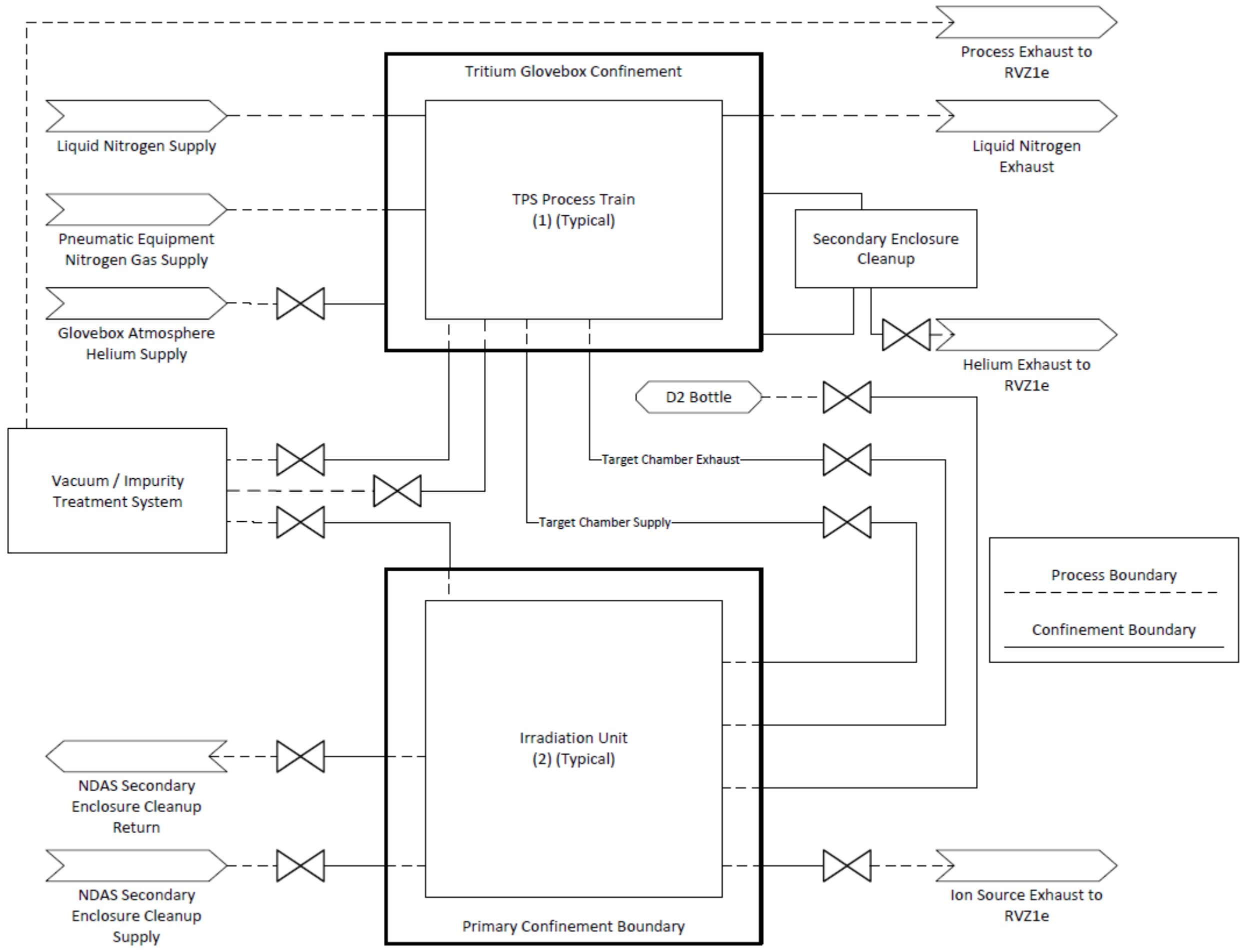
6a2.3 NUCLEAR CRITICALITY SAFETY IN THE IRRADIATION FACILITY

The information provided in Section 6a2.3 of the FSAR is not affected by phased startup operations. The criticality safety controls described in Section 6a2.3 of the FSAR are not affected by phased startup operations.

6a2.4 REFERENCES

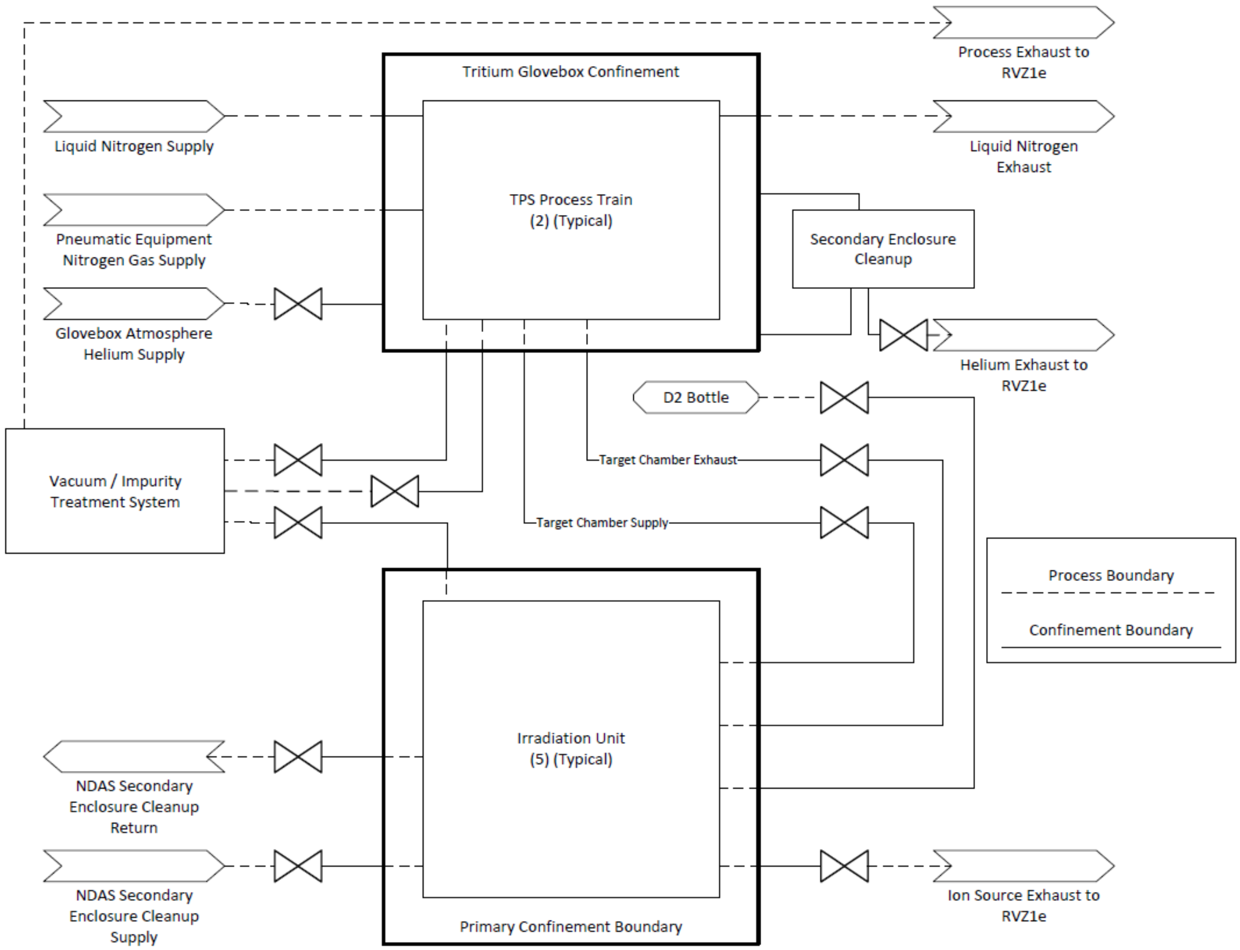
None

Figure 6a2.2-1 – Tritium Confinement Boundary (Sheet 1 of 2)



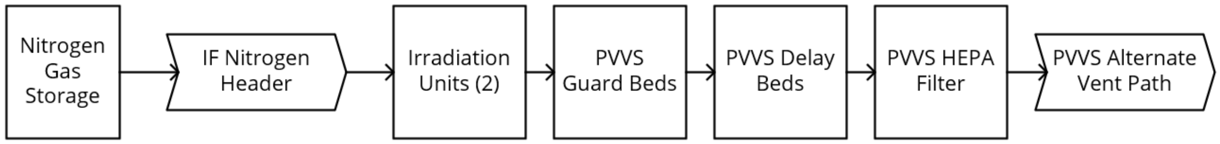
Applicable to Phase 1

Figure 6a2.2-1 – Tritium Confinement Boundary
(Sheet 2 of 2)

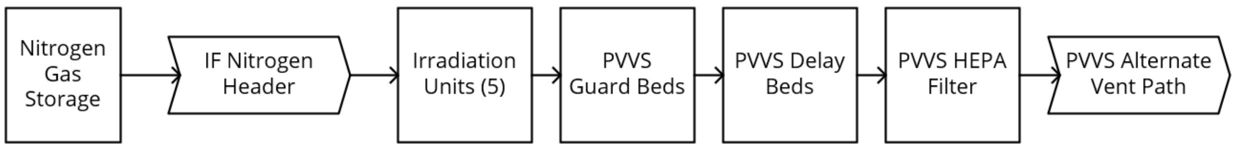


Applicable to Phase 2

Figure 6a2.2-2 – Irradiation Facility Combustible Gas Management Functional Block Diagram



Applicable to Phase 1



Applicable to Phase 2

CHAPTER 6b – RADIOISOTOPE PRODUCTION FACILITY ENGINEERED SAFETY FEATURES

6b.1 SUMMARY DESCRIPTION

The iodine and xenon purification and packaging (IXP) system equipment is not installed as part of Phase 1, 2, or 3 operations. To support installation of this system for Phase 4, the IXP hot cell is not part of the supercell confinement in Phase 1, 2, and 3 operations. Structures, systems, and components (SSCs) are installed to isolate any connections to the IXP from other installed systems. Isolation is maintained between the IXP cell and the other hot cells using the bubble tight dampers shown in Figure 9a2.1-3 of the FSAR. These dampers remain closed until the IXP cell is in operation to maintain the supercell confinement boundary. Figure 6b.2-1 provides a block diagram of the supercell confinement boundary in Phases 1, 2, and 3.

The entirety of the subgrade equipment and confinement, as described in the Chapter 6b FSAR, is installed as part of Phase 1 operations. Isolation capability is provided to segregate the installed subgrade equipment from equipment that is installed as part of subsequent phases. These isolation SSCs remain operational during and following any design basis accident (DBA), including seismic events and loss of off-site power. Thus, the unmitigated and mitigated doses to the public and the worker provided in the FSAR remain bounding (Tables 6b.1-2 and 13b.2-2 of the FSAR).

As described in Section 6b.2, the process vessel vent system (PVVS) isolation and combustible gas management engineered safety features are not affected by phased startup operations.

6b.2 DETAILED DESCRIPTIONS

The radioisotope production facility (RPF) design basis accidents (DBAs), the engineered safety features (ESFs) required to mitigate the DBAs, and the location of the bases for these determinations provided in Table 6b.1-1 of the FSAR are not affected by phased startup operations.

6b.2.1 CONFINEMENT

The information provided in Subsection 6b.2.1 of the FSAR is not affected by phased startup operations. The engineered safety features described in Figure 6b.1-1 of the FSAR are not affected by phased startup operations.

6b.2.1.1 Supercell Confinement

The iodine and xenon purification and packaging (IXP) equipment is not installed a part of Phase 1, 2, or 3 operations. However, the IXP cell, including the confinement box and bubble tight isolation dampers are installed. To allow for the installation of the IXP equipment within the IXP hot cell during the Phase 1, 2, and 3 operations, the IXP hot cell is isolated from the other nine cells of the supercell and is therefore not considered part of the supercell confinement. Isolation of interfacing process and supporting systems to IXP equipment during Phase 1, 2, and 3 operations is described in Section 4b.3. Isolation of ventilation to the IXP hot cell during Phase 1, 2, and 3 operations is described in Section 9a2.1.

Figure 6b.2-1 provides a block diagram of the supercell confinement boundary applicable to Phase 1, 2, and 3 operations.

6b.2.1.2 Below Grade Confinement

The below grade confinement is installed in full, as described in Subsection 6b.2.1.2 of the FSAR, to support initial operations of the SHINE facility.

The below grade confinement functional block diagram, as described in Figure 6b.2-2 of the FSAR, is not affected by phased startup operations.

6b.2.2 PROCESS VESSEL VENT ISOLATION

The process vessel vent isolation SSCs are installed in full, as described in Subsection 6b.2.2 of the FSAR, to support initial operations of the SHINE facility.

6b.2.3 COMBUSTIBLE GAS MANAGEMENT

The combustible gas management system is installed in full, as described in Subsection 6b.2.3 of the FSAR, to support initial operations of the SHINE facility.

The RPF combustible gas management functional block diagram, as described in Figure 6b.2-3 of the FSAR, is not affected by phased startup operations.

6b.2.4 CHEMICAL PROTECTION

The description provided in Subsection 6b.2.4 of the FSAR is not affected by phased startup operations.

6b.3 NUCLEAR CRITICALITY SAFETY IN THE RADIOISOTOPE PRODUCTION FACILITY

6b.3.1 NUCLEAR CRITICALITY SAFETY PROGRAM

The description of the criticality safety program provided in Subsection 6b.3.1 of the FSAR is not affected by phased startup operations

6b.3.2 CRITICALITY SAFETY CONTROLS

The criticality safety controls described in Subsection 6b.3.2 of the FSAR are not affected by phased startup operations.

The iodine and xenon purification and packaging (IXP) system is not installed as part of Phase 1, 2, or 3 operations. The criticality safety controls which support the criticality safety basis of the IXP system described in Subsection 6b.3.2.12 of the FSAR are installed to support Phase 4 operation.

To reflect installation of the IXP system to support Phase 4 operation, Figures 6b.3-1, 6b.3-2, and 6b.3-3 provide system overviews of the radioactive liquid waste storage (RLWS) system, the molybdenum extraction and purification system (MEPS), and the radioactive drain system (RDS), respectively, in Phases 1, 2, and 3. The Phase 1, 2, and 3 system overviews provided in Figures 6b.3-1, 6b.3-2, and 6b.3-3 provide configuration updates to the system overviews provided in Figures 6b.3-2, 6b.3-3, and 6b.3-7 of the FSAR, respectively. The system overviews provided in Figures 6b.3-1, 6b.3-4, 6b.3-5, 6b.3-6, and 6b.3-8 of the FSAR are not affected by phased startup operations.

6b.3.3 CRITICALITY ACCIDENT ALARM SYSTEM

The criticality accident alarm system is installed prior to Phase 1 operation; therefore, the description provided in Subsection 6b.3.3 of the FSAR is not affected by phased startup operations.

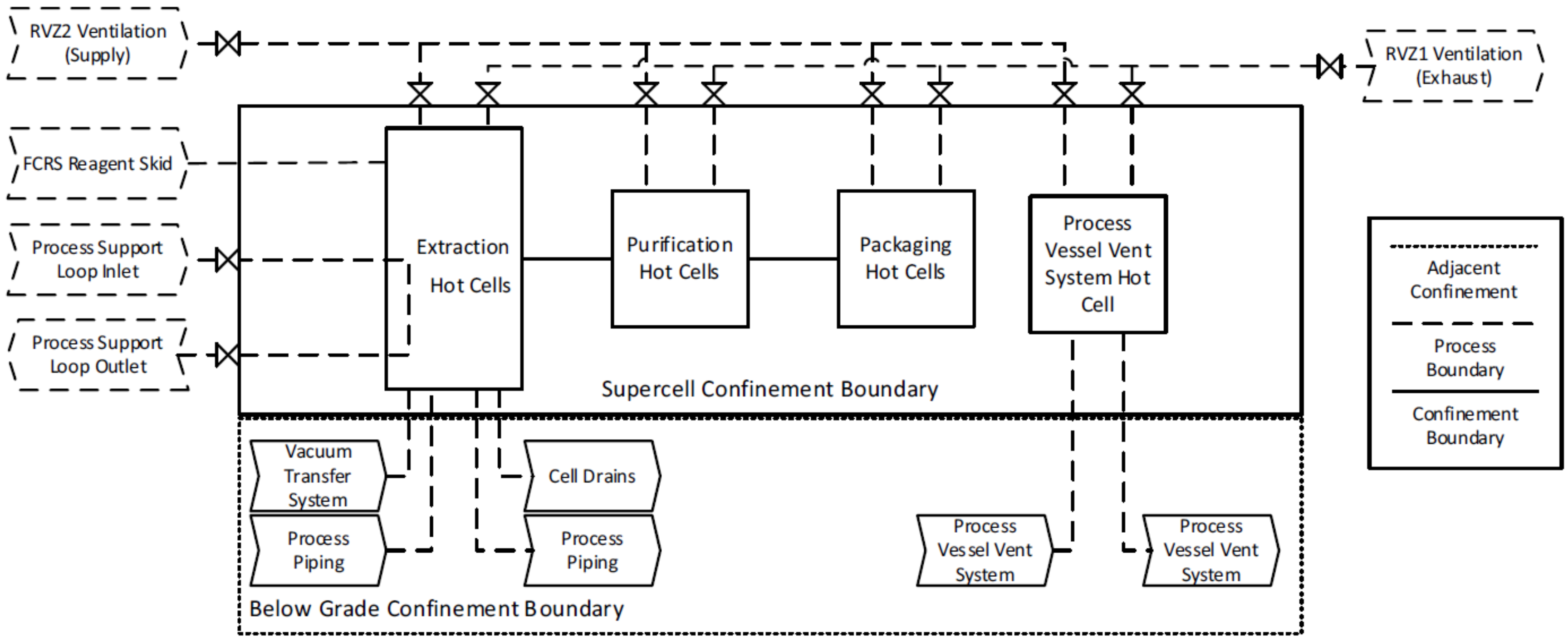
6b.3.4 TECHNICAL SPECIFICATIONS

The description provided in Subsection 6b.3.4 of the FSAR is not affected by phased startup operations.

6b.4 REFERENCES

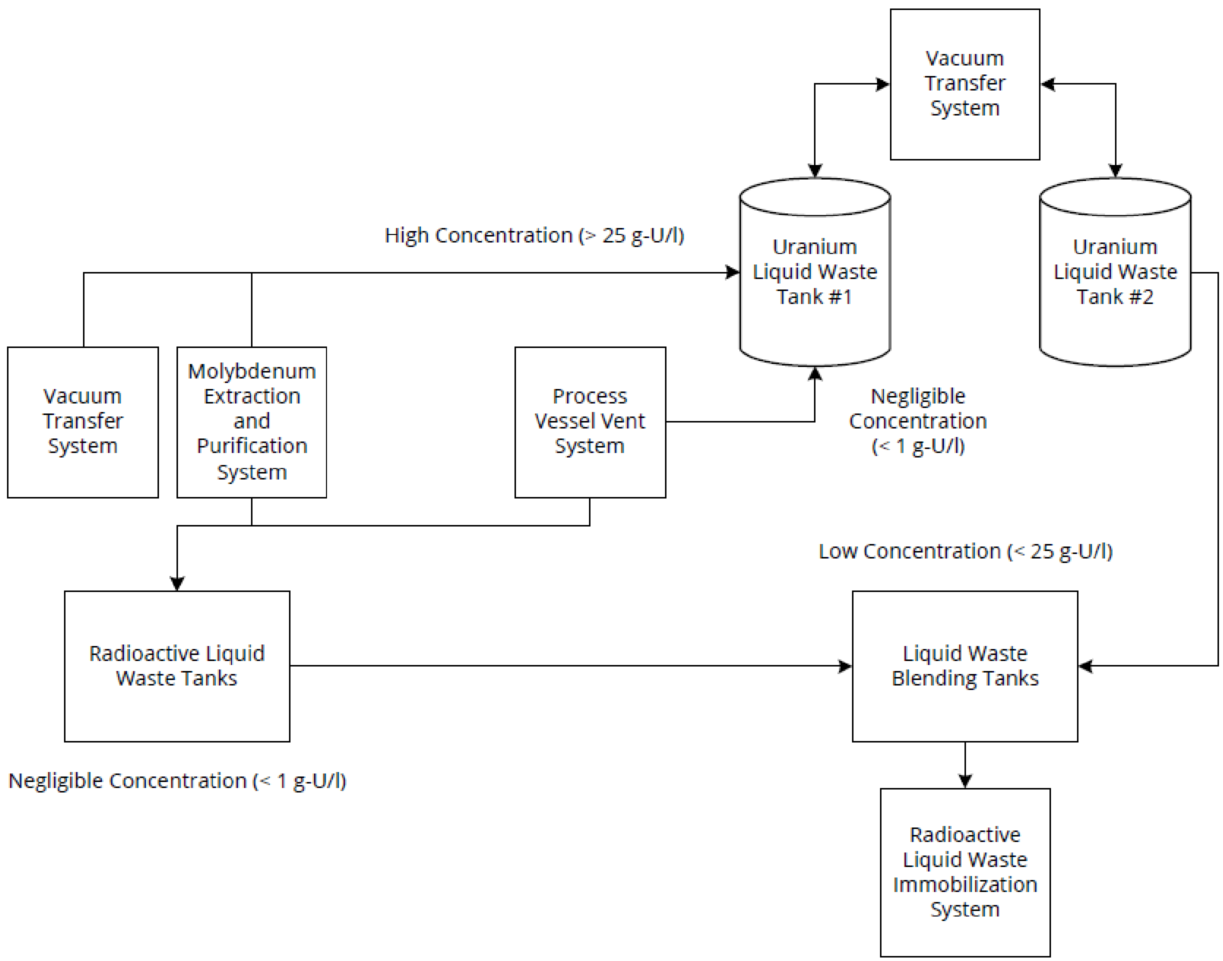
None

Figure 6b.2-1 – Supercell Confinement Boundary



Applicable to Phase 1, 2, and 3

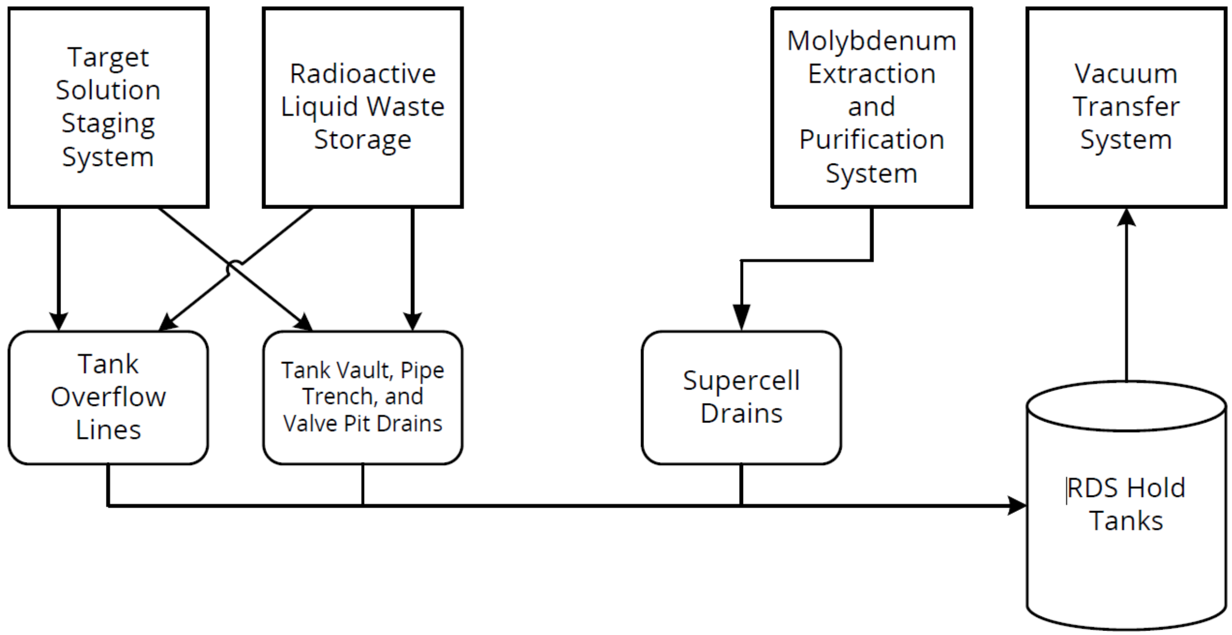
Figure 6b.3-1 – Radioactive Liquid Waste System Overview



Applicable to Phases 1, 2, and 3

Figure 6b.3-2 – Molybdenum Extraction and Purification System Overview

Figure 6b.3-3 – Radioactive Drain System Overview



Applicable to Phases 1, 2, and 3

CHAPTER 7 – INSTRUMENTATION AND CONTROL SYSTEMS

7.1 SUMMARY DESCRIPTION

The summary description of instrumentation and control (I&C) systems provide in Section 7.1 of the FSAR is not affected by phased startup operations.

During phased startup operations, the I&C systems are installed to the extent practicable given the extent of equipment installation. Instrumentation and controls required for the safe operation of the process equipment in each phase are fully tested and operable. Sufficient isolation exists between operable and non-operable portions of the systems to ensure non-operable portions do not impact the safe operation of the active systems during installation or testing activities, for each phase of startup operations. The manner of isolation is described in Sections 7.3 through 7.8 of this supplement.

For systems associated with individual irradiation units (IUs), including the target solution vessel (TSV) reactivity protection system (TRPS), neutron flux detection system (NFDS), and the radiological ventilation zone 1 exhaust subsystem (RVZ1e) IU cell radiation monitors, the systems will be brought online with the associated IU in the applicable phases. Chapter 1 provides a description of the IU phasing.

Descriptions of how phased startup operations affects each I&C system are provided in Sections 7.3 through 7.8 of this supplement.

Figure 7.1-1 of the FSAR is not affected by phased startup operations with the exception of the number of IU instances (i.e., x8) pictured in the blocks labeled Irradiation Unit 1 Div A, Irradiation Unit 1 Div B, and Irradiation Unit 1 Div C. The number of installed instances in each phase will be consistent with the IU phasing described in Chapter 1.

Figures 7.1-2 and 7.1-3 of the FSAR are not affected by phased startup operations.

7.2 DESIGN OF INSTRUMENTATION AND CONTROL SYSTEMS

The design information provided in Section 7.2 of the FSAR is not affected by phased startup operations. The design criteria and design bases are applied to operable portions of systems as described in Subsections 7.2.2 and 7.2.3 of the FSAR, respectively. Non-operable portions are isolated such that the design criteria of the operable portions remain satisfied. The manner of isolation is described in Sections 7.3 through 7.8 of this supplement.

7.3 PROCESS INTEGRATED CONTROL SYSTEM

7.3.1 SYSTEM DESCRIPTION

Process integrated control system (PICS) hardware (i.e., cabinets, power supplies, controllers, programmable logic controllers [PLCs]) is installed prior to Phase 1 operations, with the exception of hardware associated with tritium purification system (TPS) trains B and C. PICS monitoring and controls associated with equipment that is not yet installed or not yet operable to support Phase 1 operations are tested and placed in operation as required for a given phase.

PICS monitoring includes inputs to PICS from field instruments associated with the process parameters such as temperatures and flow. PICS controls include outputs to field equipment to perform process functions such as starting and stopping pumps and opening or closing valves. Cabling, conduit, and raceways for these monitoring and control functions will be installed prior to Phase 1 operations.

Vendor-provided nonsafety-related control systems provided for the SHINE facility are installed to support phased startup operations, as follows:

- The building automation system is installed and made operational prior to Phase 1 operations.
- The supercell control system is installed and made operational prior to Phase 1 operations.
- The radioactive liquid waste immobilization (RLWI) control system, except portions associated with selective removal, is installed and made operational prior to Phase 1 operations. The portions of the RLWI control system associated with selective removal are installed to support Phase 3 operations.
- The neutron driver assembly system (NDAS) control system control stations are installed and made operational prior to Phase 1 operations. NDAS units are connected to the NDAS control system as they are installed to support operation of a given phase.
- Integral controllers associated with the standby generator system (SGS), facility demineralized water system (FDWS) reverse osmosis (RO) unit, facility nitrogen handling system (FNHS) unit, facility heating water system (FHWS) boilers, and facility chilled water system (FCHS) and processed chilled water system (PCHS) chillers are installed and made operational prior to Phase 1 operations.

Physical barriers, as described in Chapters 4, 5, and 9, are provided to prevent interactions between operational systems and systems that are not yet installed or not yet operable. Information display for equipment that has not been field terminated is described in Section 7.6.

7.3.1.1 Irradiation Unit Systems

The operational mode definitions provided in Subsection 7.3.1.1 of the FSAR are not affected by phased startup operations. The description of the monitoring and alarms, control functions, and interlocks and permissives associated with the subcritical assembly system (SCAS), TSV off-gas system (TOGS), primary closed loop cooling system (PCLS), light water pool system (LWPS), NDAS, and NFDS provided in Subsection 7.3.1.1 of the FSAR is not affected by phased startup operations. PICS will function as described as this equipment is made operable to support an individual IU in a given phase.

7.3.1.2 Supercell Systems

The description of the monitoring and alarms, control functions, and interlocks permissives associated with the molybdenum extraction and purification system (MEPS), molybdenum isotope product packaging system (MIPS), process vessel vent system (PVVS), vacuum transfer system (VTS), and target solution staging system (TSSS) provided in Subsection 7.3.1.2 of the FSAR is not affected by phased startup operation.

The monitoring and alarms, control functions, and interlocks and permissives associated with the iodine and xenon purification and packaging (IXP) system, as described in

Subsection 7.3.1.2 of the FSAR, are made available when the system is made operational to support Phase 4 operations.

7.3.1.3 Ancillary Process Systems

The description of the monitoring and alarms, control functions, and interlocks and permissives associated with the uranium receipt and storage system (URSS), the target solution preparation system (TSPS), radioactive drain system (RDS), radioactive liquid waste storage (RLWS) system, and the RLWI system provided in Subsection 7.3.1.3 of the FSAR is not impacted by phased startup operation.

The description of the monitoring and alarms, control functions, and interlocks and permissives associated with the TPS provided in Subsection 7.3.1.3 of the FSAR is applicable to each TPS train that is in service. TPS Train A serves IUs 1 and 2, and the PICS hardware, monitoring, and controls for TPS train A is installed and commissioned to support Phase 1 operations. Train B serves IUs 3, 4, and 5 and the PICS hardware, monitoring, and controls for TPS train B is installed and commissioned to support Phase 2 operations. Train C serves IUs 6, 7, and 8 and the PICS hardware, monitoring, and controls for TPS train C is installed and commissioned to support Phase 3 operations.

The description of the monitoring and alarms, control functions, and interlocks and permissives associated with stack release monitoring system (SRMS), radiation area monitoring system (RAMS), continuous air monitoring system (CAMS), and the quality control and analytical testing laboratory provided in Subsection 7.3.1.3 of the FSAR is not affected by phased startup operations.

The description of the monitoring and alarms, control functions, and interlocks and permissives associated with the interrelation between the PICS and the TRPS and the engineered safety features actuation system (ESFAS) described in Subsection 7.3.1.3 of the FSAR remains accurate for phased startup operations. A description of the impact of the phased startup operations on the TRPS and ESFAS is provided in Sections 7.4 and 7.5.

7.3.1.4 Other Facility Systems

The description of the monitoring and alarms, control functions, and interlocks and permissives associated with the normal electrical power supply system (NPSS), uninterruptible electrical power supply system (UPSS), SGS, facility ventilation system (FVZ4), FCHS, FHWS, PCHS, FDWS, and seismic monitoring system as provided in Subsection 7.3.1.4.are not affected by phased startup operations. PICS equipment associated with the nitrogen purge system (N2PS), radiological ventilation (RV) systems, radioisotope process facility cooling water system (RPCS), FNHS, and facility chemical reagent system (FCRS) will be connected and tested as equipment is made operational to support operation of a given phase. The description of the monitoring and alarms, control functions, and interlocks and permissives associated with these systems remains accurate for equipment that is installed.

7.3.2 DESIGN CRITERIA

The descriptions of the SHINE facility design criteria applicable to PICS and PICS system design criteria, including the descriptions of how these design criteria are met, provided in Subsections 7.3.2.1 and 7.3.2.2 of the FSAR, are not affected by phased startup operations.

7.3.3 DESIGN BASIS

The descriptions of the design basis functions, modes of operation, operating conditions, software development, access control and cyber security, and loss of power provided in Subsections 7.3.3.1 through 7.3.3.6 of the FSAR are not affected by phased startup operations. Software development and testing will be completed during each phase of startup operations.

7.3.4 OPERATION AND PERFORMANCE

The description of system operation provided in Subsection 7.3.4.1 of the FSAR is not affected by phased startup operations.

The description of testing and maintenance provided in Subsection 7.3.4.2 of the FSAR remains accurate for phased startup operations. During phased startup operations, each input to PICS will be validated from the field to the cabinet as the field devices are installed and cabinet side leads terminated. Site acceptance testing is completed for the full set of equipment applicable to each phase prior to releasing the phase to operations for commissioning.

The description of technical specifications and surveillance provided in Subsection 7.3.4.3 of the FSAR is not affected by phased startup operations.

7.3.5 CONCLUSION

The conclusions provided in Subsection 7.3.5 of the FSAR is not affected by phased startup operations.

7.4 TARGET SOLUTION VESSEL REACTIVITY PROTECTION SYSTEM

7.4.1 SYSTEM DESCRIPTION

The TRPS description provided in Section 7.4.1 of the FSAR is not affected by phased startup operations. Each IU is supported by a unit specific instance of the TRPS. The TRPS logic diagrams provided in Figure 7.4-1 of the FSAR are not affected by phased startup operations.

The nine TRPS cabinets are installed in the facility control room (FCR) prior to Phase 1 operations but are brought into operation with the corresponding IU phasing as described in Chapter 1. The first three cabinets, which correspond to Divisions A, B, and C for TRPS instances associated with IUs 1 and 2, are made operational prior to Phase 1. The second three cabinets, corresponding to Divisions A, B, and C for TRPS instances associated with IUs 3, 4, and 5, are made operational prior to Phase 2. The third three cabinets, corresponding to Divisions A, B, and C for TRPS instances corresponding to IUs 6, 7, and 8, are made operational prior to Phase 3.

7.4.2 DESIGN CRITERIA

The description of the SHINE facility design criteria and TRPS system design criteria provided in Subsection 7.4.2 of the FSAR is not affected by phased startup operations. As described in Section 7.4.1, TRPS cabinets associated with each different phase of operation operate according to their appropriate phase. SHINE facility design criteria and TRPS system design criteria are satisfied for TRPS cabinets that are in operation for a particular phase. Section 7.4.5 describes an application-specific modification to the generic highly integrated protection system (HIPS) platform described in Subsection 7.4.5.1 of the FSAR. This modification, which provides for the disabling of inputs, will not be used during the phased implementation of the TRPS. Hence, the description of the SHINE facility design criteria and TRPS system design criteria provided in Subsection 7.4.2 of the FSAR is not affected.

7.4.3 DESIGN BASIS

The description of the safety functions provided in Subsection 7.4.3.1 of the FSAR is not affected by phased startup operations. The safety functions operate as described for each individual instance of TRPS as it is brought online.

The descriptions of mode transition, completion of protective actions, single failure, operating conditions, and seismic, tornado, flood provided in Subsections 7.4.3.2 through 7.4.3.6 of the FSAR are not affected by phased startup operations. The descriptions are accurate for each individual instance of TRPS as it is brought online.

The description of human factors provided in Subsection 7.4.3.7 of the FSAR is not affected by phased startup operations, with the exception of the implementation of the manual TPS Isolation push button. Manual TPS Isolation from both the facility master operating permissive and the manual push button are only tied to instances of TRPS for the installed TPS trains during each phase of operation. Phased installation of TPS trains is described in Section 9a2.7. In this way, the same actuation push button is provided to the operator to initiate the manual TPS isolation, and only equipment applicable to the particular phase is actuated when the button is depressed. Section 7.5 provides additional information on disabled outputs from the ESFAS to instances of TRPS that are not yet operable.

The descriptions of loss of external power, fire protection, classification and identification, setpoints, prioritization of functions, and design codes and standards provided in Subsections 7.4.3.8 through 7.4.3.13 of the FSAR are not affected by phased startup operations.

7.4.4 OPERATION AND PERFORMANCE

The description of operation and performance provided in Subsection 7.4.4 of the FSAR is not affected by phased startup operations. The information provided in Table 7.4-1 of the FSAR on monitored variables in TRPS is not affected by phased startup operations.

7.4.5 HIGHLY INTEGRATED PROTECTION SYSTEM DESIGN

To accommodate phased startup operations, SHINE has performed an application-specific modification to the generic HIPS platform described in Subsection 7.4.5.1 of the FSAR. This modification provides the ability to disable an individual input that is not required for a given phase of facility operation. The disabling of individual inputs is necessary in Phases 1, 2, and 3 because ESFAS equipment that is not yet operable will not send signals to the system and thus would prevent facility operation. The disabled inputs are restored to an operable status prior to entering the technical specification mode of applicability for the given input. The ability to disable inputs is only used in conjunction with the ESFAS during phased startup operations. Although the capability to disable inputs exists for the TRPS in the same manner as the ESFAS, it is not used. Each instance of the TRPS is operable, to include all individual inputs, prior to commencing operation in a given phase.

Individual inputs to the ESFAS are disabled using the maintenance workstation (MWS). Physically, this process occurs in a similar manner to modifying a setpoint with the MWS. The technician performing the modification accesses the MWS with a password, selects the ESFAS, the division, the specific safety function module (SFM), and the individual input to be disabled. The technician then activates a hardwired switch near the MWS to allow for physical connection of the MWS to the calibration and test bus (CTB). The technician then toggles the input disable switch on the MWS that indicates the individual input is disabled. The technician asserts the disable function to complete disabling of the individual input. The disable status associated with the disabled input is stored in a location on the SFM's non-volatile memory (NVM). The NVM location is loaded to the triplicated logic designs on the field programmable gate array (FPGA) during startup or a manual NVM data load command from the module's front panel switch. The SFM's safety function logic is independent (i.e., different logic resources on the FPGA) from both the logic used to store information to the NVM and the logic used to load information from the NVM to the safety function logic.

Individual inputs for each safety actuation not required to be operable in a given phase are disabled across all divisions. The disabling of these inputs causes the ESFAS to not process them as an actuation request, and hence, does not initiate unnecessary protection actions based upon them. The MWS continues to function as described in Subsection 7.4.5.3.3 of the FSAR. Information for inputs that are disabled will be transmitted to the PICS and displayed to the operator as described in Section 7.6.3.

The modification to the generic HIPS platform to disable individual inputs does not impact how the TRPS and ESFAS satisfy application specific action items (ASAIs) 24 and 54 described in the HIPS topical report Safety Evaluation Report (SER) (USNRC, 2017) or how the TRPS and ESFAS comply with IEEE Standard 7-4.3.2-2003 (IEEE, 2003), as described in Subsection 7.4.5.1 of the FSAR.

The HIPS design attributes provided in Subsection 7.4.5.2 of the FSAR are not affected by phased startup operations. Since the TRPS is being implemented in instances associated with individual IUs, the HIPS design is being implemented in full for each instance. The disabling of individual inputs to the ESFAS do not impact the independence, redundancy, and diversity of the ESFAS in a given phase. No new failure modes are introduced by disabling individual inputs, so the failure modes and effects analysis (FMEA), diversity and defense-in-depth assessment, and single failure analysis are not affected. The descriptions of independence, redundancy, predictability and repeatability, diversity, and simplicity provided in Subsection 7.4.5.2 of the FSAR are not affected by phased startup operations. The HIPS platform timing shown in Figure 7.4-2 of the FSAR is not affected by phased startup operations.

The access control and cyber security considerations provided in Subsection 7.4.5.3 of the FSAR are not affected by phased startup operations.

The software requirements development considerations provided in Subsection 7.4.5.4 of the FSAR are not affected by phased startup operations. For cabinets not in operation, implementation and verification of the appropriate software version occurs during the testing activities prior to operation. The same development scheme, development oversight, testing, planning, review, and approval occurs for each cabinet as described in Subsection 7.4.5.4 of the FSAR. The TRPS and ESFAS programmable logic lifecycle process shown in Figure 7.4-3 of the FSAR is not affected by phased startup operations.

Configuration management, as described in Subsection 7.4.5.4.6 of the FSAR, is implemented on a per-cabinet basis. This is to ensure that proper version control is adequately implemented across the cabinets in each phase of operation. During startup testing for each phase, configuration management is conducted for each individual cabinet tied to the phase of operation.

Independent testing, as described in Subsection 7.4.5.4.7 of the FSAR, is not affected by phased startup operations. The functionality of disabling inputs is tested as part of the Pre-Factory Acceptance Test (FAT) and FAT as described in this subsection of the FSAR.

Inputs for ESFAS and TRPS are tested as a part of the Site Acceptance Test (SAT) prior to Phase 1 of operations. Inputs for Phases 2, 3, and 4 are energized in order to simulate each SFM's ability to trigger on pre-determined setpoints and send the appropriate output signals for voting. This will be used to test the ability of each ESFAS/TRPS cabinet to send the appropriate output signals needed for actuations. Upon successful completion of the SAT, TRPS cabinets associated with Phases 2, 3, and 4 are removed from operation, and the ESFAS inputs associated with Phases 2, 3, and 4 are disabled.

Prior to testing newly installed inputs to ESFAS, the MWS is used to configure the newly installed inputs such that it does not affect equipment in operation. The input is then enabled, verified, and the setpoint is adjusted to the design value prior to process equipment operation.

The HIPS performance analysis provided in Subsection 7.4.5.5 of the FSAR is not affected by phased startup operations. The disabling of individual inputs in the ESFAS does not affect the self-testing features of the HIPS platform.

7.4.6 CONCLUSION

The conclusions provided in Subsection 7.4.6 of the FSAR is not affected by phased startup operations.

7.5 ENGINEERED SAFETY FEATURES ACTUATION SYSTEM

7.5.1 SYSTEM DESCRIPTION

The ESFAS description provided in Subsection 7.5.1 of the FSAR remains accurate during phased startup operations relative to the capabilities of the ESFAS. The ESFAS logic diagrams provided in Figure 7.5-1 of the FSAR are not affected by phased startup operations. During phased startup operations, inputs to the ESFAS for equipment that is not required to be operable are disabled using the MWS as described in Subsection 7.4.5. These inputs are restored and verified to be operable prior to entering the technical specification mode of applicability associated with the given input.

ESFAS cabinets are installed prior to Phase 1 operation. Table 7.5-1 provides a list of monitored variable inputs that are disabled during specific phases of the phased startup operations. Table 7.5-2 provides a list of safety functions that are not utilized during specific phases of the phased startup operations. These inputs and functions do not affect the safety or operability of the systems during the phases they are disabled or not utilized, because the associated equipment is not operable and does not contain hazardous material.

7.5.2 DESIGN CRITERIA

The description of the SHINE facility design criteria and ESFAS system design criteria provided in Subsection 7.5.2 of the FSAR are not affected by phased startup operations. ESFAS functions are operable as required for equipment that is in operation for a given phase and meet the design criteria. ESFAS inputs that are disabled as described in Section 7.5.1 do not impact the ability of the system to meet the design criteria.

Since disabled inputs are not processed as an actuation request as described in Section 7.4.5, they do not function in a manner analogous to the maintenance bypass feature described in Section 7.5 of the FSAR. The maintenance bypass feature is utilized in conjunction with taking an SFM out of service, where the feature to disable inputs will be part of the normal operation of the ESFAS during the phased approach. The ESFAS will continue to satisfy SHINE facility design criteria and ESFAS system design criteria as provided in Subsection 7.5.2 of the FSAR, since the disabled inputs do not impact the trip determination logic or the ability to perform maintenance on the system. Disabled inputs will be restored and verified to be operable prior to entering the specified conditions in the applicability of the technical specifications.

7.5.3 DESIGN BASIS

The descriptions of the safety functions associated with Supercell Area 1 (PVVS Area) Isolation, Supercell Area 2 (Extraction Area A) Isolation, Supercell Area 3 (Purification Area A) Isolation, Supercell Area 4 (Packaging Area 1) Isolation, Supercell Area 5 (Purification Area B) Isolation, Supercell Area 6 (Extraction Area B) Isolation, Supercell Area 7 (Extraction Area C) Isolation, Supercell Area 8 (Purification Area C) Isolation, Supercell Area 9 (Packaging Area 2) Isolation, MEPS A Heating Loop Isolation, MEPS B Heating Isolation, MEPS C Heating Loop Isolation, Carbon Delay Bed Group 1 Isolation, Carbon Delay Bed Group 2 Isolation, Carbon Delay Bed Group 3 Isolation, TPS Train A Isolation, RPF Nitrogen Purge, Extraction Column A Alignment Actuation, Extraction Column B Alignment Actuation, Extraction Column C Alignment Actuation, and Dissolution Tank Isolation provided in Subsection 7.5.3.1 of the FSAR are not affected by phased startup operations.

The safety functions associated with Supercell Area 10 (IXP Area) Isolation, VTS Safety Actuation, TPS Train B Isolation, TPS Train C Isolation, TPS Process Vent Actuation, IU Cell Nitrogen Purge, RCA Isolation, and IXP Alignment Actuation, as described in Subsection 7.5.3.1 of the FSAR, have inputs disabled and safety functions not utilized during the phased startup operations, as described in Table 7.5-1 and Table 7.5-2.

The descriptions of the completion of protective actions; single failure; operating conditions; and seismic, tornado, flood provided in Subsections 7.5.3.2 through 7.5.3.5 of the FSAR are not affected by phased startup operations.

The manual push buttons identified in Subsection 7.5.3.6 of the FSAR will only actuate safety functions utilized in a given phase of operation. A list of safety functions not utilized during specific phases of the phased startup operations is provided in Table 7.5-2.

The descriptions of loss of external power, fire protection, classification and identification, setpoints, prioritization of functions, and design codes and standards provided in Subsections 7.5.3.7 through 7.5.3.12 of the FSAR are not affected by phased startup operations. The information in Table 7.5-2 of the FSAR for fail safe component positions on ESFAS loss of power is not affected by phased startup operations.

7.5.4 OPERATION AND PERFORMANCE

The descriptions of high radiological ventilation zone 1 (RVZ1)/ radiological ventilation zone 2 (RVZ2) RCA Exhaust Radiation, High RVZ1 Supercell Exhaust Ventilation Radiation (PVVS Hot Cell), High RVZ1 Supercell Exhaust Ventilation Radiation (MEPS Hot Extraction Cells), High RVZ1 Supercell Exhaust Ventilation Radiation (Purification and Packaging Hot Cells), High MEPS Heating Loop Radiation, High PVVS Carbon Delay Bed Exhaust Carbon Monoxide, VTS Vacuum Header Liquid Detection, RDS Liquid Detection, High TPS Exhaust to Facility Stack Tritium, Low PVVS Flow, MEPS Area A/B/C Three-Way Valve Position Indication, TSPS Dissolution Tank 1/2 Level, and UPSS Loss of External Power provided in Subsection 7.5.4.1 of the FSAR are not affected by phased startup operations.

The monitored variables and response associated with High RVZ1 Supercell Exhaust Ventilation Radiation (IXP Hot Cell), High TPS IU Cell 1/2/3/4/5/6/7/8 Target Chamber Exhaust Pressure, High TPS IU Cell 1/2/3/4/5/6/7/8 Target Chamber Supply Pressure, High TPS Confinement Tritium, TRPS IU Cell 1/2/3/4/5/6/7/8 Nitrogen Purge, and IXP Three-Way Valve Position Indication provided in Subsection 7.5.4.1 of the FSAR have inputs disabled as described in Table 7.5-1. The system response for these monitored variables remains as described in Subsection 7.5.4.1 of the FSAR for inputs that are not disabled, to include the actuation of safety functions that are utilized in a given phase of operation. A list of safety functions not utilized during specific phases of the phased startup operations is provided in Table 7.5-2.

The description of operational bypass, permissives, and interlocks provided in Subsection 7.5.4.2 of the FSAR is not affected by phased startup operations.

The facility master operating permissive provided in Subsection 7.5.4.3 of the FSAR will only actuate safety functions utilized in a given phase of operation. A list of safety functions not utilized during specific phases of the phased startup operations is provided in Table 7.5-2.

The description of maintenance bypass, testing capability, and technical specification and surveillance provided in Subsections 7.5.4.4 through 7.5.4.6 of the FSAR are not affected by phased startup operations.

7.5.5 HIGHLY INTEGRATED PROTECTION SYSTEM (HIPS) DESIGN

The phased startup approach in association with the HIPS platform is described in Subsection 7.4.5. This subsection addresses the HIPS design attributes, access control and cyber security, software development requirements, and HIPS performance analysis for phased startup operations.

7.5.6 CONCLUSION

The conclusions described in Subsection 7.5.6 of the FSAR is not affected by phased startup operations.

7.6 CONTROL CONSOLE AND DISPLAY INSTRUMENTS

Control console and display instruments in the FCR described in Section 7.6 of the FSAR will be installed prior to Phase 1 operation.

7.6.1 DESCRIPTION

The descriptions of the main control board, operator workstations, supervisor workstation, maintenance workstations, and other control room interface equipment provided in Subsections 7.6.1.1 through 7.6.1.5 of the FSAR, respectively, are not affected by phased startup operations. Control consoles and displays associated with equipment to be installed in later phases will have the capability to have their displays secured or their signals removed to avoid distracting the operators.

During Phase 1, the following local PICS control stations, as described in Subsection 7.6.1.6 of the FSAR, are functional and available for operation:

- Target solution preparation
- Radioactive liquid waste immobilization
- Supercell A
- Supercell B
- Supercell C
- TPS Train A

During Phase 2, in addition to the above local PICS control stations, the TPS Train B control station is functional and available for operation.

During Phase 3, the eight local PICS control stations described in Subsection 7.6.1.6 of the FSAR are functional and available for operation.

7.6.2 DESIGN CRITERIA

The descriptions of the SHINE facility design criteria and system design criteria, including the descriptions of how the system design criteria are met, provided in Subsections 7.6.2.1 and 7.6.2.2 of the FSAR are not affected by phased startup operations. System design criteria related to human factors and annunciators, as described in Subsections 7.6.2.2.7 and 7.6.2.2.8 of the FSAR, continue to be met by applying human factors engineering principles to alarms and indications that are impacted by systems or components that are not yet installed or not yet operable.

7.6.3 DESIGN BASIS

The description of the design basis provided in Subsection 7.6.3 of the FSAR is not affected by phased startup operations. Indication will be provided to the operator for components that have been disabled and for components that have not been field terminated, so the description of how the PICS satisfies PICS Criterion 17 and the display and control functions provided in Subsection 7.6.3 of the FSAR is not affected.

7.6.4 OPERATION AND PERFORMANCE

The description of operation and performance provided in Subsection 7.6.4 of the FSAR is not affected by phased startup operations.

7.6.5 CONCLUSION

The conclusions provided in Subsection 7.6.5 of the FSAR are not affected by phased startup operations.

7.7 RADIATION MONITORING SYSTEMS

Safety-related process radiation monitors required for Phase 1 are installed prior to Phase 1 operation. Safety-related process radiation monitors not required for Phase 1 operations are installed to support the phased operation of the IUs, TPS trains, and IXP system. Nonsafety-related process radiation monitoring and nonsafety-related radiation monitoring systems are installed prior to Phase 1 operations.

7.7.1 SAFETY-RELATED PROCESS RADIATION MONITORING

The safety-related process radiation monitors are installed to the extent practicable given the extent of equipment installation. Radiation monitors required for the safe operation of the process equipment in each phase are fully tested and operable. Radiation monitors associated with individual IUs and TPS trains are installed during the phase associated with that IU or TPS train. Table 7.7-1 provides a list of the safety-related process radiation monitors and the phase in which they will be installed to support operation.

Safety-related process radiation monitor inputs to the TRPS are impacted by the phased installation of IUs. Safety-related process radiation monitors and their associated TRPS units for uninstalled IUs are not made operational until the associated IU is installed and in operation, as described in Section 7.4. Safety-related process radiation monitor inputs to the ESFAS are impacted by the phased installation of TPS trains and the IXP system. The functions associated with inputs from uninstalled safety-related process radiation monitors will be disabled, as described in Section 7.5.

The descriptions of the design criteria, design bases, and operation and performance provided in Subsections 7.7.1.2 through 7.7.1.4 of the FSAR are not affected by phased startup operations.

7.7.2 NONSAFETY-RELATED PROCESS RADIATION MONITORING

The description of nonsafety-related process radiation monitoring provided in Subsection 7.7.2 of the FSAR is not affected by phased startup operations.

7.7.3 AREA RADIATION MONITORING

The description of area radiation monitoring provided in Subsection 7.7.3 of the FSAR is not affected by phased startup operations. The RAMS is installed in full to support Phase 1 operations.

7.7.4 CONTINUOUS AIR MONITORING

The description of continuous air monitoring provided in Subsection 7.7.4 of the FSAR is not affected by phased startup operations. The CAMS is installed in full to support Phase 1 operations.

7.7.5 EFFLUENT MONITORING

The description of effluent monitoring provided in Subsection 7.7.5 of the FSAR is not affected by phased startup operations. The SRMS is installed in full to support Phase 1 operations.

7.7.6 CONCLUSION

The conclusions provided in Subsection 7.7.6 of the FSAR are not affected by phased startup operations.

7.8 NEUTRON FLUX DETECTION SYSTEM

IU-specific instances of the NFDS, as described in Section 7.8 of the FSAR, are installed to support phased startup operations. The system description, design criteria, design bases, operation and performance, and the conclusions provided in Section 7.8 of the FSAR are not affected by the phased startup operations.

7.9 REFERENCES

IEEE, 2003. IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations, IEEE 7-4.3.2, Institute of Electrical and Electronics Engineers, 2003.

USNRC, 2017. Safety Evaluation by the Office of New Reactors, Licensing Topical Report (TR) 1015-18653-P (Revision 2), “Design of the Highly Integrated Protection System Platform,” NuScale Power, LLC, U.S. Nuclear Regulatory Commission, May 2017.

Table 7.5-1 – Monitored Variable Inputs Disabled During Phases of Startup Operations

Input Variable	Phase(s) Disabled
TPS confinement B tritium	1
TPS IU cell 3 target chamber supply pressure	1
TPS IU cell 3 target chamber exhaust pressure	1
TPS IU cell 4 target chamber supply pressure	1
TPS IU cell 4 target chamber exhaust pressure	1
TPS IU cell 5 target chamber supply pressure	1
TPS IU cell 5 target chamber exhaust pressure	1
TRPS IU cell 3 nitrogen purge	1
TRPS IU cell 4 nitrogen purge	1
TRPS IU cell 5 nitrogen purge	1
High TPS confinement C tritium	1, 2
TPS IU cell 6 target chamber supply pressure	1, 2
TPS IU cell 6 target chamber exhaust pressure	1, 2
TPS IU cell 7 target chamber supply pressure	1, 2
TPS IU cell 7 target chamber exhaust pressure	1, 2
TPS IU cell 8 target chamber supply pressure	1, 2
TPS IU cell 8 target chamber exhaust pressure	1, 2
TRPS IU cell 6 nitrogen purge	1, 2
TRPS IU cell 7 nitrogen purge	1, 2
TRPS IU cell 8 nitrogen purge	1, 2
RVZ1 supercell area 10 (IXP) exhaust ventilation radiation	1, 2, 3
IXP lower three-way valve position indication	1, 2, 3
IXP upper three-way valve position indication	1, 2, 3

Table 7.5-2 – Safety Functions Not Utilized During Phases of Startup Operations (Sheet 1 of 2)

Actuation/Isolation	Safety Function	Phase(s) Not Utilized
Supercell Area 10 (IXP Area) Isolation	All associated safety functions	1, 2, 3
VTS Safety Actuation	Deenergize IXP recovery column wash supply valve	1, 2, 3
	Deenergize IXP recovery column eluent valve	1, 2, 3
	Deenergize IXP [ ][PROP/ECI] wash supply valve	1, 2, 3
	Deenergize IXP [ ][PROP/ECI] eluent valve	1, 2, 3
	Deenergize IXP FNHS supply valve	1, 2, 3
	Deenergize IXP liquid nitrogen supply valve	1, 2, 3
TPS Train B Isolation	All associated safety functions	1
TPS Train C Isolation	All associated safety functions	1, 2
TPS Process Vent Actuation	Deenergize TPS train B vacuum isolation valves	1
	Deenergize TPS train B ITS isolation valves	1
	Deenergize TPS train C vacuum isolation valves	1, 2
	Deenergize TPS train C ITS isolation valves	1, 2
	TRPS IU Cell 3 TPS Actuation	1
	TRPS IU Cell 4 TPS Actuation	1
	TRPS IU Cell 5 TPS Actuation	1
	TRPS IU Cell 6 TPS Actuation	1, 2
	TRPS IU Cell 7 TPS Actuation	1, 2
	TRPS IU Cell 8 TPS Actuation	1, 2

Table 7.5-2 – Safety Functions Not Utilized During Phases of Startup Operations (Sheet 2 of 2)

Actuation/Isolation	Safety Function	Phase(s) Not Utilized
RCA Isolation	Supercell Area 10 Isolation	1, 2, 3
	TPS Train B Isolation	1
	TPS Train C Isolation	1, 2
IXP Alignment Actuation	All associated safety functions	1, 2, 3

Table 7.7-1 – Safety-Related Process Radiation Monitor Phasing (Sheet 1 of 3)

Unit	Monitored Location	Function	Installed Phase
1	RVZ1 supercell area 1 (PVVS) exhaust ventilation	Detect elevated radiation levels from process vessel ventilation cell (input to ESFAS)	1
2	RVZ1 supercell area 2 (extraction A) exhaust ventilation	Detect elevated radiation levels from extraction cell A (input to ESFAS)	1
3	RVZ1 supercell area 3 (purification A) exhaust ventilation	Detect elevated radiation levels from purification cell A (input to ESFAS)	1
4	RVZ1 supercell area 4 (packaging 1) exhaust ventilation	Detect elevated radiation levels from packaging cell 1 (input to ESFAS)	1
5	RVZ1 supercell area 5 (purification B) exhaust ventilation	Detect elevated radiation levels from purification cell B (input to ESFAS)	1
6	RVZ1 supercell area 6 (extraction B) exhaust ventilation	Detect elevated radiation levels from extraction cell B (input to ESFAS)	1
7	RVZ1 supercell area 7 (extraction C) exhaust ventilation	Detect elevated radiation levels from extraction cell C (input to ESFAS)	1
8	RVZ1 supercell area 8 (purification C) exhaust ventilation	Detect elevated radiation levels from purification cell C (input to ESFAS)	1
9	RVZ1 supercell area 9 (packaging 2) exhaust ventilation	Detect elevated radiation levels from packaging cell 2 (input to ESFAS)	1
10	RVZ1 supercell area 10 (IXP) exhaust ventilation	Detect elevated radiation levels from iodine and xenon purification cell (input to ESFAS)	4
11	RVZ1 RCA exhaust	Detected elevated radiation levels from RVZ1 RCA exhaust (input to ESFAS)	1
12	RVZ2 RCA exhaust	Detected elevated radiation levels from RVZ2 RCA exhaust (input to ESFAS)	1

Table 7.7-1 – Safety-Related Process Radiation Monitor Phasing (Sheet 2 of 3)

Unit	Monitored Location	Function	Installed Phase
13	TPS confinement A atmosphere	Detect elevated tritium concentration in tritium purification system confinement (input to ESFAS)	1
14	TPS confinement B atmosphere	Detect elevated tritium concentration in tritium purification system confinement (input to ESFAS)	2
15	TPS confinement C atmosphere	Detect elevated tritium concentration in tritium purification system confinement (input to ESFAS)	3
16	TPS exhaust to facility stack	Detect elevated tritium concentration in tritium purification system exhaust to RVZ1e (input to ESFAS)	1
17	RVZ1e IU cell 1 primary closed loop cooling system (PCLS) expansion tank exhaust	Detect elevated radiation levels from IU 1 PCLS expansion tank exhaust (input to TRPS)	1
18	RVZ1e IU cell 2 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 2 PCLS expansion tank exhaust (input to TRPS)	1
19	RVZ1e IU cell 3 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 3 PCLS expansion tank exhaust (input to TRPS)	2
20	RVZ1e IU cell 4 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 4 PCLS expansion tank exhaust (input to TRPS)	2
21	RVZ1e IU cell 5 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 5 PCLS expansion tank exhaust (input to TRPS)	2
22	RVZ1e IU cell 6 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 6 PCLS expansion tank exhaust (input to TRPS)	3
23	RVZ1e IU cell 7 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 7 PCLS expansion tank exhaust (input to TRPS)	3

Table 7.7-1 – Safety-Related Process Radiation Monitor Phasing (Sheet 3 of 3)

Unit	Monitored Location	Function	Installed Phase
24	RVZ1e IU cell 8 PCLS expansion tank exhaust	Detect elevated radiation levels from IU 8 PCLS expansion tank exhaust (input to TRPS)	3
25	MEPS area A hot water loop	Detect elevated radiation levels from area A of the hot water loop (input to ESFAS)	1
26	MEPS area B hot water loop	Detect elevated radiation levels from area B of the hot water loop (input to ESFAS)	1
27	MEPS area C hot water loop	Detect elevated radiation levels from area C of the hot water loop (input to ESFAS)	1

CHAPTER 8a2 – IRRADIATION FACILITY ELECTRICAL POWER SYSTEMS

8a2.1 NORMAL ELECTRICAL POWER SUPPLY SYSTEM

The description of the normal electrical power supply system (NPSS) provided in Section 8a2.1 of the FSAR is not affected by phased startup operations. The NPSS is installed in full to support Phase 1 operations. Sufficient isolation exists between operable and not yet installed or not yet operable equipment to ensure that not yet installed or not yet operable equipment loads do not impact the NPSS. Loads on the NPSS that are not yet installed or not yet operable in Phases 1, 2, or 3 have the associated isolation device removed or placed in an out-of-service condition.

The NPSS continues to satisfy codes and standards as described in Subsections 8a2.1.1, 8a2.1.3, 8a2.1.4, and 8a2.1.5 of the FSAR. The raceway and cable routing described in Subsection 8a2.1.5 of the FSAR is installed in full to support Phase 1 operations. Cabling associated with equipment that is not yet installed or not yet operable for a given phase is routed with the power removed at the associated panel or load.

The simplified electrical distribution system diagram provided in Figure 8a2.1-1 of the FSAR is not affected by phased startup operations.

8a2.2 EMERGENCY ELECTRICAL POWER SYSTEMS

The description of the emergency electrical power systems provided in Section 8a2.2 of the FSAR is not affected by phased startup operations. During the phased startup operations, the uninterruptible electrical power supply system (UPSS), the nonsafety-related standby generator system (SGS), and nonsafety-related local power supplies and unit batteries are installed in full to support Phase 1 operations. Sufficient isolation exists between operable and not yet installed or not yet operable equipment to ensure that not yet installed or not yet operable equipment loads do not impact the UPSS. Loads on the UPSS that are not yet installed or not yet operable in Phases 1, 2, or 3 have the associated isolation device removed or placed in an out-of-service condition.

Since the UPSS is fully installed prior to Phase 1 operations, the system and operational description provided in Subsections 8a2.2.1, 8a2.2.2, 8a2.2.3, 8a2.2.7, and 8a2.2.8 of the FSAR is not impacted by isolating loads that are not yet installed or not yet operable. The UPSS continues to satisfy codes and standards as described in Subsections 8a2.2.2 and 8a2.2.3 of the FSAR. The loads listed in Table 8a2.2-1 and 8a2.2-2 of the FSAR reflect full system loading and bound the loading during Phases 1, 2, and 3.

The SGS is installed in full as described in Subsections 8a2.2.4, 8a2.2.5, and 8a2.2.6 of the FSAR prior to Phase 1 operations.

The simplified UPSS diagram provided in Figure 8a2.2-1 of the FSAR is not affected by phased startup operations.

8a2.3 REFERENCES

None

CHAPTER 8b – RADIOISOTOPE PRODUCTION FACILITY ELECTRICAL POWER SYSTEMS

8b.1 NORMAL ELECTRICAL POWER SYSTEMS

The SHINE facility has one common normal electrical power system. The common normal electrical power system is described in Section 8a2.1.

8b.2 EMERGENCY ELECTRICAL POWER SYSTEMS

The SHINE facility has one common emergency electrical power system. The common emergency electrical power system is described in Section 8a2.2.

CHAPTER 9a2 – IRRADIATION FACILITY AUXILIARY SYSTEMS

9a2.1 HEATING, VENTILATION, AND AIR CONDITIONING SYSTEMS

9a2.1.1 RADIOLOGICALLY CONTROLLED AREA VENTILATION SYSTEM

The radiological ventilation (RV) system descriptions provided in Subsection 9a2.1.1 of the FSAR are not affected by phased startup operations except for the following:

- The ventilation system zone designations identified in Figure 9a2.1-1 of the FSAR are not applicable for certain areas of the facility that do not contain operational equipment during phased startup operations (i.e., irradiation unit [IU] cells 3 through 8 and target solution vessel [TSV] off-gas system [TOGS] cells 3 through 8 during Phase 1, IU cells 6 through 8 and TOGS cells 6 through 8 during Phase 2, and the iodine and the xenon purification and packaging [IXP] hot cell during Phase 1 through Phase 3).
- IU specific instances of the radiological ventilation zone 1 recirculation subsystem (RVZ1r) are installed to support phased startup operations (i.e., IU specific instances of RVZ1r are not operational for IUs 3 through 8 during Phase 1 and IU specific instances of RVZ1r are not operational for IUs 6 through 8 during Phase 2).
- IU specific portions of the radiological ventilation zone 1 exhaust subsystem (RVZ1e) within the cooling rooms and IU cells are installed to support phased startup operation (i.e., IU specific portions of RVZ1e are not operational for IUs 3 through 8 during Phase 1 and IU specific portions of RVZ1e are not operational for IUs 6 through 8 during Phase 2).
- RV system interface points with IU systems, tritium purification system (TPS) trains, and the IXP system are isolated to support phased startup operations (i.e., RV interfaces with IUs 3 through 8 are isolated during Phase 1, RV interfaces with IUs 6 through 8 are isolated during Phase 2, RV interfaces with TPS Train B and TPS Train C are isolated during Phase 1, RV interfaces with TPS Train C are isolated during Phase 2, and RV interfaces with the IXP system are isolated during Phase 1 through Phase 3).

The irradiation cell biological shield (ICBS) cover plugs for cooling rooms, TOGS cell, and IU cell are installed to support phased operations as described in Section 4a2.5 (i.e., cover plugs are installed for IU 1 and 2 during Phase 1, cover plugs are installed for IUs 1 through 5 during Phase 2, and cover plugs are installed for IUs 1 through 8 during Phase 3 and Phase 4). During Phase 1, IU cells 1 and 2 and TOGS cells 1 and 2 are ventilated by RVZ1r, while IU cells 3 through 8 and TOGS cells 3 through 8 are open to ventilation zone 2. During Phase 2, IU cells 1 through 5 and TOGS cells 1 through 5 are ventilated by RVZ1r, while IU cells 6 through 8 and TOGS cells 6 through 8 are open to ventilation zone 2. During Phase 3 and 4, IU cells 1 through 8 and TOGS cells 1 through 8 are ventilated by RVZ1r consistent with the zone designations in Figure 9a2.1-1 of the FSAR. During Phase 1 through Phase 4, the cooling rooms are designated as ventilation zone 2 consistent with the zone designations in Figure 9a2.1-1 of the FSAR.

During Phase 1 through Phase 3, the IXP system is not operational and the IXP hot cell is isolated from the supercell confinement boundary as described in Section 4b.2. During Phase 1 through Phase 3, the IXP hot cell is open to ventilation zone 2. During Phase 4, the IXP hot cell is designated as ventilation zone 1 consistent with the zone designations in Figure 9a2.1-1 of the FSAR.

IU specific instances of RV systems are installed to support phase startup operation and RV system interface points are isolated as needed to support phase startup operation as described below for each RV system.

Radiological Ventilation Zone 1 (RVZ1)

Each IU is supported by a unit specific instance of RVZ1r installed to support phase startup operation. Unit specific instances of RVZ1r are operational for IUs 1 and 2 in Phase 1, unit specific instances of RVZ1r are operational for IUs 1 through 5 in Phase 2, and unit specific instances of RVZ1r are operational for IUs 1 through 8 in Phase 3 and Phase 4. There are no common components or connections between the unit specific instances of RVZ1r or between RVZ1r and other RV systems.

The RVZ1e system interfaces with IU specific instances of the primary closed loop cooling system (PCLS) within the IU cells (i.e., PCLS expansion tank exhaust). IU specific portions of RVZ1e within the cooling rooms and IU cells are installed to support phased startup operation (i.e., IU specific portions of RVZ1e are operational for IUs 1 and 2 in Phase 1, IU specific portions of RVZ1e are operational for IUs 1 through 5 in Phase 2, and IU specific portions of RVZ1e are operational for IUs 1 through 8 in Phase 3 and Phase 4). The RVZ1e system interface points are isolated outside of the cooling rooms and IU cells to support phased startup operation (i.e., RVZ1e interfaces supporting IUs 3 through 8 are isolated during Phase 1 operation, RVZ1e interfaces supporting IUs 6 through 8 are isolated during Phase 2 operation) via a manual isolation valve and a blind flange or cap.

The RVZ1 interfaces with train specific instances of the TPS (i.e., TPS process exhaust). The RVZ1 system interface points with train specific instances of TPS are isolated to support phased startup operation (i.e., RVZ1 interfaces with TPS Train B and TPS Train C are isolated during Phase 1 operation, RVZ1 interfaces with TPS Train C are isolated during Phase 2 operation) via a manual isolation valve and a blind flange or cap.

The RVZ1 system interfaces with the IXP hot cell (i.e., IXP hot cell exhaust). During Phase 1 through Phase 3, the RVZ1 system interface points with the IXP hot cell are isolated to support phased startup operation via two bubble-tight dampers.

The RVZ1 system interfaces with the IXP system processes (i.e., IXP cryotrap exhaust). During Phase 1 through Phase 3, the RVZ1 system interface point with the IXP system is isolated to support phased startup operation via a manual isolation valve and a blind flange or cap.

Radiological Ventilation Zone 2 (RVZ2)

The RVZ2 system interfaces with train specific instances of TPS (i.e., TPS nitrogen exhaust). The RVZ2 system interface points with train specific instances of TPS are isolated to support phased startup operation (i.e., RVZ2 interfaces with TPS Train B and TPS Train C are isolated during Phase 1 operation, RVZ2 interfaces with TPS Train C are isolated during Phase 2 operation) via a manual isolation valve and a blind flange or cap.

The RVZ2 system interfaces with the IXP system (i.e., supply air for tanks ventilated by the process vessel vent system [PVVS]). During Phase 1 through Phase 3, the RVZ2 system interface point with the IXP system is isolated to support phased startup operation via a manual isolation valve and a blind flange or cap.

The radiological ventilation zone 2 recirculation subsystem (RVZ2r) interfaces with the IXP hot cell (i.e., IXP hot cell supply air). During Phase 1 through Phase 3, the RVZ2r interface points with the IXP hot cell are isolated to support phased startup operation via two bubble-tight dampers.

Radiological Ventilation Zone 3 (RVZ3)

The RVZ3 description provided in Subsection 9a2.1.1 of the FSAR is not affected by phased startup operations.

9a2.1.2 NON-RADIOLOGICAL AREA VENTILATION SYSTEM

The non-radiological area ventilation system description provided in Subsection 9a2.1.2 of the FSAR is not affected by phased startup operations.

9a2.1.3 FACILITY CHILLED WATER SYSTEM

The facility chilled water system (FCHS) description provided in Subsection 9a2.1.3 of the FSAR is not affected by phased startup operations.

9a2.1.4 FACILITY HEATED WATER SYSTEM

The facility heated water system (FHWS) description provided in Subsection 9a2.1.4 of the FSAR is not affected by phased startup operations.

9a2.2 HANDLING AND STORAGE OF TARGET SOLUTION

The handling and storage of target solution in the irradiation facility (IF), as described in Section 9a2.2 of the FSAR, is not affected by phased startup operations. The major target solution storage and handling equipment in the IF includes the TSV and the TSV dump tank, both of which are components of the subcritical assembly (SCAS). Each IU includes unit specific instances of the TSV and TSV dump tank.

9a2.3 FIRE PROTECTION SYSTEMS AND PROGRAMS

The Fire Protection Program (FPP) and facility fire protection systems described in Section 9a2.3 of the FSAR are not affected by the phased approach to initial facility operations. The FPP and facility fire protection systems are implemented in full, as described in Section 9a2.3 of the FSAR, to support Phase 1 thru 4 operations of the SHINE facility. Changes to fire protection documents or procedures necessitated by the phased approach (e.g., additional combustible materials or ignition sources added because of construction activities) will be managed through the FPP and meet the requirements established in Section 9a2.3 of the FSAR.

9a2.4 COMMUNICATION SYSTEMS

The facility data and communication system (FDCS) is installed in full, as described in Section 9a2.4 of the FSAR, to support Phase 1 operations of the SHINE facility. The FDCS description provided in Section 9a2.4 of the FSAR is not affected by the phased approach to initial facility operations.

9a2.5 POSSESSION AND USE OF BYPRODUCT, SOURCE, AND SPECIAL NUCLEAR MATERIAL

The possession and use of byproduct, source, and special nuclear material (SNM), as described in Section 9a2.5 of the FSAR, is not affected by the phased approach to initial facility operations. Quantities of materials described in Section 9a2.5 of the FSAR remain bounding for Phase 1 through Phase 4 operations.

9a2.6 COVER GAS CONTROL IN CLOSED PRIMARY COOLANT SYSTEMS

The PCLS is the closed loop cooling system that provides cooling to the TSV. Cover gas control for the PCLS is described in Section 5a2.2 of the FSAR. PCLS Phase 1 through Phase 4 integration is described in Section 5a2.2.

9a2.7 OTHER AUXILIARY SYSTEMS

9a2.7.1 TRITIUM PURIFICATION SYSTEM

The TPS consists of three independent trains (i.e., Train A, Train B, and Train C). Each TPS train supports specific neutron driver assembly (NDAS) units (i.e., TPS Train A supports NDAS units 1 and 2; TPS Train B supports NDAS units 3, 4, and 5; and TPS Train C supports NDAS units 6, 7, and 8). During Phase 1, TPS Train A is functional and available for operation. During Phase 2, TPS Trains A and B are functional and available for operation. During Phases 3 and 4, TPS Trains A, B, and C are functional and available for operation. TPS fume hoods are installed prior to Phase 1 operations.

The TPS train descriptions provided in Section 9a2.7.1 of the FSAR are not affected by phased startup operations. Each TPS train includes independent train specific instances of the isotope separation system (Thermal Cycling Adsorption Process [TCAP]), TPS-NDAS interface lines, secondary enclosure cleanup (SEC), vacuum/impurity treatment subsystem (Vac/ITS), NDAS SEC, and TPS glovebox. The tritium confinement boundary for each TPS train (including the TPS glovebox, SEC, isolation valves, TPS-NDAS interface lines, and tubing up to isolation valves) is independent and isolated from the other TPS trains; no portion of the tritium confinement boundary is shared between TPS trains. Each TPS train operates independently of the other two trains and is not impacted by the installation and commissioning of the other trains.

Each TPS train is supported by facility systems (e.g., TPS deuterium supply, TPS Helium supply, facility nitrogen handling system [FNHS], RVZ1, and RVZ2). Isolation is provided at the following TPS interface points to facility systems to allow TPS trains to be connected and commissioned without impacting operating TPS trains:

- Process exhaust to facility ventilation RVZ1e connections to TPS trains are isolated with manual valves and blind flanges or caps.
- Liquid nitrogen exhaust to facility ventilation RVZ2e connections to TPS trains are isolated with manual valves and blind flanges or caps.
- Pneumatic equipment gas line connections to TPS trains are isolated with manual valves.
- Liquid nitrogen supply connections to TPS trains are isolated with manual valves.
- Deuterium supply connections to TPS trains are isolated with manual valves
- Inert flush gas connections to TPS trains are isolated with manual valves.

9a2.7.2 NEUTRON DRIVER ASSEMBLY SYSTEM SERVICE CELL

The NDAS service cell (NSC), as described in Section 9a2.7.2 of the FSAR, is not affected by phased startup operations. The NSC is installed prior to Phase 1 operations.

9a2.8 REFERENCES

None

CHAPTER 9b – RADIOISOTOPE PRODUCTION FACILITY AUXILIARY SYSTEMS

9b.1 HEATING, VENTILATION, AND AIR CONDITIONING SYSTEMS

The heating, ventilation, and air conditioning (HVAC) systems for the main production facility are common to the irradiation facility (IF) and the radioisotope production facility (RPF). Phased startup operations of the main production facility HVAC systems are described in Section 9a2.1.

9b.2 HANDLING AND STORAGE OF TARGET SOLUTION

9b.2.1 TARGET SOLUTION LIFECYCLE

The target solution lifecycle description provided in Section 9b.2.1 of the FSAR is not affected by phased startup operations, except that target solution is not delivered to the iodine and xenon purification and packaging (IXP) system during Phase 1 through Phase 3. The IXP system is not installed, process connections to IXP are isolated, and the IXP hot cell is isolated during Phase 1 through Phase 3, as described in Section 4b.2 and Section 4b.3.

9b.2.2 RECEIPT AND STORAGE OF UNIRRADIATED SNM

The description of receipt and storage of unirradiated special nuclear material (SNM) provided in Subsection 9b.2.2 of the FSAR is not affected by phased startup operations.

9b.2.3 TARGET SOLUTION PREPARATION

The target solution preparation description provided in Subsection 9b.2.3 of the FSAR is not affected by phased startup operations.

9b.2.4 TARGET SOLUTION STAGING SYSTEM

The target solution staging system (TSSS) description provided in Subsection 9b.2.4 of the FSAR is not affected by phased startup operations.

9b.2.5 VACUUM TRANSFER SYSTEM

The vacuum transfer system (VTS) description provided in Subsection 9b.2.5 of the FSAR is not affected by phased startup operations, VTS is available for operation in Phase 1. During Phase 1 and Phase 2, interfacing VTS connections to irradiation unit (IU) specific instances of IU systems and components (i.e., target solution vessel [TSV], TSV dump tank, and TSV off-gas system [TOGS]) are isolated as described in Section 4a2.1 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1, interfaces with IUs 6 through 8 are isolated during Phase 2). During Phase 1 through Phase 3, interfacing VTS connections to the IXP system are isolated as described in Section 4b.3. Isolating the interfaces to individual IU systems and the IXP system does not affect the capability of the VTS to perform its functions for other system interfaces.

9b.2.6 RADIOACTIVE LIQUID WASTE STORAGE

The radioactive liquid waste storage (RLWS) system description provided in Subsection 9b.2.6 of the FSAR is not affected by phased startup operations.

9b.2.7 RADIOACTIVE LIQUID WASTE IMMOBILIZATION

The radioactive liquid waste immobilization (RLWI) system description in Subsection 9b.2.7 of the FSAR is not affected by phased startup operations, except that the adsorption columns to remove selective isotopes (e.g., Sr-90, Cs-137) are not available during Phase 1 and Phase 2. Additional description of RLWI operations during phased startup operations is provided in Section 9b.7.3.

9b.2.8 SOLID WASTE PACKAGING AND SHIPMENT

The solid radioactive waste packaging (SRWP) system description provided in Subsection 9b.2.8 of the FSAR is not affected by phased startup operations, except that the material staging building (MATB) is not available during Phase 1 and Phase 2. Solid wastes generated during Phase 1 and Phase 2 are stored in the radiologically controlled area (RCA) within the main production facility prior to shipment off site to a designated disposal site. Additional description of SRWP operations during phased startup operations is provided in Subsection 9b.7.5.

9b.2.9 CRITICALITY CONTROL

Inadvertent criticality is prevented in RPF systems involved in the processing of fissile materials through the application of the nuclear criticality safety program, described in Section 6b.3.

9b.3 FIRE PROTECTION SYSTEMS AND PROGRAMS

The fire protection system and program for the SHINE facility are common to the IF and RPF. As described in Section 9a2.3, the fire protection program and facility fire protection systems are implemented in full to support Phase 1 operations.

9b.4 COMMUNICATION SYSTEMS

The communication systems for the SHINE facility are common to the IF and RPF. As described in Section 9a2.4, the facility data and communication system (FDCS) is installed in full to support Phase 1 operations.

9b.5 POSSESSION AND USE OF BYPRODUCT, SOURCE, AND SPECIAL NUCLEAR MATERIAL

The possession and use of byproduct, source, and special nuclear material (SNM) described in Section 9b.5 of the FSAR is not affected by phased startup operations, except that the IXP system is not operational until Phase 4. During Phase 1 through Phase 3, radioactive material is not present in the IXP system, iodine-131 and xenon-133 is not produced or shipped, and the quality control and analytical testing laboratories (LABS) does not process iodine-131 and xenon-133 samples for analysis. Quantities of materials described in Section 9b.5 of the FSAR remain bounding for Phase 1 through Phase 4 operations.

9b.6 COVER GAS CONTROL IN THE RADIOISOTOPE PRODUCTION FACILITY

9b.6.1 PROCESS VESSEL VENT SYSTEM

The process vessel vent system (PVVS) description provided in Subsection 9b.6.1 of the FSAR is not affected by phased startup operations, PVVS is available for operation in Phase 1. During Phase 1 and Phase 2, interfacing PVVS connections to IU specific instances of IU systems (i.e., TOGS) are isolated within the IU cell as described in Section 4a2.1 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1, interfaces with IUs 6 through 8 are isolated during Phase 2). During Phase 1 through Phase 3, interfacing PVVS connections to the IXP system are isolated as described in Section 4b.3. Isolating the interfaces to individual IU systems and the IXP system does not affect the capability of the PVVS to perform its functions for other system interfaces.

9b.6.2 NITROGEN PURGE SYSTEM

The nitrogen purge system (N2PS) description provided in Subsection 9b.6.2 of the FSAR is not affected by phased startup operations, N2PS is available for operation in Phase 1. During Phase 1 and Phase 2, interfacing N2PS connections to IU specific instances of IU systems and components (i.e., TSV, TSV dump tank, and TOGS) are isolated as described in Section 4a2.1 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1, interfaces with IUs 6 through 8 are isolated during Phase 2). During Phase 1 through Phase 3, interfacing N2PS connections to the IXP system are isolated as described in Section 4b.3. Isolating the interfaces to individual IU systems and components and the IXP system does not affect the capability of the N2PS to perform its functions for other system interfaces.

9b.7 OTHER AUXILIARY SYSTEMS

9b.7.1 MOLYBDENUM ISOTOPE PRODUCT PACKAGING SYSTEM

The molybdenum isotope product packaging system (MIPS) description provided in Subsection 9b.7.1 of the FSAR is not affected by phased startup operations, except that IXP is not available during Phase 1 through Phase 3. During Phase 1 through Phase 3, MIPS is isolated from the IXP as described in Section 4b.3.

9b.7.2 MATERIAL HANDLING SYSTEM

The material handling system (MHS) description provided in Subsection 9b.7.2 of the FSAR is not affected by phased startup operations.

9b.7.3 RADIOACTIVE LIQUID WASTE IMMOBILIZATION SYSTEM

The RLWI description provided in Subsection 9b.7.3 of the FSAR is not affected by phased startup operations, except that the selective removal process (i.e., removal of classification-driving isotopes, as needed, from blended liquid waste in waste cleanup columns) is not available during Phase 1 and Phase 2. RLWI solidification equipment is available in Phase 1. During Phase 1 and Phase 2, the RLWI receives blended liquid waste from the RLWS and solidifies the waste. During Phase 1 and Phase 2, the RLWI selective removal process interfacing connections are isolated with a valve and a blind flange or cap.

Waste solidified during Phase 1 and Phase 2 may have higher dose rates and higher waste classifications than wastes solidified during Phase 3 and Phase 4. During Phase 1 and Phase 2, liquid waste is stored in the subgrade RLWS tanks prior to transfer to RLWI in order to maximize the decay time and limit the volume of solidified waste requiring disposal. Estimated waste streams during phased startup operations are described in Section 11.2.

9b.7.4 RADIOACTIVE LIQUID WASTE STORAGE SYSTEM

The RLWS description provided in Subsection 9b.7.4 of the FSAR is not affected by phased startup operations, except that IXP is not available during Phase 1 through Phase 3. During Phase 1 through Phase 3 operations, interfacing RLWS connections to the IXP system are isolated as described in Section 4b.3; RLWS does not receive or process wastes from IXP during Phase 1 through Phase 3.

9b.7.5 SOLID RADIOACTIVE WASTE PACKAGING SYSTEM

The SRWP description provided in Subsection 9b.7.5 of the FSAR is not affected by phased startup operations, except that the MATB is not available during Phase 1 and Phase 2. Solidified waste generated during Phase 1 and Phase 2 are stored in the RCA within the main production facility prior to shipment off site to a designated disposal site. During Phase 1 and Phase 2, solid wastes are characterized and staged for shipment in the main production facility in accordance with the radioactive waste management program.

9b.7.6 RADIOACTIVE DRAIN SYSTEM

The radioactive drain system (RDS) description provided in Subsection 9b.7.6 of the FSAR is not affected by phased startup operations, except that IXP is not available during Phase 1 through Phase 3. During Phase 1 through Phase 3, the IXP hot cell drain to RDS is plugged as described in Section 4b.1; RDS does not provide collection of IXP process liquids or overpressure protection for IXP during Phase 1 through Phase 3.

9b.7.7 FACILITY POTABLE WATER SYSTEM

The facility potable water system (FPWS) description provided in Subsection 9b.7.7 of the FSAR is not affected by phased startup operations.

9b.7.8 FACILITY NITROGEN HANDLING SYSTEM

The facility nitrogen handling system (FNHS) description provided in Subsection 9b.7.8 of the FSAR is not affected by phased startup operations, FNHS is available for operation in Phase 1. During Phase 1 and Phase 2, interfacing FNHS connections to IU specific instances of IU systems (i.e., TOGS) are isolated outside the IU cell as described in Section 4a2.1 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1, interfaces with IUs 6 through 8 are isolated during Phase 2). During Phase 1 and Phase 2, interfacing FNHS connections to tritium purification system (TPS) trains are isolated as described in Section 9a2.7 (i.e., interfaces with TPS Train B and Train C are isolated during Phase 1, interfaces with TPS Train C are isolated during Phase 2). During Phase 1 through Phase 3, interfacing FNHS connections to the IXP system are isolated as described in Section 4b.3. Isolating the interfaces to individual IU systems, TPS trains, and the IXP system does not affect the capability of the FNHS to perform its functions for other system interfaces.

9b.7.9 FACILITY SANITARY DRAIN SYSTEM

The facility sanitary drain system (FSDS) description in Section 9b.7.9 of the FSAR is not affected by phased startup operations.

9b.7.10 FACILITY CHEMICAL REAGENT SYSTEM

The facility chemical reagent system (FCRS) description in Section 9b.7.10 of the FSAR is not affected by phased startup operations, FCRS is available for operation in Phase 1. During Phase 1 and Phase 2, interfacing FCRS connections to irradiation unit-specific systems (i.e., TOGS) are isolated as described in Section 4a2.1 (i.e., interfaces with IUs 3 through 8 are isolated during Phase 1, interfaces with IUs 6 through 8 are isolated during Phase 2). FCRS reagents transported in portable containers are not connected to process tie-in locations until the respective equipment is installed. During Phase 1 through Phase 3, interfacing FCRS connections to the IXP system are isolated as described in Section 4b.3. Isolating the interfaces to individual IUs and the IXP system does not affect the capability of the FCRS to perform its functions for other system interfaces.

9b.8 REFERENCES

None

CHAPTER 10 – EXPERIMENTAL FACILITIES

10.1 SUMMARY DESCRIPTION

The SHINE facility does not contain experimental facilities as described in NUREG-1537, Part 1, Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content (USNRC, 1996) and the Interim Staff Guidance Augmenting NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,” for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors (USNRC, 2012).

10.2 REFERENCES

USNRC, 1996. Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content, NUREG-1537, Part 1, U.S. Nuclear Regulatory Commission, February 1996.

USNRC, 2012. Interim Staff Guidance Augmenting NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content,” for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors, Interim Staff Guidance Augmenting NUREG-1537, Part 1, U.S. Nuclear Regulatory Commission, October 17, 2012.

CHAPTER 11 – RADIATION PROTECTION PROGRAM AND WASTE MANAGEMENT

11.1 RADIATION PROTECTION

11.1.1 RADIATION SOURCES

The radiation sources described in Subsection 11.1.1 of the FSAR are not affected by phased startup operations (i.e., the radiation sources described in Subsection 11.1.1 of the FSAR are bounding for Phase 1 through Phase 4 operations).

Figure 11.1-1 of the FSAR provides probable radiation area designations within the irradiation unit (IU) cells, target solution vessel (TSV) off-gas system (TOGS) cells, and primary cooling rooms, assuming IUs 1 through 8 are operating simultaneously. During Phase 1, IUs 1 and 2 may be operating while installation activities continue within the IU cells 3 through 8, TOGS cells 3 through 8, and primary cooling rooms 3 through 8. During Phase 2, IUs 1 through 5 may be operating while installation activities continue within the IU cells 6 through 8, TOGS cells 6 through 8, and primary cooling rooms 6 through 8.

During Phase 1, with IUs 1 and 2 operating, the dose rate in IU cell 3 and primary cooling room 3 is expected to be between 5 and 100 millirem per hour (mrem/hr), while the dose rate in the remaining cells (i.e., IU cells 4 through 8, TOGS cells 3 through 8, and primary cooling rooms 4 through 8) is expected to be less than 5 mrem/hr. During Phase 2, with IUs 1 through 5 operating, the dose rate in IU cell 6 and TOGS cell 6 is expected to be between 5 and 100 mrem/hr, while the dose rate in the remaining cells (i.e., IU cells 7 and 8, TOGS cells 7 and 8, and primary cooling rooms 6 through 8) is expected to be less than 5 mrem/hr. The probable dose rates within operating IU cells, TOGS cells, and cooling rooms during Phase 1 and Phase 2 are as provided in Figure 11.1-1 of the FSAR. The probable dose rates within the irradiation facility (IF) during Phase 3 and Phase 4 are as provided in Figure 11.1-1 of the FSAR.

Figure 11.1-1 of the FSAR provides probable radiation area designations within the supercell assuming each hot cell is operational. During Phase 1 through Phase 3, the iodine and xenon purification and packaging (IXP) hot cell is not operational. The dose rate in the IXP hot cell is expected to be between 5 and 100 mrem/hr during Phase 1 through Phase 3. The probable dose rates during Phase 4 are as provided in Figure 11.1-1 of the FSAR.

Figure 11.1-2 of the FSAR provides estimated derived air concentrations (DACs) within the IU cells and TOGS cells assuming all IUs (i.e., IUs 1 through 8) are operational. During Phase 1, the estimated DAC in IU cells 3 through 8 and TOGS cells 3 through 8 are less than 1. During Phase 2, the estimated DAC in IU cells 6 through 8 and TOGS cells 6 through 8 are less than 1. The estimated DAC within operational IU cells and TOGS cells during Phase 1 and Phase 2 are as provided in Figure 11.1-2 of the FSAR. The estimated DAC within the IF during Phase 3 and Phase 4 are as provided in Figure 11.1-1 of the FSAR.

The estimated DAC within the supercell, provided in Figure 11.1-2 of the FSAR, is not affected by phased startup operations.

11.1.2 RADIATION PROTECTION PROGRAM

The radiation protection program described in Subsection 11.1.2 of the FSAR is not affected by phased startup operations.

11.1.3 ALARA PROGRAM

The as low as reasonably achievable (ALARA) program described in Subsection 11.1.3 of the FSAR is not affected by phased startup operations.

11.1.4 RADIATION MONITORING AND SURVEYING

Radiation monitoring and surveying, as described in Subsection 11.1.4 of the FSAR, is not affected by phased startup operations.

11.1.5 RADIATION EXPOSURE CONTROL AND DOSIMETRY

Radiation exposure control and dosimetry, as described in Subsection 11.1.5 of the FSAR, is not affected by phased startup operations.

11.1.6 CONTAMINATION CONTROL EQUIPMENT AND FACILITY LAYOUT GENERAL DESIGN CONSIDERATIONS FOR 10 CFR 20.1406

Contamination control equipment and facility layout general design considerations for 10 CFR 20.1406, as described in Subsection 11.1.6 of the FSAR, is not affected by phased startup operations.

11.1.7 ENVIRONMENTAL MONITORING

Environmental monitoring, as described in Subsection 11.1.7 of the FSAR, is not affected by phased startup operations.

11.2 RADIOACTIVE WASTE MANAGEMENT

11.2.1 RADIOACTIVE WASTE MANAGEMENT PROGRAM

The radioactive waste management program description provided in Subsection 11.2.1 of the FSAR is not affected by phased startup operations.

11.2.2 RADIOACTIVE WASTE CONTROLS

The radioactive waste controls described in Subsection 11.2.2 of the FSAR are not affected by phased approach operations, except that the material staging building (MATB) will not be available during Phase 1 and Phase 2. The MATB will not be used for interim storage of wastes for decay until it is operational as part of Phase 3. Solidified waste generated during Phase 1 and Phase 2 are stored in the subgrade bore holes in the radioisotope production facility (RPF) as discussed in Chapter 9b. The shielding provided by the subgrade bore holes in the RPF ensures dose rates within the RPF remain ALARA (i.e., the bore hole shielding analysis for storage of spent columns is bounding for storage of solidified wastes). Additional radioactive storage areas (e.g., storage areas for wastes requiring limited shielding) are available within the radiologically controlled area of the main production facility. Waste disposal shipments will occur regularly to minimize the volume of waste requiring storage within the radiologically controlled area (RCA) of the main production facility. The radioactive waste storage areas designated within the RCA of the main production facility ensure 10 CFR 20 site dose limits are met and ALARA principles are followed.

11.2.2.1 Radioactive Waste Minimization

The description of radioactive waste minimization provided in Subsection 11.2.2.1 of the FSAR is not affected by phased approach operations.

11.2.2.2 Waste Stream Sources

The description of waste stream sources provided in Subsection 11.2.2.2 of the FSAR is not affected by phased startup operations. The estimated annual waste volumes generated, including estimated waste classifications, during Phase 1 through Phase 3 are provided in Table 11.2-1. The estimated annual waste volumes disposed, including estimated waste classifications, shipment types, and disposal destinations, during Phase 1 through Phase 3 are provided in Table 11.2-2. The waste volume estimates provided in Table 11.2-1 of the FSAR are representative of Phase 4 operations.

11.2.3 RELEASE OF RADIOACTIVE WASTE

The release of radioactive waste description provided in Subsection 11.2.3 of the FSAR is not affected by phased startup operations, except that radioactive liquid waste immobilization system (RLWI) selective removal process is not available during Phase 1 and Phase 2, and the IXP system is not available during Phase 1 though Phase 3.

The RLWI selective removal process (i.e., removal of classification-driving isotopes, as needed, from blended liquid waste in waste cleanup columns) is not available during Phase 1 and Phase 2 as described in Subsection 9b.7.3. Waste solidified during Phase 1 and Phase 2 may have higher dose rates and higher waste classifications than wastes solidified during Phase 3 and Phase 4. During Phase 1 and Phase 2, liquid waste is stored in the subgrade radioactive liquid waste storage (RLWS) tanks prior to transfer to RLWI in order to maximize the decay time and limit the volume of solidified waste requiring disposal.

Waste from the IXP system will not be generated in Phases 1 through 3.

11.3 RESPIRATORY PROTECTION PROGRAM

The respiratory protection program description provided in Section 11.3 of the FSAR is not affected by phased startup operations.

11.4 REFERENCES

None

Table 11.2-1 – Estimated As-Generated Annual Waste Stream Summary During Phased Startup Operations (Sheet 1 of 2)

Description	Matrix	Class as Generated	Phase 1	Phase 2	Phase 3	Units
MEPS Extraction Columns [ ]PROP/ECI	[ ]PROP/ECI	B or C	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	ft^3/yr
Selective Ion Stripping Columns	[ ]PROP/ECI	B or C	N/A	N/A	72	ft^3/yr
IXP Separation Columns	[ ]PROP/ECI	B or C	N/A	N/A	N/A	ft^3/yr
LWPS Deionizer Units	Resin	A	12	30	48	ft^3/yr
PCLS Deionizer Units	Resin	A	12	30	48	ft^3/yr
Uranium Canisters	Solid	A	0.49[(a)]	1.2[(a)]	2.0[(a)]	ft^3/yr
NDAS Accelerator Subassembly[(b)]	Solid	A	N/A	N/A	[ ]PROP/ECI	ft^3/yr
NDAS Target Chamber Subassembly[(b)]	Solid	A	N/A	N/A	[ ]PROP/ECI	ft^3/yr
TOGS Skids[(b)]	Solid	A or B	N/A	N/A	846	ft^3/yr
TOGS Zeolite Beds[(b)]	Solid	B or C	N/A	N/A	0.64	ft^3/yr
LWPS Filters	Solid	A	0.41	1.0	1.6	ft^3/yr
PCLS Filters	Solid	A	0.41	1.0	1.6	ft^3/yr
TSPS, URSS, PVVS, Hot Cell, RVZ1, RVZ2, RLWI HEPA Filters	Solid	A	182	182	182	ft^3/yr
Hot Cell, RVZ1, RVZ2 Charcoal Filters	Solid	A	32	32	32	ft^3/yr
TSPS Uranyl Sulfate Solution Filters	Solid	A	0.35[(c)]	0.35[(c)]	0.35[(c)]	ft^3/yr

Table 11.2-1 – Estimated As-Generated Annual Waste Stream Summary During Phased Startup Operations (Sheet 2 of 2)

Description	Matrix	Class as Generated	Phase 1	Phase 2	Phase 3	Units
MEPS Glassware	Solid	A	52	130	208	ft^3/yr
Class A Trash	Solid	A	100(d)	300(d)	400(d)	ft^3/yr
Contaminated Oil	Oil	B	0.51	1.3	2.0	ft^3/yr
Extraction Column Acid Wash	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
Extraction Column Water Wash	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
[ ]PROP/ECI	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
[ ]PROP/ECI	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
[ ]PROP/ECI	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
Iodine Recovery Column [ ]PROP/ECI	Liquid(e)	See Notes(f)(g)	N/A	N/A	N/A	gal/yr
Spent Target Solution	Liquid(e)	See Notes(f)(g)	[ ]PROP/ECI	[ ]PROP/ECI	[ ]PROP/ECI	gal/yr
Vacuum Transfer System Knockout Pot	Liquid(e)	See Notes(f)(g)	3	9	14	gal/yr
Radiological Laboratory Waste	Liquid(e)	See Notes(f)(g)	69	172	275	gal/yr
Decontamination Waste	Liquid(e)	See Notes(f)(g)	1,004	1,886	2,768	gal/yr
Cintichem Purification Waste & Rotary Evaporator Condensate	Liquid(e)	See Notes(f)(g)	21	52	82	gal/yr
[ ]PROP/ECI	Liquid(e)	See Notes(f)(g)	N/A	N/A	N/A	gal/yr
PVVS Condenser Condensate	Liquid(e)	See Notes(f)(g)	175	438	701	gal/yr

a. Uranium metal and/or uranium oxide cannisters may be returned to the supplier in lieu of disposition as solid waste.
b. Specified waste stream is not anticipated to be generated during phases 1 and 2.
c. TSPS uranyl sulfate dissolution tank filter elements may not become a waste stream if reconditioned and reused.
d. Class A trash is exclusive of other solid wastes identified in the table.
e. Liquid waste streams may be reused or may be combined and treated as a homogenous influent waste stream and solidified together.
f. Class A, Class B, or Class C waste during phases 1 and 2.
g. Class A waste during phases 3 and 4.

Table 11.2-2 - Estimated As-Disposed Annual Waste Stream Summary During Phased Startup Operations (Sheet 1 of 2)

Description	Matrix	Class as Disposed	Phase 1 (ft^3/yr)	Phase 2 (ft^3/yr)	Phase 3 (ft^3/yr)	Shipment Type	Destination(a)
MEPS Extraction Columns [ ]PROP/ECI	[ ]PROP/ECI	B or C	68	169	270	Type B	WCS
Selective Ion Stripping Columns	[ ]PROP/ECI	B or C	N/A	N/A	72	Type B	WCS
IXP Separation Columns	[ ]PROP/ECI	B or C	N/A	N/A	N/A	Type B	WCS
LWPS Deionizer Units	Resin	A	20	50	80	Type A or LSA	Energy*Solutions*
PCLS Deionizer Units	Resin	A	20	50	80	Type A or LSA	Energy*Solutions*
Uranium Canisters(b)	Solid	A	0.82	2.1	3.3	Type A or LSA	Energy*Solutions*
NDAS Accelerator Subassembly(c)	Solid	A	N/A	N/A	3,321	Type A or LSA	Energy*Solutions*
NDAS Target Chamber Subassembly(c)	Solid	A	N/A	N/A	586	Type A or LSA	Energy*Solutions*
TOGS Skids(c)	Solid	A or B	N/A	N/A	1,411	Type A, B, or LSA	Energy*Solutions* or WCS
TOGS Zeolite Beds(c)	Solid	B or C	N/A	N/A	1.1	Type B	WCS
LWPS Filters	Solid	A	0.68	1.7	2.7	Type A or LSA	Energy*Solutions*
PCLS Filters	Solid	A	0.68	1.7	2.7	Type A or LSA	Energy*Solutions*
TSPS, URSS, PVVS, Hot Cell, RVZ1, RVZ2, RLWI HEPA Filters	Solid	A	142	142	142	Type A or LSA	Energy*Solutions*
Hot Cell, RVZ1, RVZ2 Charcoal Filters	Solid	A	54	54	54	Type A or LSA	Energy*Solutions*
TSPS Uranyl Sulfate Solution Filters(d)	Solid	A	0.58	0.58	0.58	Type A or LSA	Energy*Solutions*

Table 11.2-2 - Estimated As-Disposed Annual Waste Stream Summary During Phased Startup Operations (Sheet 2 of 2)

<table>
<tr><th>Description</th><th>Matrix</th><th>Class as Disposed</th><th>Phase 1 (ft^3/yr)</th><th>Phase 2 (ft^3/yr)</th><th>Phase 3 (ft^3/yr)</th><th>Shipment Type</th><th>Destination[a]</th></tr>
<tr><td>MEPS Glassware</td><td>Solid</td><td>A</td><td>87</td><td>217</td><td>347</td><td>Type A or LSA</td><td>EnergySolutions</td></tr>
<tr><td>Class A Trash[e]</td><td>Solid</td><td>A</td><td>167</td><td>500</td><td>667</td><td>Type A or LSA</td><td>EnergySolutions</td></tr>
<tr><td>Contaminated Oil</td><td>Oil</td><td>B</td><td>0.85</td><td>2.1</td><td>3.4</td><td>Type A or LSA</td><td>WCS</td></tr>
<tr><td>Extraction Column Acid Wash</td><td rowspan="14">Liquid[f]</td><td rowspan="14">See Notes[g][h]</td><td rowspan="14">1,102[g][i][j]</td><td rowspan="14">1,791[g][i][j]</td><td rowspan="14">2,479[h][i][j]</td><td rowspan="14">Type A, B, or LSA</td><td rowspan="14">EnergySolutions</td></tr>
<tr><td>Extraction Column Water Wash</td></tr>
<tr><td>[ ][PROP/ECI]</td></tr>
<tr><td>[ ][PROP/ECI]</td></tr>
<tr><td>[ ][PROP/ECI]</td></tr>
<tr><td>Iodine Recovery Column [ ][PROP/ECI]</td></tr>
<tr><td>Spent Target Solution</td></tr>
<tr><td>Vacuum Transfer System Knockout Pot</td></tr>
<tr><td>Radiological Laboratory Waste</td></tr>
<tr><td>Decontamination Waste</td></tr>
<tr><td>Cintichem Purification Waste & Rotary Evaporator Condensate</td></tr>
<tr><td>[ ][PROP/ECI]</td></tr>
<tr><td>PVVS Condenser Condensate</td></tr>
</table>

a. Waste destination may be subject to change.
b. Uranium metal and/or uranium oxide canisters may be returned to the supplier in lieu of disposition as solid waste.
c. Specified waste stream is not anticipated to be generated during phases 1 and 2.
d. TSPS uranyl sulfate dissolution tank filter elements may not become a waste stream if reconditioned and reused.
e. Class A trash is exclusive of other solid wastes identified in the table.
f. Liquid waste streams may be reused or may be combined and treated as a homogenous influent waste stream and solidified together.
g. Waste is disposed as Class A, Class B, or Class C waste during phases 1 and 2.
h. Waste is disposed as Class A waste during phases 3 and 4.
i. As disposed volume of liquid waste streams is in the form of a uniform solidified matrix using a solidification agent.
j. 25 percent margin has been added to volume of solidified liquid disposed waste.

CHAPTER 12 – CONDUCT OF OPERATIONS

The conduct of operations described in Chapter 12 of the FSAR is not affected by phased startup operations. The organizational and programmatic descriptions provided in Chapter 12 of the FSAR are implemented to support Phase 1 operations.

CHAPTER 13a2 – IRRADIATION FACILITY ACCIDENT ANALYSIS

The SHINE Safety Analysis (SSA) methodology, as described in Chapter 13a2 of the FSAR, was used to evaluate the impacts of phased startup operations on the SSA and the accident analysis provided as Chapter 13 of the FSAR. A hazard evaluation was performed along with a review of the current process hazard analysis for the facility to identify new or different accident scenarios, including changes to likelihood or consequences of existing accident scenarios.

The likelihood and consequences for these new or different accident scenarios were then evaluated and compared to the risk matrix, as described in Chapter 13a2 of the FSAR. Where the uncontrolled scenario resulted in unacceptable risk, safety-related controls were applied to prevent or mitigate the accident scenario. These controls were applied in a method consistent with that described in Chapter 13a2 of the FSAR.

The results of accident analysis specific to phased startup operations is summarized in the remainder of this chapter. Phased startup operations do not result in new accident categories, but the following new accident sequences within the irradiation facility (IF) were identified:

- Improper target solution routing to an uninstalled irradiation unit (IU) cell
- Damage to an installed tritium purification system (TPS) train during the installation of another TPS train
- Damage to a process vessel vent system (PVVS) to target solution vessel (TSV) off-gas system (TOGS) interface line during installation of the subcritical assembly system (SCAS)

Accident sequences within the IF modified based on increased likelihood include:

- Heavy load drop on the TPS
- Heavy load drop on an open IU cell
- Fire in the IF general area

Additionally, several accident sequences have reduced likelihoods or consequences during phased startup operations due to reduced frequency of operations and a reduced material at risk. These accident sequences were not reevaluated because they are bounded by the accident analysis as currently documented in Chapter 13 of the FSAR.

Two new credited engineered controls are required to prevent phased startup operation accident sequences in the IF. Three new credited specific administrative controls are required to prevent phased startup operation accident sequences in the IF.

The following subsections provide additional detail on the scenarios listed above and the credited controls used for prevention.

13a2.1 ACCIDENT-INITIATING EVENTS AND SCENARIOS

The information provided in Section 13a2.1 of the FSAR is not affected by phased startup operations.

13a2.1.1 MAXIMUM HYPOTHETICAL ACCIDENT

The information provided in Subsection 13a2.1.1 of the FSAR is not affected by phased startup operations.

13a2.1.2 INSERTION OF EXCESS REACTIVITY

The information provided in Subsection 13a2.1.2 of the FSAR is not affected by phased startup operations.

13a2.1.3 REDUCTION IN COOLING

The information provided in Subsection 13a2.1.3 is not affected by phased startup operations.

13a2.1.4 MISHANDLING OR MALFUNCTION OF TARGET SOLUTION

The information provided in Subsection 13a2.1.4 of the FSAR remains valid for phased startup operations. Additionally, a mishandling and malfunction of target solution scenario of improper target solution routing to an uninstalled IU cell was identified and evaluated.

The initiating event in this scenario is a failure of the vacuum transfer system (VTS) lower lift tank target solution valve. In the uncontrolled sequence, failure of the valve would cause leakage of target solution into an uninstalled IU cell. This scenario is prevented by the dump tank drain isolation valve, which is installed as part of Phase 1 operation and maintained disconnected from power until the remaining IU equipment is installed and ready for hot commissioning.

Because this scenario has preventative measures in place, there are no radiological consequences.

13a2.1.5 LOSS OF OFF-SITE POWER

The information provided in Subsection 13a2.1.5 of the FSAR is not affected by phased startup operations.

13a2.1.6 EXTERNAL EVENTS

The information provided in Subsection 13a2.1.6 of the FSAR is not affected by phased startup operations.

13a2.1.7 MISHANDLING OR MALFUNCTION OF EQUIPMENT

The information provided in Subsection 13a2.1.7 of the FSAR is not affected by phased startup operations.

13a2.1.8 LARGE UNDAMPED POWER OSCILLATIONS

The information provided in Subsection 13a2.1.8 of the FSAR is not affected by phased startup operations.

13a2.1.9 DETONATION AND DEFLAGRATION IN THE PRIMARY SYSTEM BOUNDARY

The information provided in Subsection 13a2.1.9 of the FSAR is not affected by phased startup operations.

13a2.1.10 UNINTENDED EXOTHERMIC CHEMICAL REACTIONS OTHER THAN DETONATION

The information provided in Subsection 13a2.1.10 of the FSAR is not affected by phased startup operations.

13a2.1.11 SYSTEM INTERACTION EVENTS

The information provided in Subsection 13a2.1.11 of the FSAR remains valid for phased startup operations. Additionally, a system interaction event of damage to a PVVS to TOGS interface line during installation of the SCAS was identified and evaluated. The accident scenario of fire in the IF general area leading to damage of cooling room equipment was also modified and evaluated for increased initiating event likelihood during phased startup operations.

Errors during installation of SCAS equipment in an IU cell during Phase 1 or Phase 2 operations may result in damage to the PVVS to TOGS interface line that extends into the IU cell. Damage to this line could create a preferred flow path for PVVS gas to bypass process tanks, leading to deflagration and radiological dose. This scenario is prevented through the application of a new passive engineered control of a physical barrier installed over vulnerable portions of the PVVS to TOGS interface line and a specific administrative control to limit crane hoist speed during SCAS installation.

The accident sequence of a fire in the IF general area leading to damage of cooling room equipment resulting in a complete loss of primary closed loop cooling system (PCLS) cooling in one or more IU cells or TOGS cells is modified during phased startup operations to account for an increased likelihood of the initiating event as a result of on-going installation activities. Radiological release due to this scenario is prevented by the credited controls currently in place, as described in Subsection 13a2.2.3 of the FSAR.

Because these events have preventative measures in place, there are no radiological consequences.

13a2.1.12 FACILITY-SPECIFIC EVENTS

The information provided in Subsection 13a2.1.12 of the FSAR remains valid for phased startup operations. Additionally, a facility-specific event of damage to an operating TPS train during the installation of another TPS train was identified and evaluated. The accident scenarios of a heavy load drop into an open IU cell and a heavy load drop onto TPS equipment were also modified and evaluated for increased initiating event likelihood during phased startup operations.

Errors during installation of TPS trains B or C during Phase 1 or Phase 2 operations, respectively, may result in damage to an operating TPS train. In the uncontrolled scenario, mechanical damage to an installed TPS train leads to release of tritium and radiological dose to workers and the public. The physical distance separating the TPS train installation locations reduces the likelihood of the initiating event. The scenario is prevented through the application of a new specific administrative control for operators to install physical barriers (e.g., roping or stanchions) around installed TPS trains to limit access to areas where mechanical damage to an installed TPS train is possible.

The accident sequences of a heavy load drop onto TPS equipment is modified during phased startup operations for increased likelihood of the initiating event as a result of on-going installation activities. This scenario is prevented by a credited control currently in place (i.e., single failure proof crane in the IF) and through the application of a new specific administrative control which requires that operators use safe load paths that avoid lifting over the TPS room.

Because these events have preventative measures in place, there are no radiological consequences.

13a2.2 ACCIDENT ANALYSIS AND DETERMINATION OF CONSEQUENCES

The information provided in Section 13a2.2 of the FSAR is not affected by phased startup operations. No new accident scenarios resulting in radiological or chemical release were identified as a result of phased startup operations. The material at risk for certain existing scenarios may be reduced by phased startup operations due to fewer units being in operation; however, the scenarios as described in Section 13a2.2 of the FSAR remain bounding and no credit is taken for the reduction in consequence that would result.

13a3 SUMMARY AND CONCLUSIONS

The information provided in Section 13a3 of the FSAR is not affected by phased startup operations. The IF accident dose consequences provided in Table 13a3-1 of the FSAR bound the IF accident dose consequences during any of the initial phases of operation.

13a4 REFERENCES

None

CHAPTER 13b – RADIOISOTOPE PRODUCTION FACILITY ACCIDENT ANALYSIS

13b.1 RADIOISOTOPE PRODUCTION FACILITY ACCIDENT ANALYSIS METHODOLOGY

The information provided in Section 13b.1 of the FSAR remains valid for phased startup operations. The methodology used to evaluate the impacts of phased startup operations is described in Chapter 13a2 of this supplement.

13b.1.1 PROCESSES CONDUCTED OUTSIDE THE IRRADIATION FACILITY

The process descriptions provided in Subsection 13b.1.1 of the FSAR remain valid for phased startup operations with the exception that the iodine and xenon purification and packaging (IXP) system is not installed as part of Phase 1, 2, or 3 operations.

13b.1.2 ACCIDENT INITIATING EVENTS

The information provided in Subsection 13b.1.2 of the FSAR remains valid for phased startup operations.

Phased startup operations do not result in new accident categories, but the following new accident sequence within the radioisotope production facility (RPF) was identified:

- Improper target solution routing to the IXP cell, prior to Phase 4 operations

Accident sequences within the RPF modified based on increased likelihood include:

- Heavy load drop onto the radioactive liquid waste immobilization (RLWI) shielded enclosure or supercell
- Fire in the RPF general area

Accident sequences that may have reduced likelihood or consequences due to the phased startup operations were not reevaluated because they are bounded by the accident analysis as currently documented in Chapter 13 of the FSAR.

One new credited engineered control is required to prevent phased startup operation accident sequences in the RPF. One new credited specific administrative control is required to prevent phased startup operation accident sequences in the RPF.

The following subsections provide additional detail on the scenarios listed above and the credited controls used for prevention.

13b.1.2.1 Maximum Hypothetical Accident

The information provided in Subsection 13b.1.2.1 of the FSAR is not affected by phased startup operations.

13b.1.2.2 External Events

The information provided in Subsection 13b.1.2.2 of the FSAR is not affected by phased startup operations.

13b.1.2.3 RPF Critical Equipment Malfunction

The information provided in Subsection 13b.1.2.3 of the FSAR remains valid for phased startup operations with the exception that the IXP system is not installed as part of Phase 1, 2, or 3 operations. The accident sequences that result from process upsets in the IXP are, therefore, not applicable during Phases 1, 2, or 3.

An additional RPF critical equipment malfunction scenario of a target solution leak into the IXP cell was identified and evaluated. The initiating event in this scenario is the failure of a locked closed valve between the molybdenum extraction and purification system (MEPS) and IXP, located in the MEPS cell. In the uncontrolled sequence, failure of the valve causes leakage of target solution into the IXP cell, resulting in dose consequences to the worker and the public. This scenario is prevented by a second locked closed manual valve between MEPS and IXP, located in the IXP cell.

The accident sequence of a heavy load drop onto the RLWI shielded enclosure or supercell is modified during phased startup operations to account for an increased likelihood of the initiating event as a result of on-going installation activities. This increase was small in comparison to the total planned lifts during normal operations and did not result in an increase in the likelihood index for the initiating event. This scenario is prevented by the credited controls currently in place, including the application of applicable guidance from NUREG-0612, Control of Heavy Loads at Nuclear Power Plants (USNRC, 1980), for control of heavy loads in the SHINE facility.

Because these scenarios have preventative measures in place, there are no radiological consequences.

13b.1.2.4 RPF Inadvertent Nuclear Criticality

The information provided in Subsection 13b.1.2.4 of the FSAR is not affected by phased startup operations.

13b.1.2.5 RPF Fire

The information provided in Subsection 13b.1.2.5 of the FSAR remains valid for phased startup operations. An increase in the initiating event likelihood for a fire in the RPF general area was reevaluated for phased startup operations, resulting in an increase in the likelihood index for the initiating event. A new specific administrative control of suspension of radiological material processing in the adjacent cell during hot work is applied in addition to the existing RPF fire controls.

Because this scenario has preventative measures in place, there are no radiological consequences.

13b.1.2.6 RPF Chemical Accidents

The information provided in Subsection 13b.1.2.6 of the FSAR is not affected by phased startup operations.

13b.2 ANALYSES OF ACCIDENTS WITH RADIOLOGICAL CONSEQUENCES

The information provided in Section 13b.2 of the FSAR is not affected by phased startup operations. No new accident scenarios resulting in radiological release were identified as a result of phased startup operations. The material at risk for certain existing scenarios may be reduced by phased startup operations due to fewer units being in operation; however, the scenarios as described in Section 13b.2 of the FSAR remain bounding and no credit is taken for the reduction in consequence that would result.

13b.3 ANALYSES OF ACCIDENTS WITH HAZARDOUS CHEMICALS

The information provided in Section 13b.3 of the FSAR is not affected by phased startup operations. No new accident scenarios resulting in chemical release were identified as a result of phased startup operations. The material at risk for certain existing scenarios may be reduced by phased startup operations due to fewer units being in operation; however, the scenarios as described in Section 13b.3 of the FSAR remain bounding and no credit is taken for the reduction in consequence that would result.

13b.4 REFERENCE

USNRC, 1980. Control of Heavy Loads Nuclear Power Plants, NUREG-0612, U.S. Nuclear Regulatory Commission, July 1980.

CHAPTER 14 – TECHNICAL SPECIFICATIONS

14.1 TECHNICAL SPECIFICATIONS

The approach to the development of the SHINE technical specifications described in Chapter 14 of the FSAR is not affected by the phased startup operations. Normal operation of the SHINE facility within the limits of the technical specifications during phased startup operations will not result in off-site radiation exposure in excess of 10 CFR Part 20 guidelines. Observance of these technical specifications limits the likelihood and consequences of malfunctions.

CHAPTER 15 – FINANCIAL QUALIFICATIONS

The financial information provided in Chapter 15 of the FSAR is not materially affected by the phased startup operations.

The decommissioning cost estimate for the facility remains bounding for phased startup operations. If the facility were to discontinue operations and undergo decommissioning prior to reaching full facility operations, the cost to decommission the facility would be reduced based on the reduced amount of contaminated equipment and contaminated or activated concrete in the facility.

CHAPTER 16 – OTHER LICENSE CONSIDERATIONS

16.1 PRIOR USE OF FACILITY COMPONENTS

The SHINE facility utilizes new and appropriately-qualified components and systems to conduct production operations. Discussions regarding used components and systems are not applicable to the SHINE facility.

16.2 MEDICAL USE OF THE FACILITY

The SHINE facility does not contain equipment or facilities associated with direct medical administration of radioisotopes or other radiation-based therapies. Therefore, discussions involving medical use of the SHINE facility are not applicable.

CHAPTER 17 – DECOMMISSIONING AND POSSESSION-ONLY LICENSE AMENDMENTS

17.1 DECOMMISSIONING

A decommissioning report, as described in 10 CFR 50.33(k)(1) and 10 CFR 50.75, indicating how reasonable assurance will be provided that funds will be available to decommission the facility, is provided in Section 15.3 of the FSAR.

17.2 POSSESSION-ONLY LICENSE AMENDMENTS

This section relates to a possession-only license and is not applicable to the SHINE facility.

CHAPTER 18 – HIGHLY ENRICHED TO LOW ENRICHED URANIUM CONVERSION

18.1 HIGHLY ENRICHED TO LOW ENRICHED URANIUM CONVERSION

This chapter does not apply to the SHINE facility since it is a new facility that uses low enriched uranium.