OAK RIDGE National Laboratory

SNS ASE Rev 7 Changes

Jacob Platfoot, Accelerator Safety Program Lead

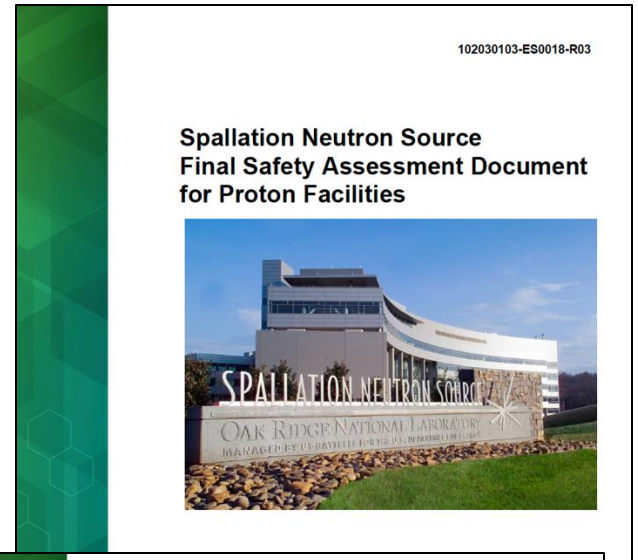
Thomas Copinger, Senior Accelerator Facility Safety Engineer

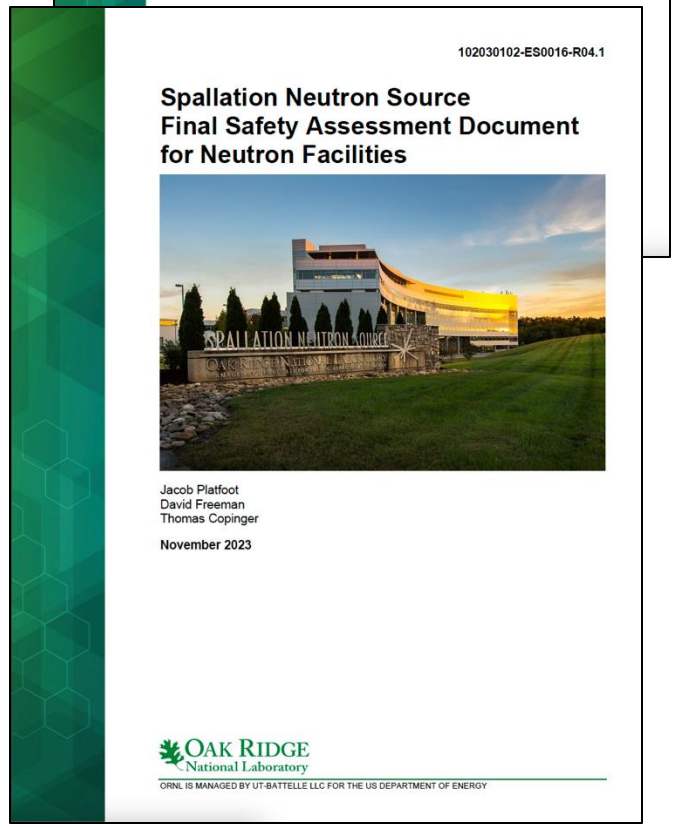
ORNL is managed by UT-Battelle LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Why Rev the ASE?

- ASE Revs 6 & 7 address changes to FSAD-PF and FSAD-NF needed for PPU
  - ASE Rev 6 -> FSAD-PF Rev 3
    - Timing: before operation with more than 23 cryomodules (~Nov 2022)
  - ASE Rev 7 -> FSAD-NF Rev 4
    - Timing: before operation with high flow gas injection (~Mar 2024)
- Also, FSADs were more than a decade old, and in need of revision





Sections with Substantive Changes

Sec	Desc	Sec	Desc
Sec 3.1	TPS	App 1 Sec 3	Service Bay and CV 2-h Fire Barrier
Sec 3.2	PPS	App 1 Sec 5	Service Bay and Monolith Hg Confinement
Sec 3.5	SBDPMS	App 1 Sec 6	PCES
Sec 3.6	TBAC	App 1 Sec 7	High Bay Floor Design
Sec 3.8	Target Bldg FSS Outside the Service Bay	App 1 Sec 8	Hg H/X Design
Sec 4	CACs	App 1 Sec 9	Hg Pump Tank Exhaust Line Loop Seal
Sec 5	ASE Modifications and Violations	App 1 Sec 12	High Bay Crane Design
Sec 6	Staffing	App 1 Sec 14	CMS Catalytic Converter Retention Elements

Section 3.1, TPS

- Added to safety function
- Clarified operability statement
- Added compensatory measure

3.1 **Target Protection System (TPS)**
The TPS prohibits proton beam on target based on high Hg temperature and/or low Hg flow (as indicated by pump ΔP or power to the pump) to ensure Hg temperature remains below the Hg boiling point (357 ºC).

3.1.1 **Operability** – The TPS shall be operable whenever beam in excess of 5.6 kW-hrs in any 24 hour period is directed onto the target.

3.1.2 **Compensatory Measures** – None.

3.1.3 **Surveillance** - The TPS system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedures.

3.1 **Target Protection System (TPS)**
The TPS prohibits beam on target based on high mercury temperature or low mercury flow to ensure the mercury temperature remains below the mercury boiling point (357 ºC). The TPS also prevents beam on target when the target cart is not fully inserted.

3.1.1 **Operability**
The TPS shall be operable whenever beam in excess of 5.6 kWh in any 24-hour period is directed onto the target or when the target cart is retracted.

3.1.2 **Compensatory Measures**
If the TPS is not operable while the target cart is not fully inserted, beam on target shall be prohibited and controlled in accordance with the appropriate lock out of critical devices.

3.1.3 **Surveillance**
The TPS system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedures.

Section 3.2, PPS

- Reworded compensatory measure

3.2 **Personnel Protection System (PPS)**
The PPS safety functions are 1) Prevent beam operation in a segment unless its associated exclusion areas are cleared of personnel (beam containment), 2) Shut off beam if personnel enter an exclusion area associated with a segment where beam is permitted (access violation), 3) shut off beam if radiation levels set by the SNS RSO are reached at PPS interlocked area radiation monitor locations, 4) prohibit beam to the target when the target cart is out of the "cart-inserted" position, and 5) shut off beam to prevent beam directed to the target from exceeding the beam power limit defined in Section 1.1 via the Beam Power Limiting System (BPLS) portion of the PPS.

3.2.1 **Operability -** Those functions of the PPS required to support the applicable operational configuration shall be operable during operations with beam.

The BPLS portion of the PPS shall be operable during beam operations to the target whenever more than 23 cryomodules are in service in the superconducting linac system.

3.2.2 **Compensatory Measures**

3.2.2.1 Operations with beam to segments with an inoperable PPS shall be prohibited and controlled in accordance with the appropriate lock out of PPS Critical Devices.

3.2.2.2 The PPS target cart position interlock may be bypassed under the following conditions:

- **Beam to target prevented** – Critical Device is locked and tagged as a Radiation Safety Hold in the de-energized mode thus preventing beam transport to target.

- - OR - -

- **Beam to target allowed -** the following restrictions must be in place:
  - The TPS shall be operable.
  - The RSO and SNS Operations Manager (or designees) visually verify that the target cart is fully inserted into the target cart tunnel.
  - The cart hydraulic drive unit is locked out and tagged as a Radiation Safety Hold such that it cannot be energized.

3.2.2.3 If the BPLS portion of the PPS is required but inoperable, operations with beam to target may be permitted at a nominal beam power of 1.8 MW or less using approved SNS procedures that develop and document parameter constraints to ensure beam power to the target does not exceed 2 MW as described below:

- The SNS Operations Manager shall provide authorization prior to any operations with beam to target while the BPLS is inoperable to develop parameter constraints. During these operations, the repetition rate of the accelerator shall be limited to 1 Hz.
- Once the parameter constraints are documented and implemented, the SNS Operations Manager shall approve commencement of 60 Hz operations under the documented parameter constraints.
- The documented parameter constraints shall be maintained in the CCR and adherence to the parameter constraints shall be verified by the Control Room Shift Supervisor every shift.

3.2.3 **Surveillance -** The PPS shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedures.

3.2 **Personnel Protection System (PPS)**
The PPS safety functions are (1) prevent beam operation in a segment unless its associated exclusion areas are cleared of personnel (beam containment), (2) shut off beam if personnel enter an exclusion area associated with a segment where beam is permitted (access violation), (3) shut off beam if radiation levels set by the Radiation Safety Officer (RSO) are reached at PPS interlocked area radiation monitor locations, (4) prohibit beam to the target when the target cart is out of the "cart-inserted" position, and (5) shut off beam to prevent beam directed to the target from exceeding the beam power limit defined in Section 1.1 of the ASE principal document via the Beam Power Limiting System (BPLS) portion of the PPS.

3.2.1 **Operability**
Those functions of the PPS required to support the applicable operational configuration shall be operable during operations with beam.

The BPLS portion of the PPS shall be operable during beam operations to the target whenever more than 23 cryomodules are in service in the superconducting linac system.

3.2.2 **Compensatory Measures**

3.2.2.1 Operations with beam to segments with an inoperable PPS shall be prohibited and controlled in accordance with the appropriate lock out of PPS critical devices.

3.2.2.2 Beam to target may be allowed with the PPS target cart position interlock bypassed provided the following restrictions are in place:

- The TPS shall be operable.
- The RSO and SNS Operations Manager (or designees) visually verify that the target cart is fully inserted into the target cart tunnel.
- The cart hydraulic drive unit is locked out and tagged as a Radiation Safety Hold such that it cannot be energized.

3.2.2.3 If the BPLS portion of the PPS is required but inoperable, operations with beam to target may be permitted at a nominal beam power of 1.8 MW or less using approved SNS procedures that develop and document parameter constraints to ensure beam power to the target does not exceed 2 MW as described below:

- The SNS Operations Manager (or designee) shall provide authorization prior to any operations with beam to target while the BPLS is inoperable to develop parameter constraints. During these operations, the repetition rate of the accelerator shall be limited to 1 Hz.
- Once the parameter constraints are documented and implemented, the SNS Operations Manager (or designee) shall approve commencement of 60 Hz operations under the documented parameter constraints.
- The documented parameter constraints shall be maintained in the Central Control Room (CCR) and adherence to the parameter constraints shall be verified by the Control Room Shift Supervisor (CRSS) every shift.

3.2.3 **Surveillance**
The PPS shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedures.

Section 3.5, SBDPMS

- Rewrote safety function
- Rewrote operability statement
- Added compensatory measure

3.5 Target Service Bay Differential Pressure Monitoring (SBDP) System

Monitors the pressure difference between the Target Service Bay atmosphere and the adjacent area. The system initiates audible alarms to warn staff in or near the Transfer Bay to evacuate the area. When the Transfer Bay Personnel Door is open, the SBDP system should promptly be placed in the Air Flow Mode. In the Air Flow Mode, the system alarms on low Primary Confinement Exhaust System (PCES) air flow instead of differential pressure.

3.5.1 **Operability** – In order to protect personnel in or near the Transfer Bay, the SBDP system shall be operable when:

3.5.1.1 The Transfer Bay Personnel Door is not in the closed position

- - **AND** - -

3.5.1.2 airborne Hg concentrations inside the Service Bay exceed the OSHA ceiling of 0.1 mg/m³ [6].

3.5.2 **Compensatory Measures** – In the event that the SBDP system is not operable or is bypassed, the Transfer Bay Personnel Door may be opened and personnel allowed to enter only when the following conditions are met:

3.5.2.1 The RSO and SNS Operations Manager (or designees) visually verify that both the upper and lower Intra-Bay Doors are in the closed position.

3.5.2.2 Prior to opening the Personnel Door, airborne Hg concentration in the Transfer Bay and surrounding area shall be measured.

3.5.2.3 The SNS Operations Manager (or designee) shall review the airborne Hg concentration measurements and shall ensure the appropriate controls are in place to protect the worker prior to authorizing entry.

3.5.2.4 Transfer Bay and surrounding area Hg airborne concentrations shall be monitored when personnel are in the Transfer Bay.

3.5.2.5 In the event that the SBDP becomes inoperable while the Transfer Bay Personnel door is open, response shall be performed in accordance with SNS procedures.

3.5.3 **Surveillance** - The system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

3.5 Service Bay Differential Pressure Monitoring System (SBDPMS)

The SBDPMS provides audible and visual alarms in areas adjacent to the service bay if confinement exhaust is not maintaining sufficient negative pressure or system flow to ensure confinement of service bay atmosphere, supporting evacuation of personnel.

3.5.1 **Operability**

In order to protect personnel in areas adjacent to the service bay, the SBDPMS shall be operable if any of the following conditions exist:

3.5.1.1 Mercury is loaded in the mercury circulation loop.

3.5.1.2 Airborne mercury concentrations inside the service bay exceed the OSHA ceiling of 0.1 mg/m³ [3].

3.5.1.3 One or more service bay T-beams are removed.

3.5.2 **Compensatory Measures**

In the event that the SBDPMS is not operable:

3.5.2.1 Personnel access to areas adjacent to the service bay may be allowed by approved SNS procedures that ensure personnel evacuation upon loss of Primary Confinement Exhaust System (PCES) ventilation. The SNS procedures shall also ensure personnel safety upon subsequent re-entry.

3.5.2.2 The transfer bay personnel door may be opened and personnel allowed to enter only when the following conditions are met:

- The RSO and SNS Operations Manager (or designees) visually verify that both the upper and lower intrabay doors are in the closed position.
- Prior to fully opening the transfer bay personnel door, the airborne mercury concentration in the transfer bay and surrounding areas shall be measured.
- The SNS Operations Manager (or designee) shall review the airborne mercury concentration measurements and shall ensure that appropriate controls are in place to protect the worker prior to authorizing entry.
- Mercury airborne concentrations in the transfer bay and surrounding areas shall be monitored when personnel are in the transfer bay.

3.5.2.3 In the event that the SBDPMS becomes inoperable while the transfer bay personnel door is open, response shall be performed in accordance with approved SNS procedures.

3.5.3 **Surveillance**

The system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

Section 3.6, TBAC

- Rewrote safety function
- Rewrote operability statement
- Removed a compensatory measure
- Rewrote a compensatory measure

3.6 **Transfer Bay Access Control (TBAC) System**
In order to limit personnel radiation and Hg exposure, the TBAC prevents opening of the Transfer Bay personnel door unless both Intra-Bay doors are closed.

3.6.1 **Operability** – The TBAC system shall be operable when dose rates in the Service Bay exceed 1 R/hr or airborne Hg concentrations exceed the OSHA ceiling of 0.1 mg/m³ [6] and the Transfer Bay Personnel Door is not locked in the closed position.

3.6.2 **Compensatory Measures**

3.6.2.1 The TBAC system may be inoperable or bypassed when the Transfer Bay Personnel Door is locked in the closed position and tagged as a Radiation Safety Hold to prevent inadvertent opening of the door.

3.6.2.2 Entry into the Transfer Bay with the Intra-Bay doors closed and the TBAC system inoperable or bypassed must adhere to the following restrictions:

- The Intra-Bay doors shall be visually verified to be in the closed position and the electrical breakers that supply power for opening the Intra-Bay doors are locked out and tagged as a Radiation Safety Hold to prevent opening; and

- - **AND** - -

- Entry is conducted in accordance with an approved Radiological Work Permit.

3.6.2.3 Entry into the Transfer Bay and/or other areas of the Service Bay with the TBAC System inoperable or key bypassed and the Intra-Bay doors open must adhere to the following restrictions:

- Beam on target is prohibited using a Credited Engineered Control or RS Hold of critical device.
- RSO and SNS Operations Manager (or designees) approve a radiation survey to be conducted in accordance with RWP.
- Subsequent entries are conducted in accordance with a Radiological Work Permit and approval of the SNS RSO and SNS Operations Manager (or designees).

3.6.2.4 In the event that the TBAC becomes inoperable while the Transfer Bay Personnel door is open, response shall be performed in accordance with SNS procedures

3.6.3 **Surveillance** - The TBAC system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

→

3.6 **Transfer Bay Access Control (TBAC) System**
The safety function of the TBAC is to (1) prevent opening of the transfer bay personnel door unless both intrabay doors are closed, and (2) sound an alarm if the intrabay doors are opened while the transfer bay personnel door is open.

3.6.1 **Operability**
The TBAC system shall be operable unless the transfer bay personnel door is locked in the closed position and tagged with a radiation safety hold.

3.6.2 **Compensatory Measures**

3.6.2.1 Entry into the transfer bay with the intrabay doors closed and the TBAC system inoperable must adhere to the following restrictions:

- The intrabay doors shall be visually verified to be in the closed position and the electrical breakers that supply power for opening the intrabay doors are locked out and tagged as a Radiation Safety Hold to prevent opening.
- Entry is conducted in accordance with an approved Radiological Work Permit (RWP).

3.6.2.2 Entry into the transfer bay and other areas of the service bay with the TBAC System inoperable or key bypassed and the intrabay doors open must adhere to the following restrictions:

- Beam on target shall be prohibited and controlled in accordance with the appropriate lock out of critical devices.
- Entry is conducted in accordance with SNS procedures approved by the RSO and SNS Operations Manager (or designees) that require radiation surveys to be conducted in accordance with an RWP. Entry shall be approved by the RSO and SNS Operations Manager (or designees).

3.6.2.3 If the TBAC becomes inoperable while the transfer bay personnel door is open, response shall be performed in accordance with approved SNS procedures.

3.6.3 **Surveillance**
The TBAC system shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

Section 3.8, Target Bldg FSS Outside the Service Bay

- Rewrote Safety Function

3.8 **Target Building Fire Suppression System (FSS) Outside the Service Bay**
To minimize the fire hazard to the credited target service bay/core vessel fire barrier and prevent challenges to the structural integrity of the target building.

3.8.1 **Operability** - The fire suppression systems that provide protection outside the service bay shall be operable as required by ORNL fire protection SBMS and SNS procedures.

3.8.2 **Compensatory Measures**

3.8.2.1 Planned impairments associated with scheduled inspection, testing, and maintenance activities are performed in accordance with ORNL Fire Department instructions.

3.8.2.2 Temporary impairment of the fire suppression system is allowed when interim compensatory measures are conducted in accordance with SNS procedures.

3.8.3 **Surveillance** - The system shall undergo annual inspection, testing, and maintenance (not to exceed 15 months).

3.8 **Target Building Fire Suppression System (FSS) Outside the Service Bay**
To automatically initiate sprinkler flow to control a fire that develops in areas directly adjacent to the service bay and in the high bay, instrument hall, or target building basement area, and to prevent challenges to the structural integrity of the target building.

3.8.1 **Operability**
The FSS outside the service bay shall be operable as required by the ORNL Standards Based Management System (SBMS) Fire Protection, Prevention, and Control subject area and approved SNS procedures.

3.8.2 **Compensatory Measures**

3.8.2.1 Planned impairments associated with scheduled inspection, testing, and maintenance activities are performed in accordance with ORNL Fire Department instructions.

3.8.2.2 Temporary impairment of the FSS outside the service bay is allowed when interim compensatory measures are conducted in accordance with approved SNS procedures.

3.8.3 **Surveillance**
The system shall undergo annual (not to exceed 15 months) inspection, testing, and maintenance in accordance with the ORNL SBMS Fire Protection, Prevention, and Control subject area.

Section 4, CACs

- Removed three CACs
- Reworded two CACs for clarity

Section 4: Credited Administrative Controls

This section identifies the Credited Administrative Controls (**CACs**) listed in the FSAD-NF to mitigate hazards associated with Target Building activities. The CACs apply to Target Building activities and are promulgated through SNS programs and procedures.

1. The Radiological Protection Program provides a means of controlling the radiological exposure received by facility workers by controlling the planning, approval, monitoring, and execution of radiological work
2. The Chemical Safety Program provides protection against inadvertent exposure to mercury or mercury vapor during initial facility startup (chemical protection)
3. The Combustible Materials Control Program inside and outside of the target service bay
4. The Ignition Control Program outside of Two-Hour Fire Barrier
5. The Hoisting and Rigging Program:
   - Restricts Crane Lifts in high bay
   - Restricts External Crane Lifts Over Target Facility
   - Addresses Certification and Preventive Maintenance for Service Bay Crane and Gantry Crane Robotic Arm.
6. Procedures are required and are in place for the following:
   - To control access to the target service bay
   - To ensure proper response to loss of negative pressure alarm (PCE System – Target Bay Delta P alarm)
   - To ensure workers close personnel door when evacuating in response to negative pressure alarm
   - To protect workers from radiological hazards during target changeout activities
   - To control Hg inventory on charcoal adsorbers
7. Emergency Response Procedures are required and are in place for the following:
   - Fire with worker(s) in the transfer bay and the personnel door in the open position
   - Evacuation of Workers outside target building as required in response to an external crane load drop on the target building resulting in a release
   - Evacuation of Workers in event of fire during maintenance activities when the target service bay, transfer bay and high bay are open to common air flow

SECTION 4: CREDITED ADMINISTRATIVE CONTROLS

This section identifies the credited administrative controls (CAC) listed in the FSAD-NF [2] to mitigate hazards associated with target building activities. The CACs are promulgated through SNS programs and approved procedures.

1. The **Radiological Protection Program** provides a means of controlling the radiological exposure received by facility workers by controlling the planning, approval, monitoring, and execution of radiological work.
2. The **Chemical Safety Program** provides protection against inadvertent exposure to mercury or mercury vapor during initial facility startup.
3. The **Combustible Materials Control Program** inside and outside of the service bay.
4. The **Ignition Control Program** outside of the Service Bay and Core Vessel 2-Hour Equivalent Fire Barrier.
5. The **Hoisting and Rigging Program**:
   - Restricts crane lifts in the high bay.
   - Restricts external crane lifts over the target building.
   - Addresses certification and preventative maintenance for the Service Bay Crane and Gantry Crane Robotic Arm.
6. **Procedures and training** are required and are in place for the following:
   - To ensure proper response to a SBDPMS alarm including evacuation of areas adjacent to the service bay.
   - To control mercury inventory on the PCES charcoal adsorbers.
7. **Emergency response procedures and training** are required and are in place for the following:
   - To close the transfer bay personnel door upon evacuation from a service bay fire.
   - To ensure evacuation of personnel in response to an external crane load drop on the target building.
   - To ensure evacuation of personnel in response to a service bay fire during maintenance activities when the target service bay, transfer bay, and high bay are open to common air flow.

Sections 5 & 6, ASE Mods and Violations & Staffing

- Added bullet for lifesaving activities
- Clarified who approves OST vacancy

Section 5: Modifications and Violations of the ASE

5.1 The following are the basic requirements for control of modifications to the Accelerator Safety Envelope and general actions to be taken upon discovery of a violation of the Accelerator Safety Envelope:

- Modifications to the ASE shall be approved by the DOE prior to implementation.
- Any activity violating the ASE Limits or Requirements must be terminated immediately and put in a safe and stable condition. Any activity that was shut down by DOE must not recommence until DOE approves the activity.

Section 6: Staffing

6.1 The staffing requirement for all machine operations with particle beam is a minimum of 1 qualified Control Room Shift Supervisor and 1 qualified Control Room Accelerator Specialist. During such operations, one of the two must remain in the CCR at all times. If one Operations staff member is incapacitated, the remaining Operations staff member may continue beam operations as long as staffing requirements are restored within four hours.

6.2 At least 1 qualified Target Systems Operations Shift Technician shall be onsite during beam on target operations and at times when Hg is loaded in the circulation loop or Hydrogen is loaded in the cryogenic moderator system (CMS). Under extenuating circumstances (e.g., inclement weather, sudden illness, etc.) the Target Systems Operations Shift Technician post may be vacated for a period not to exceed six hours with the approval of the Target Systems Group Operations Shift Technicians Team Leader and notification of the Control Room Shift Supervisor.

SECTION 5: MODIFICATIONS AND VIOLATIONS OF THE ASE

5.1 The following are the basic requirements for control of modifications to the ASE and general actions to be taken upon discovery of a violation of the ASE:

- Modifications to the ASE shall be approved by the Department of Energy (DOE) prior to implementation.
- Any activity violating ASE limits or requirements must be terminated immediately and put in a safe and stable condition.
- Any activity that was shut down by DOE must not recommence until DOE approves the activity.
- Exception to the requirements of the ASE is provided for lifesaving activities when the required actions of the ASE would unnecessarily delay medical services or increase the risk of death or serious bodily harm to personnel from a real and present danger.

SECTION 6: STAFFING

6.1 The staffing requirement for all machine operations with particle beam is a minimum of one qualified CRSS and one qualified Control Room Accelerator Specialist (CRAS). During such operations, one of the two must remain in the CCR at all times. If one operations staff member is incapacitated, the remaining operations staff member may continue beam operations as long as staffing requirements are restored within four hours.

6.2 At least one qualified Operations Shift Technician (OST) shall be onsite during beam on target operations and at times when mercury is loaded in the mercury circulation loop or hydrogen is loaded in the CMS. Under extenuating circumstances (e.g., inclement weather, sudden illness) the OST post may be vacated for a period not to exceed six hours with the approval of target operations line management and notification of the CRSS.

App 1 Sec 3, Service Bay and CV 2-h Fire Barrier

- Rewrote safety function
- Added requirements to both compensatory measures

3. **Service Bay / Core Vessel Fire Barrier**
To isolate the service bay / core vessel in case of a fire.

3.1. **Operability** – Designed and built as a concrete and steel structure with steel shielding surrounding the core vessel.

3.2. **Compensatory Measures** - If mercury is not loaded into the Hg circulation loop, then the monolith and Service Bay T-beams may be removed. Mercury may be loaded into the Hg circulation loop with the monolith T-beams removed provided the following compensatory measures are taken:
- Bulk shielding remains in place (does not include shutters and shutter drive units), and
- A dedicated Target Operations Shift Technician will be stationed to operate the Hg circulation loop and will have written instructions to drain the loop in the event of a fire.

3.3. **Surveillance** – Configuration controlled through SNS procedures.

3. **Service Bay and Core Vessel 2-Hour Equivalent Fire Barrier**
Isolation Function: provide a physical barrier between the service bay and core vessel and combustibles located outside of the service bay and core vessel. The barrier shall be designed to prevent migration of either combustibles or mercury across the barrier.
Fire Barrier Function: prevents a fire outside of the service bay and core vessel from propagating into the service bay and core vessel for a two-hour equivalent fire.

3.1. **Operability**
Designed and built as a concrete and steel structure with steel shielding surrounding the core vessel.

3.2. **Compensatory Measures**

3.2.1. If mercury is not loaded into the mercury circulation loop, then the monolith and service bay T-beams may be removed.

- Prior to the removal of service bay T-beams, approved SNS procedures shall be in place to ensure safety of personnel in the high bay during the period when the T-beams are removed, including provision for evacuation of personnel in the case of a fire inside the service bay (see Section 4.7 of the ASE principal document).

3.2.2. Mercury may be loaded into the mercury circulation loop with the monolith T-beams removed provided the following compensatory measures are taken:

- Bulk shielding remains in place (does not include shutters and shutter drive units).
- A dedicated OST will be stationed to operate the mercury circulation loop and will have written instructions to drain the loop in the event of a fire.
- Lift restrictions supporting Section 7 of the ASE appendix are followed.

3.3. **Surveillance**
Configuration controlled through approved SNS procedures.

App 1 Sec 5, Service Bay and Monolith Hg Confinement

- Updated safety function

5. **Target Service Bay and Monolith (Confinement of Hg)**
To provide confinement of the mercury.

5.1. **Operability** – The Service Bay was designed and built with a stainless steel liner and a sloped floor. The Monolith support pedestal has a sloped steel liner designed to direct spilled mercury to a stainless steel lined pit which can contain the maximum credible spill within a two hour fire wall boundary. The penetration location is adequately above floor level.

5.2. **Compensatory Measures** - None.

5.3. **Surveillance -** Configuration controlled through SNS procedures.

5. **Service Bay and Monolith Confinement of Mercury**
Provide confinement of liquid mercury and mitigate an airborne mercury release by retaining the liquid mercury in a confined location in the service bay or monolith.

5.1. **Operability**
The service bay was designed and built with a stainless-steel liner and a sloped floor. The monolith support pedestal has a sloped steel liner designed to direct spilled mercury to a stainless-steel lined pit which can contain the maximum credible spill within a two-hour fire wall boundary. Penetrations are adequately above floor level.

5.2. **Compensatory Measures**
None.

5.3. **Surveillance**
Configuration controlled through approved SNS procedures.

App 1 Sec 6, PCES

- Rewrote safety function
- Added compensatory measure

6. **Primary Confinement Exhaust System (PCES)**
To ensure 1) prevention or minimization of worker exposure to mercury vapor in the event of a spill or fire, and 2) that the amount of Hg deposited on the Charcoal Adsorbers is maintained below levels that could represent an unacceptable hazard if vaporized in a fire.

6.1. **Operability:**

6.1.1. The backdraft dampers shall be operable when Hg is loaded in the Hg circulation loop (i.e. that portion of the mercury process system on the process side of the storage tank transfer valve; does not include the Hg storage tank).

6.2. **Compensatory Measures** – None.

6.3. **Surveillance** - Annual verification (not to exceed 15 months) is to be performed to assure that the backdraft dampers close freely upon loss of airflow.

6. **Primary Confinement Exhaust System (PCES)**
The PCES ductwork protects workers inside the target building from exposure to mercury vapor by preventing or minimizing leakage of confinement exhaust from the service bay into occupiable areas. Design features of the PCES also support the Service Bay and Core Vessel 2-Hour Equivalent Fire Barrier by preventing transmission of hot gases into or out of the service bay via the PCES intake ducting.

6.1. **Operability**
The backdraft dampers shall be operable when mercury is loaded in the mercury circulation loop.

6.2. **Compensatory Measures**
If the leak-tight integrity of the PCES ductwork is compromised:

6.2.1. The mercury shall be drained from the mercury circulation loop.

6.2.2. Personnel occupancy in the area of the compromised ducting shall be monitored and controlled in accordance with approved SNS procedures.

6.2.3. Appropriate measures shall be implemented to account for effects on SBDPMS (per Section 3.5 of the ASE principal document).

6.3. **Surveillance**
Annual verification (not to exceed 15 months) as specified in approved SNS procedures is to be performed to assure that the backdraft dampers close freely upon loss of airflow.

App 1 Sec 7, High Bay Floor Design

- Added safety function
- Rewrote operability statement
- Added two compensatory measures

7. **High Bay Floor Design**

7.1. **Operability** – Designed and built with T-Beams over the Service Bay and over the Monolith.

7.2. **Compensatory Measures** – None.

7.3. **Surveillance** - Configuration controlled through SNS procedures.

7. **High Bay Floor Design**

Prevent a dropped load from contacting the interior of the service bay or core vessel by ensuring that the high bay floor can withstand a load drop for all allowable crane lifts.

7.1. **Operability**

Administrative limits on crane lifts in the high bay shall be in force whenever mercury is loaded into the mercury circulation loop.

7.2. **Compensatory Measures**

- T-beams may be removed from the high bay floor in accordance with Section 3.2 of the ASE appendix.
- If the monolith T-beams are removed with mercury loaded in the mercury circulation loop, lifts that will pass over the core vessel must be approved by the SNS Operations Manager.

7.3. **Surveillance**

Configuration controlled through approved SNS procedures.

App 1 Sec 8, Hg H/X Design

- Rewrote safety function
- Removed compensatory measure

8. **Robust Hg Heat Exchanger**
To assure periodic checks of heat exchanger integrity to ensure operability.

8.1. **Operability** - The double-walled barrier shall be intact when Hg is loaded in the Hg circulation loop.

8.2. **Compensatory Measures**

8.2.1. The Limits specified above shall be in force unless approved written temporary procedure(s) to ensure safety as approved by the RAD Target Systems Group Leader, SNS Operations Manager and the System Engineer are enacted as a compensatory measure. The proposed compensatory measure is to be assessed to assure an Unreviewed Safety Issue is not involved in accordance with SNS procedures.

8.3. **Surveillance** - The integrity of both barriers shall be verified to be intact prior to each Hg fill of the Hg circulation loop.

→

8. **Mercury Heat Exchanger Double-Wall Design**
Prevent target mercury release into cooling water which could lead to escape from the service bay.

8.1. **Operability**
The double-walled barrier shall be intact when mercury is loaded in the mercury circulation loop.

8.2. **Compensatory Measures**
None.

8.3. **Surveillance**
The integrity of both barriers shall be verified to be intact prior to each fill of the mercury circulation loop.

App 1 Sec 9, Hg Pump Tank Exhaust Line Loop Seal

- Rewrote safety function
- Removed sentence from operability statement
- Added compensatory measure

9. **Mercury Pump Tank Exhaust Line Loop Seal (Hg Process System Fill Limitations)**
To prevent mercury pump tank overfill during system startup from leaking mercury outside the target service bay via the off-gas system.

9.1. **Operability** – This CEC provides a last layer of safety to prevent pump tank overfill during system startup from leaking mercury outside the target service bay via the mercury off-gas treatment system piping. The top of the loop seal, as installed in the service bay, is sufficiently high that the inert gas pressure in the mercury storage tank is insufficient to force liquid mercury up to the top of the loop.

9.2. **Compensatory Measures** – None.

9.3. **Surveillance** – Configuration controlled through SNS procedures.

9. **Mercury Pump Tank Exhaust Line Loop Seal**
Prevent liquid mercury from escaping the service bay via the mercury off-gas treatment system (MOTS) in the event of a mercury pump tank overfill during routine mercury circulation loop filling operations.

9.1. **Operability**
The top of the mercury pump tank loop seal, as installed in the service bay, must be sufficiently high to prevent the inert gas pressure in the mercury storage tank from forcing liquid mercury over the top of the loop seal.

9.2. **Compensatory Measures**
If the mercury pump tank loop seal does not satisfy the operability requirement in Section 9.1 of the ASE appendix, the mercury storage tank shall be vented to atmospheric pressure.

9.3. **Surveillance**
Configuration controlled through approved SNS procedures.

App 1 Sec 12, High Bay Crane Design

- Added safety function
- Added sentence to operability statement

12. High Bay Crane Design

12.1. **Operability** – The High Bay Crane was designed per ASME NOG-1.

12.2. **Compensatory Measures** – None.

12.3. **Surveillance** – Configuration controlled through SNS procedures.

→

12. High Bay Crane Design

The design of the high bay crane prevents failures that could result in a dropped load.

12.1. **Operability**
The High Bay Crane was designed per ASME NOG-1. If the High Bay Crane does not meet the requirements of ASME NOG-1, then it shall not be used to lift loads over the service bay or monolith.

12.2. **Compensatory Measures**
None.

12.3. **Surveillance**
Configuration controlled in accordance with ORNL SBMS Perform Hoisting and Rigging procedure.

App 1 Sec 14, CMS Catalytic Converter Retention Elements

- New CEC

14. Cryogenic Moderator System (CMS) Catalytic Converter Retention Elements

The CMS Catalytic Converter Retention Elements confine the catalyst media to its designed canister and prevent transport into the CMS loop.

14.1. **Operability**

The CMS Catalytic Converter Retention Elements must be operable whenever catalyst media is loaded into the associated catalyst module.

14.2. **Compensatory Measures**

None.

14.3. **Surveillance**

Configuration controlled through approved SNS procedures.

Thank you!

- Questions?