SNS Accelerator Safety Envelope (ASE):
for Full Power Operations of the
Front End, Linac, Ring, Transport Lines, Beam Dumps and Target

SNS 102030103-ES0016-R05

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Introduction

This document constitutes the integrated Accelerator Safety Envelope (ASE) for full power operation of the entire SNS facility. The bases for the safety envelope requirements are found in Chapter 5 of the Final Safety Assessment Document for Proton Facilities (FSAD-PF) [1] and in Chapter 5 of the Final Safety Assessment Document for Neutron Facilities (FSAD-NF) [2].

Definitions

a. **Certification** – verification that a system is operable and calibrated as required in accordance with written approved SNS procedure(s).

b. **Compensatory Measures** - temporary measures that may be invoked to allow for safe operations when a system is not operable.

c. **Credited Engineered Control** – engineered control identified in the safety assessment documents per SNS policy.

d. **Passive Credited Engineered Control** - a safety feature that accomplishes its credited safety function by its inherent physical characteristics and does not require frequent surveillance or operator intervention for reliable functioning. A passive control typically does not require human interaction or electronic feedback when called upon to perform the safety function.

e. **Active Credited Engineered Control** – one that is not passive.

f. **Credited Administrative Control** – administrative control identified in the safety assessment documents per SNS policy.

g. **Critical Beam Production and Transport Devices** – Devices essential to produce or transport beam (e.g. Ion Source 65 kV Power Supply, HEBT Dipoles, RTBT DH-13, etc.) as defined and controlled by the PPS (FSAD-PF Section 3.2.4.4.4).

h. **Hg circulation loop** - portion of mercury process system on the process side of the storage tank transfer valve; does not include the Hg storage tank.

i. **Operable** - a structure, component, or system is capable of performing intended function(s).

j. **Operating** – a structure, component, or system which is performing its intended function(s).

k. **Oxygen Deficiency Hazard** - an oxygen deficiency hazard shall be assumed to be present if the amount of inert gas present could, if released, dilute the oxygen concentration of air breathable by workers to below 18 %.

l. **Shall, should, and may** – the word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may" to denote permission.

Section 1: Limitations to Operating Parameters

This section identifies the measurable limitations on critical operating parameters that, in conjunction with the specifically identified hazard control considerations established by the facility design and construction, ensure that accelerator operations do not exceed the corresponding Radiological Dose Limits.

Control of Beam Power

1.1 When beam is directed to the Target, beam power **shall not exceed the nominal 2MW limit** by more than 10%, averaged over any 1 minute period.

1.2 When beam is directed to the Ring Injection Dump, beam power **shall not exceed the nominal 150 kW limit** by more than 50 kW, averaged over any 1 hour period. Beam power shall not exceed 200 kW for more than 1 minute.

1.3 When beam is **not** directed to either the Target or the Ring Injection Dump, beam power shall not exceed the nominal 7.5 kW by more than 10%, averaged over any 1 minute period.

Section 2: Shielding

This section identifies the SNS Shielding criteria.

2.1 SNS has only one mode of operation for shielding which is defined in the shielding policy.

2.2 Permanent shielding shall be designed to be consistent with 2 MW beam operation.

2.3 Incomplete Beamlines (i.e. those that have **not** successfully completed an Instrument Readiness Review) shall have their Primary Shutters locked in the closed position (or have their concrete shield plug replacements secured) and tagged as a Radiation Safety Hold to prevent movement during beam on Target operations.

2.4 Installed Beamlines (i.e. those that have successfully completed an Instrument Readiness Review for the applicable operational configuration) shall be allowed to open their Primary Shutter during beam operation to the Target.

Section 3: Credited Engineered Controls

All active and passive Credited Engineered Controls (CECs) are configuration controlled. Active CECs are certified by SNS procedures and/or applicable ORNL Fire Department instructions.

Credited Engineered Controls that perform an active safety function include:

1. Target Protection System (**TPS**)
2. Personnel Protection System (**PPS**) for Accelerator, Target, and Instruments and PPS interlocked Area Radiation Monitors.
3. Oxygen Deficiency Hazard (**ODH**) system
4. Linac Tunnel Emergency Ventilation System (**EVS**)
5. Target Service Bay Differential Pressure Monitoring System (**SBDP**)
6. Target Transfer Bay Access Control System (**TBAC**)
7. Fire Suppression System Inside the Service Bay (Water Mist)
8. Target Building Fire Suppression System Outside the Service Bay

Credited Engineered Controls with passive safety functions are listed below and further discussed in Appendix 1:

1. CMS Hydrogen Boundary
2. CMS Vacuum Boundary
3. Service Bay / Core Vessel Fire Barrier
4. Core Vessel with Rupture Disk and Neutron Beam Windows
5. Target Service Bay and Monolith (Confinement of Hg)
6. Primary Confinement Exhaust System
7. High Bay Floor Design
8. Robust Hg Heat Exchanger
9. Mercury Pump Tank Exhaust Line Loop Seal
10. High Bay Crane Design

The following sections specify requirements for each Credited Engineered Control with regard to:

- Safety function requirements for operability
- Compensatory measures
- Requirements for periodic surveillance to ensure the CEC remains operable

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 (357º C).

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.

3.2 **Personnel Protection System (PPS)** and PPS-interlocked **Area Radiation Monitor** system:
The **PPS** and **Area Radiation Monitors** that are interlocked to the PPS 1) prevent entry in areas with significant radiation hazard 2) trip the beam off when radiation levels set by the SNS RSO are reached in occupied areas, and 3) prohibit beam to the target when the target cart is out of "cart-inserted" position.

3.2.1 **Operability** - Those portions of the **PPS** and PPS-interlocked **Area Radiation Monitor** systems required to support the applicable operational configuration shall be operable during operations with beam.

3.2.2 **Compensatory Measures**

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

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

- - OR - -

3.2.2.1.2 **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.

3.2.2.2 Operations with beam to areas with a non-operable PPS shall be prohibited and controlled in accordance with the appropriate lockup of PPS critical beam production or transport devices.

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

3.3 **Oxygen Deficiency Hazard System:**
The **ODH** system monitors oxygen levels in the CHL and Linac tunnel and provides audible and visual alarms to alert workers in the area of hazards.

3.3.1 **Operability** - The ODH system shall be operable if a potential oxygen deficiency hazard could exist in the LINAC or CHL unless compensatory action measures are taken.

3.3.2 **Compensatory Measures**

3.3.2.1 exclusion of personnel from the areas in which the ODH system is inoperable,

- - OR - -

3.3.2.2 providing a watch–stander and providing portable ODH monitoring, and/or using breathing apparatus per SNS procedure.

3.3.3 **Surveillance** – The ODH and EVS systems shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

3.4 **Linac Tunnel Emergency Ventilation System** (**EVS**)
The **EVS** system is available to ventilate the Linac tunnel upon alarm of the **ODH** system.

3.4.1 **Operability** - The ODH system and its control of the Linac EVS Systems shall

be operable if a potential oxygen deficiency hazard could exist in the LINAC or CHL unless compensatory action measures are taken.

3.4.2 **Compensatory Measures**

3.4.2.1 exclusion of personnel from the areas in which the ODH system is inoperable,

- - OR - -

3.4.2.2 providing a watch–stander and providing portable ODH monitoring, and/or using breathing apparatus per SNS procedure.

3.4.3 **Surveillance** – The ODH and EVS systems shall undergo annual certification (not to exceed 15 months) as specified by approved SNS procedure.

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/m^3 [3].

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 that 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.

3.6 **Transfer Bay Access Control (TBAC) System for the Target**:
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/m^3 [3] 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:

3.6.2.2.1 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 - -

3.6.2.2.2 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:

3.6.2.3.1 Beam on target is prohibited using a Credited Engineered Control or RS Hold of critical beam production or transport device.

3.6.2.3.2 RSO and SNS Operations Manager (or designees) approve a radiation survey to be conducted in accordance with RWP.

3.6.2.3.3 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.

3.7 **Fire Suppression System Inside the Target Service Bay (Water Mist)**

To ensure that the Target Service Bay Fire Suppression System (FSS) is operable and capable of minimizing the risk associated with a fire potentially vaporizing process Hg.

3.7.1 **Operability** – The FSS in the Process/Maintenance Bay portion of the Target Service Bay shall be operable at any time Hg is in the Hg circulation loop unless:

- The process Hg is drained to the storage tank; or
- The steel shielding designed to cover the mercury loop is fully installed.

3.7.2 **Compensatory Measures**

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

3.7.2.2 Temporary impairment and bypasses of the system are allowed by approved SNS procedures or task specific JHA for instances including but not limited to:

- when personnel enter the Service Bay
- when activities are being conducted that have a high probability of actuating a false alarm (e.g. welding, cutting, etc.)

3.7.3 **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 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).

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 5: Monitoring and Release Control of Ventilation Effluent and Mitigation Measures for the Protection of the Environment as Identified in the FSAD

This section identifies how ventilation effluent is monitored and controlled in order to protect the environment.

5.1 Airborne radionuclide emissions from SNS operations are collected, monitored, and discharged at the Central Exhaust Facility (CEF). The air emissions are regulated and permitted by the Tennessee Department of Environment and Conservation (TDEC) and the U. S. Environmental Protection Agency (EPA) , and are subject to compliance with 40 Code of Federal Regulations (CFR) Part 61, Subpart H.

Section 6: Administrative Controls

This section contains limits on SNS Operations to ensure that regulatory requirements established to protect our environment, public, and staff/visitors are met.

6.1 Modifications and Violations of the ASE

6.1.1 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 DOE must be notified. DOE shall have the option of approving the resumption of activities involved in the ASE violation.

6.2 Radiological Dose Limits

6.2.1 The occupational dose received by a worker shall not exceed a total effective dose equivalent of 2 rem per year (DOE Administrative Control Level) unless prior approval has been granted by the appropriate DOE Secretarial Officer.

6.2.2 The occupational dose received by a worker shall not exceed a total effective dose equivalent of 1 rem per year (DOE Administrative Control Level) unless prior approval has been granted by the ORNL ALARA Steering Committee.

6.2.3 The total effective dose equivalent received by an on-site member of the public shall not exceed 100 mrem per year.

6.2.4 The total effective dose equivalent received by any off-site member of the public from airborne emissions of radionuclides to the ambient air from the SNS facility shall not exceed 10 mrem/yr (radionuclide release), 25 mrem/yr (all pathways).

6.3 **Staffing**

6.3.1 The staffing requirement for all machine operations with particle beams 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.

6.3.2 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 target moderator system. 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 7: Procedures Addressing the ASE-Required Administrative and Engineered Controls

7.1 All active and passive Credited Engineered Controls are configuration controlled. Active CECs are certified by SNS procedures and/or applicable ORNL Fire Department instructions.

7.2 All ASE-required administrative controls are managed by SNS procedures.

7.3 Intent changes, as determined by the SNS Operations Manager, to ASE-related procedures are reviewed through the Unreviewed Safety Issue Determination (USID) screening process.

Appendix 1: Passive Credited Engineered Controls

1. **CMS Hydrogen Boundary**
The safety function of the CMS hydrogen boundary is to prevent failures resulting in hydrogen leakage into the core vessel due to breaches of the system.

1.1. **Operability** - The CMS hydrogen rupture disks and vent path are required to be operable unless hydrogen is purged from the CMS.

1.2. **Compensatory Measures**

1.2.1. A Rupture disk shall be replaced if:
- pressure to the disk rises to the deformation pressure (note: not applicable to reverse-buckling rupture disks),
- the disk safety head has been removed from the system, or
- it has not been replaced in five years.

1.3. **Surveillance** - The integrity and configuration of the vent paths from the rupture disks to atmosphere shall be visually verified at least annually (not to exceed 15 months). This check will include the piping and exhaust ("Top Hat") cover.

2. **CMS Vacuum Boundary**
The CMS vacuum boundary (vessel and piping) shall provide a robust barrier as a second level of protection to the hydrogen barriers preventing hydrogen from escaping into the core vessel.

2.1. **Operability** - The rupture disks and vent paths associated with CMS Vacuum lines are required to be operable unless hydrogen is purged from the CMS.

2.2. **Compensatory Measures**

2.2.1. A Rupture disk shall be replaced if:
- pressure to the disk rises to the deformation pressure (note: not applicable to reverse-buckling rupture disks),
- the disk safety head has been removed from the system, or
- it has not been replaced in five years.

2.3. **Surveillance** - The integrity and configuration of the vent paths from the rupture disk to atmosphere shall be visually verified at least annually (not to exceed 15 months). This check will include the piping and exhaust ("Top Hat") cover.

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 shut down and drain the loop in the event of a fire.

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

4. **Core Vessel with Rupture Disk and Neutron Beam Windows**

The core vessel and neutron beam windows shall: (1) retain liquid mercury in a confined location and (2) mitigate mercury vapor release inside the building in the event of a mercury spill inside the core vessel. The rupture disk provides assurance that the core vessel is able to relieve excess pressure.

4.1. **Operability** - The rupture disk and vent path associated with Core Vessel are required to be operable when mercury is in the target mercury loop (i.e., and, thus, in the core vessel).

4.2. **Compensatory Measures**

4.2.1. A Rupture disk shall be replaced if:

- pressure to the disk rises to the deformation pressure (not applicable to reverse-buckling rupture disks),
- the disk safety head is disassembled, or
- it has not been replaced in five years.

4.2.2. If the rupture disk is not intact, the mercury shall be drained from the

loop.

4.3. **Surveillance** - The integrity and configuration of the vent paths from the rupture disk to atmosphere shall be visually verified at least annually (not to exceed 15 months). This check will include the piping and exhaust covers.

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.

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 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.

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.

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 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 circulation loop.

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 offgas 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 offgas 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.

10. **High Bay Crane Design**

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

10.2. **Compensatory Measures** – None.

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

REFERENCES

1. *Spallation Neutron Source Final Safety Assessment Document for Proton Facilities*, SNS- 102030103-ES0018, Oak Ridge National Laboratory, Oak Ridge, TN.
2. *Spallation Neutron Source Final Safety Assessment Document for Neutron Facilities*, SNS-102030102-ES0016, Oak Ridge National Laboratory, Oak Ridge, TN.
3. Code of Federal Regulations, Title 29 *OSHA,* Part 1910.100 *Toxic and Hazardous Substances,* Table Z-2.
4. *Radiological Control*, DOE-STD-1098-99, section 211.