SNS-OPM-ATT 2.B-10.a
Unreviewed Safety Issue (USI) Evaluation Form

I. Title of USI Evaluation

USI Evaluation for Putting SBDPMS into Flow Mode with the Service Bay T-Beams Removed During the FY24A Outage

II. Description of Proposed Activity (or discovered condition) (use attachments if necessary):

The Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory (ORNL) is inserting two components into the target building service bay during the FY24A outage. Those components are the new Vent Line Shield Block (VLSB) and the Overflow Tank (OFT), which are shown in Figures 1 and 2, respectively. The time frame for the FY24A outage is from August 2023 to April 2024.

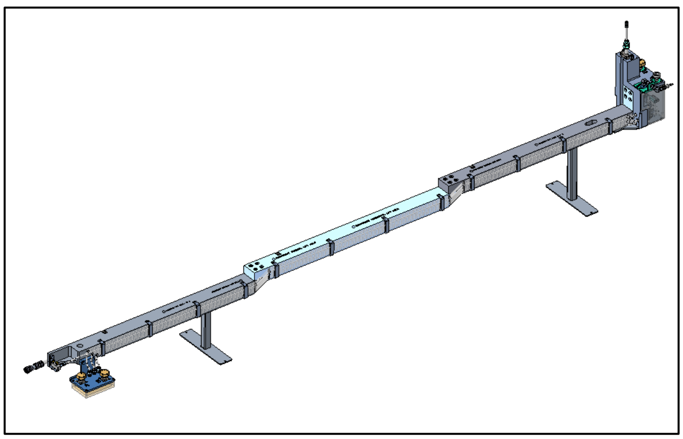

Figure 1: New Vent Line Shield Block

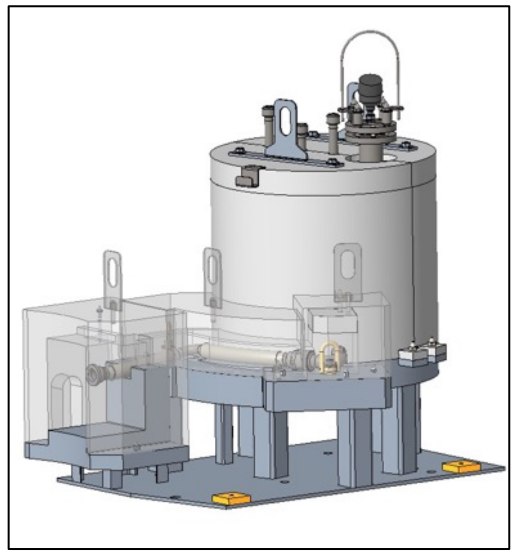

Figure 2: Overflow Tank

Two service bay t-beams need to be removed to put the new VLSB and OFT into the service bay. This USI evaluation (USIE) shows that it is acceptable to put the Service Bay Differential Pressure Monitoring System (SBDPMS) into flow mode when the service bay t-beams are removed. Future maintenance operations that require removing service bay t-beams will need to be evaluated separately.

A depiction of the target building service bay and high bay is shown in Figure 3. The service bay comprises the process bay, maintenance bay, and transfer bay. Figure 3 also shows the two service bay t-beams that are planned to be removed to insert the new VLSB and OFT. More specifically, the teal-colored t-beam in Figure 3 is being removed to insert the new VLSB, while both the teal- and pink-colored t-beams are being removed to insert the OFT.

One of the credited engineered controls (CEC) in the SNS Accelerator Safety Envelope (ASE) [1] and Final Safety Assessment Document for Neutron Facilities (FSAD-NF) [2] is the SBDPMS. SBDPMS ensures prompt evacuation of personnel from areas adjacent to the service bay if the Primary Confinement Exhaust System (PCES) is not maintaining sufficient negative pressure or system flow to ensure confinement of the service bay environment.

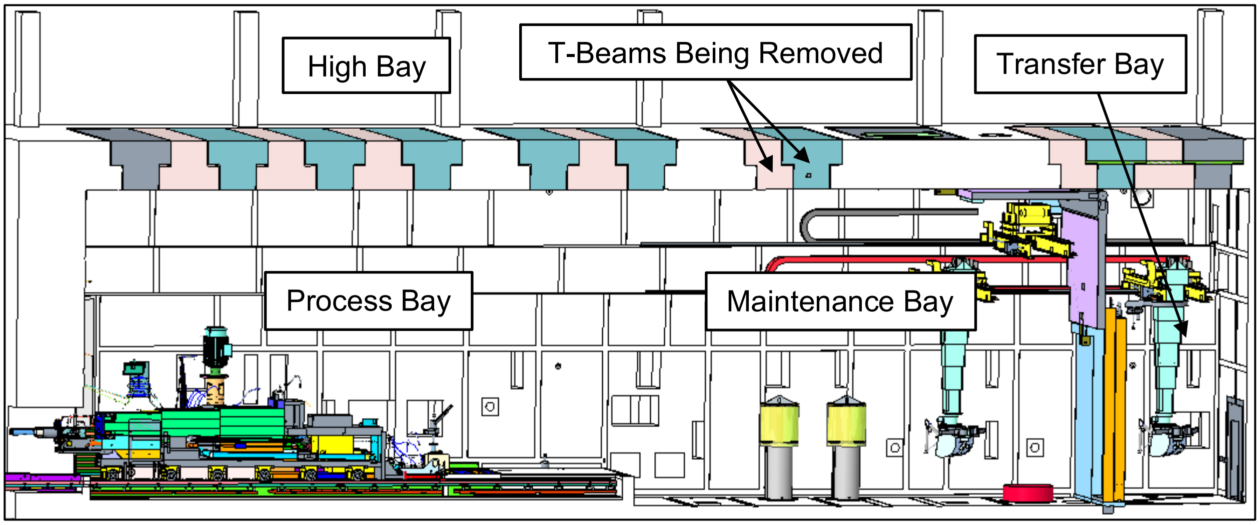

Figure 3: Service Bay and High Bay

During normal operations, SBDPMS measures the differential pressure between (1) the service bay and the decontamination room, and (2) the service bay and the manipulator gallery. The normal operating mode for SBDPMS is referred to as d/p mode. In this mode, SBDPMS provides an alarm for personnel evacuation if the differential pressure gets too low. The alarm sounds in the service gallery, decontamination room, manipulator gallery, bottom loading hatch room, and high bay (i.e., the occupiable areas adjacents the service bay). The service bay is normally operated at a differential pressure of approximately -2.0 inches of water. SBDPMS alarms if the differential pressure reaches -0.5 inches of water for 10 seconds or more. Initially, the SBDPMS did not have a time delay, but a USI determination (USID) was written in January 2010 [3] to implement the 10-second time delay to reduce the occurrence of spurious alarms.

SBDPMS has an alternate operating mode, which is referred to as flow mode. Flow mode was evaluated as an approved mode of operation in a USID written in February 2006 [4]. Initially flow mode was only allowed when the transfer bay personnel door was open. With the personnel door open, PCES is unable to maintain sufficient differential pressure between the transfer bay and the decontamination room to not cause spurious alarms. When in flow mode, SBDPMS alarms if PCES flow is reduced below 1,000 standard cubic feet per minute (SCFM). During normal operations, the flow rate for PCES is limited by the sulfur-impregnated charcoal absorbers. The design flowrate for each of the eight charcoal absorbers is 440 SCFM. Since there are eight charcoal absorbers, the total PCES design flowrate is 3,520 SCFM. Operationally, PCES flowrate is maintained at approximately 3,000 SCFM by programmable logic controllers (PLC) for the variable frequency drives (VFD) on the two PCES fans.

A USID was written in January 2009 [5] that evaluated SBDPMS operation in flow mode when either the top or bottom loading port is opened, though operationally it has only been necessary when opening the top loading port. When the bottom loading port is opened, PCES is able to maintain sufficient differential pressure.

Next it is beneficial to evaluate what accident scenarios in the FSAD-NF [2] are potentially impacted by removing the service bay t-beams. The accident scenarios for the target building are defined in the FSAD-NF [2], and more details are provided in the hazard evaluation in [7]. A thorough review of those two documents reveals one accident scenario that merits futher discussion, TS1-4, which is a fire that is postulated to occur in the service bay when the service bay, transfer bay, and high bay are open to common air flow and the mercury is drained to the storage tank.

The concept of common air flow is explored next. Common air flow between the service bay and the transfer bay occurs whether the intra-bay doors are open or closed. This is because PCES is designed to flow across that boundary in both situations. PCES takes suction from the decontamination room, runs it through a bank of high efficiency particulate air (HEPA) filters, and discharges it to the top of the transfer bay. That air travels from the transfer bay to the service bay and is sucked into HEPA filters at the bottom of the service bay. Thus, common air flow between the service bay and the transfer bay is always present. Common air flow between the service bay and the high bay can occur when either the service bay t-beams are removed or the top loading port is opened. Historically, the more frequent of the two is opening the top loading port. Because common air flow always occurs between the service bay and the transfer bay, the current understanding of hazard event TS1-4 assumes the consequences are driven by a fire that occurs when there is common air flow between the service bay and the high bay.

For TS1-4, the unmitigated radiological consequences for the onsite 1 receptor are high and the unmitigated chemical consequences for the onsite 1 receptor exceed Emergency Response Planning Guideline (ERPG) 3. All other receptors have negligible radiological and chemical consequences. It is worth noting that these consequences are not based on calculational methods, they are instead based entirely on qualitative engineering judgement. Since the mercury has been drained to the storage tank, the fire that starts in the service bay is only assumed to vaporize the residual mercury that is present in the service bay. The vaporized mercury is released into the high bay through the opening created by the removed t-beams, which leads to unacceptable radiological and chemical consequences to the onsite 1 receptor (bounded by a person in the high bay).

The credited controls for TS1-4 are as follows:

- **Emergency response procedures** for evacuation from a fire in the service bay with common air flow between the service bay, high bay, and transfer bay,
- **SBDPMS**,
- **Procedures and training** for evacuation of adjacent areas from SBDPMS alarm.

The FSAD-NF [2] discusses the credited controls for TS1-4 in three important locations: Section 4.3 (hazard analysis), Section 5.0 (credited controls), and Appendix A (controls matrix). In both the hazard analysis for TS1-4 and the description of the credited controls, there is no distinction as to which of the three credited controls applies to which worker group (WG). (As a reminder, the onsite 1 receptor includes both WG 1 and WG 2.) Thus, it is entirely logical that all three credited controls apply to both WG 1 and WG 2. The only part of the FSAD-NF that makes a distinction is the controls matrix. In the controls matrix, the emergency response procedures and SBDPMS are listed as protecting WG 1, while SBDPMS and the procedures and training are listed as protecting WG 2. With this distinction, it is unclear how SBDPMS and the procedures and training protect the WG 2 receptor given that SBDPMS will be placed into flow mode when the service bay t-beams are removed. WG 1 presents a clean argument, since the emergency response procedures serve as the primary means of protection, with SBDPMS as a backup.

If a fire were to occur in the service bay with SBDPMS in d/p mode, the pressure increase from combustion will quickly increase pressure in the service bay, causing the measured d/p to increase, thus causing SBDPMS to alarm. This alarm will alert people in the occupiable areas around the service bay to evacuate, thus protecting them. When in flow mode (which will be the status of SBDPMS while the service bay t-beams are removed), SBDPMS alarms on low PCES flow, which is not postulated to occur within enough time to fully protect personnel in occupiable areas surrounding the service bay. The quickest mechanism for causing a SBDPMS alarm in flow mode is particulate matter clogging the inlet HEPA filters in the service bay, which reduces PCES flow below the alarm setpoint.

Even though the credited controls listed for WG 2 for hazard event TS1-4 are not entirely bounding in the controls matrix, it is worth noting that the three credited controls for TS1-4 do serve to protect all potential receptors within the onsite 1 receptor category. The primary credited control for the onsite 1 receptor is the emergency response procedures. SBDPMS and its corresponding procedures and training are the backup credited controls.

It is worth noting that there are other mitigative and preventative measures in place or being implemented that can serve to reduce the risk associated with a fire in the service bay while the service bay t-beams are removed. These measures are only listed to give context about the defense-in-depth measures being taken for this evolution. They do not formally reduce either the consequences or frequency of hazard event TS1-4. Only the listed credited controls serve that purpose. The following bullets describe some of the risk-prevention measures being taken for removing service bay t-beams during the FY24A outage (not listed in order of importance):

- Where possible, a temporary cover should be placed over the hole created by the removed service bay t-beams in order to reduce the time the service bay and high bay have common air flow.
- If possible, the very early smoke detection apparatus (VESDA) and water mist system in the service bay should be maintained in an active status. It is understood that the VESDAs might need to be put into bypass while the t-beams are being removed or during the entire time the t-beams are removed in order to reduce spurious alarms. If the VESDAs and water mist systems are bypassed, a dedicated operator should be stationed to manually start the fire suppression system in the service bay in the event of a fire.
- There is also a fire detection and suppression system in the target building that potentially could detect a fire in the service bay while the t-beams are removed.
- If possible, a dedicated fire watch should be stationed while the t-beams are removed.
- When possible, the SBDPMS should be put into d/p mode vice flow mode, since that provides another level of protection.
- The PCES should be maintained throughout this operation at a maximum possible flow.
- A Fire Protection Engineer (FPE) should do a walkdown of the service bay, transfer bay, and high bay prior to removing the service bay t-beams to ensure all unnecessary combustible material is removed.
- A portable mercury monitor should be placed in the vicinity of the removed t-beams to detect and alarm upon the presence of elevated mercury vapor levels in the high bay.
- ORNL has well developed combustible control program that ensures combustible loading limits are maintained throughout the target building and inside the service bay. The ORNL combustible control program is maintained in Standards Based Management System (SBMS).
- ORNL also has a well developed ignition control program that protects against fires developing in the target building or in the service bay. The ORNL ignition control program is maintained in SBMS.
- If possible, while the service bay t-beams are removed, unnecessary personnel entry or exit from the high bay should be restricted in order to not disturb the airflow patterns established with the service bay t-beams removed.
- Personnel should be stationed to ensure PCES, secondary confinement exhaust flow (SCES), and makeup air (MUA) are maintained such that flow goes from MUA to SCES and that flow is maintained from SCES to PCES in the maximum amount possible through the opening created by the removed service bay t-beams.
- ORNL has a well developed and well tested radiation protection program (RPP). The RPP requires the development of radiological work permits (RWP) for any radiation or contamination areas (or higher classifications). All personnel are required to have sufficient radiation worker training to enter either radiation areas or contamination areas, and must be logged into the RWP. The RPP

also necessitates an as-low-as-reasonably-achievable (ALARA) mindset toward any radiological hazard. Furthermore, the RPP necessitates the RWP describe any necessary personnel protective equipment (PPE) that will be needed in the area surrounding the removed t-beams. Lastly, the RPP necessitates the presence of radiological controls technicians (RCT) in the posted area. All of these measures will help protect personnel in the high bay from the hazards associated with removing service bay t-beams.

III. Does the proposed activity or discovered condition affect information presented in the FSAD-NF or FSAD-PF, e.g., regarding equipment, administrative controls, or safety analyses. If so specify the applicable FSAD and relevant sections.

No. While it is true that Revision 3 of the FSAD-NF [2] required changes to (1) clarify SBDPMS flow mode opertions and (2) clarity how the three credited controls for hazard event TS1-4 apply to the different WGs for the onsite 1 receptor in the controls matrix, those changes have been addressed in Revision 4 of the FSAD-NF [6], which was issued in the time between when this USIE was drafted and when it was issued.

IV. Does the proposed activity or discovered condition affect any of the requirements of the ASE. If so, list the affected sections.

No.

V. USI Evaluation Criteria:

1. Could the change significantly increase the probability of occurrence of an accident previously evaluated in the FSADs?
   Yes __ No _X_
   Justification:

This USIE updates the acceptable operational configuration of the SBDPMS, which is a CEC. The SBDPMS is not actually being changed. The use of flow mode for the SBDPMS when the service bay t-beams are removed for the insertion of the new VLSB and OFT during the FY24A outage does not significantly increase the probability of occurrence of an accident previously evaluated in the FSADs.

2. Could the change significantly increase the consequences of an accident previously evaluated in the FSADs?
   Yes __ No _X_
   Justification:

This USIE updates the acceptable operational configuration of the SBDPMS, which is a CEC. The SBDPMS is not actually being changed. The use of flow mode for the SBDPMS when the service bay t-beams are removed for the insertion of the VLSB and OFT during the FY24A outage does not significantly increase the consequences of an accident previously evaluated in the FSADs.

3. Could the change significantly increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the FSADs?
   Yes __ No _X_
   Justification:

Flow mode is already an approved, alternate means of operation for the SBDPMS. Two previous USIDs [4, 5] evaluated this question in detail regarding flow mode only being based on one instrument (vice multiple instruments for d/p mode). Approving flow mode for additional maintenance operations does not impact the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the FSADs.

4. Could the change significantly increase the consequences of a malfunction of equipment important to safety previously evaluated in the FSADs?
   Yes __ No _X_
   Justification:

It is assumed that a malfunction of equipment important to safety provides no mitigation for associated accidents. Therefore, full unmitigated accident consequences are assumed for a CEC malfunction. Since the use of flow mode for the SBDPMS when the service bay t-beams are removed for the insertion of the VLSB and OFT during the FY24A outage does not have an impact on the unmitigated consequences of associated accidents, the operational configuration update proposed in this USIE does not significantly increase the consequences of a malfunction of equipment important to safety previously evaluated in the FSADs.

5. Could the change create the possibility of a different type of accident than any previously evaluated in the FSADs that would have potentially significant safety consequences?
   Yes __ No _X_
   Justification:

The use of flow mode for SBDPMS when the service bay t-beams are removed for the insertion of the VLSB and OFT during the FY24A outage does not introduce any new hazards or accident initiators. Therefore, the operational configuration update proposed in this USIE does not create the possibility of a different type of accident than any previously evaluated in the FSADs.

6. Could the change increase the possibility of a different type of malfunction of equipment important to safety than any previously evaluated in the FSADs?
   Yes __ No _X_
   Justification:

The use of flow mode for SBDPMS when the service bay t-beams are removed to insert the VLSB and OFT during the FY24A outage does not increase the possibility of a different type of equipment malfunction important to safety.

VI. USI Determination: A USI is determined to exist if the answer to any of the 6 questions above (Section V) is "Yes." If the answer to all 6 questions is "No", then no USI exists.

a. Does the proposed activity (or discovered condition) constitute a USI?
   ___ Yes – DOE approval required prior to implementing.
   _X_ No – Proposed activity may be implemented with appropriate internal review.

Thomas Copinger Digitally signed by Thomas Copinger
Date: 2023.09.01 13:26:46 -04'00'

Thomas Copinger, Senior Accel. Fac. Safety Engr, Qualified Preparer — Date

Ryan Schultz Ryan Schultz
2023.09.01 14:51:04 -04'00'

Ryan Schultz, Senior Mechanical Design Engineer — Date

John Denison John Denison
2023.09.05 08:25:19 -04'00'

John Denison, Target Operations Group Leader — Date

Jacob Platfoot Digitally signed by Jacob Platfoot
Date: 2023.09.01 13:33:42 -04'00'

Jacob Platfoot, Accelerator Safety Program Lead, Qualified Reviewer — Date

Approvals:

Fulvia Pilat Digitally signed by Fulvia Pilat
Date: 2023.09.05 12:17:51 -04'00'

Signature of SNS Operations Manager or Designee — Date

References

1. *SNS Accelerator Safety Envelope (ASE)*, Revision 6, SNS 102030103-ES0016-R06, dated September 18, 2022.
2. *Spallation Neutron Source Final Safety Assessment Document for Neutron Facilities*, Revision 3, 102030102-ES0016-R03, dated September 29, 2011.
3. R.M. Harrington, *USID to Modify the Alarm Time Response for Low Differential Pressure of the Service Bay Differential Pressure Monitoring System (SBDPMS)*, SNS 102030103-ES0052-R00, dated January 15, 2010.
4. R.E. Battle, *USID for Modifications to Service Bay Differential Pressure Monitoring System*, SNS 102030102-ES0018-R00, dated February 24, 2006.
5. R.M. Harrington, *USID for Modifications to Service Bay Differential Pressure Monitoring System (SBDPMS)*, SNS 102030102-ES0018-R01, dated January 12, 2009.
6. *Spallation Neutron Source Final Safety Assessment Document for Neutron Facilities*, Revision 4, 102030102-ES0016-R04, dated August 31, 2023.
7. *Spallation Neutron Source Target Facility Hazard Identification and Evaluation*, SNS 102030102-ES0017-R00, dated October 2005.