DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

The Honorable Jill Hruby
Administrator
National Nuclear Security Administration
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Administrator Hruby:

On January 30, 2022, operations at H-Area New Manufacturing at the Savannah River Site had an unplanned release of approximately 1000 curies (about 0.1 grams) of tritium gas from the stack. Some of the tritium was then anomalously drawn back into the facility's ventilation system.

The Defense Nuclear Facilities Safety Board (Board) is monitoring actions being taken by the National Nuclear Security Administration (NNSA) and its contractor in response to this tritium release event. The Board understands that the NNSA's field office and contractor have recently taken actions to more thoroughly investigate this event and its safety impacts. The attached staff report details the Board's safety concerns and is provided for NNSA's consideration.

Pursuant to 42 United States Code § 2286b(d), the Board requests a briefing within 120 days of receipt of this letter on (1) any plans to address this scenario in the hazards analysis, and (2) any improvements to the Savannah River Tritium Enterprise's operations, safety controls, and planned responses to abnormal conditions that will be implemented to protect workers from similar events.

Sincerely,

Joyce L. Connery
Chair

Enclosure

c: The Honorable Jennifer Granholm
Mr. William I. White
Mr. Jason A. Armstrong
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

June 8, 2022

Observations Related to the Inadvertent Tritium Release Event

Summary. On January 30, 2022, operators at H-Area New Manufacturing (HANM) inadvertently released tritium gas through the stack to the atmosphere. The facility's ventilation system then pulled some of the tritium back into the building, potentially exposing personnel to tritium. The Defense Nuclear Facilities Safety Board (Board) is not aware of any similar events at HANM in the past. This previously unanalyzed event has raised several safety concerns regarding the implications of released tritium being pulled into a facility through the ventilation system.

The Board's staff has discussed these safety concerns with the National Nuclear Security Administration's Savannah River Field Office (SRFO) and Savannah River Nuclear Solutions (SRNS), which is the contractor for the Savannah River Tritium Enterprise (SRTE). SRFO has since directed SRNS to evaluate potential impacts on the safety basis.

Background. HANM operators needed to disposition the contents of a process tank containing gas with high oxygen content but negligible hydrogen isotopes. Facility personnel chose to send the gas mixture out of the stack to the atmosphere via a recovered gas dryer and the purge stripper system. An operator drafted the procedure to accomplish the proposed actions since the exact configuration was not covered by a standard operating procedure.

On January 30, 2022, operators were lining up the purge stripper and recovered gas dryer when the stack radioactivity alarms activated, followed by tritium air monitor (TAM) alarms throughout the facility. Personnel took response actions and secured the lines. Tritium activity levels dropped below alarm levels within a few minutes. Because HANM personnel may have been exposed to tritium, radiological protection department personnel took bioassay samples from all personnel in HANM. The sample results indicated that none of the workers had a measurable tritium uptake.

Following the event, SRNS determined that approximately 1000 curies of tritium gas from the recovered gas dryer was released from the HANM stack. The HANM ventilation supply intake, which is approximately 150 feet from the 50-foot-tall exhaust stack, pulled some of the tritium back into the facility (see Figure 1). The tritium then spread through occupied portions of the facility where tritium would not normally be found, including the corridors and control room.

The initial investigation and fact-finding meeting for this event focused on the immediate facility impacts, the decision-making, and the misunderstandings that resulted in the tritium release. The investigation initially failed to consider the broader safety implications of this event, including the potential impacts to the safety basis and controls for protecting facility workers.

The Board's staff posed questions to SRFO and SRNS regarding these broader safety implications. Shortly afterwards, SRFO issued formal direction to SRNS to enter the potential inadequacy in the safety analysis (PISA) process to evaluate the potential impacts on the safety basis. SRFO's direction led to a more thorough and appropriate safety investigation. The Board's safety concerns and SRNS's efforts to date are summarized below.

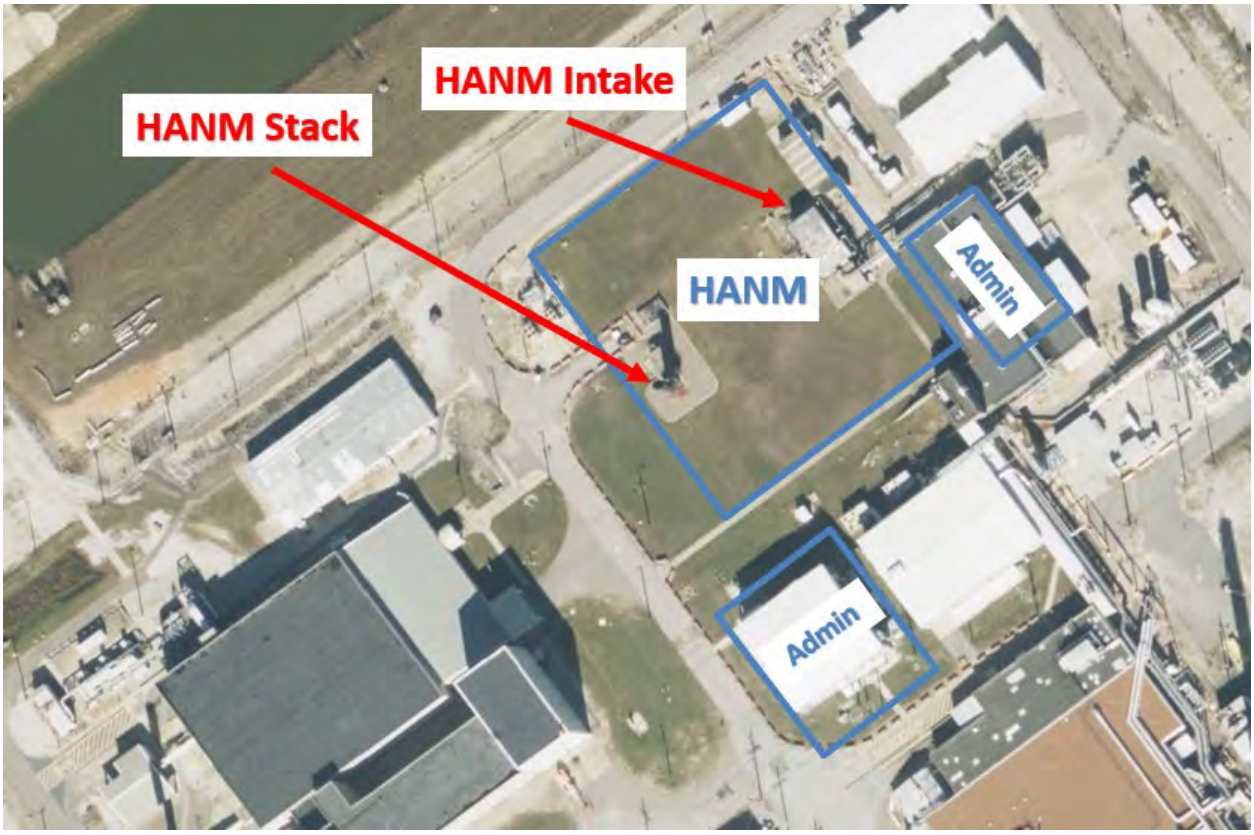

Figure 1. *H-Area New Manufacturing (HANM) and nearby buildings.*

Discussion. This section details some areas where SRFO and SRNS could consider identifying lessons learned and making safety improvements.

Incomplete Hazards Analysis—Many design basis accidents involve tritium releases that are much larger than what occurred on January 30, 2022. Thus, it is important to consider whether the behavior of the plume that day has any implications to the safety analysis for HANM, including the identified controls.

SRNS's hazard analyses for the SRTE estimated the consequences of various events that involve the release of tritium. For many events, the hazard analyses assumed that facility workers would evacuate the immediate area around the initial point of release in order to reduce their exposure. The hazard analyses did not consider the possibility that tritium could be released from a facility and then re-enter a building through the ventilation system. Re-entry of tritium into buildings could expose facility workers to tritium in locations that the hazard analyses did not anticipate, and therefore it is unclear whether the assumptions of the hazard

analyses remain valid for such an accident progression. For some cases, the hazard analyses identify TAMs as a safety control to inform workers of airborne tritium. NNSA should consider evaluating the location, configuration, and safety classification of TAMs in light of possible tritium re-entry, as discussed further in the next section.

Following discussions with the Board's staff, SRFO directed SRNS to enter the PISA process on February 17, 2022. SRNS concluded that a PISA did not exist on March 3, 2022. SRNS stated that the safety analysis assumes 50th percentile (i.e., median) meteorological conditions when evaluating consequences to workers. SRNS, with assistance from Savannah River National Laboratory (SRNL) meteorologists, determined that the conditions of January 30, 2022, were beyond the 50th percentile conditions (i.e., half the time, the release would have led to lower worker exposure; the other half, the same release amount would have led to higher worker exposure). Accordingly, SRNS concluded there is no safety issue with the safety basis because this meteorological condition did not need to be analyzed in the safety analysis.

The fact that tritium re-entry occurred shows that re-entry is a plausible accident progression at HANM, and Department of Energy (DOE) standards indicate that plausible (or credible) progressions should be analyzed. An event with tritium re-entry could be initiated in several different ways, including operational events as well as natural phenomena (e.g., earthquake). DOE Standard 3009-94 Change Notice 3, *Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, [1] states that "there is no predetermined frequency cutoff value…for excluding low frequency operational accidents (i.e., internally initiated)." DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, [2] provided further clarification by indicating that operational accidents should be analyzed if they are plausible. Thus, operational events that could credibly result in tritium re-entry should be considered in the hazard analysis. For natural phenomena events, both versions of DOE Standard 3009 discusses frequency cutoffs that DOE's contractors should use when determining what events should be analyzed (e.g., the strength of the earthquake that should be analyzed). These frequency cutoffs are not directly applicable to the tritium re-entry phenomenon because they are relevant to the event that initiates the accident, not the subsequent event progression. Still, it is noteworthy that DOE contractors analyze meteorological events such as tornados and hurricanes that are much less common than the median meteorology condition.

DOE Standard 3009 does include criteria related to meteorology, but these criteria are intended for calculating the consequences of a given event. Both versions of the standard calls for the use of 95th percentile meteorological conditions in the dispersion analysis to estimate consequences to the off-site public. In this case, the staff is concerned with whether this accident scenario could affect personnel closer to the plume, such as facility workers and other nearby co-located workers. As discussed in DOE Standard 3009 DOE's contractors use the calculated consequences to determine the functional classification of the identified controls (i.e., whether a given control is general service, safety significant, or safety class). The standard does not discuss the use of the 95th percentile criterion as a means for excluding plausible event progressions from the hazard analysis.

The new SRTE safety basis, which is awaiting implementation, will use the more conservative 95th percentile meteorology conditions (i.e., lower frequency conditions that lead to higher estimated consequences). SRNS personnel also stated that SRNS will consider whether tritium re-entry needs to be included in the upcoming safety basis, but it is currently unclear to the staff team if SRNS will evaluate this scenario and if it could result in changes to the control set.

Whether the safety analysis should evaluate a tritium re-entry scenario depends on whether a release of tritium concurrent with meteorological conditions conducive to tritium being pulled into a facility is credible or not. If the event is credible, then the question would be whether the existing controls are adequate to protect the facility workers and co-located workers. This could involve either the identification of new controls or the upgrading of existing controls.

Protection of Workers—The SRTE safety bases credit TAMs in process areas to alert the workers to the presence of tritium and rely on workers to follow the abnormal response procedures to minimize worker exposure. Since existing response procedures assume a tritium release is originating from a process room, personnel are trained to evacuate the room when the local high activity alarm is received. However, as this event illustrated, personnel could be exposed to higher tritium concentrations in the corridors or outside the facility.

One way to identify that tritium re-entry is occurring is by detecting the tritium at the supply air intakes and in the corridors of the processing facilities. TAMs at the air supply intake and the corridors of processing facilities are not credited safety systems. After the Board's staff discussed these concerns with SRFO and SRNS, SRNS implemented a standing order with additional guidance on actions to take when a stack release is coupled with the TAM alarm on the air intake for processing facilities. SRNS is currently evaluating the feasibility of isolating ventilation makeup air to the control rooms if the ventilation pulls tritium back into those processing facilities.

There are nearby administrative buildings without any radiation detection systems (e.g., TAMs) in place. In the event of an elevated tritium release (i.e., more tritium released than normally expected or indications that there is tritium re-entry), SRNS's standing order calls for shutting down the ventilation system of Building 766-H (a training building that includes the main site cafeteria) and announcing a remain-indoors protective action, which would include securing ventilation in nearby administrative buildings. Currently, the plan after an elevated tritium release is to conduct a bioassay for a minimum of one person at each unmonitored SRTE location. SRFO should consider placing additional TAMs to accelerate detection of when tritium is pulled into a facility and assist in determining which locations are safe or when a worker should evacuate. Placement of TAMs at the air supply intake to normally occupied administrative buildings could also more reliably identify additional personnel potentially exposed to tritium in those locations for triage and bioassay sampling purposes.

Additional Observations.

Review of Alternative Procedures—The rigor of operations at HANM could be improved, as demonstrated by decisions leading to the tritium release. The operators chose to develop a

less formal, handwritten procedure rather than use a standard operating procedure. The standard operating procedure would have sent the gas mixture to the tritium process stripper, which is far more effective in removing tritium gas than the purge stripper. While the use of less formal procedures provides operational flexibility, the magnitude of the tritium release might have been reduced if there had been a more rigorous process for reviewing and approving the alternative procedure.

Improving the Safety of Planned Releases—SRTE personnel sometimes intentionally vent tritium through the stack to the atmosphere. If possible, it would be prudent to avoid planned releases during meteorological conditions that could allow the tritium to return to ground level in significant concentrations. SRTE's plan for improvements includes contacting SRNL meteorologists prior to and on the day of planned releases.

After the January event, SRNL produced an analysis of the meteorological conditions of that day. In the staff team's perspective, it would be beneficial to evaluate whether other meteorological conditions could lead to similar plume behavior. Such an evaluation would strengthen this planned improvement.

Facility Design—The event at HANM demonstrated that radiological material released from a facility could get pulled back into the facility by its ventilation system. While this phenomenon is most challenging for tritium gas or vapors, which are not effectively filtered at the building's exhaust or inlets, it is a consideration for any radionuclide. This phenomenon is not a new or unique concern. The Board raised this issue 27 years ago in DNFSB/TECH-3, *Overview of Ventilation Systems at Selected DOE Plutonium Processing and Handling Facilities* [3]. The Board also recently raised this topic in its review of the Savannah River Plutonium Processing Facility (see letter dated January 24, 2022) [4].

There are DOE handbooks with guidance on this topic. DOE Handbook 1132-99, *Design Considerations*, states, "Stack location and height should also consider intakes on the facility and adjacent facilities to preclude uptake" [5]. In addition, DOE Handbook 1169-2022, *Handbook for Use with DOE-STD-1269-2022*, states, "Average wind direction and weather conditions that are likely to cause stack discharges to areas close to the ground (known as looping and fumigation) should be analyzed when establishing the location of stacks and intakes. This analysis is necessary to ensure that stack effluents cannot be drawn back into the building or into an adjacent building" [6]. The possibility of uptake into buildings warrants emphasis as new facilities are designed or as new structures are built in proximity to existing stacks.

Conclusion. After the Board's staff discussed its safety concerns about the tritium release event with SRFO, the field office and SRNS took actions to further investigate the event and its safety implications. It is encouranging that SRTE has evaluated, and in some cases implemented, improvements in its procedures and planned responses to abnormal conditions. SRFO should ensure that any remaining safety gaps are addressed.

In view of the fact that a tritium release and re-entry event occurred, it is important for the hazard analyses to address the possibility of tritium entry via a building's ventilation system, a condition that previously had not been analyzed. In such an event, facility workers could be

exposed to tritium in unanticipated locations. If facilities continue to rely on alarms to inform response actions intended to minimize dose consequences to personnel, then SRFO should consider evaluating the alarm locations, configurations, and safety classifications with this event progression in mind.

References

[1] Department of Energy, *Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, DOE Standard 3009-94 Change Notice 3, 2006.

[2] Department of Energy, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, DOE Standard 3009-2014, 2014.

[3] Defense Nuclear Facilities Safety Board, *Overview of Ventilation Systems at Selected DOE Plutonium Processing and Handling Facilities*, DNFSB/TECH-3, 1995.

[4] Defense Nuclear Facilities Safety Board, *Conceptual Design Review of the Savannah River Plutonium Processing Facility*, 2022.

[5] Department of Energy, *Design Considerations*, DOE Handbook 1132-99 (Reaffirmed 2014), 1999.

[6] Department of Energy, *Handbook for Use with DOE-STD-1269-2022, "Air Cleaning Systems in DOE Nuclear Facilities"*, DOE Handbook 1169-2022, 2022.

AFFIRMATION OF BOARD VOTING RECORD

SUBJECT: January 30, 2022 Tritium Release Event

Doc Control#: 2022-100-0034

The Board acted on the above document on 08/02/2022. The document was Approved.

The votes were recorded as:

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIPATING	COMMENT	DATE
Joyce L. Connery	✔	☐	☐	☐	☐	08/02/2022
Thomas Summers	✔	☐	☐	☐	☐	08/02/2022
Jessie H. Roberson	✔	☐	☐	☐	☐	08/02/2022

This Record contains a summary of voting on this matter together with the individual vote sheets, views and comments of the Board Members.

Shelby Qualls

Executive Secretary to the Board

Attachments:

1. Voting Summary
2. Board Member Vote Sheets

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Joyce L. Connery

SUBJECT: January 30, 2022 Tritium Release Event

Doc Control#: 2022-100-0034

DATE: 08/02/2022

VOTE: Approved

COMMENTS:

None

Joyce L. Connery

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Thomas Summers

SUBJECT: January 30, 2022 Tritium Release Event

Doc Control#: 2022-100-0034

DATE: 08/02/2022

VOTE: Approved

COMMENTS:

None

Thomas Summers

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Jessie H. Roberson

SUBJECT: January 30, 2022 Tritium Release Event

Doc Control#: 2022-100-0034

DATE: 08/02/2022

VOTE: Approved

Member voted by email.

COMMENTS:

None

Jessie H. Roberson