DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

May 21, 2025

The Honorable Christopher Wright
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Wright:

As part of its statutory role, the Defense Nuclear Facilities Safety Board (Board) reviews the design of new Department of Energy (DOE) defense nuclear facilities before and during their construction to ensure adequate protection of public health and safety. The Savannah River Plutonium Processing Facility project is critically needed for production of plutonium pits for the nuclear deterrent. Three DOE safety organizations identified safety concerns with the facility worker safety approach for this project. The Board documented related safety concerns in previous correspondence to the Secretary in 2022 and 2023.

The National Nuclear Security Administration (NNSA) concurred and in response, NNSA upgraded safety controls to improve their reliability and availability. In 2024, the Board's staff reviewed the upgraded safety controls and concluded (1) they are a significant improvement to safety, and (2) they resolve safety concerns from the Board's previous correspondence. The attached advisory report includes safety observations that were identified during the review and includes observations focused on ensuring operations remain within the boundaries of safety analyses. NNSA should ensure proper implementation of the new safety controls.

Sincerely,

Thomas A. Summers

Thomas A. Summers
Acting Chairman

Enclosure

c: Ms. Teresa Robbins, Acting Administrator, National Nuclear Security Administration
Mr. Joe Olencz, Director, Office of the Departmental Representative to the DNFSB

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

March 6, 2025

Facility Worker Safety at the Savannah River Plutonium Processing Facility

Summary. A staff review team from the Defense Nuclear Facilities Safety Board (DNFSB) evaluated facility worker safety at the Savannah River Plutonium Processing Facility (SRPPF). The staff team conducted onsite discussions at Savannah River Site on May 29–30, 2024, with personnel from the National Nuclear Security Administration (NNSA) and their lead contractor for the project, Savannah River Nuclear Solutions, LLC (SRNS). The overall review conclusion is that NNSA's decision to upgrade controls to safety significant[1] greatly improved facility worker safety and resolved previous safety concerns. The staff team also identified nine safety observations summarized below:

1. ***Lessons Learned for Safety-in-Design are Needed—***NNSA's delayed resolution of facility worker safety issues at SRPPF highlight the need for lessons learned to prevent reoccurrence at other projects. One area for improvement is the Department of Energy's (DOE) guidance on the application of facility worker self-protection.

2. ***Laser Welder Glovebox Requires Safety Significant Alarms—***A laser welder glovebox met criteria in the consolidated hazards analysis[2] (CHA) [1] for receiving safety significant alarms, but it was not originally listed as receiving them. Project personnel agreed with the staff team and added safety significant alarms to this glovebox in a revised CHA. This safety observation is resolved.

3. ***Pyrophoricity of Briquettes Should Be Reevaluated—***Processes in SRPPF will create plutonium briquettes. A briquette is a compressed collection of metal turnings. Briquettes of uranium and plutonium have been involved in pyrophoric events at the Y-12 National Security Complex (Y-12) and Rocky Flats Plant, respectively. The draft preliminary documented safety analysis[3] (PDSA) [2] requires safety significant alarms in gloveboxes that could exceed a threshold quantity of pyrophoric plutonium. NNSA should ensure that gloveboxes that could contain plutonium briquettes have safety significant alarms, unless there is a strong technical basis for not considering briquettes to be pyrophoric.

4. ***Work Should Only Be Performed in Gloveboxes with Appropriate Controls—***Pyrophoric plutonium and plutonium oxide pose hazards to the facility worker. The draft PDSA identifies which gloveboxes could contain a sufficient

[1] Safety significant controls are intended to provide a major contribution to defense-in-depth and/or worker protection from accidents. These controls supplement safety class controls designed to protect the public.
[2] The CHA analyzes facility hazards and preliminarily assigns safety controls to protect the public and workers.
[3] The PDSA, which requires DOE approval, is a safety design basis document that analyzes facility hazards and identifies safety controls. The CHA is an input to the PDSA.

quantity of those materials to necessitate safety significant alarms. NNSA should ensure that any work that meets these criteria will be performed in gloveboxes with those safety controls.

5. ***The Safety Analysis Should Address the Transfer of Additional Forms of Plutonium—***The draft PDSA identifies a safety significant container for the transfer of plutonium oxide outside of gloveboxes. This control protects facility workers by preventing or mitigating releases of this dispersible material. However, processes in SRPPF will generate other dispersible forms of plutonium that could also be transferred outside gloveboxes in off-normal situations. If such transfers will be allowed, the PDSA should address them to ensure they are performed safely.

6. ***Spray Leak Hazards Should Be Reevaluated—***The facility design includes a pressurized pipe that transfers plutonium nitrate solution outside glovebox confinement. The draft PDSA analyzes a loss of confinement event for this piping, but concludes the event is not credible due to the presence of a pipe jacket. In such a case, DOE requirements call for an evaluation of the jacket to determine whether it prevents significant consequences that would require its classification as safety significant. Alternatively, NNSA could consider eliminating or reducing the hazard.

7. ***Oxidation Events at Los Alamos National Laboratory (LANL) Should Be Evaluated—***Oxidation events at LANL's Plutonium Facility involving titanium fines and a plutonium ingot in 2021 and 2024, respectively, should be evaluated for lessons learned applicable to SRPPF.

8. ***Credited Controls for Accidental Weapons Discharges Should Be Reevaluated—***The draft PDSA credits a safeguards and security plan (S&SP) as a safety significant preventive control for inadvertent weapons discharges. DOE requirements do not allow a broad plan or program to be credited for high consequence events in this way.

9. ***Design Opportunities Exist to Strengthen Protections for Facility Workers—***After events that necessitate evacuation from process areas, workers will move to the A and P-Wings of the facility. While emergency management plans are not yet developed, there are improvements to the design that NNSA should consider to help ensure habitability of the A and P-Wings after an event. These design improvements include installing high efficiency particulate air (HEPA) filters in the ventilation intakes, installing sampling ports in the air supply registers, or having continuous air monitors (CAM) in those areas.

Facility Background. The 2018 Nuclear Posture Review, published by the Department of Defense, recommended establishing "the enduring capability and capacity to produce plutonium pits at a rate of no fewer than 80 pits per year by 2030" [3]. NNSA is designing SRPPF to produce 50 of these pits per year using the partially constructed buildings located at F-Area of Savannah River Site. Figures 1 and 2 show the current facility structures and a rendering of the project at completion, respectively.

Figure 1. *An aerial photograph of the existing structures at F-Area of Savannah River Site that were originally intended for the Mixed Oxide Fuel Fabrication Facility.*

Figure 2. *A rendering of the facility at project completion.*

On June 25, 2021, the Deputy Secretary of Energy approved critical decision 1, *Approve Alternative Selection and Cost Range*, marking completion of the project definition phase and conceptual design [4]. The project is now in final design[4]. There are several early procurement and construction activities that are nearing completion, in progress, or authorized to begin in the near term. These activities include interior concrete demolition work, equipment removal, glovebox fabrication, grading/trenching, and sand filter excavation (see Figure 3). At its critical decision 1 approval, NNSA estimated project completion between fiscal years 2032 and 2035.

[4] DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets* [40], states that preliminary safety and design results complete the preliminary design phase. On March 10, 2025, NNSA issued a safety review letter that approved preliminary safety and design results in the form of a draft PDSA [41].

Review Background. In reviews completed in 2022 and 2023, DNFSB found that SRPPF project personnel assumed facility workers could use their senses to detect accidents such as a spill or fire and then exit the area prior to receiving a significant radiological exposure. Using this assumption of worker self-protection, project personnel avoided designating safety significant controls, such as gloveboxes or glovebox ventilation, that other DOE plutonium processing facilities have traditionally designated.

Figure 3. *An aerial photograph of excavators and other heavy equipment conducting site preparation work next to the existing structures, which includes sand filter excavation.*

SRPPF will process kilogram quantities of weapons grade plutonium, and inhalation of very small amounts of this material can result in significant radiological exposures. There are scenarios where self-protection would not be sufficient to prevent significant exposure, including pyrophoric fires and loss of confinement events involving dispersible plutonium. Given the quantities and forms of plutonium expected at SRPPF, DNFSB concluded that assuming facility worker self-protection was nonconservative. The Board sent four letters to the Secretary of Energy citing concerns with this approach (see Table 1). On May 11, 2023, DNFSB also traveled to Savannah River Site and discussed these concerns with site management.

Table 1. *A summary of Board correspondences to the Secretary of Energy on SRPPF.*

Letter Date	*Summary*
January 24, 2022 [5]	Documents concerns with the lack of credited safety controls for facility workers typically found at other plutonium facilities.
March 29, 2023 [6]	Announces Board visit to Savannah River Site with facility worker safety at SRPPF as a discussion topic.
August 3, 2023 [7]	Documents concerns with assuming facility worker self-protection for accidents and requests a briefing and report in 45 days.
November 29, 2023 [8]	Reaffirms reporting requirement from the August correspondence.

Three DOE safety organizations cited similar concerns with facility worker safety:

- In 2021, DOE's Office of Enterprise Assessments completed a review of the conceptual design and concluded that it "remains concerned that the functional classification of SSCs [structures, systems, and components] currently in the conceptual design may not be adequate to ensure worker safety [9]."

- In 2023, NNSA's Office of Environment, Safety, and Health found that project personnel over relied on facility worker self-protection and mitigative controls over available preventative controls [10].

- In 2023, DOE's Office of Environment, Health, Safety, and Security issued a memorandum that states that "it is especially concerning that this type of protection strategy [use of facility worker self-protection] is being discussed during the design phase of a new DOE nuclear facility when the development and crediting of controls are attainable and will be integral to the long-term safe operations of the facility" [11].

In response, NNSA sent letters of direction to SRNS [12] [13] to incorporate new facility worker safety controls. On January 17, 2024, NNSA sent a letter to the Board [14] that states it "concurs with the Board's concerns regarding the previous facility worker control strategy…." Finally, on February 21, 2024, NNSA provided a briefing to the Board on the new safety controls. SRNS's resulting actions included the following:

- SRNS upgraded over 200 gloveboxes, hoods, and material transfer system tunnel sections from general service to safety significant. The draft PDSA states that their safety function "mitigates the release of radioactive material by being seismically qualified to not topple during and following a seismic event thus preventing radioactive material from free-fall spilling out of the glovebox" [2].

- SRNS upgraded the building fire suppression system from general service to safety significant. The draft PDSA states that its safety function "mitigates the spread and consequences of a process module fire" [2]. The facility structure is separated into process modules by safety class fire barriers. The fire barriers prevent the spread of fire between modules, while the newly upgraded suppression system will control a fire within a module.

- SRNS designated a specific container used for transport of plutonium oxide outside glovebox confinement as safety significant. The draft PDSA states that its safety function is to "[m]itigate the release of radioactive material from an energetic impact" and to "[p]revent the release of Pu [plutonium] oxide when outside of process enclosures" [2].

- SRNS upgraded over 100 alarms from general service to safety significant. The safety function of these alarms is to alert the facility worker to hazardous conditions. The CHA states [1] that "[loss of confinement] events involving greater than

30 grams Pu (in the form of Pu Oxide) and fire events involving greater than 30 grams Pu (in the form of pyrophoric Pu) were conservatively considered High consequences to the [facility worker]….” As a result, gloveboxes with an assumed inventory exceeding 30 grams[5] of pyrophoric plutonium will be equipped with a safety significant differential pressure alarm and a safety significant oxygen alarm,[6] while gloveboxes with above 30 grams of plutonium oxide will have a safety significant differential pressure alarm. In addition, at least one CAM is installed in process rooms containing a glovebox meeting this 30-gram criteria.

In Spring 2024, the staff team began a follow-up review focused on the new facility worker safety controls (see Figure 4 for examples of the safety controls). The staff team sought to understand the capabilities and limitations of the new controls and how they would be implemented. The review included the SRPPF flowsheet and the revised CHA and draft PDSA that incorporated the new safety controls.

Figure 4. *Examples of devices that could serve the purpose of the new safety significant controls (SRNS has not yet necessarily chosen manufacturers and models*) [15]*: glovebox differential pressure (top left) and oxygen (top right) alarms, a robust container for transport of plutonium outside glovebox confinement (bottom left), and renderings of gloveboxes for disassembly (bottom center) and oxide roasting (bottom right). Inclusion of these devices and associated trademarks is for illustrative purposes only and does not indicate an endorsement of them by the DNFSB or the United States.*

[5] This 30-gram threshold for glovebox inventories of pyrophoric plutonium and plutonium oxide requiring safety significant controls will be referred to herein this document as the “30-gram criteria.”

[6] The PDSA states that the glovebox oxygen alarm, which is formally known as the “glovebox fire protection oxygen monitor alarm,” “[p]rovides indication of degradation of glovebox inert environment.” Therefore, this control is not applicable to gloveboxes with an air environment.

On May 29–30, 2024, the staff team conducted discussions with project personnel at Savannah River Site. The staff team submitted additional follow-up questions to NNSA and received written responses on August 20, 2024. Finally, on December 4, 2024, the staff team conducted a factual accuracy discussion on its review conclusions with project personnel. The overall review conclusion was that the new safety controls represented a substantial improvement in facility worker safety. The staff team identified additional safety observations during performance of this review.

Discussion. The staff team identified nine safety observations described below:

Lessons Learned in Safety-in-Design are Needed—Nuclear safety issues can negatively impact a project's cost and schedule if not resolved in a timely manner. In the case of facility worker safety at SRPPF, it took more than two years from the time that DOE safety organizations and DNFSB raised concerns to when NNSA settled on a final resolution. The discussions that occurred during that time indicate a need for DOE to clarify its guidance on the topic of facility worker self-protection. Different parties were interpreting the same language in DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* [16], but were reaching very different conclusions. Clear standards can improve the efficiency of DOE's design process.

DOE issued Handbook 1224-2024, *Hazard and Accident Analysis* [17], in February 2024. This handbook provides clarifying guidance on the use of facility worker self-protection, which should be beneficial to future design projects. However, there are still some gaps in DOE's guidance. For example, if a DOE contractor assumes that its workers will evacuate from a hazardous condition to avoid what would have been a high radiological consequence, it is not clear what requirements apply to systems needed to enable that evacuation (e.g., emergency lighting). NNSA and SRNS personnel are currently discussing such topics. DOE should develop guidance in these areas and add it to the handbook.

Finally, NNSA developed a charter for a team to study lessons learned for SRPPF. NNSA stated in a letter to the Board dated January 17, 2024 [14], that "NNSA takes the safety and protection of workers very seriously and recognizes the need to develop lessons learned and apply them to support continuous improvement. Once developed, the lessons learned will be published for consideration across the DOE nuclear complex." From DNFSB's standpoint, there are lessons for DOE to learn associated with the communication and adjudication of nuclear safety issues that arise during design and construction projects. As of the time of this report, NNSA has not yet completed the lessons learned. DNFSB looks forward to seeing NNSA's results.

Laser Welder Glovebox Requires Safety Significant Alarms—The facility design includes three laser welder gloveboxes, which may contain greater than 30 grams of pyrophoric plutonium. Since they exceed this 30-gram criterion, such gloveboxes require a safety significant glovebox oxygen alarm and a safety significant glovebox differential pressure alarm. Revision 7 of the CHA [18] assigned these safety significant alarms to two of the boxes, but it was missing the third box. SRNS personnel agreed that the third box should have safety

significant alarms, and they made the appropriate change in revision 8 of the CHA [1]. This safety observation is resolved.

Pyrophoricity of Briquettes Should Be Reevaluated—Processes in SRPPF will collect plutonium machining turnings and compact them into briquettes. If briquettes were considered pyrophoric, then gloveboxes that contain briquettes would need safety significant alarms. The staff team reviewed a project document that shows that at least one glovebox lacks safety significant alarms but may process briquettes [19].

Y-12 has extensive experience with compacting uranium machining turnings into briquettes. On November 18, 2022, the Board sent correspondence to the Secretary of Energy that raised concerns with a series of pyrophoric events at Y-12 [20]. This correspondence cites 15 pyrophoric events, many of which involved briquettes (see Figure 5), that occurred between 2016 and 2021. Additional pyrophoric events involving briquettes occurred on February 22, 2023, and August 9, 2023 [21] [22]. While the Y-12 events involved uranium, plutonium is more pyrophoric than uranium [23]. Additionally, oxidation events involving plutonium briquettes occurred at the Rocky Flats Plant. For example, the May 11, 1969, fire (see Figure 6), the worst accident in the plant's history, was reportedly caused by spontaneous ignition of a plutonium briquette [23].

Figure 5. *Uranium briquettes at Y-12.*

Briquettes should either conservatively be assumed as pyrophoric, or a technical basis should be documented for why they are not. If briquettes are considered pyrophoric, then the staff team also concludes that any glovebox that processes briquettes should be fitted with a safety significant oxygen alarm (for inert gloveboxes) and a safety significant differential pressure alarm to alert workers to hazards.

Figure 6. *Fire damage from the 1969 Fire at the Rocky Flats Plant.*

SRNS acknowledged the oxidation issues with briquettes at Y-12 and the Rocky Flats Plant. However, SRNS stated that the processes at Y-12 and Rocky Flats were different from SRPFF in terms of the amount and type of cutting fluids used. SRNS's response did not elaborate on why these differences were significant with respect to potential pyrophoric behavior. If these aspects of cutting fluids are significant to preventing rapid oxidation, then those represent assumptions that should be documented and protected. For example, DOE Standard 3009-2014 states [16]: "The initial conditions and assumptions for the analysis shall be documented and evaluated to determine if controls are needed to maintain the validity of the evaluation."

Work Should Only Be Performed in Gloveboxes with Appropriate Controls—Pyrophoric plutonium and plutonium oxide pose particular hazards to the facility worker. Pyrophoric plutonium can initiate fires that release plutonium, while oxide is dispersible (i.e., it can easily be made airborne, leading to worker exposure). Figure 7 provides a photograph of plutonium oxide. The draft PDSA identifies the need for safety significant alarms in gloveboxes that could contain more than 30 grams of these materials. The draft PDSA identifies which specific gloveboxes will receive safety significant alarms, based on application of the 30-gram criteria. This list of gloveboxes is reasonable for the planned process flowsheet, except as noted in the prior two observations. However, there could be circumstances where operations depart from the planned flowsheet. Throughout the facility's operational life, NNSA should ensure that only gloveboxes with the safety significant alarms will be used for work where inventory could exceed the 30-gram criteria.

Figure 7. *A photograph of plutonium oxide, which is a powder-like substance.*

During the life of SRPPF, there could be scenarios where operations depart from the planned flowsheet. For example, if there is an equipment outage that leads to a backlog of pyrophoric or dispersible plutonium, the gloveboxes intended for staging those materials could reach their capacity. Operators might then seek to temporarily use a different glovebox as a staging glovebox. Alternatively, there could be future changes to the process flowsheet whereby new gloveboxes are added, or existing gloveboxes are repurposed.

There are different mechanisms available for ensuring the facility remains consistent with the safety analysis, such as the unreviewed safety question (USQ) process and administrative controls. The USQ process should address cases where there are planned changes to the process flowsheet. Administrative controls would also be beneficial to prevent operators from staging pyrophoric plutonium or plutonium oxide in gloveboxes without the safety significant alarms. Such controls could include limits on the inventory in those boxes, or limits on transfers to those boxes.

The most robust administrative controls are known as specific administrative controls (SAC). While the draft PDSA currently includes a SAC for inventory control, the description of that control currently does not address the 30-gram criteria. DOE Standard 1186-2016, *Specific Administrative Controls*, states that SACs should be designated when "[t]he administrative control is the basis for validity of the hazard or accident analysis (e.g., a hazardous material inventory, such as an assumed MAR [material at risk])." The standard further elaborates, "a MAR inventory greater than assumed in the DSA [documented safety analysis] would place [the] facility in an unanalyzed condition. As such, MAR assumptions would need to be protected in a highly reliable and enforceable manner" [24]. The Plutonium Facilities at both Lawrence Livermore National Laboratory and LANL include glovebox inventory limits in a MAR SAC. Accordingly, NNSA and SRNS should consider enacting administrative controls, and should also consider whether those controls should take the form of SACs.

Additionally, the 30-gram criteria are defined too narrowly. Safety significant differential pressure alarms are needed for gloveboxes with above 30 grams of plutonium oxide because that material is dispersible, making it especially hazardous if confinement is lost. However, there are other forms of plutonium that can be dispersible. For example, SRNS has a project document that considers plutonium chloride and plutonium in spent salt to also be dispersible [25]. SRNS personnel stated that these MAR forms will only be present in gloveboxes that already exceed the 30-gram criteria for plutonium oxide. This means these gloveboxes already have safety significant alarms for facility worker protection. While the safety control set will thus be appropriate for normal operations, there may be off-normal operations where the other dispersible forms are transferred to other gloveboxes. Accordingly, the PDSA should clarify that the 30-gram criterion on oxide also applies to these other dispersible forms of plutonium.

Finally, the analysis of the material removal gloveboxes in the draft PDSA appears to contradict the 30-gram criteria. Per the CHA, these gloveboxes could contain 3 kg of "plutonium oxide in waste." Although appearing to exceed the 30-gram criteria, these gloveboxes are not assigned safety significant differential pressure alarms for facility worker protection. SRNS personnel clarified that these gloveboxes could contain 3 kg of waste with contamination levels of plutonium oxide (i.e., less than 30 grams), which would not meet the criteria for requiring the safety significant alarms. The PDSA should be revised to state that the material removal boxes will have less than 30 grams of plutonium oxide, and there should be a control to ensure this is the case.

The Safety Analysis Should Address the Transfer of Additional Forms of Plutonium—The draft PDSA analyzes loss of confinement hazards during transfers outside of glovebox confinement. The draft PDSA concludes hazards involving greater than 30 grams of plutonium oxide results in significant radiological consequences to the facility worker and require safety significant controls. The robust outer oxide container is credited as safety significant for these events to mitigate "the release of radioactive material from an energetic impact" or to prevent "release of plutonium oxide."

As previously stated, there are other dispersible forms of plutonium that can present radiological hazards similar to oxide. A project document considers dispersible MAR to include plutonium chloride and plutonium in spent salt [25]. These MAR forms are not explicitly analyzed in the draft PDSA for transfers outside glovebox confinement. SRNS personnel clarified that there are no planned movements of these MAR forms outside glovebox confinement. However, contrary to these statements, there is a project document that suggests that the plutonium vault "could contain 'in-process' material forms (metal, oxide, and salt) when the staging gloveboxes within the process are unavailable or full" [25]. Thus, plutonium-bearing salt could plausibly be transferred outside glovebox confinement to the vault.

DOE Standard 3009-2014 states: "The initial conditions and assumptions for the analysis shall be documented and evaluated to determine if controls are needed to maintain the validity of the evaluation." Accordingly, NNSA should consider the following options:

- If dispersible forms of plutonium (other than oxide) will not be transferred outside glovebox confinement, then this should be documented and protected.

- If transfers of dispersible forms of plutonium (other than oxide) are planned or may be possible outside glovebox confinement, then hazards involving that transfer should be evaluated in the PDSA. In that case, the robust outer oxide container (see Figure 8) could serve as a safety significant control to protect the facility worker.

- The project is already required to comply with DOE Manual 441.1-1, *Nuclear Packaging Manual* [26]. This manual specifies requirements for robust packaging that must be used for handling of greater than about 0.5 grams of weapons grade plutonium outside of confinement systems. NNSA could simplify the analysis by crediting containers that comply with the manual as safety significant. This would ensure a uniform, compliant, and operator-friendly approach to container operations.

Figure 8. *SAVY containers are available in various sizes and are a potential option for designation as the robust outer oxide container.*

Spray Leak Hazards in the Aqueous Recovery System Should Be Reevaluated—A pressurized pipe poses a spray leak hazard that could expose facility workers to radiological materials. Most liquid transfers in SRPPF will be conducted using vacuum transfers, which should not pose a spray leak hazard. However, the design includes two pumped transfers where the pipe will be pressurized. One of these transfers, from the concentrate tank to the precipitator, involves a concentrated plutonium nitrate solution that has potential for higher radiological consequences.

An event in the draft PDSA evaluates "[l]oss of confinement of solution in primary confinement resulting in a release of hazardous material." The draft PDSA states that this event is not credible, and thus it does not list the consequences of the event, nor does it identify controls. The notes in the draft PDSA state: "Although leakage of the tanks and solution transfer piping is anticipated during the life of the facility, by nature of process these tanks and piping will be enclosed by primary confinement (e.g., gloveboxes, ducted/jacketed piping). It is deemed implausible that a non-energetic event solely consisting of a leak of process solution

would also result in loss of confinement of this primary confinement as it would remain undamaged, and there is no identifiable common cause or initiator that would result in a breach of both primary and secondary confinement. Therefore, this event is considered to be NC" [not credible] [18]. Thus, the unmitigated analysis in the draft PDSA includes the assumption that the pipe jacket will prevent the spray leak event.

DOE Standard 3009-2014 allows for the unmitigated analysis to assume that passive SSCs, such as this pipe jacket, will function. The standard includes some requirements that shall be met in such cases. For example, the standard states [16]: "If the presence of an assumed passive SSC prevents significant consequences, it shall be classified as either SS [safety significant] or SC [safety class]." If SRNS personnel qualitatively determine that the consequences to the facility worker would be high without the jacket, then the jacket should be designated as safety significant. SRNS personnel stated that they will reevaluate and may consider steps to eliminate or reduce the hazard.

Oxidation Events at LANL Should Be Evaluated—There were two recent oxidation events at LANL's Plutonium Facility that should be examined for implications to safety at SRPPF:

- On August 14, 2024, "glovebox workers opening a container holding a plutonium ingot saw evidence of rapid oxidation and high temperatures….The cause of this oxidation event is unknown as it involved an ingot rather than high surface area metal such as turnings" [27]. SRNS personnel have assumed that ingots are not pyrophoric, so this event should be examined for lessons learned that could be applied to SRPPF. SRNS personnel stated that the LANL event was not representative because it involved an ingot that had previously degraded due to oxidation. However, rapid oxidation has also historically been observed with ingots that had degraded in storage [28]. NNSA should consider whether controls are needed to prevent degradation in storage. In the absence of such controls, rapid oxidation events should be considered possible with ingots.

- On February 26, 2021, there was an unexpected oxidation event involving titanium fines during waste drumout [29]. LANL personnel have since implemented a procedure to attempt to passivate waste material. NNSA should consider the implications of this event at SRPPF, particularly when potentially oxygen-reactive materials are moved from inert environments to air gloveboxes, air trunklines, or to waste containers outside the glovebox system. NNSA personnel stated that Savannah River National Laboratory completed a study on passivation of SRPPF job waste prior to bagout from waste removal gloveboxes. NNSA personnel stated they are considering this study in developing a waste passivation strategy at SRPPF.

Credited Controls for Accidental Weapons Discharges Should Be Reevaluated—An event in the draft PDSA evaluates an "[a]ccidental weapons discharge resulting in a release of hazardous material." The draft PDSA states that this event could have high consequences to the facility worker and identifies the safeguards and security plan (S&SP) as a safety significant preventive control with a safety function that "[p]revents radioactive material release due to weapons discharge" [18].

DOE Standard 3009-2014 states [10]: "Programmatic ACs [administrative controls] are not intended to be used to provide specific or mitigative functions for accident scenarios identified in DSAs where the safety function has importance similar to, or the same as, the safety function of SC or SS SSCs – the classification of SAC was specifically created for this safety function." Accordingly, the credited control for high consequence events should be a safety SSC or a SAC, and not a broad program or plan such as the S&SP. SRNS personnel stated that they would reevaluate this control.

Design Opportunities Exist to Strengthen Protections for Facility Workers—The staff team conducted follow-up on a previous observation from the Board letter dated January 24, 2022, which raised concerns about protections for facility workers mustered in the A and P-Wings following an accident (see Figure 9). The Board letter states [5]: "The magnitude of postulated accidents considered in the CSDR [conceptual safety design report] suggests that airborne contamination levels surrounding the facility could still be elevated following mitigation by safety systems. Following accidents, the A-Wing and P-Wing will house [approximately 700] facility workers and have ventilation systems that will draw approximately 25 percent of their airflow from the outside."

Figure 9. *An aerial photograph of the existing SRPPF structure that shows approximate boundaries of the three wings of the facility*

On January 30, 2022, a tritium release from the stack of the H-Area New Manufacturing Facility at Savannah River Site was forced back to ground level due to the meteorological conditions. Tritium then re-entered the facility through the ventilation intake [30]. If such meteorological conditions exist at the time of an accidental release from SRPPF's stack, airborne radiological material may enter the A and P-Wings. Further, any plutonium that gets released from the stack will have gone through filtration. Thus, plutonium that gets pulled back into the building will be filtered material, which will tend to be of the smaller particle sizes that will be challenging for air intake filters.

At the time of the conceptual design review, the staff team understood that facility workers would have to remain in the area of refuge for up to 2 hours, even if that area became

contaminated, until they are cleared by security/nuclear material control and accounting. After additional discussion with project personnel during this review, the staff team's current understanding of the situation is summarized below:

- Facility workers will evacuate to the A-Wing (i.e., area of refuge) during a facility-wide accident that forces evacuation such as a seismic event or facility fire. Additional facility workers will reside in the P-Wing since the central control room will act as an emergency management center in the event of an accident.

- The A and P-Wing ventilation systems will be non-safety and designed to natural phenomenon hazard design category-3. The system design description for the ventilation system states: "The non-confinement supply systems shall have filters (minimum rating MERV [minimum efficiency reporting value] 10-11) upstream of any cooling and/or heating coil [31]." The basis for this requirement is to "prevent dust accumulation." An equipment data sheet for the A-Wing states that the air handling units will include a pre-filter and final filter, which will have a MERV rating of 8 and 14, respectively [32].

- MERV filters, such as those specified for the air intakes for the A and P-Wing ventilation systems, do not have the design, construction, or testing requirements to support their use as the means for particulate capture in nuclear air cleaning applications. These filters may remove some particulate, but not as effectively as a HEPA filter. American Society of Mechanical Engineers (ASME) AG-1-2019, *Code on Nuclear Air and Gas Treatment*, refers to filters with MERV ratings of 9 to 15 as "medium efficiency filters", and it states that the "normal function of these filters is to reduce the particulate loading to HEPA filters" [33]. A MERV 14 filter is specified to remove particles in the size range of 0.3 to 1 μm with an efficiency of at least 75 percent [34]. In contrast, HEPA filters are tested to ensure efficiency of 99.97 percent at a particle size of 0.3 μm, which is typically considered the most penetrating particle size. Individual MERV filters are not inspected or tested for efficiency. In addition, the MERV filter installation is not required to meet ASME AG-1 requirements for housing integrity or periodic testing to ensure the filtration efficiency. The HEPA filtration assembly is typically verified to be 99.95 percent efficient through in-place testing.

- Following an accident, radiological control personnel will conduct surveys of the A and P-Wings. The details of this monitoring have not yet been documented, but it will likely include air monitoring as well as surveys of surface contamination. The scope of the contamination surveys could include the air supply registers for the A and P-Wing.

- If airborne radiological material is detected by radiological control personnel in the A and P-Wings, the facility workers would be evacuated to an area not impacted by the release. For example, the workers could be evacuated to outdoor locations, upwind of the stack, that can still be controlled by security personnel. The workers would remain in that outdoor area until they are cleared to leave.

It is important for airborne contamination in the area of refuge to be detected in a timely manner, so that workers can move to another location if appropriate. The staff team encourages NNSA to consider ways to improve airborne radiological detection capabilities, such as installing sampling ports in the A and P-Wing air supply registers, or having CAMs in those areas. Alternatively, improving filtering capability, such as adding HEPA filters, would ensure habitability. The following additional requirements and guidance should be considered as the design is developed:

- DOE Standard 1189-2016 states [35]: "Early integration of EMP [emergency management program] considerations into the safety design process can provide opportunities to minimize the hazardous nature of operations and to improve the ability to respond if an emergency occurs…. Incorporating instrumentation, hardware, and related requirements into the design can improve the ability to detect emergency situations during operations" [emphasis added].

- DOE Order 151.1E, *Comprehensive Emergency Management System*, states that DOE facilities must identify protective actions for workers that are commensurate with potential hazards. It states [36]: "Protective actions must be predetermined and serve to minimize emergency-related consequences and maximize life safety and health."

- DOE Guide 151.1-1B, *Response Elements Emergency Management Guide*, states [37]: "People who remain inside a shelter where the air is contaminated by infiltration from the passing plume could, under some circumstances, receive about the same cumulative inhalation dose or exposure as would an unprotected person exposed to the same plume."

- DOE Handbook 1132-99, *Design Considerations*, states that "[w]here spaces, such as a control room, are to be occupied during abnormal events, filtration systems on the air inlets should be considered to protect the occupants" [38].

- DOE Handbook 1169-2022, *Handbook for use with DOE-STD-1269-2022, "Air Cleaning Systems in DOE Nuclear Facilities,"* states that the "airflow rates and radioactivity levels for habitability systems should be monitored and alarmed" [39].

Conclusion. The staff team completed a follow-up review of facility worker protection at SRPPF. This review included actions taken in response to NNSA's decision to upgrade over 200 gloveboxes, hoods, and material transfer system tunnel sections; over 100 local alarms; the building fire suppression system; and a robust outer oxide container to safety significant. The staff team's review focused on the capabilities and limitations of these controls and how they would be implemented. Overall, the staff team found that these new safety controls represent a significant safety upgrade to the facility that will greatly benefit facility worker protection. During this review, the staff team also identified nine safety observations that are documented in this report that can be used by NNSA to further strengthen the safety of the facility.

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