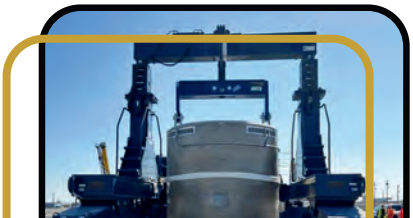
Defense Nuclear Facilities
Safety Board

35th
ANNUAL REPORT
to Congress



July 30, 2025

To the Congress of the United States:

The Defense Nuclear Facilities Safety Board (DNFSB or Board) is pleased to submit its 35th Annual Report to Congress. The DNFSB is an independent, executive branch agency responsible for making recommendations to the Secretary of Energy, and in certain cases to the President, to provide adequate protection of public health and safety at U.S. Department of Energy (DOE) defense nuclear facilities.

As required by 42 United States Code § 2286e(a), this report describes DNFSB activities for calendar year 2024 including safety accomplishments, current safety initiatives, assessments regarding improvements in the safety of DOE defense nuclear facilities, and unresolved safety issues.

For the past 35 years, we have played a vital role in strengthening the safety framework that underpins our nation's nuclear deterrent and defense capabilities. This role exemplifies our responsibility to advance national security objectives by ensuring DOE protects nuclear safety while maintaining mission readiness.

However, during FY 2025 the Board, for the second time in two years, lost quorum and is operating under special provisions included in the *James M. Inhofe National Defense Authorization Act for Fiscal Year 2023*, which allow the Board to continue exercising certain powers and functions for up to one year during a period without quorum. This recurring lapse in quorum compromises the Board's ability to provide sustained, independent oversight of nuclear safety at DOE defense nuclear facilities.

Respectfully submitted,

Thomas A. Summers

Thomas A. Summers
Acting Chairman

c: The Honorable Christopher Wright

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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Agency Annual Report to Congress

The Defense Nuclear Facilities Safety Board (DNFSB or Board) Annual Report to Congress for calendar year 2024 provides a comprehensive description of agency activities under its enabling legislation as required under **42 United States Code § 2286e(a)**.

HOW THIS REPORT IS ORGANIZED

The DNFSB performs its critical nuclear safety oversight mission across five main functional areas. These mission essential functional areas correspond to dedicated groups within the agency that cover specific activities within the Department of Energy, as discussed in the following main sections of this report:

- **Nuclear Weapon Operations**—Evaluates complex, high-hazard operations involving the assembly and disassembly of nuclear weapons, and the operation of nuclear facilities related to DOE's national security and defense mission.
- **Defense Nuclear Waste Operations**—Evaluates legacy facilities and cleanup activities of nuclear waste that must be safely treated and disposed from more than 80 years of DOE defense nuclear operations.
- **Nuclear Facility Infrastructure and Projects**—Evaluates design and construction of new DOE defense nuclear facilities and aging and deteriorating mission-critical safety infrastructure.
- **Nuclear Safety Requirements, Programs, and Standards**—Evaluates the adequacy of DOE safety standards related to design, construction, operation, and decommissioning of defense nuclear facilities and their implementation across the DOE defense nuclear complex.
- **Field Operations**—Provides oversight of day-to-day operations at defense nuclear facilities; the Board's eyes, ears, and representation on the ground at DOE sites and nearby communities.

BASELINE INFORMATION

U.S. nuclear weapons are produced in the Department of Energy's (DOE) defense nuclear facilities for the Department of Defense. Defense nuclear facilities also stabilize (i.e., clean up) radioactive wastes from previous nuclear weapon production.

"The mission of the Board shall be to provide independent analysis, advice, and recommendations to the Secretary of Energy to inform the Secretary, in the role of the Secretary as operator and regulator of the defense nuclear facilities of the Department of Energy, in providing adequate protection of public health and safety at such defense nuclear facilities, including with respect to the health and safety of employees and contractors at such facilities."
-Atomic Energy Act of 1954, as amended

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202-694-7000

EXECUTIVE SUMMARY

EX. Executive Summary

For the past 35 years, the Defense Nuclear Facilities Safety Board (DNFSB or Board) has played a vital role in strengthening the safety framework that underpins our nation's nuclear deterrent and defense capabilities. The DNFSB's work exemplifies our responsibility to advance national security objectives by ensuring the Department of Energy (DOE) protects nuclear safety while maintaining mission readiness.

Under the Atomic Energy Act of 1954, as amended, the DNFSB is charged with providing objective, independent safety oversight of DOE's defense nuclear facilities. These facilities perform DOE's national security missions, including design, manufacturing, testing, maintenance, and decommissioning of nuclear weapons, as well as nuclear waste cleanup from legacy facilities that performed these missions. The act mandates that the Board review the content and implementation of DOE standards, facility and system designs, and events and practices at DOE defense nuclear facilities to provide independent analysis, advice, and recommendations to inform the Secretary of Energy regarding safety issues of adequate protection of public health and safety at DOE defense nuclear facilities.

The DNFSB prioritizes its safety oversight activities based on risk to the public and workers presented by the nuclear and hazardous materials at DOE's defense nuclear facilities and the hazards of associated operations. This annual report summarizes the DNFSB's significant safety oversight initiatives and high-priority safety issues at defense nuclear facilities during 2024. Foremost among these initiatives and safety issues were:

Aging Infrastructure Management—Many defense nuclear facilities supporting the nation's nuclear deterrent are more than 40 years old and some are much older. Aging facilities and safety systems are less reliable and more susceptible to failure. DOE has struggled with adequately addressing this situation.

The DNFSB initiated a series of activities aimed at supporting DOE in safely managing the stockpile for years to come. First, the Board held a public hearing on August 14, 2024, which explored common issues and best practices across other high-hazard industries. Representatives from the Nuclear Regulatory Commission, Government Accountability Office, National Aeronautics and Space Administration, Army Corps of Engineers, and the American Nuclear Society provided testimony and supported panel discussions to lend their collective experience to DOE's infrastructure challenges. Information from the hearing is being applied to subsequent activities, which will explore solutions for extending the life of major facilities, improving requirements for safety systems, and leveraging industry consensus standards.

An Independent Voice for Nuclear Safety

Strengthening the Safety of Onsite Transportation of Nuclear Materials—Radioactive materials are frequently transported between defense nuclear facilities within a site. To ensure transportation is done safely, DOE requires contractors to develop a transportation safety document to fully analyze potential accidents and identify controls to prevent or mitigate them. Los Alamos National Laboratory (LANL)—where the transportation routes are close to the site boundary—did not adequately identify, analyze, and control hazards, increasing the risk of radiological exposure to the public.

The Board identified that the weaknesses at LANL were due to issues with DOE's oversight and onsite transportation directives, and issued Recommendation 2023-1, *Onsite Transportation Safety*, to address these issues. Per DOE's implementation plan, compensatory safety measures were implemented at LANL (e.g., by reducing the amount of radioactive material allowed in a shipment and restricting traffic for certain shipments). Additionally, DOE committed to evaluate other sites for these issues and revise the directives.

Improving Nuclear Safety Requirements and Guidance—DOE governs the safe operations of its nuclear facilities through Title 10, Code of Federal Regulations, Part 830, Nuclear Safety Management, (10 CFR 830), and associated safety standards. The Board routinely advises DOE on needed changes to these requirements to ensure continued safe operation of its nuclear facilities. The Board issued Recommendation 2020-1, *Nuclear Safety Requirements*, in February 2020 to address gaps in DOE's nuclear safety requirements. DOE accepted this recommendation in 2022 and has since completed several milestones toward addressing the recommendation.

In 2024, the DNFSB worked closely with DOE as they made progress on the recommendation through close staff-to-staff interaction and Board-level engagement, including a November 15, 2024, Board letter to the Secretary of Energy. Overall, DOE's actions in response to Recommendation 2020-1 have been positive and are poised to improve how DOE and its contractors develop, approve, and maintain nuclear safety processes that ensure adequate protection of the public and workers.

Worker Self-Protection at Savannah River Plutonium Processing Facility—This vital infrastructure project will produce plutonium pits (the trigger at the heart of a nuclear weapon). Congress mandated that the Board advise DOE on early integration of safety into its nuclear facility designs to ensure efficient completion of these important projects. Early in the design process for the Savannah River Plutonium Processing Facility, the Board found that project personnel did not apply appropriate design requirements to ensure reliable performance of safety controls to protect workers. Instead, the National Nuclear Security Administration (NNSA) relied on a safety strategy in which workers used their senses to detect accidents, such as a glovebox spill or fire, and exit the area to protect themselves from significant radiological exposure.

The Board identified that this approach did not provide adequate worker protection and departed from the safety strategies used at other DOE plutonium processing facilities. In 2024, NNSA added safety controls to address the facility worker safety concerns identified by the Board and three other DOE safety entities. These controls affected more than 200 gloveboxes and associated enclosures, more than 100 local alarms, the building fire suppression system, and robust outer oxide containers to protect workers from radiological exposures.

Key Improvements to Pantex Plant Safety—The Pantex Plant assembles, disassembles, and refurbishes the nation's nuclear weapons. These nuclear explosive operations must be conducted using robust processes to identify hazards and implement effective safety controls.

Board Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*, identified the need for NNSA "to take actions to ensure that adequate protection from hazards associated with nuclear operations at Pantex is sustained." As a result, NNSA addressed numerous legacy nuclear safety issues, such as upgrading facility infrastructure including replacement of ceilings in facilities where nuclear explosives are built and taken apart, minimizing the potential for debris to fall on nuclear explosives and cause an explosion. NNSA also added safety controls designed to prevent accidental high explosive detonation and worker loss of life across weapon programs. As a result of these improvements, the Board closed Recommendation 2019-1 in a letter to the Acting Secretary of Energy dated January 30, 2025, while identifying a few additional safety concerns that will require further action by NNSA.

Savannah River Tritium Enterprise Safety Improvements—The Savannah River Tritium Enterprise provides radioactive gas called tritium that is used in nuclear weapons and must be periodically replenished. These are the only facilities in the nation capable of extracting, purifying, and reloading tritium to maintain the nuclear deterrent. There are several credible accidents that could occur such as building-wide fires, crane drops, and explosions, that have the potential to release large quantities of tritium and result in very high radiological doses to a significant number of individuals.

Since the issuance of Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, the DNFSB has continued engagement with DOE to drive progress on implementing safety improvements. DOE recently installed new fire barriers to reduce the risk of a tritium release due to a fire. Additionally, DOE improved the emergency preparedness program, which helps ensure that the site can respond effectively to potential accident situations to protect the public and workforce. While the Board is encouraged by DOE's continued efforts, additional physical upgrades to further reduce safety risk for workers remain years away. The Board continues to emphasize the importance of these physical upgrades and monitor DOE's progress to reduce the safety risk.

Savannah River Site (SRS) Facility Representative Program—As DOE's first line of field oversight, facility representatives are integral to safe operations at defense nuclear facilities, providing day-to-day oversight of DOE's most hazardous operations and proactively ensuring that work is completed in a safe manner.

The DNFSB reviewed aspects of the facility representative program at SRS and identified safety concerns with the overall effectiveness of the program as documented in a Board letter to the Senior Advisor for the DOE Office of Environmental Management dated June 14, 2024. The Board identified shortcomings in the implementation of requirements related to facility coverage, assessment quality, management oversight, issue tracking and trending, and risk-based prioritization of safety oversight activities. DOE committed to take action to improve their safety oversight approach for ensuring safe nuclear operations at SRS.

Hanford Low-Activity Waste Facility Startup—The Hanford Site tank farms store millions of gallons of highly-radioactive liquid waste left over from past nuclear weapon production activities. This liquid must be converted into safer, stable forms. The liquid radioactive waste mission is entering a crucial phase with the startup testing of the Low-Activity Waste Facility. This testing will ensure that the facility can safely process Hanford Site radioactive waste. The complexity and difficulty of starting up a first-of-a-kind, high-hazard processing facility creates significant operational and safety challenges.

Consequently, the DNFSB increased its safety oversight by focusing on key programs that help ensure safe operations. In an October 3, 2024, letter, the Board advised the Senior Advisor for the DOE Office of Environmental Management that plant safety and efficiency could be improved by upgrading work planning processes and standards for corrective and preventive maintenance. The DNFSB staff completed two additional safety reviews at this facility in 2024 and have presented their preliminary observations to DOE. Additional reviews are planned in 2025 prior to the facility's upcoming transition to hazardous radioactive waste operations.

THE DNFSB'S STATUTORY MISSION

I. The DNFSB's Statutory Mission

Congress established the Defense Nuclear Facilities Safety Board (DNFSB or Board) in 1988. The Board was established to be composed of five members, who are appointed by the President and confirmed by the Senate. These members must be "respected experts in the field of nuclear safety with a demonstrated competence and knowledge relevant to the independent investigative and oversight functions of the Board."[1] The DNFSB is a collegial agency, meaning that its actions are determined by the Board as a whole.

The Board's essential mission is to provide independent analysis, advice, and recommendations to the Secretary of Energy to inform the Secretary, in the Secretary's role as operator and regulator of Department of Energy (DOE) defense nuclear facilities, on providing adequate protection of public health and safety, including the health and safety of defense nuclear facility workers.

The term "defense nuclear facilities" is defined in the Atomic Energy Act of 1954, as amended, to include nuclear facilities operated by DOE that have a function related to national defense or store nuclear waste (excluding Yucca Mountain and other facilities operated pursuant to the Nuclear Waste Policy Act). These facilities do not include DOE's nuclear projects that are civilian in purpose or commercial nuclear facilities regulated by the Nuclear Regulatory Commission. The Board's safety oversight jurisdiction also does not extend to the U.S. Navy's nuclear propulsion program or to environmental hazards regulated by other federal and state agencies. Sites with defense nuclear facilities that the DNFSB oversees are summarized below.

Figure 1. Major sites subject to DNFSB jurisdiction.

[1] Atomic Energy Act of 1954, 42 U.S.C. § 2286

Table 1. Major Sites Subject to DNFSB Jurisdiction

Site	Location	Operations	Website
Hanford Site	Richland, WA	Management and treatment of radioactive wastes; facility decommissioning	www.hanford.gov
Idaho National Laboratory	45 miles west of Idaho Falls, ID	Storage and processing of radioactive waste	www.inl.gov
Lawrence Livermore National Laboratory	Livermore, CA	Research to support the nuclear weapons arsenal	www.llnl.gov
Los Alamos National Laboratory	Los Alamos, NM	Research to support the nuclear weapons arsenal; manufacturing of nuclear weapon components; disposition of legacy transuranic waste	www.lanl.gov
Nevada National Security Sites	65 miles northwest of Las Vegas, NV	Disposition of damaged nuclear weapons; critical and subcritical experiments; waste management	www.nnss.gov
Oak Ridge National Laboratory	Oak Ridge, TN	Energy research; treatment and disposal of radioactive wastes	www.ornl.gov
Pantex Plant	17 miles northeast of Amarillo, TX	Assembly, disassembly, and refurbishment of the nuclear weapons stockpile	pantex.energy.gov
Sandia National Laboratories	Albuquerque, NM	Nuclear research; support for the weapons stockpile maintenance program	www.sandia.gov
Savannah River Site	Aiken, SC	Tritium extraction, recycling, and storage; management and treatment of radioactive wastes; nuclear materials storage and disposition; research and development	www.srs.gov
Waste Isolation Pilot Plant	26 miles east of Carlsbad, NM	Disposal of transuranic waste in underground repository	wipp.energy.gov
Y-12 National Security Complex	Oak Ridge, TN	Manufacturing and surveillance of nuclear weapons components; processing of weapons-grade uranium	www.y12.doe.gov

The Board's safety oversight mission spans all phases in the life cycle of a defense nuclear facility, including design, construction, operation, and decommissioning. This safety oversight includes complex, high-hazard operations involving the assembly or disassembly of nuclear weapons, and the operation of nuclear facilities related to DOE's national security and defense mission. The DNFSB evaluates the remediation of nuclear waste and legacy facilities resulting from more than 80 years of DOE defense nuclear operations, as well as the design and construction of new DOE defense nuclear facilities. The DNFSB also assesses aging and deteriorating mission-critical infrastructure at DOE defense nuclear facilities and sites, along with the adequacy of DOE safety standards governing the design, construction, operation, and decommissioning of these facilities.

Congress granted the Board a suite of statutory tools to carry out its mission, the most significant of which is its authority to issue formal recommendations to the Secretary of Energy. These tools give the Board the authority to issue formal recommendations to the Secretary of Energy regarding the adequate protection of public health and safety, levy reporting requirements on the Secretary, conduct open or closed hearings and meetings (including subpoenaing witnesses if necessary), and conduct investigations and special studies related to nuclear safety concerns.

The Atomic Energy Act requires the Secretary to either accept or reject a Board recommendation. If accepted, the Secretary must develop and execute an implementation plan. If rejected, the Secretary must report to the relevant congressional committees and explain the rationale for the rejection. This process occurs on the public record. In addition to issuing formal recommendations, the Board is required to review and evaluate DOE requirements and standards affecting safety at defense nuclear facilities. These evaluations may lead to recommendations or other analyses and advice provided to DOE.

To ensure DOE provides adequate protection of public health and safety at defense nuclear facilities, the Board conducts several additional statutory safety oversight activities. The agency reviews the content and implementation of DOE safety standards, investigates events or practices that may adversely impact public health or safety, analyzes design and operational data for defense nuclear facilities, and reviews facility design and construction to ensure they meet appropriate safety requirements.

Beyond formal recommendations and reporting, the Board issues advice letters and reports to highlight questionable practices, potential root causes, or systemic problems affecting multiple defense nuclear facilities. Additionally, the Board promotes early resolution of identified safety issues through direct engagement between DNFSB staff and DOE personnel. Staff-to-staff discussions often provide DOE and its contractors with the opportunity to address issues at the lowest level before they escalate into more significant safety concerns.

In fulfilling its safety oversight responsibilities, the Board has broad authority to obtain information from DOE and its contractors. The Board is empowered to hold public hearings, subpoena witnesses or documents if necessary, and conduct investigations to assess nuclear safety risks. DOE is required by law to grant the DNFSB "prompt

and unfettered access to such facilities, personnel, and information as the Board considers necessary to carry out its responsibilities."

The DNFSB also welcomes information from members of the public who have reason to believe an unsafe condition may exist at a defense nuclear facility. These safety allegations, which frequently come from DOE employees or contractors with relevant expertise and direct access to specific defense nuclear facilities, are fully evaluated by the DNFSB, which uses its full range of statutory powers to investigate and address them.

The DNFSB maintains a presence at several DOE sites through its resident inspectors. These inspectors provide real-time information to the DNFSB regarding operations and safety issues at their respective sites, ensuring continuous safety oversight of DOE's defense nuclear facilities. Through its statutory authorities, investigative powers, and technical expertise, the DNFSB plays a critical role in ensuring the safety of defense nuclear facilities and holding DOE accountable for protecting public and worker health and safety.

Board Membership Status and Transition

As described above, the Board was established to consist of up to five members. The Atomic Energy Act of 1954 mandates that at least three members must be present for the Board to carry out its statutory functions and powers. Under certain circumstances, the Act permits individual members to continue serving beyond their term to maintain quorum. In October 2023, the Board lost quorum for the first time ever following the departure of long-serving member Jessie Hill Roberson. In 2024, the Senate confirmed Dr. Patricia Lee as a new Board Member, thereby restoring the Board's ability to achieve quorum.

At the close of 2024, the Board consisted of three serving members, which was sufficient to maintain quorum. However, Chair Joyce Connery, who had been serving beyond her term as permitted by the Act, resigned from the Board on January 31, 2025. Her departure triggered the Board's second loss of quorum in the Board's history, within 2 years. Following this loss, the Board began operating under special provisions included in the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023. These provisions allow the Board to continue exercising certain powers and functions for up to one year during a period without quorum.

Moving into 2025, the DNFSB is engaging with the new administration and will actively work to establish positive working relationships with new counterparts at DOE.

Responding to Safety Allegations and Conducting Safety Investigations

Since its creation, the DNFSB has received and evaluated safety allegations concerning defense nuclear facilities from interested members of the public and DOE's federal and contractor workforce. Moreover, under the Atomic Energy Act of 1954, the Board is charged with investigating any event or practice at a defense nuclear facility that may adversely affect public health and safety. To enhance the execution of these safety oversight functions, the Board recently approved a new policy statement outlining its approach for receiving and evaluating safety allegations, as well as how it will exercise its investigative authority over defense nuclear facilities.

In 2024, the Board continued its formal safety allegations program, receiving nine new allegations. At the close of 2024, seven were successfully resolved, with two still under review. The allegations program serves as a vital resource for DNFSB employees who encounter information and concerns from the public, often from DOE employees or contractors, while carrying out daily oversight responsibilities. This program ensures that safety concerns from the public are thoroughly evaluated, leading to appropriate follow-up reviews by the DNFSB staff, when appropriate.

Sharing Best Practices

The Board has acknowledged best practices and DOE safety successes in its correspondence, thus serving the vital role of sharing best practice information across the defense nuclear complex. The following are several notable examples:

- A January 19, 2024, Board letter to the Secretary of Energy highlights a best practice at Los Alamos National Laboratory (LANL) in which contractor personnel limit the possibility of caustic leaking from batteries during radioactive waste packaging efforts.
- A February 12, 2024, Board letter to the NNSA Administrator notes several best practices at the Pantex Plant related to fire damper evaluation and documentation, fire suppression system maintenance procedure updates, fire hazards analysis preparation guide updates, fire suppression system freeze protection, high pressure fire loop monitoring, and fire department staff involvement.
- An April 10, 2024, Board letter to the Secretary of Energy documents LANL plans to incorporate best practices from the American Glovebox Society and other DOE sites to develop training and operator aids for glovebox operators.
- A June 3, 2024, Board letter to the Secretary of Energy identified several underground cabling maintenance best practices at DOE sites.
- A January 30, 2025, Board letter to the Acting Secretary of Energy identified several positive developments on Pantex Plant safety analysis practices resulting from implementation of Board Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*.

Additionally, the Board continues to encourage its staff to resolve safety issues with DOE at the lowest level possible to encourage quick action to protect the public and workers. In 2024, the DNFSB staff worked particularly well with the leadership of DOE's Office of Environment, Health, Safety & Security, specifically the Office of Nuclear Safety, to constructively engage on safety-related matters including:

- Supporting early engagement between the DNFSB and DOE for the revision process used on several important safety-related DOE directives and standards. Such a practice improves the efficiency for all parties involved and minimizes the number of unexpected issues presented to senior leadership.
- Providing timely feedback on topics and content for operating experience program documents to alert the complex on important safety matters.

NUCLEAR WEAPON OPERATIONS

II. Nuclear Weapon Operations

In 2024, the DNFSB performed safety oversight of nuclear weapon operations across the DOE defense nuclear complex, maintaining a steadfast commitment to rigorous safety standards and operational excellence. Significant safety achievements in 2024 include the evaluation of fire protection systems, the comprehensive review of seismic hazard updates, the identification of interior building material replacements necessary to address fire and structural risk, and enhancements to safety-critical documentation. Targeted reviews and actions addressing outstanding issues, such as improper use of cast iron fittings in fire suppression systems and procedural compliance gaps in nuclear explosive operations, exemplify a proactive approach to continuously improving safeguards for personnel and facilities.

The DNFSB staff reviews and Board letters covered in this section illustrate an unwavering dedication to protecting workers, the public, and critical national assets. In 2024, DNFSB nuclear weapon operations oversight activities focused on modernizing infrastructure, mitigating hazards, and strengthening safety protocols. Reviews addressed persistent issues, such as the robustness of fire suppression systems at the Y-12 National Security Complex (Y-12) and glovebox system improvements at LANL, as well as new and evolving safety postures, such as the ongoing LANL Plutonium Facility documented safety analysis review. These efforts underscore the DNFSB's role in identifying systemic and emerging safety issues and ensuring the implementation of corrective actions to mitigate risks and enhance safety standards. In 2024, the DNFSB staff, including the resident inspectors at LANL, the Pantex Plant, the Savannah River Site, and Y-12, and cognizant engineers monitoring Lawrence Livermore National Laboratory (LLNL), the Nevada National Security Sites (NNSS), and Sandia National Laboratories (SNL), were key to monitoring operations, reviewing directives, and bringing forth observations and opportunities for safety improvement.

Pantex Plant

Fire Protection Program

The DNFSB completed the review of the Pantex Plant fire protection program, evaluating fire hazard analyses; fire prevention practices; fire protection system inspection, testing, and maintenance; and fire department response against DOE and industry standards. The DNFSB found that the Pantex Plant is implementing an adequate fire protection program, with all expected major components, consistent with DOE requirements and expectations. The DNFSB has identified several best practices (e.g., fire suppression system maintenance procedure updates), as well as opportunities for improvement related to fire protection system impairments, false alarms, and requirements for manual fire extinguisher use within the technical safety requirements. The Board provided the results of this review to the NNSA Administrator in a letter dated February 12, 2024, and the Pantex Field Office and Pantex Plant contractor have undertaken corrective actions in response.

In 2024, DNFSB's oversight of nuclear weapon operations focused on modernizing infrastructure, mitigating hazards, and strengthening safety protocols.

False Ceiling Replacement and Improper Use of Cast Iron Fittings

The DNFSB identified the improper use of cast iron fittings in fire suppression systems, leading to sitewide reviews, operational restrictions, and corrective measures to prevent seismic-related failures that could compromise nuclear explosive safety.

The DNFSB conducted a review of quality assurance practices applied to the replacement of wood-framed false ceilings in two nuclear explosive cells at the Pantex Plant. In March 2023, the Pantex Plant replaced the wood-framed false ceilings with metal, eliminating a potential impact hazard that could insult nuclear explosives and lead to severe consequences to the workers and public. The site conducted these replacement activities for two of the nuclear explosive cells (12-44 cells)—the oldest nuclear explosive cells at the site—as a deliverable in response to Board Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*. On April 9, 2024, the Board issued a letter to the Secretary of Energy summarizing the outcome of the review. Overall, the Board found that the Pantex Plant contractor and its subcontractors applied appropriate quality assurance practices for the false ceiling replacement project and noted the improvements made to quality assurance practices since 2016. In response to the DNFSB's review, the Pantex Plant contractor conducted a thorough assessment of the identified safety concerns and took appropriate corrective actions.

The DNFSB identified the improper use of cast iron fittings in fire suppression systems, leading DOE to implement operational restrictions and take corrective actions to reduce the risk of system failure after a seismic event, resulting in potential nuclear material releases.

During the review, the DNFSB identified that a construction subcontractor installed cast iron fittings in new deluge fire suppression systems for the two cells, contrary to requirements and guidance in DOE directives. Cast iron fittings generally have poor seismic performance, and failure can result in an impaired or mechanically damaged fire suppression system after an earthquake. The presence of cast iron fittings within a fire suppression system can make the system vulnerable to post-seismic collapse, which could cause falling debris to impact nuclear explosive materials located below and potentially result in nuclear material release. Besides the two nuclear explosive cells of the false ceiling replacement project, the Pantex Plant contractor also installed cast iron fittings, as part of replacement activities for lead-in piping, in the fire suppression risers of most nuclear explosive bays.

In response to the DNFSB finding, the Pantex Field Office and Pantex Plant contractor took appropriate actions, including imposing operational restrictions, performing a sitewide extent-of-condition review, and prohibiting the use of cast iron fittings for upcoming construction projects. The Pantex Plant contractor has replaced the deluge system fire risers in the two affected cells and installed appropriate fittings made of ductile material, and also is planning to replace cast iron fittings installed in nuclear explosive bay risers during upcoming planned infrastructure improvement activities. In the April 2024 letter, the Board advised the Secretary of Energy to share the lessons learned on improper use of cast iron fittings in credited fire suppression systems complex-wide through issuing an operating experience program document. Subsequently, in January 2025, DOE issued an operating experience program document to the DOE complex.

Considering safety issues identified by the DNFSB, DOE issued an operating experience program document to share the lessons learned on improper use of cast iron fittings in credited fire suppression systems.

Figure 2. 12-44 cell fire suppression deluge riser where cast iron fittings were installed.

B61 Hazard Analysis Report

During 2024, the DNFSB evaluated the B61 Hazard Analysis Report, which was developed and issued by the Pantex Plant contractor and constituted the first safety basis document—establishing rules and requirements for conducting safe nuclear explosive operations—that incorporates safety improvements resulting from Recommendation 2019-1 and other Pantex Plant safety basis enhancement efforts. While NNSA and its contractor have addressed most of the safety issues from the recommendation for this safety basis document, the DNFSB identified several safety concerns warranting further action:

- *Design Feature Implementation*—The Pantex Plant reconfigured various specific administrative controls (required operator actions) into safety class and safety significant design features (safety-credited equipment). Since the design features require operator action to provide the safety function, there is a gap regarding consistent and reliable application of such controls.

- *Special Tooling Performance Criteria*—Resulting from Board Recommendation 2019-1, the Pantex Plant defined performance criteria for crediting special tooling as a safety control. However, the criteria for static and rare event loading were non-conservatively established. The Pantex Plant adopted lower factors of safety within these criteria—compared to previous safety margin [2] design requirements—to allow use of a limited set of commercial components. Given the limited scope of these components, it would instead be prudent to define tooling performance criteria consistent with previous design requirements.

- *Procedural Compliance Assumptions within the Safety Analysis*—The current Pantex Plant safety basis assumes 100% operator compliance with the operating procedures. While the Pantex Plant contractor should not be expected to evaluate gross deviations from the procedure within the safety basis, this assumption of perfection is unrealistic and inconsistent with the operating environment, which includes instances where incorrect special tooling was brought in proximity to the unit. Safety basis changes may be warranted to rely less on compliance from the technicians (e.g., use of more conservative weights for impact hazards for instances where incorrect tooling could be introduced). Opportunities to update the safety basis are available during upcoming life extension programs for the various weapon programs.

NNSA and its contractor continue to apply similar improvements as seen in the revised B61 Hazard Analysis Report to the remaining Pantex Plant safety basis documents with a planned completion of December 2025. Based on exhibited safety improvements, on January 30, 2025, the Board issued a letter and report to the Acting Secretary of Energy closing Board Recommendation 2019-1, while noting the above safety concerns, which will require further action and consideration from NNSA.

[2] Safety margin refers to built-in extra protection to prevent failure or reaching a safety limit.

Nuclear Explosive Safety Oversight

During 2024, the DNFSB provided safety oversight of nuclear explosive operations at the Pantex Plant. This included observation and evaluation of the W76 and W88 Operational Safety Reviews, Known State Nuclear Explosive Safety Study, and Approved Equipment Program Master Study for the electrical tester program. The DNFSB also assessed various nuclear explosive safety change evaluations associated with off-normal conditions encountered with B83 and W88 units and operating procedure modifications.

The Pantex Plant contractor improved the reliability of safely executing nuclear explosive operating procedures, incorporating safety enhancements identified by the DNFSB.

During such activities, the DNFSB evaluated execution of the nuclear explosive safety evaluation by the NNSA-led study group, assessed the operations against the requirements in DOE and NNSA directives, and provided safety-related observations to the study group and project team. Additionally, while observing proposed operations for an off-normal unit in a nuclear explosive cell, the DNFSB staff identified an opportunity to improve the operating procedures by providing explicit directions to the production technicians on necessary actions versus relying on training and by adding surveillance steps to assess further potential degradation of the unit. Based on these observations, the Pantex Plant contractor revised the nuclear explosive operating procedure to incorporate these safety enhancements.

Probabilistic Seismic Hazard Analysis Update

The DNFSB reviewed the Pantex Plant's updated probabilistic seismic hazard analysis, which was the first complete seismic hazard update for the site since 1998.The new analysis incorporated the latest data, models, and methods in characterizing seismic sources, ground motions, and site response. The DNFSB found it to be a technically defensible seismic hazard assessment for existing facilities and for potential new construction at the site. Additionally, both the Pantex Plant contractor and the DNFSB identified that the new seismic spectra exceeded the design spectra at a specific frequency range. However, the Pantex Field Office and Pantex Plant contractor determined that compensatory measures were not required as sufficient safety margin is present within the design for existing safety structures. The DNFSB will continue to monitor site progress in implementing the updated analysis and assessing the impact of the new seismic design spectra on safety structures, systems, and components.

Los Alamos National Laboratory

Plutonium Facility Safety Posture

The Los Alamos Plutonium Facility is currently the only facility in the DOE complex capable of producing plutonium pits (the trigger at the heart of a nuclear weapon) and is also used to accomplish other mission work with significant quantities of plutonium. In April 2024, the LANL contractor submitted a draft of an updated safety framework to the NNSA Los Alamos Field Office for approval. This new framework represents a formal shift in safety strategy by adjusting which controls are credited with public-facing safety functions.

The Los Alamos Plutonium Facility is currently the only facility in the DOE complex capable of producing plutonium pits (the trigger at the heart of a nuclear weapon).

In a letter to the Board dated March 15, 2022, the NNSA Administrator stated that the safety strategy for protecting the public against key accidents at the Plutonium Facility would shift from NNSA's longstanding plan to upgrade the ventilation system to instead upgrade and credit the facility fire suppression system. If pursued, the ventilation upgrades would have been credited to filter most of the radioactive particles before they could leave the facility. Instead, the fire suppression system will be credited with lessening the motive force from a fire that would drive radioactive particles out of the facility and therefore reduce the amount of material that would escape following an accident. The Board's position has long been that, from a safety perspective, crediting the ventilation system would be more desirable because it is more effective at removing radioactive particles and is thus more effective at protecting the public.

Figure 3. One of the fire pump houses servicing the Plutonium Facility.

Figure 4. The first diamond stamp applied to the surface of the W87-1 pit on October 1, 2024, denoting that this component has met or exceeded all quality and design requirements.

The new safety documentation submitted by the LANL contractor includes more comprehensive computer modeling of accidents and attempts to more accurately quantify the effectiveness of the fire suppression system. The DNFSB is evaluating this documentation against applicable requirements in DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. Ensuring that the Plutonium Facility safety strategy adequately protects the public is more important than ever, as the facility transitions from a research and development mission to one focused on production.

NNSA is also planning to use the Plutonium Facility to receive and repackage large amounts of heat source plutonium[3] currently located at Idaho National Laboratory (INL). NNSA originally proposed this mission in 2021. The initial safety analysis showed the potential for very high radiological exposure to members of the public for certain seismic accident scenarios

[3] Heat source plutonium consists primarily of the isotope plutonium-238 and is used in space related missions (e.g., as a power source for satellites and rovers) and other applications. It is significantly more radioactive than weapons grade plutonium.

necessitating special risk acceptance from NNSA headquarters. This was the subject of an August 11, 2022, letter wherein the Board advised the Secretary of Energy to implement additional safety controls and operational restrictions to reduce the safety risk of this mission to the extent practicable and urged better planning to avoid similar high-risk situations in the future.

Since the time of the Board's 2022 letter, NNSA has delayed this mission due to issues with operational readiness as well as the discovery of assumptions in the 2021 safety analysis that underestimated the safety risks. Revisions to the safety analysis required further approval from NNSA headquarters (granted in April 2024) to accept additional risk. In granting this approval, NNSA established an expectation—in alignment with language from the Board's 2022 letter—that those operations be accompanied by enhanced surveillances to lessen the risk from fires. While instituting additional administrative measures to improve safety is commendable, NNSA should also use opportunities such as this operational delay to make meaningful facility upgrades to further mitigate risks to the public.

In 2024, NNSA established an expectation—in alignment with language from the Board's 2022 letter—that operations involving heat source plutonium be accompanied by enhanced surveillances to lessen fire risk and mitigate risks to the public.

Glovebox Safety and Glovebox Glove Integrity Programs

Most hazardous radiological work in the Plutonium Facility is performed using gloveboxes, which provide an engineered barrier to confine radiological material. In 2022 and 2023, the Plutonium Facility experienced an increased number of occurrences of glovebox glove breaches, failures, and subsequent contaminations. These events led the DNFSB to review the glovebox safety and glovebox glove integrity programs. The DNFSB assessed the effectiveness of glovebox barriers (e.g., gloves, seals) to prevent release of radioactive contamination, the qualification of glovebox barriers, the degradation and monitoring of certain glovebox equipment, and the use of technologies to ensure material confinement.

During the DNFSB review, the LANL contractor instituted significant changes to correct negative trends in glovebox and glove-related incidents. These changes included improvements to workforce training, institution of a more comprehensive glovebox glove database to track and trend breaches and failures, and other programmatic improvements. The DNFSB noted, however, that neither LANL nor DOE had communicated lessons learned on the LANL glovebox-related events to the DOE complex.

Following the review, the Board issued a letter to the Secretary of Energy on April 10, 2024, that detailed additional information and further improvements for consideration. The letter also requested that NNSA respond regarding program actions taken and NNSA's plans for disseminating

lessons learned. On August 6, 2024, NNSA and LANL contractor management briefed the Board on the scope and status of program improvement actions. In December 2024, DOE issued an operating experience program document to the DOE complex on glovebox-related events at LANL and other sites and provided several recommendations for sites that use gloveboxes.

Figure 5. Glovebox glove puncture, risking worker exposure to plutonium.

Decontamination and Decommissioning Work Planning and Control

As part of the Los Alamos Plutonium Pit Production Project and other projects at the Plutonium Facility to support DOE's expanding pit mission, workers are continually removing legacy equipment, such as contaminated gloveboxes, from the facility in preparation for installation of new equipment. The DNFSB is reviewing the work planning and control practices related to these activities.

As part of this review, the DNFSB conducted several facility and project walkdowns with project managers, observed mock-ups that aid in preparing for eventual radiological work, and reviewed work packages that describe safety controls to be used during decontamination and decommissioning activities.

The review found that the large scope of decontamination and decommissioning activities occurring concurrently with mission work will challenge facility safety. While removal of an individual glovebox is analyzed and considered a routine operation, the projected removal of many gloveboxes affects the facility safety systems, such as facility ventilation. The review further identified several weaknesses in work packages and the processes used to generate them. The DNFSB will complete this review in 2025.

Figure 6. DNFSB staff members discuss mockups of decontamination and decommissioning activities with site personnel.

Savannah River Site

Savannah River Tritium Enterprise Safety Improvements

The Savannah River Tritium Enterprise has an important enduring mission to ensure the safety and reliability of the nuclear stockpile by supplying tritium, a key element in nuclear weapons. The Savannah River Tritium Enterprise faces several safety risks such as the age of facilities and the unique hazards posed by tritium processing. Accordingly, the DNFSB continues to focus its safety oversight on safety control upgrades, emergency preparedness, safety basis, and the safety of routine operations.

The DNFSB engaged with NNSA to drive necessary safety improvements at the Savannah River Tritium Enterprise. In Board Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, the Board communicated safety concerns with the high mitigated calculated dose consequences to the co-located worker from several postulated accident scenarios. As a follow-on to the recommendation, the Board sent a letter to the Secretary of Energy on October 4, 2023, requesting DOE to provide an annual report and briefing to the Board regarding DOE's progress on safety improvements at the Savannah River Tritium Enterprise. DOE delivered the first report and briefing in Spring 2024.

DOE completed safety advancements such as installation of fire barriers in a storage location for tritium containers, which reduces the risk of a fire causing a tritium release. Additionally, DOE improved the emergency preparedness program, which helps ensure that the site can respond effectively to potential accident situations to protect the public and workforce. DOE also continued efforts to reduce safety risk through physical facility upgrades, analytical refinements, and implementation of a new safety basis. The DNFSB is encouraged by DOE's continued efforts; however, additional physical upgrades to reduce safety risk (specifically, the co-located worker calculated dose consequences [4]) remain years away.

The Board is encouraged by DOE's continued efforts to improve safety at the tritium facilities; however, additional physical upgrades to reduce safety risk remain years away.

Given the safety risk at the Savannah River Tritium Enterprise and proximity to large populations onsite, strong emergency preparedness plays an important role in providing assurance of safety. As a result, the

[4] This is the estimated radiation dose a worker in the general vicinity of a nuclear hazard (but not directly involved in an accident) might receive. This helps determine whether additional protective measures are needed for on-site personnel.

DNFSB prioritizes observing emergency preparedness drills and exercises to identify and communicate areas for improvement. The DNFSB observed a mass casualty drill scenario that postulated exceeding the capability of onsite resources, noting that this complex scenario was appropriately challenging, allowing for identification of areas for improvement and experience with more complicated and realistic situations.

The DNFSB reviewed other key safety topics at the Savannah River Tritium Enterprise. The DNFSB conducted a review of the co-located worker dose reduction strategy to evaluate the long-term plans of DOE and its contractors to reduce safety risk to the co-located worker. While the review is still ongoing, the DNFSB is concerned that DOE's long-term plans may not adequately reduce the safety risk for all postulated accident scenarios.

The DNFSB performed routine safety oversight of major activities at the Savannah River Tritium Enterprise, including the partial outage at H-Area New Manufacturing to replace process equipment, which involves personnel performing work in plastic suits to protect them from hazards.

Figure 7. Mass casualty emergency preparedness drill at the Savannah River Tritium Enterprise.

Figure 8. Preparation of a plastic suit to be used in the H-Area New Manufacturing partial outage.

The DNFSB also performed oversight of the implementation of the new combined tritium facilities documented safety analysis that implements numerous safety improvements, several of which partially address concerns the DNFSB previously raised. Examples of improvements include elevating some programmatic controls to more robust specific administrative controls, no longer crediting emergency preparedness for calculated dose consequence reductions, and implementing updated dispersion modeling parameters. The documented safety analysis also includes a new postulated accident scenario, described in the DNFSB letter dated July 26, 2022, of an exhaust stack toppling during a seismic event and impacting a key tritium container storage location. The DNFSB has initiated a review of the documented safety analysis that continues into 2025.

Tritium Release and Re-Entry Event at the Savannah River Tritium Enterprise

In January 2022, due to unfavorable meteorological conditions, some tritium released out of the stack was drawn back into a facility through the ventilation system and spread throughout the facility. This type of accident scenario was not previously included in the hazard analysis or safety basis. On August 11, 2022, the Board sent a letter to the NNSA Administrator requesting a briefing regarding the inadvertent tritium release and re-entry event in a process building. In November 2022, NNSA officials informed the Board that no additional analysis was needed because the existing analysis was adequate. However, in July 2024, after re-evaluating the enterprise contractor's analysis, NNSA's Savannah River Field Office directed the Savannah River Tritium Enterprise contractor to re-perform the analysis related to the re-entry event and re-evaluate whether the hazard analysis is adequate. The Savannah River Tritium Enterprise contractor subsequently declared a potential inadequacy in the safety analysis and positive unreviewed safety question[5] determination for two process buildings. In September 2024, the Savannah River Field Office approved the Savannah River Tritium Enterprise contractor's evaluations and noted its expectation that the Savannah River Tritium Enterprise contractor proceeds with incorporating the re-entry event analysis in the hazard analysis and safety basis, which may result in the need to place additional controls in service.

Two and a half years after a tritium release and re-entry event at SRS, NNSA concurred with DNFSB that the site should re-evaluate whether the hazard analysis is adequate. This will confirm whether additional controls to protect workers may be needed.

[5] The unreviewed safety question process is a formal procedure used by DOE to determine whether a proposed change in operations, facility design, or procedures could introduce new safety risks that were not previously analyzed. If a change might increase risk, further safety review is required.

Y-12 National Security Complex

Conduct of Operations

Y-12 processes and stores enriched uranium for nuclear weapon and naval nuclear fuel applications and supports the nation's nuclear nonproliferation activities.

In April 2023, a significant nuclear criticality safety [6] violation occurred in Building 9215 that resulted in both Y-12 and the DOE Office of Enforcement conducting investigations. During the removal of a lathe used for machining enriched uranium components, workers cut into a machine coolant line believed to be drained and isolated. However, the coolant line was not empty of uranium-bearing coolant and began to leak. Several breakdowns in work planning, work execution, and abnormal condition response resulted in the unsafe collection of the coolant in buckets and unsafe handling of contaminated piping. The Y-12 contractor and NNSA recognized the significance of the conduct of operations breakdowns and developed plans and initiatives to address these issues. Examples of improvements included: increasing field presence of management; enhancing training for facility operations management on roles and responsibilities; and strengthening event tracking, trending, and corrective action identification. In addition, Y-12 has established a Conduct of Operations Center of Excellence with the objective of providing additional resources and enhanced oversight of work planning and execution.

In 2024, conduct of operations issues persisted at Y-12. Of note, there was a significant increase in technical safety requirements violations, several which were associated with poor conduct of operations practices. These types of violations correspond to a failure to meet required conditions or execute required controls to ensure safe operations of a nuclear facility, as derived in a facility's safety basis. In addition, several preventable nuclear criticality safety issues occurred in 2024 due to improper work planning and execution. NNSA continues to track the Y-12 contractor's efforts to implement more effective disciplined operations practices. The DNFSB is conducting its own review of conduct of operations practices at Y-12.

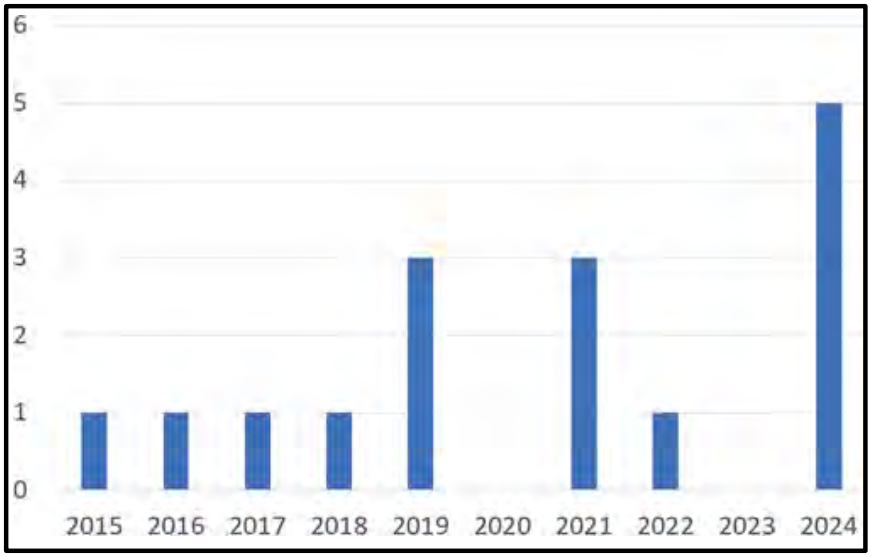

Figure 9. Number of technical safety requirements violations at Y-12 per year.

[6] Criticality safety is a field of nuclear engineering that prevents nuclear accidents caused by uncontrolled nuclear chain reactions.

Electrorefining

The DNFSB is following Y-12's progress toward start-up of the new electrorefining capability in the 9215 Complex. Establishing this capability is critical for the transition out of the 9212 Complex and ceasing chemical processing operations involving uranium solutions in this aged facility. In a letter dated December 5, 2023, the Board expressed concerns with NNSA's plans to conduct the electrorefining readiness assessment in parallel with Y-12 the contractor readiness assessment. The DNFSB will closely follow readiness activities, planned for 2025, to ensure the federal and contractor reviews are conducted with adequate independence and provide assurance that the electrorefining capability is ready for operational start-up.

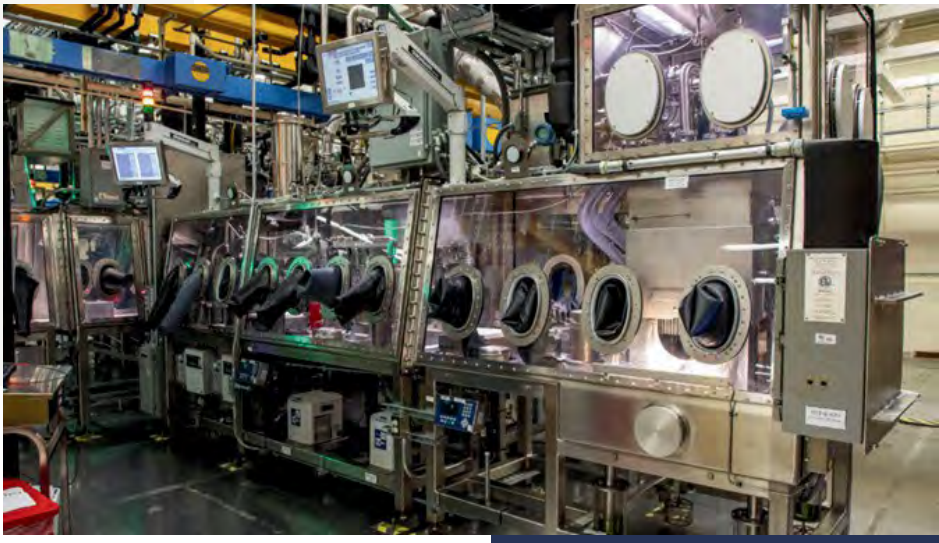

Figure 10. Electrorefining glovebox in the 9215 Complex.

Water Supply to Credited Fire Suppression Systems

Credited fire suppression systems for Y-12 defense nuclear facilities are supplied from the sitewide potable water network. Two elevated water tanks provide supply to the potable water network, and these towers are supplied by local municipal water. During 2024, two significant water main breaks occurred that resulted in disruptions to the water supply and nuclear operations. In June 2024, an on-site water main from the City of Oak Ridge ruptured, causing a loss of supply to the Y-12 water tanks until an alternate line up could be established. In November, a potable water network main line ruptured, resulting in the impairment of several credited fire suppressions systems in several buildings. Similar water line breaks have occurred elsewhere in the potable water network in recent years, affecting nuclear facilities. Both recent ruptures highlight ongoing aging issues with this important part of Y-12's infrastructure.

Y-12 continues to implement actions to improve fire water supply reliability, address deficiencies, and prioritize repairs. This includes replacing older, higher risk water lines and replacing lead-in lines to defense nuclear facilities. The site maintains a prioritized list of improvements to the fire water supply. The recent water line breaks highlight that priorities may need to be re-evaluated, especially regarding single-point failures that can affect multiple credited fire systems simultaneously. In addition to addressing the buried pipe network and facility lead-in lines, Y-12 conducted refurbishment activities on the elevated supply water tanks in 2024, resulting in one tower supplying water to the site for several months at a time. The DNFSB continues to follow the Y-12 efforts to address aging infrastructure across the site, particularly with a focus on the Extended Life Program facilities and the construction of the Uranium Processing Facility.

Figure 11. System supply towers that provide potable water to Y-12 facilities.

Sandia National Laboratories

Annular Core Research Reactor Fuel Health Program Review

The DNFSB began a review of the Annular Core Research Reactor fuel health program in October 2024. This review is focused on fuel element inspection efforts undertaken by SNL. In addition, SNL is conducting advanced fuel characterization efforts including computed tomography radiographs of Annular Core Research Reactor fuel elements and regulating rods. The computed tomography scans provide significant new information on the structural integrity of the fuel pellets and cladding materials. The DNFSB review of the Annular Core Research Reactor fuel health program will continue in 2025.

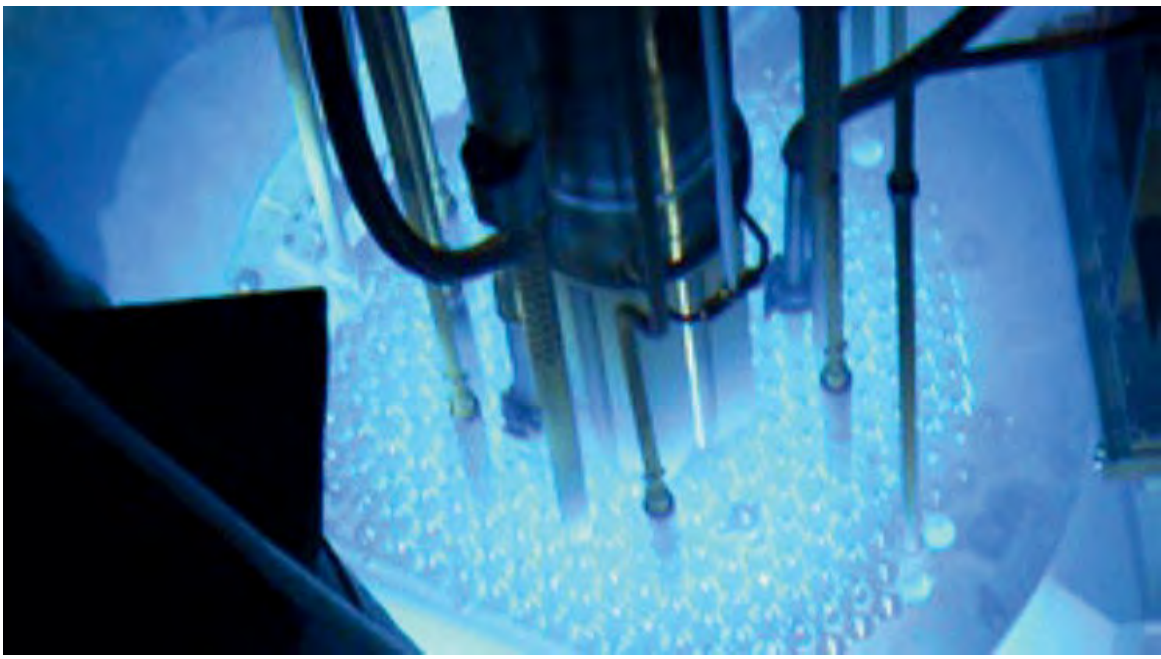

Figure 12. Annular Core Research Reactor central cavity, fuel elements, and regulating rods.

Nevada National Security Sites

Device Assembly Facility Lithium-Ion Batteries in Uninterruptible Power Supply

In 2024, the DNFSB completed a safety review of the installation and operation of the new uninterruptible power supply for the Device Assembly Facility (DAF). The new uninterruptible power supply uses large format lithium-ion batteries and replaces the previous lead-acid battery system. This application represented the first installation of a lithium-ion-battery energy storage system to serve a safety significant function at a DOE defense nuclear facility.

Figure 13. Representative single train lithium-ion uninterruptible power supply cabinet.

The DNFSB identified safety concerns related to the use of lithium-ion batteries, which present inherent safety risks related to the difficulty in suppressing and extinguishing lithium-ion battery fires. However, DOE had neither issued requirements nor provided guidance to assess the hazards and identify safety controls necessary for the use of lithium-ion energy storage systems. Additionally, the DNFSB identified several safety concerns related to the hazards associated with operation of the lithium-ion battery uninterruptible power supply and protection features to mitigate the impacts of a fire. Given the significance of the safety issues, in a letter dated August 13, 2024, the Board requested a briefing from the Secretary of Energy on its plans to develop or adopt requirements and provide guidance on hazard analysis and controls for lithium-ion battery energy storage systems at defense nuclear facilities. The Board also requested that DOE address the identified safety issues with the lithium-ion battery uninterruptible power supply now installed at the DAF. In November 2024, NNSA informed the Board that DOE's response and briefing will be provided in 2025.

The DNFSB found that DOE had not issued requirements nor provided guidance to assess the hazards and identify safety controls necessary for the use of lithium-ion energy storage.

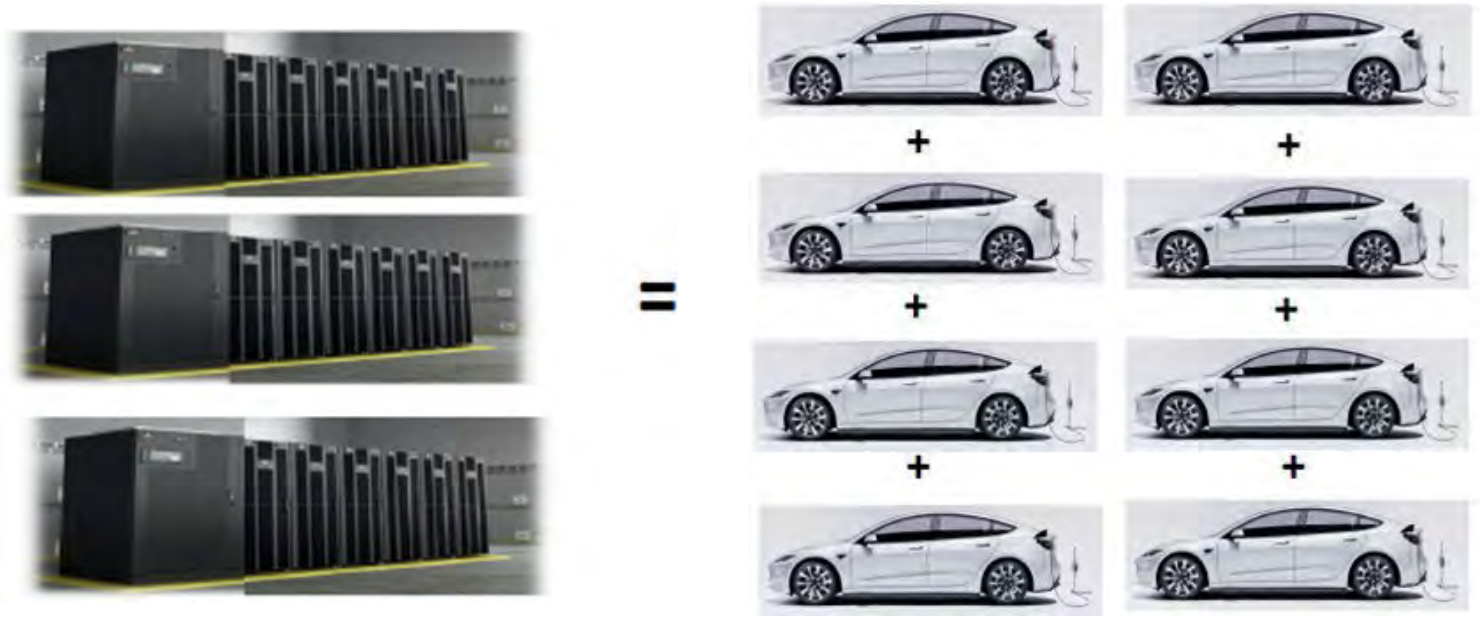

Figure 14. Uninterruptible power supply battery capacity inside the Device Assembly Facility is equivalent to approximately 8 electric vehicles.

NNSA and DNFSB Engagement on the Quality of NNSS Safety Basis Documents

The DNFSB continues to follow NNSS progress toward improving the quality of safety basis documents for NNSS facilities and the NNSS contractor's recent efforts to rewrite the documented safety analysis for the DAF. In a letter dated December 12, 2023, the Board requested that the Secretary of Energy provide information on actions that have been taken by NNSA to ensure the safety and document quality issues identified for the DAF are resolved in the final version of the documented safety analysis. On April 2, 2024, NNSA briefed the Board highlighting several corrective actions implemented by the NNSS contractor and continued efforts to resolve outstanding safety and document quality issues at the DAF. The corrective actions include developing improved NNSS contractor internal review processes and procedures to evaluate safety documents prior to submittal to the Nevada Field Office for formal review and approval. The field office also committed to perform a formal assessment in 2025 on the effectiveness of the implemented actions. The DNFSB will closely follow assessment activities and continued maturation of the DAF documented safety analysis to ensure adequate protection of workers and the public.

Lawrence Livermore National Laboratory

Conduct of Operations Review

The DNFSB completed a review of conduct of operations at the LLNL Plutonium Facility in November 2024. This review is part of a series of reviews of conduct of operations across the DOE nuclear complex. The review focused on formality and rigor of operations, procedure development and use, independent verification, training and qualifications, and the control of hazardous energy sources. The DNFSB staff identified the need to improve the formality and rigor of conduct of operations, which is required for sustained, high-level safety performance, and discussed these observations with LLNL personnel on numerous occasions over the course of the review. The complex-wide review of conduct of operations will continue in 2025.

Figure 15. Centralized waste processing gloveboxes in the LLNL Plutonium Facility.

DEFENSE NUCLEAR WASTE OPERATIONS

III. Defense Nuclear Waste Operations

In 2024, the DNFSB performed nuclear safety oversight of high priority and risk significant Office of Environmental Management operations within the defense nuclear complex. The DNFSB continued safety oversight of DOE's efforts to update facility safety bases using the latest DOE nuclear safety standards at the Hanford Site, LANL, and INL. The Hanford Site concluded holistic negotiations with the Washington State Department of Ecology that will lead DOE to increase the tempo of cleanup efforts at the Hanford Tank Farms. Consequently, the DNFSB focused significant resources on the Hanford liquid waste mission, including the Low-Activity Waste Facility and the 242-A Evaporator. The DNFSB also focused on the safe execution of nuclear operations, notably at SRS's Defense Waste Processing Facility and the Waste Isolation Pilot Plant (WIPP).

Oversight of nuclear waste operations is focused on modernizing facility safety bases and improving conduct of operations.

Savannah River Site

Savannah River National Laboratory Safety Basis Modernization

After a decade of effort, the Savannah River National Laboratory (SRNL) and DOE personnel implemented an upgraded and modernized safety basis governing nuclear operations. This substantive upgrade addresses longstanding deficiencies, including weaknesses identified in a Board letter dated April 5, 2023. In direct response to the Board's engagement, the recently implemented SRNL safety basis identifies new specific administrative controls that should enhance the reliability and effectiveness of facility protocols that perform critical safety functions. As an important follow-on effort, the DNFSB began reviewing the implementation of more than 40 new controls identified in the new safety basis to independently validate whether they reliably fulfill their credited safety functions. This effort continues into 2025.

SRNL implemented a host of new safety controls that enhance the reliability and effectiveness of facility safety functions.

A second significant outcome of the Board's engagement involved SRNL personnel completing a backfit analysis of the safety significant fire water supply and sprinkler system. The Board raised safety concerns that many system components were procured, installed, and classified as general service, despite being necessary to ensure the system could perform vital fire protection functions identified in the facility's safety basis. Based on the results of the backfit analysis, SRNL personnel identified a path forward to upgrade the safety classification of key system components, which will improve long-term reliability and bring the system into compliance with key DOE safety basis requirements.

The Mark-18A Target Material Recovery Program is another significant activity falling under the umbrella of the updated safety basis discussed above. This new activity enables recovery of valuable isotopes

of americium, curium, and plutonium for use in medical research and nuclear forensics. The laboratory contractor applied significant resources to readiness activities and conducted a contractor readiness assessment in late 2024. The DNFSB staff independently evaluated these efforts, raising concerns regarding the scope of operations covered by the assessment to the readiness assessment team and DOE. It became further evident to the readiness assessment team throughout the performance of the assessment that the scope of planned demonstrations was not sufficient to fully meet the review objectives. The team broadened the scope of their review, despite the delay to operations, which demonstrated effective engagement between the DNFSB staff, contractor, and federal personnel aimed at ensuring the safe execution of nuclear operations. The DNFSB will continue to evaluate readiness activities for this isotope recovery program to ensure safe operations.

Defense Waste Processing Facility Operations

The Defense Waste Processing Facility (DWPF) experienced a series of conduct of operations issues dating back to 2022. In October 2023, the liquid waste contractor entered a period of deliberate operations, requiring increased management engagement and oversight, particularly through assignment of senior supervisory watches. Through a series of DOE and contractor-led reviews, liquid waste contractor management developed and implemented a Deliberate Operations Improvement Plan.

After 11 months of being in deliberate operations, the DNFSB assessed the overall state of the conduct of operations and maintenance programs at the DWPF, including the effectiveness of corrective actions taken by the liquid waste contractor to ensure safe nuclear operations. The DNFSB staff communicated preliminary observations to DOE and DWPF management, concluding that the DWPF has demonstrated an overall improvement, albeit with several areas that warrant additional attention to help drive a continued upward performance trend. The DNFSB staff reinforced the need to rigorously implement planned process enhancements, institutionalize compensatory measures, communicate effectively across the workforce, and enhance training.

DNFSB is helping to drive performance improvement and sustainment at DWPF through rigorous oversight of operations.

<u>Hanford Site</u>

Holistic Agreement

DOE and the Washington State Department of Ecology concluded negotiations resulting in a holistic agreement that defines the approach DOE will use for the safe disposal of radioactive waste at the Hanford Site over the next two decades. The agreement also establishes an expectation that DOE will ship significant amounts of Hanford Site tank waste offsite for disposal and pushes more complicated and difficult cleanup work into the future.

To meet the terms of the agreement, DOE must increase the operational tempo for existing facilities and aggressively execute a phased approach to design and construct new facilities. This will require a substantial level of effort for development of associated safety basis documents to ensure safe operations. These conditions point to a continuing need for strong and focused oversight of nuclear cleanup work at the Hanford Site, which will continue to be accounted for in the DNFSB's work planning efforts.

DNFSB will increase safety oversight to match the operational tempo, safety analysis, design, and construction work under the new holistic agreement at Hanford.

Figure 16. Worker installing a transfer line that will transport waste between facilities at Hanford site.

Low-Activity Waste Facility

The Low-Activity Waste facility is part of the Hanford Site's Waste Treatment and Immobilization Plant Project, which is DOE's approach for treating the radioactive and chemical waste stored in Hanford Site's tank farms to support safe and permanent disposition.

Over the last year, the Low-Activity Waste Facility has been undergoing start-up activities leading toward cold commissioning (testing without radioactive constituents) and hot commissioning (testing with radioactive constituents) in 2025. The DNFSB provided oversight of ongoing startup and commissioning activities, including routine facility operations and maintenance.

Startup of the Low- Activity Waste Facility is a significant milestone, marking the culmination of years of engagement between DOE and the DNFSB.

The DNFSB conducted reviews of key program areas that affect safety. The review of the maintenance program resulted in a Board letter dated October 3, 2024, to the Senior Advisor for the DOE Office of Environmental Management. The Board identified opportunities to improve plant safety and efficiency by reducing maintenance backlogs and enhancing standards for corrective and preventive maintenance, as well as work planning processes. The DNFSB staff also reviewed the conduct of operations and configuration management programs. These reviews validated earlier findings related to the maintenance program and identified that the facility still needs to improve the quality of its operating procedures. The DNFSB staff also noted examples where the existing facility configuration did not match the design, resulting in a significant number of non-conforming conditions, fire system impairments, and reliance on temporary modifications to support facility operations.

Figure 17. First container of simulated waste produced at the Low-Activity Waste Facility.

The DNFSB began reviewing the Low-Activity Waste Facility radiation protection, training, and emergency planning and response programs, an effort that will continue into 2025. The DNFSB also plans to review the implementation of the documented safety analysis before the facility moves into hot commissioning.

Separately, in its letter of February 28, 2023, the Board communicated a concern to the Secretary of Energy regarding the implementation strategy for a specific administrative control that protects workers from leaks of radioactive material associated with the Tank Farms in the Low-Activity Waste Facility. Information and requirements related to the specific administrative control were not appropriately controlled in the safety basis, resulting in the potential for erosion of the control over time. In December 2024, following Board engagement, the Waste Treatment and Immobilization Plant contractor submitted a change to the facility safety basis to improve the reliability in implementing important safety-related administrative controls.

242-A Evaporator

Safety Control Strategy—The Board sent a letter to the Secretary of Energy on June 27, 2023, regarding DOE's path forward for the design and installation of engineered safety controls for the evaporator facility. The Board letter expressed concern that DOE was allowing the evaporator to be restarted after an extended outage before implementing important safety design changes and requested that DOE provide semiannual briefings regarding: (1) the design, procurement, and installation of the planned improvements; (2) any emergent technical issues and funding constraints; and (3) compensatory measures or interim controls to be used if DOE decides to commence evaporator operations before completing implementation of the revised engineered controls.

DOE personnel provided the second semiannual briefing to the Board in March 2024, and the third briefing in September 2024. Although DOE will allow restart of the evaporator and waste processing to occur before the new, engineered safety controls are in place, DOE identified appropriate compensatory measures that will serve until the engineered controls are installed in late 2027. DOE has approved this approach to meet the waste processing mission milestones at Hanford Site.

The DNFSB is driving enhanced safety system reliability and conduct of operations at the Hanford Evaporator.

During the second briefing, information provided by DOE prompted the Board to raise a concern with the proposed reliability of new safety instrumentation, which does not align with DOE guidance in current technical standards. The DNFSB staff transmitted preliminary observations regarding the issue in December 2024 and the Board is evaluating the path forward.

Restart Readiness—During 2024, the DNFSB reviewed implementation of aspects of the conduct of operations program. The DNFSB staff noted weaknesses in procedure use and adherence, procedure quality, configuration control, and training. Contractor and DOE readiness review teams also independently identified weaknesses in these areas. While the evaporator contractor initiated corrective actions for most of the identified weaknesses, they did not sufficiently address the weaknesses on a programmatic level. Subsequently, in July 2024, DOE suspended its readiness review. DOE plans a resumption of readiness review activities in 2025. In the interim, the evaporator contractor has taken action to resolve procedural, training, and facility reliability issues. The DNFSB will perform safety oversight of these readiness activities to ensure the safe restart of the evaporator, which is critical to ensure the safe disposal of legacy radioactive waste.

Figure 18. Hanford 242-A evaporator exterior.

Tank Farms Projects and Operations

Single-Shell Tank Retrieval—The tank operations contractor completed the retrieval of waste from single-shell tank 241-AX-101 in June 2024, finishing the retrieval work in the Hanford Site AX Tank Farm. In July 2024, the tank farms contractor began retrieval of the approximate 400,000 gallons of waste in tank 241-A-101. The retrieval process generates additional waste that must be transferred to the double-shell tank system for safe storage. The Hanford Site double-shell tank system is nearly full and future single-shell tank retrieval activities are dependent on resumption of 242-A Evaporator operations and on the startup of the Waste Treatment and Immobilization Plant Project's Low-Activity Waste Facility. Operation of these facilities will reduce double-shell tank waste volume to allow continued retrieval from single-shell tanks in the Hanford Site 200-east area, providing a safer way to store hazardous radioactive materials.

Figure 19. Waste retrieval operations at Hanford Tank Farms.

Tank Farms Documented Safety Analysis—On September 15, 2021, the Board advised the Secretary of Energy that the Tank Farms documented safety analysis was based on a dated methodology and lacked sufficient documentation to support its conclusions regarding risk to the workers and the public. Further, the Board noted that it would be prudent to update the safety analysis using DOE Standard 3009-2014, *Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, to ensure a smooth transition to the next phase of Tank Farms operations, which will involve changing tank waste conditions and an increased contractor initiated an effort to update the Tank Farms safety basis using DOE Standard 3009-2014. The DNFSB will monitor this effort to ensure risk to workers and the public from Hanford Site Tank Farms operations is appropriately documented and adequately addressed.

DNFSB prompted an effort to update the Tank Farms safety basis to ensure workers and the public are protected from radioactive waste processing activities.

Change of Single-Shell Tank 241-T-101 Condition Status—On August 15, 2024, the tank operations contractor revised the condition of single-shell tank 241-T-101 from "presumed sound" to "assumed leaker." This is the third Hanford Site single-shell tank with this designation. DOE determined that any new safety impact to workers resulting from the leak is negligible because the leak is below ground level and the leak rate is low. Additionally, DOE notes that the leak does not substantially change risk to the public or the environment since there is an effective ground water treatment system in place to mitigate the condition and there is large distance between the tank and the site boundary and the Columbia River. Consequently, although options are being evaluated, DOE does not currently intend to modify single-shell tank retrieval plans to address this leak in the near term.

The DNFSB routinely monitors Hanford Site single-shell tank conditions and performs oversight of an expert panel that is tasked to advise DOE on actions to sustain the integrity of Hanford Site's aging tank and pipeline systems. Additionally, the DNFSB Hanford Site resident inspectors provide day-to-day safety oversight of system conditions.

Tank Side Cesium Removal

The Tank Side Cesium Removal system is a pilot program that pretreats tank waste by removing cesium and solid particulate from the waste stream. The system has been in operation since 2022 and its product is stored in a Tank Farm double-shell tank, pending transfer to the Low-Activity Waste Facility, where it will be vitrified prior to disposal. In 2024, the tank operations contractor completed their first campaign using the system. The DNFSB focused safety oversight efforts on quality assurance, classification of safety-related components, and safety system design requirements. Further detail regarding application of lessons learned to future projects is provided in Section IV: Nuclear Facility Infrastructure and Projects of this report.

Figure 20. Tank side cesium removal system process enclosure.

Central Plateau Cleanup and Risk Reduction

The Hanford Site contains former plutonium production, processing, and refining facilities that are no longer required. In 2024, DOE focused on mitigating risk associated with these facilities by characterizing, removing, and remediating nuclear and chemical hazards; interim maintenance and stabilization of facilities; demolition of degrading support facilities; and interim safe storage or disposal of waste products. Significant projects of interest are discussed below.

105-K West Basin—105-K West reactor and its associated fuel storage basin together are one of the few significant hazards remaining along the Hanford Site River Corridor. During 2024, the central plateau cleanup contractor successfully dewatered and grouted the basin, which stabilizes much of the existing radiological hazard. Although environmental remediation work will continue around the facilities to eliminate chemical hazards to the river, DOE paused work on the reactor and basin and will complete that work in the future.

Throughout 2024, the DNFSB conducted safety oversight activities associated with dewatering the basin. Significant activities included observation of a contractor management self-assessment prior to dewatering the basin, evaluation of radiological controls used during the dewatering process, and monitoring of central plateau cleanup contractor work performed to manage technical issues identified during startup of the dewatering system.

Building 324—Along the river corridor, Building 324 is being decommissioned after operating for more than 30 years. DOE paused initial decommissioning efforts in 2010 after discovering significant contamination under a portion of the building. Full-scale remediation activities intended to remove contaminated soil from below Building 324 began in 2022. However, as of March 2023, the central plateau cleanup contractor no longer considered the current approach for recovering radiologically contaminated soil to be viable and recommended termination of that work. The decision was largely driven by the September 2022 discovery of an additional waste plume under the building. Risk mitigation work will slow in 2025 as DOE focuses resources on direct feed, low-activity waste startup and acceleration of the associated tank waste processing mission. However, DOE will continue to fund work associated with Building 324 since it is the most significant and nearest remaining radiological hazard to the Columbia River. The DNFSB continues to monitor DOE's selection of a new strategy for soil remediation and facility demolition and will evaluate the approach as information is made available.

Figure 21. Tanker truck carrying contaminated water that had been removed from 105-K West basin during the dewatering process.

Fire Protection

The DNFSB staff continues to work with DOE to resolve issues with fire protection systems at Hanford Site facilities. Many of these systems were not available due to required maintenance not being performed for many years. DOE and its contractors have made progress in addressing many of these issues, but continued work is necessary to ensure all fire protection systems are maintained in an operable and reliable condition.

Figure 22. Building 324 in relation to Columbia River.

The DNFSB has driven significant safety improvements to Hanford Site fire protection by prompting sitewide reviews of maintenance practices.

The DNFSB's safety oversight activities have influenced work related to the fire suppression system issues. Resident inspectors highlighted the significance of the problem originally identified at the Central Waste Complex, driving completion of a full extent-of-condition review across all Hanford Site facilities, which revealed root causes for the systemic failures in fire system maintenance. The DNFSB also performed a review of cold weather protection measures and provided DOE advice regarding potential improvements to Hanford Site freeze protection procedures to prevent freezing of piping systems including fire suppression systems. The DNFSB Hanford Site resident inspectors also questioned the role of fire suppression systems related to lightning protection at some Central Waste Complex facilities, leading the contractor to evaluate how the lightning hazard is addressed by the facility safety basis. The DNFSB staff commenced a review to evaluate aspects the fire protection programs at multiple facilities across the Hanford Site. This review remains in progress and will conclude in 2025.

In June 2024, the DNFSB responded to a Senate staff inquiry regarding the operability of fire suppression systems at Hanford Site facilities. The DNFSB provided a summary of the challenges faced at various facilities as well as the overall status of both operable and impaired fire suppression systems at the Hanford Site, an overview of the impaired fire suppression system risers at the 222-S Laboratory, and a discussion of the effects of inadequate freeze protection for some fire suppression systems.

Figure 23. Degraded 222-S Laboratory firewater riser.

Los Alamos National Laboratory

Area G Documented Safety Analysis

The LANL contractor submitted a new version of the Area G facility safety basis for federal approval in July 2024. This is one of the first safety bases in the defense nuclear complex written to comply with DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, and the first safety basis written to comply with DOE Standard 5506-2021, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*. Sections of corrugated metal pipes containing cemented radioactive waste have been placed inside standard waste boxes and staged for shipment offsite inside the domes at Area G.

Figure 24. Standard waste boxes with sections of corrugated metal pipes containing grouted waste stored in a dome at Area G.

The DNFSB conducted a limited scope review of the safety basis and shared preliminary safety concerns with the DOE review team performing its safety evaluation in support of approval of the document. As a result, several of the DOE's directed changes and conditions of approval were informed by safety concerns identified by the DNFSB. The DNFSB is evaluating DOE's safety evaluation report for the Area G documented safety analysis and plans to continue this review into 2025.

Oak Ridge National Laboratory

Uranium-233 Initial Processing Campaign

The DNFSB continues to follow the progress of the Initial Processing Campaign to disposition uranium-233 materials stored at Building 3019. The bulk of the inventory stored is in the form of uranium oxide, though other examples of material forms include uranium metal and uranium ceramics. The uranium-233 materials contained within canisters are being processed in hot cells within Building 2026, which neighbors Building 3019. Thorium-229 is extracted during processing for future use as a medical isotope, and the remaining materials are prepared for disposal as low-level waste off-site.

DNFSB influenced safety improvements by identifying and driving resolution of safety concerns with the new Area G safety basis.

Figure 25. Uranium-233 canister within a transfer cask being loaded into a hot cell at Building 2026.

In 2024, DOE processed 103 canisters of uranium-233 and produced 9 tanks of uranyl nitrate solution for disposal as waste off-site. Since the Initial Processing Campaign began in late 2022, 192 of 556 canisters from Building 3019 have been processed and over 13 grams of purified thorium-229 has been recovered. DOE approved the safety basis for the next processing campaign of uranium-233 ceramic monoliths, planned to begin in 2025. The DNFSB will continue with the oversight of uranium-233 disposition activities, including a review of the safety basis implementation for the ceramic monoliths.

Figure 26. Containers with Thorium-229 destined for off-site shipment and medical use.

Idaho National Laboratory

BN510 Supercompacted Waste

The DNFSB engaged with DOE throughout 2024 regarding ongoing activities related to BN510 supercompacted waste located at the Advanced Mixed Waste Treatment Project at INL. In 2022, INL personnel discovered free liquid and contamination inside two separate shipping containers from this waste stream. INL personnel conducted inspections, an extent-of-condition review, and further analysis, concluding that product drums newer than 5 years old should have sufficient integrity to support shipment. Older drums and those suspected of containing free liquid required enhanced inspection and overpacking before shipment. INL also began adding a phenolic coating to the inside of product drums as well as a fiberboard disk at the bottom to enhance container integrity and completed reprocessing and repackaging all product drums with free liquids in April 2024.

DNFSB prompted performance of enhanced inspections and evaluations to ensure integrity of radioactive waste containers.

Overpacking of BN510 product drums for shipping continues to be a challenge for INL, given the limited availability and cost of ten-drum overpacks and standard waste boxes. During 2024, INL began exploring alternatives to standard overpacks including overpacking bags and ultrasonic testing of drums. As part of its oversight activities, the DNFSB will review the design and implementation of safety features for these new alternatives to standard overpacks to ensure that the integrity of containers is appropriately considered and maintained.

Integrated Waste Treatment Unit

The Integrated Waste Treatment Unit is designed to process approximately 900,000 gallons of sodium-bearing liquid radioactive waste. The DNFSB closely followed facility start-up and transition to hot operations, particularly efforts to restart operations in March 2024 after an unplanned 2023 outage. During restart activities, INL personnel discovered excessive loading on the off-gas filters, which contributed to filter elements dislodging or breaking, pictured below. INL personnel decided to replace all filter bundles in the process gas filter, which was a significant radiological operation, and to add aluminum hydroxide and carbon dioxide to the waste processing to reduce agglomeration of solids on the filters. INL resumed processing sodium-bearing liquid waste in August 2024. Since then, the Integrated Waste Treatment Unit has been processing waste with only minor interruptions. The DNFSB will continue to provide oversight of operations at the Integrated Waste Treatment Unit to ensure continued adequate protection of public health and safety.

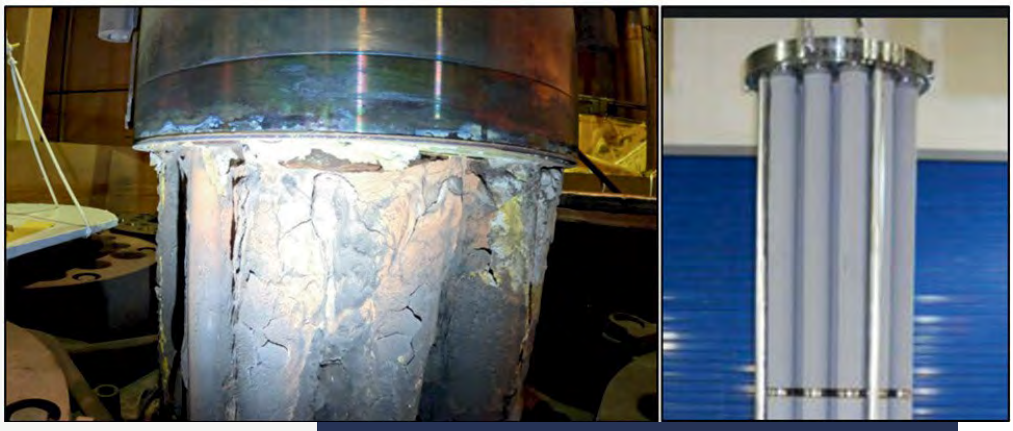

Figure 27. Integrated Waste Treatment Unit process gas filter bundle, loaded (left) and new (right).

Implementation of DOE Standard 5506-2021, "Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities"

On February 24, 2023, the Board sent a letter to the Secretary of Energy raising safety concerns related to flammable gas hazards and inadequate analyses and controls in the Advanced Mixed Waste Treatment Project safety basis. The letter requested a briefing on: (1) whether, when, and how DOE intends to implement DOE STD-5506-2021 at INL's defense nuclear facilities; and (2) any actions DOE is taking regarding the safety issues described in the report. DOE provided a briefing to the Board in May 2023. Although DOE implemented several safety upgrades related to the Board's safety concerns, these upgrades were not incorporated into the facility safety basis in 2024 and therefore are not protected commensurate with their associated safety functions.

Based on input from the DNFSB and Idaho Operation Office, the INL contractor is moving forward with a proposed approach for updating and implementing its safety basis per DOE Standard 5506-2021 over the next several years. Rigorous implementation of DOE Standard 5506-2021 into the Advanced Mixed Waste Treatment Project safety basis would address many of the DNFSB's open safety concerns.

DNFSB engagement prompted DOE and INL to drive long-term safety improvements by addressing flammable gas hazards to protect INL workers.

Figure 28. Vice Chair Summers alongside DNFSB staff at the Safety Significant Confinement Ventilation System project site.

Waste Isolation Pilot Plant

Board Member Visit

In support of WIPP's important role as the only deep geological repository for defense-generated transuranic waste in the United States, the Board's Vice Chair visited the site in October 2024. The visit included meetings with managers from the DOE Carlsbad Field Office and the WIPP contractor regarding operations, the National Transuranic Program, and capital investments in the Safety Significant Confinement Ventilation System and Utility Shaft 5 to improve nuclear safety. The Board's Vice Chair and a staff team also observed the WIPP annual emergency exercise.

DNFSB oversight highlighted the need to address worker safety issues posed by structural degradations in the hoist system, including actions to proactively manage aging infrastructure.

Salt Handling Shaft Review

The Salt Handling Shaft, which serves as a personnel ingress/egress route and avenue for transporting mined salt out of the underground, is more than 40 years old. The shaft cuts through a salt seam, which is a geological layer highly susceptible to plastic deformation (creep). As the salt seam deformed over time below the shaft station, loads increased on the structural steel reinforcing the lower part of the shaft, causing some steel members to fail. Shaft maintenance personnel installed steel bracing as a temporary mitigation measure until project funding is available to comprehensively refurbish the structural steel frame. The salt creep also continues to reduce the clearance space between the salt conveyance cart and steel guide frames, posing the likelihood of near-term mechanical impingement of the cart. DOE and the WIPP contractor continue to explore options to maintain the ingress/egress function even if the salt conveyance capabilities are lost.

In April 2024, the DNFSB evaluated the potential safety impacts resulting from the degrading conditions in the Salt Handling Shaft, including associated structures and systems. The DNFSB staff presented preliminary observations to DOE and the WIPP contractor, identifying safety concerns related to the requirements applied for ensuring worker safety in the underground during an emergency event, such as a fire or radiological release, and reliability of the hoists for providing emergency egress. In late 2024, a mine development subcontractor started work to rebuild the underground salt bin area at the bottom of the Shalt Handling Shaft. The project includes installing supports and building a new 110-foot-deep loading pocket. DOE expects to complete overhauling the underground staging area for lifting mined salt to the surface in 2025.

National Transuranic Waste Program

Waste Generator Sites' Certified Program Annual Recertification Audit Process

All DOE waste generator sites that ship transuranic waste to WIPP must have a certified program that is annually recertified to be compliant with WIPP's disposal, packaging, and transportation requirements. In accordance with the WIPP Hazardous Waste Facility Permit, the Carlsbad Field Office annually audits waste certification processes for active waste generator sites and their headquarters. Mobile loading units must also be periodically recertified for packaging and transportation of the generator site's waste in accordance with the respective transuranic waste authorized methods for payload control. The certified programs must be DOE-certified, with approval from New Mexico Environment Department, who regulate the hazardous waste under the permit.

In April 2024, the DNFSB assessed the Carlsbad Field Office and its support contractor's audit process for certified program recertification and mobile loading unit activities at Oak Ridge National Laboratory for contact-handled and remote-handled transuranic waste disposal at WIPP. Specifically, the DNFSB evaluated the adequacy, implementation, and effectiveness of the technical and quality assurance activities performed by the certified program. The audit team concluded that the Central Characterization Program waste certification and mobile loading unit programs were adequately established and satisfactorily implemented, resulting in effective processes. Overall, the DNFSB considers the recertification audits to provide valuable input to generator sites' certified programs to support safe waste shipments to WIPP.

Waste Control Specialists: Status of Waste Storage and Disposition

The 2014 WIPP radiological release event involved LANL waste with inappropriately remediated nitrate salts. Soon after the event, more than 100 of these non-compliant containers had been shipped to a Waste Control Specialists' facility for temporary storage in Andrews County, Texas.

In April 2024, Waste Control Specialists personnel retrieved the previously buried mobile concrete canisters containing the LANL waste stored in standard waste boxes. This activity was in support of preparing the waste for a proposed special packaging disposition path. Most of the mobile concrete canisters contained water up to their lids. The standard waste boxes were submerged in water and heavier than originally weighted, which indicated at least partial flooding of the standard waste boxes. In late 2024, Waste Control Specialists personnel completed retrieval of all the mobile concrete canisters and stored the standard waste boxes in a PermaCon® storage facility, in their flooded condition, at the Waste Control Specialists facility. All waste drums with free liquid will require treatment, which Waste Control Specialists personnel are not currently permitted to perform. DOE is working on a proposed treatment plan that must be supported by all hazardous waste regulators and the Nuclear Regulatory Commission. The DNFSB will independently evaluate the technical merits of the proposed path forward for the remaining drums to ensure the safety of waste processing and disposition.

NUCLEAR FACILITY INFRASTRUCTURE AND PROJECTS

IV. Nuclear Facility Infrastructure and Projects

The Board's purview granted by Congress includes the design and construction of new DOE defense nuclear facilities. The DNFSB is expected to review the design before construction begins and to periodically review and monitor the construction of new defense nuclear facilities. The Board is expected to make any recommendations needed to ensure adequate protection of public health and safety in a timely manner during the design and construction phases. Accordingly, the DNFSB performed nuclear safety oversight of DOE projects to construct new or substantially modify existing defense nuclear facilities throughout 2024 to meet these expectations.

DNFSB is innovating with new approaches that improve the efficiency and effectiveness of safety oversight of design and construction projects.

In early 2024, the DNFSB redesigned its staff structure for safety oversight of DOE's large design and construction projects by implementing a position of topical cognizant engineers for projects. These engineers oversee a portfolio of projects that have mission commonalities. For example, one position covers NNSA projects that involve the processing and handling of plutonium. The DNFSB has increased attention on safety reviews that examine multiple DOE sites resulting in safety advice that can more broadly help DOE accomplish safely its important national security missions. These new approaches improve the DNFSB's ability to trend and compare practices for similar activities across the DOE complex.

Table 2 lists major design and construction projects that the DNFSB evaluated in 2024. Most of the safety concerns identified by the DNFSB in 2024 involved ensuring the safety of workers inside and co-located to DOE projects.

Table 2. Design and Construction Projects Reviewed in 2024

Project Name	Location	Status of Project	Status of Review	Board Letters
Waste Treatment and Immobilization Plant, High-Level Waste Facility	Hanford Site	Concurrent design and construction	Ongoing	Letters to the Secretary of Energy issued on 5/09/2019, 10/14/2020, 7/19/2022
Waste Encapsulation and Storage Facility Dry Capsule Storage Project	Hanford Site	Construction and transition to operations	Ongoing	None
Tank Farms Major Modifications	Hanford Site	Preliminary design	Ongoing	None
Contact Handled Waste Processing Project	Hanford Site	Conceptual design	Ongoing	None
Plutonium Pit Production Project	Los Alamos National Laboratory	Various	Ongoing	Letter to the Secretary of Energy issued 11/24/2021
Pit Disassembly and Processing Project	Los Alamos National Laboratory	Deferred until 2035	On Hold	None
Enhanced Capabilities for Subcritical Experiments	Nevada National Security Sites	Various	Ongoing	Letters to the Secretary of Energy issued 12/1/2021, 7/25/2024

Project Name	Location	Status of Project	Status of Review	Board Letters
Combined Radiation Environments for Survivability Testing	Sandia National Laboratories	Conceptual design	Ongoing	None
Savannah River Plutonium Processing Facility	Savannah River Site	Preliminary design	Ongoing	Letters to the Secretary of Energy issued 1/24/2022, 3/29/2023, 8/3/2023, 11/28/2023
Surplus Plutonium Disposition Project	Savannah River Site	Preliminary design	Ongoing	Letters to the Secretary of Energy issued 1/6/2022, 7/17/2024
Saltstone Disposal Units	Savannah River Site	Construction and transition to operations	Ongoing	
Emergency Operations Center	Savannah River Site	Final design	Ongoing	
Safety Significant Confinement Ventilation System	Waste Isolation Pilot Plant	Construction complete; testing and readiness verification in progress	Ongoing	Letters to the Secretary of Energy issued 03/26/2018, 08/27/2019, 8/17/2022
Uranium Processing Facility	Y-12 National Security Complex	Construction	Ongoing	Letter to the NNSA Administrator issued 06/26/2017

Campaign on Aging Safety Infrastructure Management

DOE's defense nuclear complex developed over an 80-year period, and many of the key defense nuclear facilities it relies on to support the nation's nuclear deterrent are more than four decades old. The age and condition of DOE's nuclear facilities and supporting safety infrastructure present significant challenges. While DOE is actively pursuing modernization and refurbishment efforts, safely managing the effects of aging infrastructure will remain essential for years to come as age-related degradation and technical obsolescence continue to impact the overall nuclear safety posture at DOE sites.

Figure 29. Building 9212 Complex at Y-12 began operations in 1945.

To explore and address concerns related to DOE's aging safety infrastructure, the DNFSB initiated a campaign to address aging infrastructure management, which will continue into 2025. The campaign involves several elements aimed at comprehensively evaluating DOE's approach and engaging with DOE and the public.

Board Recommendation 2020-1, Nuclear Safety Requirement

In Recommendation 2020-1, the Board recognized the challenges DOE faces to safely manage its aging nuclear weapons complex. The Board recommended that DOE develop requirements for aging management, including a formal process for identifying and performing infrastructure upgrades needed to ensure facilities and structures, systems, and components can perform their safety functions. DOE accepted this recommendation and is continuing to address the milestones and deliverables in its implementation plan (see Section VI, Nuclear Safety Requirements, Programs, and Standards of this report for more detail).

Staff Reviews Related to DOE Aging Management Practices

In 2024, the DNFSB completed work on two efforts to better define existing safety weaknesses and to identify potential improvements related to DOE's practices for managing aging safety infrastructure. The first effort reviewed relevant DOE directives, internal and external assessments, and congressional reports to understand the current state of DOE's defense nuclear facilities. The second effort was a review of field implementation of requirements related to aging management at Pantex, Y-12, SRS, and the Hanford Site. The review also included interactions with DOE and NNSA headquarters organizations focused on aging infrastructure management. In 2024, the staff completed these reviews and used the results to inform the Board's public hearing, support the staff-to-staff workshop series, and populate content for the DNFSB's website, as discussed below.

Strengthening DOE's aging infrastructure management requirements would yield *safety, programmatic,* and *financial* benefits

Safety Case

- Enhances the long-term reliability and resilience of safety-related infrastructure supporting nuclear operations

Programmatic Case

- Reduces infrastructure failures from age-related degradation that impact facility availability and interrupt programmatic operations

Financial Case

- Prolongs the effective life of safety-related infrastructure easing burdens on strained upgrade and modernization budgets

Web-based Repository for Aging Infrastructure Management Content—In 2024, the DNFSB created a repository of information regarding aging infrastructure management on its public website. This site aggregates aging infrastructure management resources developed by the DNFSB staff and other organizations. The repository can be viewed here: https://www.dnfsb.gov/aging-infrastructure-management

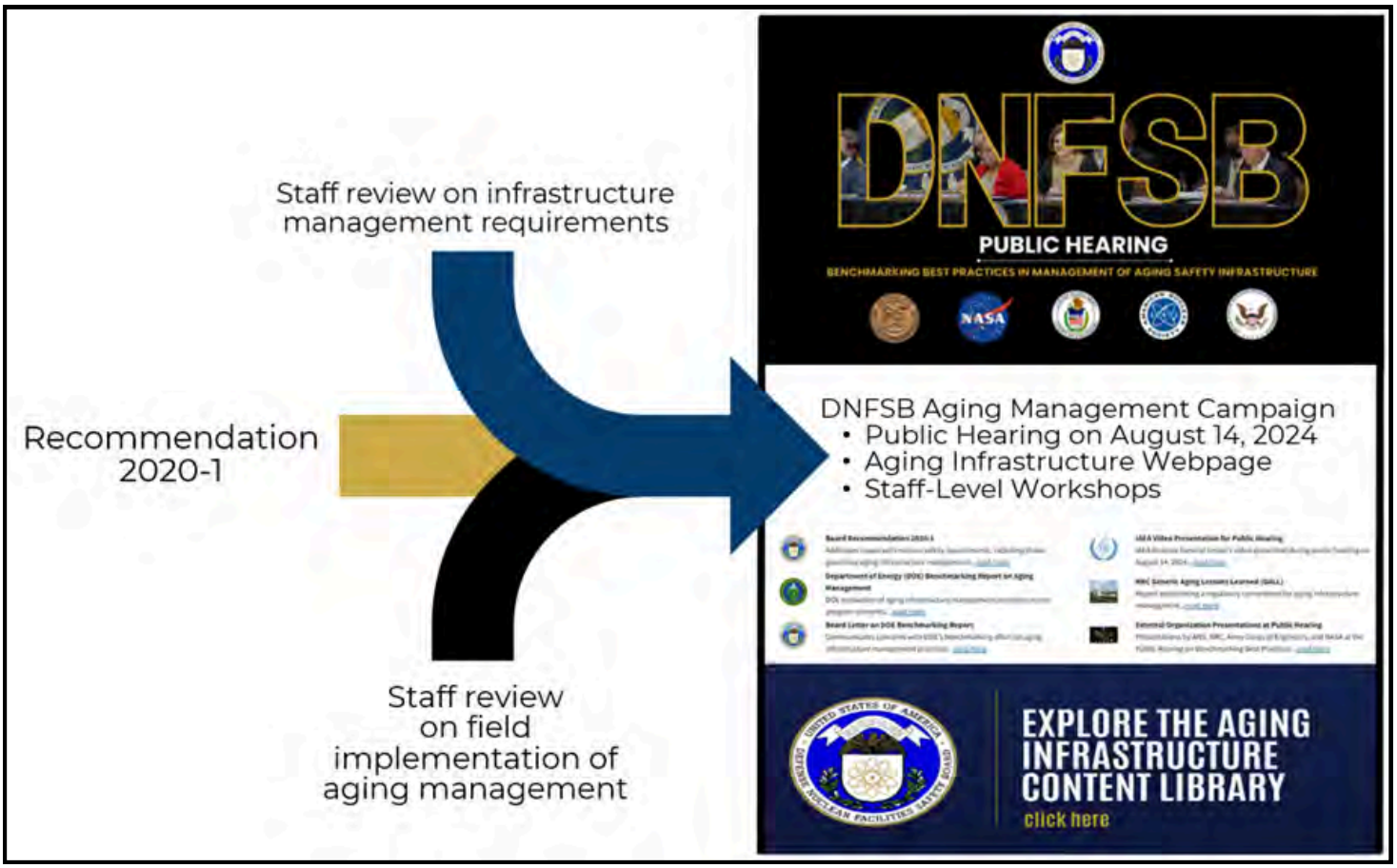

Figure 30. DNFSB management approach for oversight of aging infrastructure.

Public Hearing to Benchmark Aging Management Practices

In a letter dated November 27, 2023, the Board stated its concern that DOE's planned and completed actions in response to the aging infrastructure management sub-recommendation in Recommendation 2020-1 would not be sufficient to drive necessary safety improvements to the requirements and processes that ensure safe and effective management of aging defense nuclear facilities. The Board also noted its intent to hold public hearings focused on aging infrastructure management to develop further analysis and advice.

On August 14, 2024, the Board held a public hearing titled, Benchmarking Best Practices in Management of Aging Safety Infrastructure. The goal for the public hearing was to gather information from relevant external organizations on best practices in the management of aging safety infrastructure to inform the development of potential safety improvements to DOE's programs. After introductory remarks, the Board shared a recorded video from the Director General of the International Atomic Energy Agency, who noted that aging infrastructure challenges are of international concern. This video was followed by two sessions in which experts from the Government Accountability Office, the American Nuclear Society, the Nuclear Regulatory Commission, the U.S. Army Corps of Engineers, and the National Aeronautics and Space Administration provided prepared remarks, followed by organization-specific questions, and panel discussions. The recording, transcript, and presentation materials are available at: https://www.dnfsb.gov/public-hearings-meetings/public-hearing-benchmarking-best-practices-management-aging-safety.

Workshop Series with DOE to Discuss Opportunities to Improve its Aging Management Practices

On October 10, 2024, the DNFSB staff held the first in a planned series of workshops with DOE senior leadership. The goals of this first workshop were to: (1) establish a framework for meaningful communication on DOE's management of aging infrastructure; (2) share perspectives on potential opportunities for improvement; and (3) define a path forward for follow-on engagements in 2025. Primary DOE participants included the Chiefs of Nuclear Safety and infrastructure leads from the Office of Environmental Management, the Office of Nuclear Energy, the National Nuclear Security Administration, and the Office of Science, and the DOE directives lead from the Office of Environment, Health, Safety and Security. Following the successful initial workshop, DOE committed to hosting the next workshop in the series in mid-2025.

Figure 31. Board members discussing aging infrastructure programs with representatives from the Nuclear Regulatory Commission, the U.S. Army Corps of Engineers, and the National Aeronautics and Space Administration.

Other Complex-wide Topics

Plutonium Storage Container Fire Testing

DOE stores plutonium in containers designed to comply with DOE Standard 3013, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*. DOE sponsored testing to determine the failure pressure of these containers in fire scenarios so that safety analysts can better estimate how much plutonium could be released in an accident. The DNFSB evaluated the testing and conclusions developed in response to this testing and alerted DOE to its findings in a Board letter to the Secretary of Energy dated July 17, 2024. The DNFSB concluded that the fire testing did not bound credible fire scenarios, and that DOE should consider the limitations of the testing when using the test results. In response, and as detailed further in the Savannah River Site discussion in this section of the report, the managers of the Surplus Plutonium Disposition Project added margin to the test results to establish a failure pressure for use in their safety basis.

Construction Inspections, Tests, and Acceptance Criteria

A new facility under construction will need inspections, tests, and acceptance criteria that are properly defined for safety systems. Construction personnel must then execute these inspections and tests to ensure the safety systems meet the acceptance criteria. DOE personnel must also oversee the development of the criteria during design and the validation that the criteria have been met during construction, to provide assurance that the contractor performed its role and the facility is constructed to be safe. The DNFSB reviewed DOE requirements and guidance related to these inspections, tests, and acceptance criteria during design and construction as well as their implementation at selected projects. The DNFSB's review found that DOE directives do not establish a specific framework for DOE oversight of inspections, tests, and acceptance criteria. The DNFSB staff provided DOE feedback on potential improvements to applicable DOE directives on integrating safety in design and oversight.

DNFSB found that DOE needs to ensure proper oversight of safety system inspections, tests and acceptance criteria during design and its execution during construction.

Limited Procurement and Construction Activities Process

DNFSB identified that DOE needs to strengthen its directives for approving equipment procurement or starting construction prior to completing important safety analysis.

In 2024, the DNFSB completed a review of the process for DOE contractors to request and for DOE to approve limited equipment procurement and construction activities prior to DOE's approval of the preliminary documented safety analysis for a design and construction project. DOE directives and standards allow this process, but poor implementation could result in safety not being adequately integrated into the early design of a project and degrade the project's eventual safety performance. The DNFSB identified that DOE directives do not provide sufficient requirements or guidance for this process based on reviews of several NNSA design and construction projects. These projects included the Savannah River Plutonium Processing Facility at SRS, the Los Alamos Plutonium Pit Production Project at LANL, and the Z-Pinch Experimental Underground System test bed at NNSS. DOE and the DNFSB are mutually working to address these concerns in an upcoming revision to DOE Standard 1189, *Integration of Safety into the Design Process*.

Maintenance Practices for Aboveground and Underground Electrical Cable Systems in the DOE Defense Nuclear Complex

Since much of the electrical cabling in DOE's defense nuclear complex exceeds its 40-year design life, contractor implementation of effective maintenance, repair, and replacement practices for aboveground and underground cabling is necessary to ensure long-term reliability and safety. The DNFSB examined how DOE's contractors perform maintenance on cables at Hanford, LANL, NNSS, and SRS. The Board, in a letter to the Secretary of Energy dated June 3, 2024, observed that contractors did not uniformly apply industry standards for cable system integrity. The Board noted that a comprehensive cable maintenance plan would mitigate the risk of critical safety and general service cable in-service failures. To strengthen the integrity and reliability of in-service cables, rigorous and standardized maintenance practices are needed that address cable aging, incorporate industry consensus standards, establish routine maintenance procedures, and prepare for replacements and failures.

Hanford Site

Waste Treatment and Immobilization Plant

In the late 1990s, DOE began work on the Waste Treatment and Immobilization Plant, which will be used to vitrify the Hanford Site's highly radioactive, liquid tank waste prior to permanent disposal. This planned radiochemical processing plant consists of four primary facilities: Pretreatment, Low-Activity Waste, High-Level Waste, and the Analytical Laboratory. DOE will dispose of the low-activity waste glass onsite and will ship the high-level waste glass offsite for permanent disposal once a national repository is available. The Analytical Laboratory is operational and ready to support low-activity waste processing. The Low-Activity Waste Facility entered the cold-commissioning phase in December and DOE expects to complete the remainder of its commissioning process in 2025. Design and construction of the planned Pretreatment and High-Level Waste Facilities has been delayed by numerous technical issues. Although DOE has defined approaches that resolve the technical issues, DOE leadership has decided to forego near-term design and construction of the Pretreatment Facility. DOE will focus on easier to process high-level waste to support start of both the Low-Activity Waste and High-Level Waste Facilities in direct-feed mode. DOE will conduct any needed waste pretreatment and blending in the Tank Farms. Processing the more difficult waste streams may require the design and construction of additional facilities to provide additional pretreatment options.

High-Level Waste Facility

In 2024, the Waste Treatment and Immobilization Plant contractor has been developing the revised safety basis, issuing a draft preliminary documented safety analysis to DOE at the end of the year. The DNFSB has been evaluating the revised safety strategies and observed the safety basis development meetings to maintain cognizance of the significant changes being proposed.

The Waste Treatment and Immobilization Plant contractor also resumed construction activities at the High-Level Waste Facility. The DNFSB completed a review of the implementation of quality assurance practices associated with the resumption of concrete placements. The review included an observation of one of the placements, pictured below. The DNFSB staff concluded that the contractor workers adequately performed the placement in accordance with required standards.

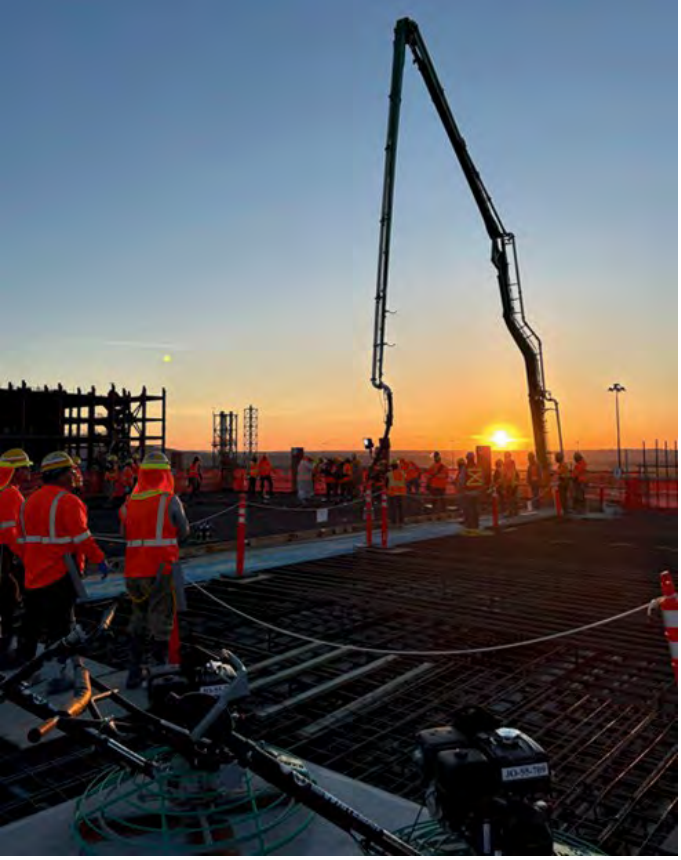

Figure 32. Concrete placements at the High-Level Waste Facility in April 2024.

Waste Encapsulation and Storage Facility Dry Capsule Storage Project

The Waste Encapsulation and Storage Facility stores 1,936 capsules of either highly radioactive cesium chloride or strontium fluoride in a water pool to protect personnel from the intense radiation. The dry storage project is being developed to remove the capsules from the pool, place them in dry transportable storage canister, and place them in a concrete cask on a storage pad. DOE is finishing the installation of equipment necessary to perform the transfer of the capsules into the storage containers. DOE expects to complete the facility readiness process and start transferring the capsules into dry storage in 2025. The DNFSB is monitoring ongoing startup preparations and will also monitor planned startup activities for both the Waste Encapsulation and Storage Facility and the Capsule Storage Area, where the storage casks will eventually reside.

DNFSB continues to monitor DOE's efforts at Hanford Site to safely move 1,936 capsules of highly radioactive materials into robust dry storage casks.

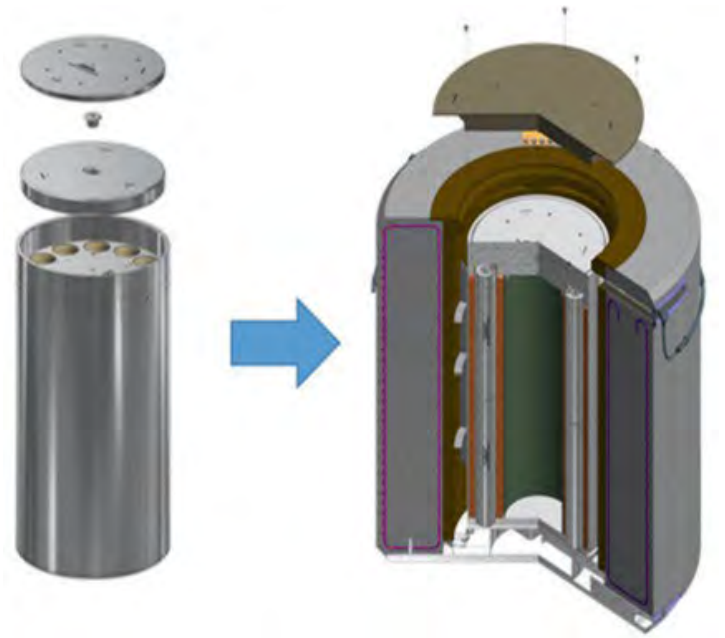

Figure 33. Dry storage container system for cesium and strontium capsules.

The storage canisters will be filled with helium to enhance heat transfer of the capsules to ensure they do not exceed temperature limits. The storage canister will be welded shut to maintain the helium atmosphere and provide confinement of the nuclear material. The DNFSB is evaluating the ability of the transportable storage container to reliably maintain the sealed closure.

Tank Farms Major Modifications

Hanford Site personnel have been operating the Tank Side Cesium Removal system as a pilot plant to pretreat waste, making it acceptable to be used as the feed for the Low-Activity Waste vitrification facility at the Waste

Treatment and Immobilization Plant. To meet the production goals for treatment of the high-level waste tanks, two additional projects are in progress that will both use the Tank Side Cesium Removal process design. The first is the Advanced Modular Pretreatment System, which will have two parallel processing modules to support the Low-Activity Waste facility planned processing capability. The second is the West Area Risk Mitigation system, which will treat wastes in the 200 West area tank farms. The DNFSB is evaluating the conceptual design information to determine if lessons learned from the Tank Side Cesium Removal System have been incorporated into the process and safety control development for these projects.

Figure 34. Tank Side Cesium Removal system ion exchange column.

Contact Handled Waste Processing Project

From 1999 to 2011, the Hanford Site retrieved buried waste containers and placed them in storage buildings on site. Most of the waste was processed and packaged for disposal. Of the remaining waste currently stored in buildings, there are approximately 11,000 cubic meters of transuranic and mixed transuranic waste with up to 500 cubic meters of mixed low-level waste. About 6,300 cubic meters of the stored waste is not in a form suitable for shipment and disposal and requires new capability to process and package it for disposal at the WIPP. The DNFSB reviewed the preconceptual design project information and confirmed that the new processing capability for this defense related waste will require either a new nuclear facility or major modification to an existing Hanford Site facility.

Figure 35. Waste retrieval from the Hanford Site burial grounds.

Los Alamos National Laboratory

Los Alamos Plutonium Pit Production Project

NNSA initiated the Los Alamos Plutonium Pit Production Project as part of its two-site strategy, the other site being SRS, to reliably produce at least 80 war reserve plutonium pits per year for the nuclear deterrent. The primary goal of this project is to improve infrastructure at LANL's Plutonium Facility to ensure it has the capability to reliably produce no fewer than 30 of these required pits each year. Several subprojects involve active work inside the operating Plutonium Facility. In 2023, NNSA approved critical decisions (CD) 2 and 3, *Approve Performance Baseline/Approve Start of Construction*, for one of these subprojects, which marks the completion of the final design phase and the start of construction. In 2024, laboratory personnel made progress on this subproject, installing several gloveboxes.

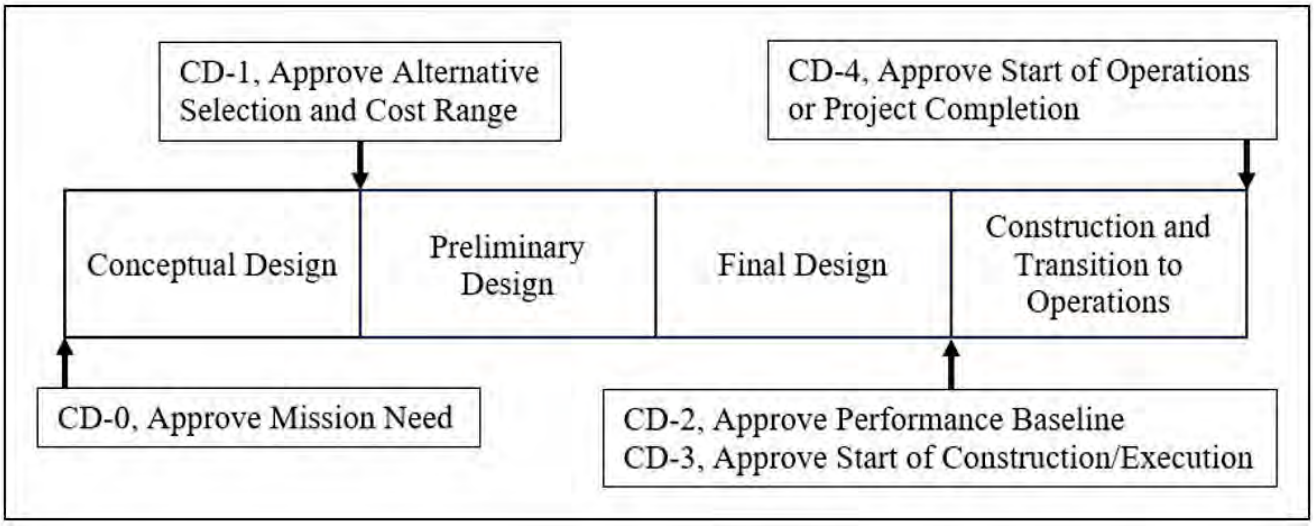

Figure 36. An illustration of a typical design and construction project's lifecycle and critical decision process.[7]

Laboratory personnel also removed numerous legacy gloveboxes from the facility (another of the subprojects) to make room for new installations. Given the similarities of this work with ongoing operations in the facility, the DNFSB has been able to integrate its safety oversight activities as discussed in the Nuclear Weapon Operations section of this report. In 2024, the DNFSB performed oversight of safety basis changes, work planning and control for the decontamination and decommissioning of radioactively contaminated equipment, and glovebox design and fabrication and conducted walkdowns with site personnel of ongoing glovebox installation work.

[7] Each critical decision represents a formal determination made by DOE management that the project has met the necessary requirements to advance to the next phase.

Figure 37. Equipment removal in the Plutonium Facility at LANL.

Pit Disassembly and Processing Project

NNSA proposed a project to expand pit disassembly and processing capability for the disposal of surplus plutonium. NNSA approved critical decision 0, *Approve Mission Need*, in July 2021, which marked the project initiation, and subsequently completed an analysis of alternatives that compared different design concepts and locations for the project. In October 2023, NNSA elected to defer the project for 10 years. The DNFSB reviewed the analysis of alternatives for this project and, despite deferral of the project, used this to inform the DNFSB's safety oversight strategy for LANL's Plutonium Facility.

Nevada National Security Sites

Enhanced Capabilities for Subcritical Experiments

NNSA performs subcritical experiments to ensure the continued viability of the nation's nuclear deterrent as part of the Stockpile Stewardship Management Program. Many of these experiments are performed at the Principal Underground Laboratory for Subcritical Experimentation (PULSE), formerly known as the U1a Complex. In 2014, NNSA approved the mission need for these projects to improve the existing capabilities. This approval includes procuring a high energy x-ray diagnostic capability to measure the late stages of implosion and a neutron diagnostic capability to infer neutron multiplication during an implosion. When NNSA completes the projects, the final facility configuration will include three underground locations that are capable of housing a subcritical experimental package with special nuclear material like plutonium.

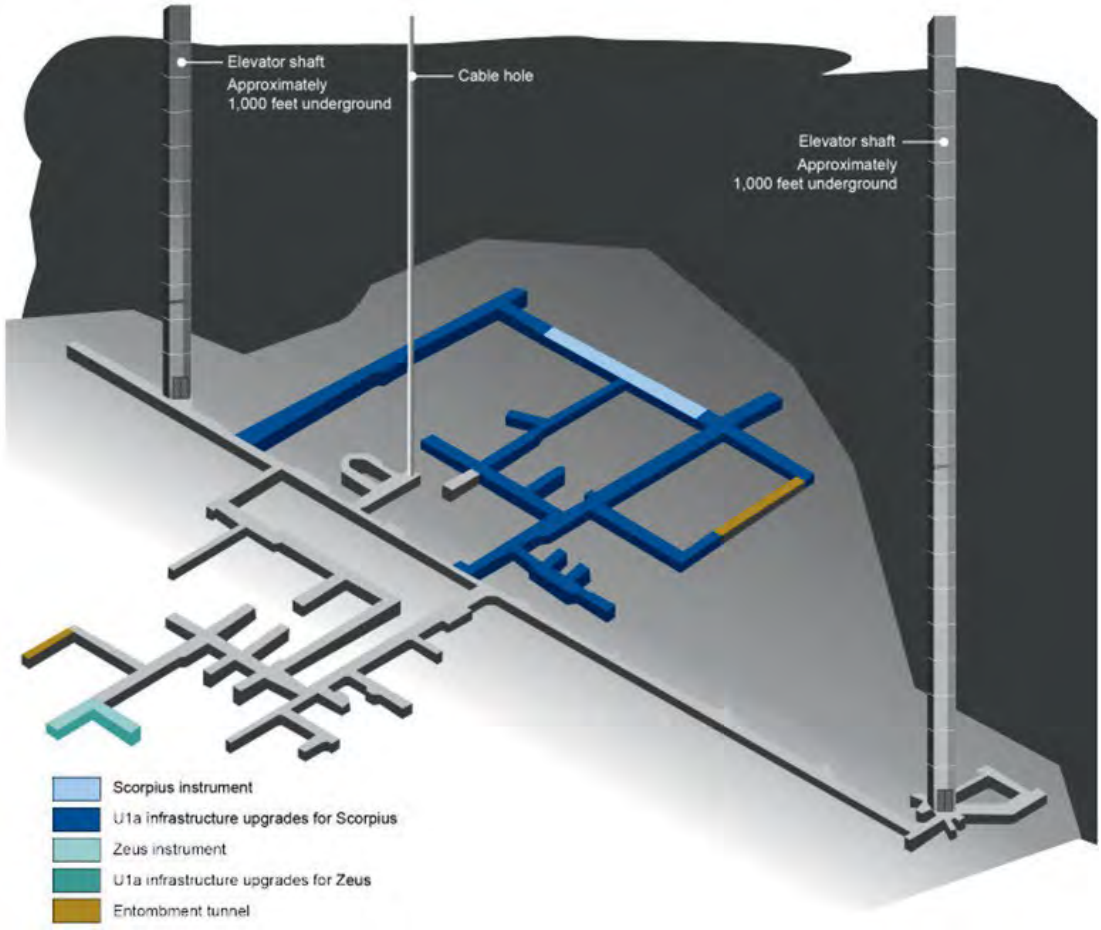

Figure 38. Projects at the Principal Underground Laboratory for Subcritical Experimentation at NNSS.

The Board identified that NNSA needs to take action to strengthen safety for the nation's key capability to study the continued viability of the nation's nuclear weapons including:

- Characterizing seismic faults
- Procuring a modern shipping container to properly protect nuclear experiments.
- Preventing leaks from vessels used to perform nuclear experiments.

In 2024, the DNFSB completed its review of the safety analyses that support the design of the projects. The DNFSB also completed its review of the seismic faults present at the facility. In a Board letter dated July 25, 2024, the Board communicated the safety issues that were identified during both reviews to the Secretary of Energy and requested a report on NNSA's response. The safety issues included inadequate characterization of the seismic faults, an inadequate control set for movement of the subcritical experiment package, unevaluated effects from changing the performance criterion for the vessel confinement system, inadequate means of facility egress for workers, and deficiencies in safety design basis documents.

On December 11, 2024, NNSA responded to the Board letter and communicated the following:

- NNSA is developing a plan to perform a more detailed investigation of the historic seismic activity of the faults present in underground facility but did not provide a schedule or timeline for completing this investigation.

- NNSA is considering different offices to fund the effort to design and procure a new shipping container that can protect a subcritical experiment package from drops, impacts, fires, or electrical insults during transport. NNSA did not provide a schedule or timeline for procuring this new container.

- NNSA assessed the design of the vessel used to confine the subcritical experiment during execution and found deviations from industry standard requirements that were not previously known. NNSA provided an alternative implementation methodology and technical rationale that demonstrate the vessel will adequately perform its safety function of confining radiological material prior to, during, and after experiment execution. NNSA will revise the safety analysis to address the deviations.

- NNSA noted that the principal standards for egress at the NNSS underground facilities are in DOE Standard 1066-2016, *Fire Protection, and 30 CFR 57, Safety and Health Standards – Underground Metal and Nonmetal Mines*. NNSA also stated that strict implementation of National Fire Protection Association 101, Life Safety Code, is not feasible due to the constraints associated with the experimental activities conducted in the NNSS underground facilities. As a result, the site will not make changes to the means of egress; however, the NNSS contractor is in the process of analyzing the egress conditions using computer fire models to simulate expected fire hazards and challenging exiting conditions in the underground. As it relates to the alcove where a rotary uninterruptible power source will be installed, NNSA agreed with the Board's observation and will follow the requirement to separate the alcove from the means of egress by installing an appropriate fire-resistant barrier.

Figure 39. Arrows pointing to the fault plane, showing evidence of historic seismic activity of the faults present within PULSE.

NNSA agreed with the Board and intends to modify fire barriers to properly protect an important pathway for workers to evacuate.

Figure 40. Current shipping container used for subcritical experiments that does not provide protection from fires or electrical insults.

Figure 41. Vessel used for subcritical experiments at PULSE.

Pantex Plant

Material Staging Facility

NNSA approved mission need for the Material Staging Capability project in November 2015 (formerly known as the Material Staging Facility). Completion of this project will allow NNSA to perform interim and long-term staging operations of nuclear weapons and nuclear components safely and securely in support of national security. The project has recently re-started conceptual design efforts. The DNFSB staff will reengage with project personnel to ensure that safety is adequately integrated into the design.

Sandia National Laboratories

Combined Radiation Environments for Survivability Testing

NNSA approved mission need for this project in August 2019. Completion of this project will replace the existing Annular Core Research Reactor facility and provide NNSA an advanced radiation environmental test capability to fill a mission gap for research and development, qualification, and certification data in combined survivability/threat environments. The figure below shows a rendering of the proposed facility. Project personnel are actively working to achieve the alternate selection and cost range milestone in 2025. The DNFSB will review the relevant safety and design documents when available.

Figure 42. Conceptual rendering of the Combined Radiation Environments for Survivability Testing project.

Savannah River Site

Savannah River Plutonium Processing Facility

Figure 43. Rendering of the completed Savannah River Plutonium Processing Facility.

The 2018 Nuclear Posture Review, conducted jointly by the Departments of State, Energy, and 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." NNSA is designing the Savannah River Plutonium Processing Facility to produce 50 of these pits per year using the partially constructed building intended for the canceled Mixed Oxide Fuel Fabrication Facility project. A rendering of the completed Savannah River Plutonium Processing Facility is pictured below. 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. NNSA stated in its critical decision 1 approval letter that it estimated project completion between fiscal years 2032 and 2035. The project is now in preliminary design.

Project personnel have either started or are set to begin various early procurement and construction work activities, which include interior concrete demolition, glovebox fabrication, site preparation (e.g., grading, stormwater), and sand filter excavation. Project personnel also completed the dismantlement and removal of equipment installed in the existing building that was part of the Mixed Oxide Fuel Fabrication Facility. This work included removing gloveboxes, conduits, ductwork, and other equipment that will not be used with the new project. NNSA also completed a technical independent project review—a preliminary design milestone requirement used to ensure early integration of safety into the design process.

Figure 44. Photographs showing before (left) and after (right) the removal of a parking lot and the start of sand filter excavation. These photographs were taken from the existing structure for the Savannah River Plutonium Processing Facility project.

In letters to the Secretary of Energy dated August 3, 2023, and November 28, 2023, the Board found that project personnel inappropriately assumed facility workers could use their senses to detect accidents, such as glovebox spills or fire, and then exit the area prior to receiving a significant radiological exposure. NNSA initially accepted this assumption and planned to procure gloveboxes for the project that were not designated as safety significant controls. The Board noted this would be atypical compared to other DOE plutonium processing facilities. The Board's engagement on the worker self-protection issue were necessary to ensure early integration of safety into the design. Ultimately, three of DOE's independent safety entities[8] cited safety concerns similar to the Board.

In 2024, NNSA added safety significant controls to address concerns with facility worker safety raised by the Board and the three DOE safety entities. These controls included more than 200 gloveboxes and other enclosures, more than 100 local alarms, the building fire suppression system, and containers for transport of plutonium oxide. The DNFSB initiated review of these facility worker safety controls and their implementation in safety basis documentation. This review is expected to conclude in 2025. The DNFSB staff also began a review of fire protection safety.

The Board found that the project's safety strategy depended on workers using their senses to detect radiological accidents and self-protecting instead of assigning safety controls. This approach was inconsistent with other comparable facilities in the DOE complex.

The DNFSB completed a review of nuclear criticality safety for the project. In a Board letter to the Secretary of Energy, dated November 13, 2024, the Board highlighted safety concerns to DOE with the coverage of the criticality accident alarm system and commended DOE for engaging the DOE Criticality Safety Support Group to perform an independent review of this topic. A criticality accident alarm system provides prompt notification of a potentially lethal radiation undetectable to workers, which can save lives and prevent large radiation exposures. Criticality accidents in areas without such coverage can result in excessive facility worker radiation exposure.

NNSA's new safety controls include over 200 gloveboxes and other enclosures, over 100 alarms, the building fire suppression system, and containers for plutonium oxide. The new safety controls are a substantial improvement in facility worker safety.

Figure 45. Examples of new safety significant controls for the Savannah River Plutonium Processing Facility: potential glovebox differential pressure (top left) and oxygen alarms (top right), potential robust outer oxide container for transport of plutonium oxide outside glovebox confinement (bottom left), and gloveboxes for disassembly (bottom center) and oxide roasting (bottom right).

[8] NNSA's Office of Environment, Safety and Health; DOE's Office of Enterprise Assessments; and DOE's Office of Environment, Health, Safety and Security.

Surplus Plutonium Disposition Project

The Surplus Plutonium Disposition Project involves a major modification to Building 105-K in the K-Area Complex at SRS, including construction of an additional structure to house ventilation and electrical equipment. The project's mission is to expedite removal of plutonium from South Carolina. On October 25, 2024, NNSA approved critical decision 2, *Approve Performance Baseline*, and critical decision 3, *Approve Start of Construction/Execution*. These milestones mark completion of final design with construction activities ongoing.

Figure 46. An aerial view of the K-Area Complex consisting of operating facilities with missions that include storage and disposition of excess plutonium. The Surplus Plutonium Disposition project will expand capabilities at this complex.

In 2024, the DNFSB staff completed a review of fire testing of storage containers conducted by Sandia National Laboratories. DOE stores plutonium across the complex in containers designed to comply with DOE Standard 3013, *Stabilization, Packaging, and Storage of Plutonium Bearing Materials*. Historically, safety analysts made assumptions regarding container failure pressures due to lack of testing. The failure pressure is a key parameter in determining the amount of material released in an accident. DOE sponsored testing to better understand the container failure in fires. The DNFSB evaluated the testing and subsequent conclusions and transmitted findings to DOE in a Board letter to the Secretary of Energy dated July 17, 2024. The Board concluded that nonconservative testing conditions did not support the use of the test results to directly calculate conservative failure pressures. Project personnel added sufficient additional conservatism to the test results to establish a failure pressure for use in its safety basis, but broader DOE engagement is necessary for other potential nuclear safety applications of this data.

Figure 47. Assembly used for fire testing of plutonium storage containers associated with the Surplus Plutonium Disposition Project.

Saltstone Disposal Units

High-level radioactive waste at the SRS is processed through the Salt Waste Processing Facility to remove actinides, strontium, and cesium. The low-activity radioactive liquid waste stream from the Salt Waste Processing Facility is then sent to the Saltstone Production Facility where it is mixed with grout. The grout is then disposed at the Saltstone Disposal Units, shown below. Saltstone Disposal Units 1 through 5 consist of rectangular and cylindrical disposal units, with the larger cylindrical units having a maximum capacity of 2.9 million gallons. Units 6 and 7 are significantly scaled up cylindrical units with a capacity of 35 million gallons each. SRS is expanding the disposal capacity through two projects: (1) units 8 and 9; and (2) units 10 through 12. These units share the design and operational characteristics of unit 6.

As the new disposal units are nearly identical to the operational units, DOE leadership has streamlined requirements from DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*. The reduced requirements involve the use of the unit 6 design to allow subsequent units to achieve design completion immediately, bypassing typical design deliverables. In addition, the requirements for an independent operational readiness review process were eliminated allowing only a facility self-assessment for the additional units. The DNFSB reviewed the facility self-assessment checklist and did not identify any safety concerns with the process to determine the readiness of units 8 and 9 for operations.

Figure 48. Aerial view of Saltstone Disposal Units at SRS.

Tritium Finishing Facility

NNSA approved mission need for the Tritium Finishing Facility in December 2019. Completion of this project will replace key capabilities located in the existing H-Area Old Manufacturing facility, an aging building that does not meet current nuclear safety codes and standards. Additionally, NNSA indicated that completing the project will address many of the safety concerns raised in Board Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*. NNSA's budget request for fiscal year 2024 did not include new funding for this effort. However, Congress allocated $35 million to the project in fiscal year 2024, allowing project personnel to proceed further with design and safety basis development efforts. Additionally, the Savannah River Tritium Enterprise contractor completed construction of a new warehouse that will replace two existing warehouses within the Tritium Finishing Facility footprint. NNSA's budget request for fiscal year 2025 anticipates that the project will be paused in fiscal year 2025 through fiscal year 2027. Regardless, the DNFSB will continue safety assessments of the project as it progresses and funding resumes.

Figure 49. New warehouse supporting preparation of the site for the Tritium Finishing Facility.

Emergency Operations Center

The Emergency Operations Center replacement project is intended to replace the existing emergency operations center located in a degrading facility with limited and outdated infrastructure to adequately support potential emergency event scenarios. While not a nuclear facility, the emergency operations center supports safety at all SRS defense nuclear facilities by supporting their emergency response function. The DNFSB evaluated the conceptual design information for the facility to evaluate whether the design incorporates features to protect the personnel within the emergency operations center during accident conditions. The DNFSB staff determined that the conceptual design adequately incorporates structural design and air filtration requirements.

Figure 50. Degraded condition of the building housing the existing Emergency Operations Center.

Y-12 National Security Complex

Uranium Processing Facility

Project personnel continued construction activities in 2024 and completed the following:

- Energized the Process Support Facilities, which will provide chemical feed to processes and support waste storage;
- Demobilized the project tower cranes as the project has achieved completion of the heavy lift and mechanical construction phase of the project;
- Completed the electrical commodities for the main casting knockout line, which will support testing of the casting gloveboxes in 2025; and
- Installed 140,000 linear feet of conduit in the Salvage and Accountability Building, which will also support future testing operations.

Figure 51. Process equipment installed in the Uranium Processing Facility.

Figure 52. Uranium Processing Facility structure following tower crane removal.

In 2024, the DNFSB started its review of revised criticality safety evaluations for processing activities involving highly enriched uranium. The DNFSB also reviewed the project's process for performing inspections and tests for safety systems to ensure they meet the appropriate acceptance criteria, as well as how NNSA oversees this process and validates the results. DNFSB staff found several strengths in these processes and has encouraged DOE leadership to adopt in appropriate directives and standards.

Waste Isolation Pilot Plant

Safety Significant Confinement Ventilation System

In 2014, a transuranic waste drum breached and contaminated portions of the underground, highlighting the need to use a high efficiency particulate air filtered exhaust system during waste placement activities. The current filtered exhaust system has limited flow, approximately 100,000 cubic feet per minute, leading to difficulties maintaining sufficient air flow to support full waste emplacement and mining activities to support current mine conditions as well as constructing new waste panels. The new exhaust system will provide 540,000 cubic feet per minute to fully support operations. In 2024, the WIPP contractor completed construction of the ventilation system as shown below. The WIPP contractor also completed commissioning testing of the associated fire loop, and initiated preparations for startup.

In a letter to the Secretary of Energy on May 15, 2024, the Board identified safety concerns regarding the final design of the continuous air monitor system for the Safety Significant Confinement Ventilation System. The air monitoring system will activate dampers to isolate the non-safety salt reduction building if contamination is detected in the mine air. The Board raised two main concerns related to: (1) the ability of the continuous air monitors to operate correctly in an environment with airborne salt particles from mining activities and combustion products from fire; and (2) the controls DOE selected to reduce the risk of potential accidents at the waste shaft station. DOE's response directed the WIPP contractor to implement a phased startup of the system. Initially the non-safety portions of the system will be isolated while additional safety basis development research is conducted to support the air monitoring system usage.

Figure 53. Safety Significant Confinement Ventilation System filtration building and exhaust stack.

NUCLEAR SAFETY REQUIREMENTS, PROGRAMS, AND STANDARDS

V. Nuclear Safety Requirements, Programs, and Standards

DOE governs the safe operations of its nuclear facilities through 10 CFR 830, *Nuclear Safety Management*, and associated safety directives and technical standards (including orders, guides, handbooks, and standards). A robust set of nuclear safety requirements is essential for ensuring safe operations at DOE's defense nuclear facilities. The DNFSB routinely advises DOE on needed changes to these directives and often engages DOE in its "RevCom" process for developing and revising directives.

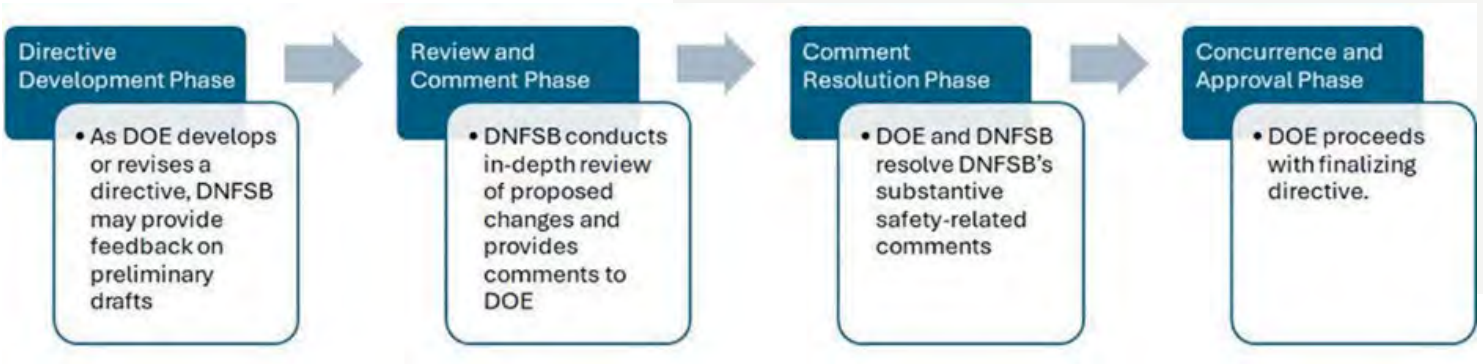

Figure 54. Flowchart for DNFSB engagement with DOE in its RevCom process for developing and revising directives.

In 2024, the DNFSB maintained its focus on key elements of DOE's approach to safely operating its nuclear facilities, including criticality safety, emergency management, and other safety management programs. The DNFSB engaged with DOE on several cross-cutting safety areas, such as nuclear safety requirements, DOE's operating experience program, and conduct of operations. Additionally, the DNFSB continued to review and comment on DOE directives that establish nuclear safety requirements for safety basis documents, quality assurance, startup and restart of nuclear facilities, and emergency management. Moving forward, the DNFSB will prioritize cross-cutting safety issues that significantly impact nuclear safety across the defense nuclear complex.

Nuclear Safety Requirements

Recommendation 2020-1, Nuclear Safety Requirements

The Board issued Recommendation 2020-1, *Nuclear Safety Requirements*, in February 2020, to highlight safety concerns with DOE's existing nuclear safety requirements and DOE's plans to change those requirements including those contained within 10 CFR 830 and relevant DOE orders and standards. The Board revised the recommendation based on feedback from DOE and approved the final version on June 1, 2021. Recommendation 2020-1 provides recommendations in the following areas:

- ***Aging Infrastructure***—The Board recommended that DOE develop requirements for managing its aging infrastructure, including a formal process for identifying and performing infrastructure upgrades needed to ensure facilities and supporting infrastructure can perform their safety functions.

- ***Hazard Categories***—The Board recommended that DOE revise DOE Standard 1027-2018, *Hazard Categorization of DOE Nuclear Facilities*, mandate use of this revised standard for new defense nuclear facilities and review existing hazard category 3 and below hazard category 3 defense nuclear facilities to ensure they are appropriately categorized. [9]

- ***DOE Approvals***—The Board recommended that DOE establish a required periodic review of facility safety bases to ensure they meet the requirements of 10 CFR 830.

- ***Evaluation of Safety Basis Preparation and Review Processes***—The Board recommended that DOE conduct an independent review of contractor and federal processes to identify and evaluate underlying issues that prevented the annual submittal and approval of high-quality safety basis documents and use the findings to improve the relevant processes.

- ***Safety Basis Process and Requirements***—The Board recommended that DOE develop specific implementation requirements for unreviewed safety questions, technical safety requirements, and specific administrative controls.

The Secretary of Energy accepted Board Recommendation 2020-1 on September 8, 2021, and transmitted DOE's implementation plan for the recommendation on June 27, 2022. The Board responded in a letter dated August 18, 2022, stating that while DOE's implementation plan does not fully endorse some actions recommended by the Board, execution of the plan could result in safety improvements to DOE's nuclear safety requirements consistent with the objectives of the recommendation. The Board further noted that achievement of those objectives would be contingent on DOE executing the implementation plan with the goal of addressing the Board's safety concerns. To date, DOE has transmitted eleven of seventeen implementation plan deliverables to the Board. Progress in key areas is summarized below:

[9] Hazard categories are based on radioactive material inventories and describe the potential level of consequences to the public and workers during an accident. Hazard Category 1 represents the highest potential consequence and Hazard Category 3 represents the lowest potential consequence.

- ***Aging Infrastructure***—While DOE's actions responding to most areas of the recommendation have been positive, DOE's response to elements of the recommendation related to aging infrastructure management requires continued leadership attention. DOE's main commitment in this area was to execute a benchmarking review to identify best practices and process enhancements regarding management of aging infrastructure. DOE completed this benchmarking review in 2023, and consistent with its implementation plan, shared the results across DOE and began implementation of the identified best practices and process enhancements in 2024. In 2023, the Board highlighted concerns with DOE's planned and completed actions to address the aging infrastructure sub-recommendation. In 2024, the Board initiated an aging infrastructure management campaign, including a public hearing and staff-to-staff workshop, to strengthen focus on this important topic and help inform the development of potential safety improvements to DOE's programs (see additional details in Section IV of this report).

- ***Hazard Categories***—In a letter dated March 8, 2023, DOE transmitted to the Board a regulatory analysis of possible approaches to enhance its current hazard categorization requirements. DOE determined in that analysis that it would develop a single, updated, and consolidated hazard categorization standard to be codified in 10 CFR 830. DOE issued a project justification statement to develop a new version of DOE Standard 1027, *Hazard Categorization of DOE Nuclear Facilities*, and sent it to the Board on June 13, 2023. DOE has since begun work to develop a draft revision to the standard, and members of the DNFSB staff have observed writing team meetings for this standard. In accordance with the implementation plan, this deliverable is due in mid-2025; however, DOE informed the Board in a May 8, 2025, letter that additional time is anticipated for completion of the revision.

DOE's actions in response to Board Recommendation 2020-1 have been positive and are poised to improve critical aspects of its approach to ensuring adequate protection of the public and workers at its nuclear facilities.

- ***DOE Approvals***—DOE's June 13, 2023, letter included a project justification statement for a revision to DOE Standard 1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. The DOE writing team began meeting in November 2023 and included a member of the DNFSB staff as an observer. DOE had informed the DNFSB in a December 18, 2024, letter that the deliverable for this sub-recommendation is delayed and anticipates completion by June 30, 2025; however, DOE stated in a May 8, 2025, letter that additional time is anticipated for completion of the revision.

- ***Evaluation of Safety Basis Preparation and Review Processes—***In December 2022, DOE transmitted to the Board a review plan for a DOE Office of Enterprise Assessments review of the safety basis development process. During 2023, the DOE team conducted the review in two phases: a broadly scoped document review and a site-specific review at a subset of sites. In December 2023, the DOE team issued its report documenting the review and providing recommendations to DOE field office and headquarters organizations regarding potential improvements to safety basis preparation, review, and approval processes. In June 2024, DOE transmitted its final deliverable for this topic in a letter to the Board, which documented its planned actions in response to this report. These planned actions include updating DOE orders and standards and taking proactive steps to ensure that protocols to formally manage safety basis change processes are established and followed.

- ***Safety Basis Process and Requirements*—**In June 2023, DOE transmitted its revised approach for developing new nuclear safety basis requirements to the Board. This approach includes developing a new order, DOE Order 421.1, *Nuclear Safety Basis*, and revising an existing order, DOE Order 420.1C, *Facility Safety*. DOE Order 421.1 will include major improvements to DOE's nuclear safety requirements set by defining essential requirements for the unreviewed safety question process, technical safety requirements, specific administrative controls, and other safety basis topics. In November 2023, DOE began the formal review and comment period for draft DOE Orders 421.1 and 420.1D.

  In January 2024, the DNFSB completed its review of both draft orders and provided comments to DOE. Throughout 2024, the DNFSB staff met with DOE personnel to discuss DOE's response to staff comments. Overall, DOE incorporated many of the staff's safety suggestions. However, the Board determined it was necessary to request that DOE address outstanding safety concerns with draft DOE Order 421.1. These safety concerns are documented in a Board letter to the Secretary of Energy dated November 15, 2024. In response, DOE personnel briefed the Board in January 2025 indicating that they plan to update draft DOE Order 421.1 to address some of the Board's safety concerns. DOE had informed the Board in a December 18, 2024, letter that the deliverable for issuing DOE Order 421.1 was delayed and anticipated completion in March 2025; however, DOE stated in a May 8, 2025, letter that additional time is anticipated for completion and issuance of the new order.

Implementation of DOE Standard 3009-2014

DOE Standard 3009-2014 provides the primary methodology for preparing documented safety analyses for DOE nonreactor nuclear facilities. A documented safety analysis that has been reviewed and approved by DOE specifies the activities that are authorized to be performed in a nuclear facility, the potential hazards of those activities, and the controls that are needed to ensure adequate protection of the public and workers from those operations.

Following Board Recommendation 2010-1, *Safety Analysis Requirements for Defining Adequate Protection for the Public and the Workers*, DOE issued DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. This major revision of the standard presents significantly clearer nuclear safety requirements and guidance for important documented safety analysis preparation topics. However, in the decade since its issuance, DOE Standard 3009-2014 has not seen widespread implementation, and evidence suggests that this trend will continue.

On December 6, 2024, the Board sent a letter to the Secretary of Energy stating this concern and provided multiple examples where applying the clear requirements found in DOE Standard 3009-2014 at DOE defense nuclear facilities could result in important safety improvements, such as the need to implement additional safety controls. The Board requested a briefing and report in early 2025 on DOE's plans to transition facility documented safety analyses to DOE Standard 3009-2014 and plans to ensure wide and timely implementation of new safe harbors that strengthen safety requirements. As of May 2025, DOE has not provided the requested briefing and report.

Nuclear Safety Programs

Emergency Preparedness and Response

The Board, in its letter of December 17, 2024, identified emergency management program guidance promulgated by NNSA that was not consistent with DOE's integrated safety management program. NNSA's guidance advised NNSA field offices to delegate federal approvals of emergency management documents that could affect safety, such as emergency planning hazards analyses, to its management and operating contractors. The Board noted that DOE Order 450.2, *Integrated Safety Management*, states that safety management responsibilities for ensuring adequate protection and safe operations could not be delegated by DOE. The Board advised the Secretary of Energy and NNSA Administrator to issue revised guidance and incorporate this guidance into the next revision of DOE's emergency management order.

The DNFSB continues to monitor the readiness of DOE to respond to potential radiological emergencies at defense nuclear facilities. In 2024, the Board's Vice Chair observed emergency response exercises at INL, SNL, NNSS, and WIPP. The DNFSB staff observed numerous emergency exercises at other sites. In these exercises, the DNFSB continues to observe challenges with responders achieving and maintaining a common operating picture between different response elements, integrating proper radiation protection practices into emergency response activities, and proficiency of less-experienced responders.

Figure 55. Simulated accidents during emergency exercises at defense nuclear facilities.

The DNFSB observed new consolidated emergency operations centers in use during annual emergency exercises at SNL and NNSS. These new facilities represent substantial improvements to the sites' emergency readiness. Similar new facilities were previously completed at LLNL and Y-12. In contrast, degrading conditions at SRS's emergency response facilities highlight a strong need for completion of the SRS emergency operations center replacement project (see Section IV, Nuclear Facility Infrastructure and Projects of this report for more detail).

In May 2024, the Board's Vice Chair attended and delivered a presentation at the DOE Emergency Management Symposium held in Atlanta, Georgia. His presentation described the history of DOE safety management programs, DOE emergency management requirements, and the DNFSB's past involvement.

Criticality Safety

Over the last several years, the DNFSB has observed persistent criticality safety staffing challenges and evaluated significant criticality safety infractions. During 2024, the DNFSB participated in a DOE-wide workshop focused on nuclear criticality safety and pursued a multi-site review of the health of nuclear criticality safety programs at SRS, LANL, and Y-12. The DNFSB also completed a review of preliminary nuclear criticality safety evaluations for the Savannah River Plutonium Processing Facility that resulted in a letter noting safety concerns with the criticality accident alarm system area of coverage.

In October 2023, the DNFSB initiated and organized a nuclear criticality safety workshop with DOE headquarters personnel to discuss nuclear criticality safety metrics, the DNFSB's nuclear criticality safety reviews, DOE directives and standards, and complex-wide challenges (e.g., staffing and infractions). The goal of the workshop was to facilitate candid discussion between the DNFSB and DOE's various organizations that are involved with nuclear criticality safety. Following the October 2023 workshop, DOE planned a separate workshop for the entire DOE complex in February 2024. The February workshop was the first time that DOE had convened a nuclear criticality safety workshop of this kind since 2008. All major DOE sites that conduct work activities where nuclear criticality is a hazard were represented, including both federal and contractor representatives. During the workshop, eighteen field offices presented their nuclear criticality safety needs and challenges.

Figure 56. Attendees at February 2024 DOE Community of Practices Workshop on Nuclear Criticality Safety.

DOE headquarters personnel from the DOE Office of Environmental Management, NNSA, DOE Office of Science, DOE Office of Nuclear Energy, and DOE Office of Enterprise Assessments attended the workshop and presented on several topics, which included DOE directives and standards, the nuclear criticality safety events database, and complex-wide challenges. The DNFSB staff led sessions on the DNFSB's perspective of nuclear criticality safety challenges and ongoing review topics. The DNFSB staff and workshop attendees also discussed DOE's annual nuclear criticality safety metrics report to the DNFSB. In August 2024, DOE held a follow-on workshop that revisited topics discussed during the February workshop and continued to foster communication between the various DOE sites and offices. DOE's continuation of supporting the nuclear criticality safety community through this series of workshops initiated by the DNFSB is a positive action to allow DOE to better understand the needs of the community and develop actions to address those needs.

DNFSB emphasis on nuclear criticality safety, an essential aspect of worker protection, has enabled positive action within the nuclear enterprise through a series of safety workshops.

The DNFSB conducted the multi-site review to evaluate the health of nuclear criticality safety programs and analyze for trends in the implementation of applicable DOE directives and requirements. SRS, LANL, and Y-12 were selected for the review based on the overall significance of the nuclear criticality safety hazard and complexity of operations. The DNFSB completed the review interactions and held closeout meetings with the three sites. The review identified areas where DOE could enhance the effectiveness of site nuclear criticality safety programs. The improvement areas focus on mitigating the impact of personnel retention challenges, implementing effective requirements and guidance to ensure reliable safety control implementation, and maintaining robust feedback mechanisms to identify and resolve root causes of criticality safety technical issues more effectively. The review also identified several best practices for DOE to consider promoting across the complex.

The DNFSB completed the first of two planned reviews of criticality safety evaluations for DOE design and construction projects. The first review focused on the Savannah River Plutonium Processing Facility and identified safety concerns with the extent of the proposed criticality accident alarm system coverage. On November 13, 2024, the Board transmitted a letter to the Secretary of Energy regarding the safety concern about the criticality accident alarm system coverage and commended DOE for engaging the DOE Criticality Safety Support Group to perform an independent review of this topic. This Criticality Safety Support Group was formed in response to Board Recommendation 97-2, *Continuation of Criticality Safety at Defense Nuclear Facilities in the DOE Complex*, as a group of DOE and contractor criticality safety experts to assist DOE with resolving criticality safety technical issues. The DNFSB plans to conduct a subsequent, nuclear criticality safety review for the Uranium Processing Facility.

In January 2024, the Board discussed with DOE the Fiscal Year 2023 nuclear criticality safety metrics report that DOE prepared in response to a Board reporting requirement from the closure of Board Recommendation 97-2. The annual metrics report and the DOE briefing to the Board on the metrics have been an important mechanisms for the DNFSB to promote a DOE-wide evaluation of nuclear criticality safety programs that is visible to DOE senior management.

DOE Operating Experience Program

The DNFSB completed a safety review of DOE's implementation of its operating experience program under DOE Order 210.2A, *DOE Corporate Operating Experience Program*. DOE Order 210.2A provides requirements governing identification, evaluation, dissemination, and use of operating experience (i.e., lessons learned from operational issues) within the DOE complex. DOE originally issued Order 210.2A in 2006 as part of its response to Board Recommendation 2004-1, *Oversight of Complex, High-Hazard Nuclear Operations*, to provide for a robust operating experience program that ensures the identification, evaluation, and incorporation of lessons learned from issues internal and external to DOE.

The DNFSB identified gaps in coverage of nuclear safety issues in DOE's Corporate Operating Experience Program. Sharing lessons regarding nuclear safety across the complex is important to public and worker safety.

The DNFSB's review identified significant gaps in the coverage of operating experience related to nuclear safety in DOE's operating experience program documents. In a letter dated March 28, 2025, the Board provided the Secretary of Energy with a detailed summary of its findings. While the Board acknowledged that DOE had begun to make some improvements, the Board advised DOE to take further actions to fully implement the requirements of DOE Order 210.2A, consistent with DOE's response to Recommendation 2004-1.

Conduct of Operations

The DNFSB is reviewing conduct of operations at multiple DOE sites to evaluate the effectiveness of the implementation of DOE Order 422.1, *Conduct of Operations*. In 2024, the DNFSB reviewed conduct of operations at the Plutonium Facility at LLNL. The DNFSB examined technical documents and conducted on-site interactions with Livermore Field Office and LLNL contractor personnel. The review identified areas for potential improvement including formality and rigor of operations, procedure development and use, independent verification, training and qualifications, and the lock-out tag-out program. The DNFSB plans to continue conduct of operations reviews in 2025, including a review at Y-12.

Nuclear Safety Standards

DOE Directives Program

In 2023, DOE began revising DOE Order 251.1D, *Departmental Directives Program*, which provides the processes to develop and maintain DOE directives, underpinning its standards-based approach to nuclear safety. DOE's goal was to improve the directives processes. However, the proposed revision lacked fundamental requirements related to the development, revision, and implementation of DOE directives. The Board's January 24, 2024, letter urged the Secretary of Energy to include needed requirements to support DOE's standards-based organization in this order and requested a report and briefing on DOE's path forward on the revision to the order. The Board identified safety issues related to the removal of directives prioritization criteria governing revisions, the lack of some key process requirements and defined terms, the removal of communication requirements between directives writers and users, insufficient information on categorizing invoked safety-related technical standards, and the decoupling of DOE orders and invoked technical standards.

On March 25, 2024, DOE sent a response and then briefed the Board in April 2024. The discussions resulted in DOE agreeing to add or retain requirements on the directive's prioritization criteria, on the key processes and defined terms, and on the communication between directives writers and users. DOE issued revised DOE Order 251.1E in June 2024; the Board notes that it retained the identified information important to safety.

Conduct of Readiness Reviews

In 2023, the DNFSB reviewed DOE's proposed revision to DOE Order 425.1D, *Verification of Readiness to Start Up or Restart Nuclear Facilities*, that provides requirements governing conduct of readiness reviews by DOE and its contractors to confirm readiness for safe start up or restart of a facility or activity. The Board's December 5, 2023, letter to the Secretary of Energy discussed safety concerns with DOE's proposed revision that included new provisions to (1) extend from 12 months to 18 months the time that a facility or activity could be shut down without requiring restart readiness reviews; and (2) allow lower levels of DOE management to authorize parallel contractor and DOE readiness reviews for certain occasions rather than sequentially conducting those reviews. The Board's letter requested that DOE report to the Board on DOE's path forward.

In June 2024, DOE personnel briefed the Board and on November 26, 2024, issued a report on its response. While DOE did not change the provisions in revised DOE Order 425.1E, DOE indicated it will consider the Board's safety concerns when providing guidance in the planned revision of DOE Standard 3006, *Planning and Conducting Readiness Reviews*.

Quality Assurance

The DNFSB reviewed DOE's proposed revision to DOE Order 414.1D, *Quality Assurance*, which provides quality assurance requirements governing work performed by DOE contractors. DOE's proposed revision included new provisions that would (1) delete safety software requirements and definitions; and (2) remove the mandated use of a key industry standard, ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*. The Board's January 31, 2025, letter to the Secretary of Energy discussed the safety concerns with these new provisions, advising DOE to improve safety oversight and provide additional guidance to support implementation of the revised order.

Review and Comment on DOE Safety Directives in 2024

The DNFSB conducted reviews of DOE directives that were being revised in DOE's online review, comment, and approval process. In 2024, DOE issued several directives that incorporated significant safety improvements proposed by the DNFSB. For instance, the DNFSB staff had provided comments on revisions to DOE Handbook 1224, *Hazard and Accident Analysis Handbook*, that was issued in February 2024. As a result of the DNFSB staff's feedback, DOE improved the technical accuracy in several areas, including plume dispersion and the modeling of explosions. Another example is new DOE Standard 1239, *Chemical Safety Management Program*, that DOE developed to provide a standardized approach in the development of a chemical safety management program. The final version that was issued in December 2024 incorporated the DNFSB staff's major comments. The DNFSB staff also provided comments on revisions to DOE Order 151.1E, *Comprehensive Emergency Management System*, that was issued in October 2024. As stated in the Board's December 17, 2024, letter to the Secretary of Energy, the revised directive retains improvements resulting from Board Recommendation 2014-1, *Emergency Preparedness and Response*, and clarifies several previous requirements.

The DNFSB is working effectively with DOE to drive incorporation of significant safety improvements into key DOE directives.

The DNFSB transmitted substantive comments to DOE for several directives undergoing revision in 2024 during the online review, comment, and approval process. After sending these comments for DOE Order 435.1, *Radioactive Waste Management*, and DOE Standard 3013, *Stabilization, Packaging and Storage of Plutonium-Bearing Materials*, the respective DNFSB staff teams met with their DOE counterparts to resolve potential safety issues. The DNFSB staff also sent comments to DOE on the revision to DOE Standard 1628, *Development of Probabilistic Risk Assessments for Nuclear Safety Applications*, and DOE Guide 151.1-1C, *Comprehensive Emergency Management System Guide*. DOE's acceptance of the comments would improve the safety posture of these directives. For DOE Handbook 3010, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, and DOE Handbook 1545, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities*, the DNFSB continued to meet with DOE personnel on several occasions in 2024 to discuss its comments from prior years. These efforts will continue in 2025 as appropriate.

Review and Comment on NNSA Safety Directives in 2024

The DNFSB engaged with NNSA during reviews of applicable directives that were being revised in DOE/NNSA's online review, comment, and approval process. After submitting substantive comments in 2023 for NNSA Supplemental Directive 251.1, *Directives Management*, the DNFSB staff met with NNSA personnel in 2024. NNSA issued a revised NNSA Supplemental Directive 251.1C, on December 16, 2024, that incorporated the DNFSB comments and will improve communications during the review and comment process for NNSA directives.

In addition, the DNFSB transmitted comments to NNSA for the proposed revisions to DOE Standard 1212, *Explosives Safety*, and NNSA Supplemental Directive 452.2, *Nuclear Explosive Safety Evaluation Processes*. NNSA has incorporated many of the comments and addressed most of the DNFSB's safety concerns in DOE Standard 1212 issued in January 2025 and in the latest draft version of NNSA Supplemental Directive 452.2. The DNFSB also sent comments to NNSA on the revision to NNSA Supplemental Directive 226.2, *Chief of Defense Nuclear Safety (CDNS) Review of Nuclear Safety Oversight Performance.*

Planned Reviews in 2025

In addition to the directives mentioned above, the DNFSB plans to review DOE's proposed revisions to the other directives that could impact safety at DOE's defense nuclear facilities. DOE started an effort in 2024 to revise its standards on high-efficiency particulate air filters used in ventilation systems to confine radiological materials for personnel and environmental protection purposes in DOE nuclear facilities. The DNFSB staff plans to review DOE Standard 3025, *Quality Assurance Inspection and Performance Testing of High Efficiency Particulate Air (HEPA) and Ultra Low Penetrating Air (ULPA) Filters*, and DOE Standard 3020, *Specification for HEPA Filters Used by DOE Contractors*, in 2025.

As noted above regarding progress on Board Recommendation 2020-1, the DNFSB has provided substantive comments on directives that were revised in response to the Board's recommendation. The DNFSB plans to continue the effort in 2025 for DOE Order 420.1, *Facility Safety*; DOE Order 421.1, *Nuclear Safety Basis*; and DOE Standard 1027, *Hazard Categorization of DOE Nuclear Facilities*. In addition, the DNFSB will start reviewing the proposed changes to DOE Standard 1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. The DNFSB will also review the guides that DOE revises or replaces because of its work per the implementation plan for Recommendation 2020-1, including DOE Guide 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*, and DOE Guide 424.1-1, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements*.

In 2024, the DNFSB staff met with DOE personnel to resolve comments on preliminary drafts of DOE Standard 1020, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, and DOE Standard 1189, *Integration of Safety into the Design Process*. In 2025, the DNFSB will continue these efforts, as well as evaluate other directives that have complex-wide effects and those that establish controls for high-hazard activities. These standards include DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*; DOE Standard 3009, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*; and DOE Handbook 1220, *Natural Phenomena Hazards Analysis and Design Handbook for DOE Facilities*. The DNFSB may elect to add reviews of DOE directives and technical standards as it deems appropriate.

FIELD
OPERATIONS

VI. Field Operations

The DNFSB Field Operations organization consists of 14 resident inspectors at five DOE sites including LANL, the Hanford Site, the Pantex Plant, Y-12, and SRS, where they provide day-to-day safety oversight of nuclear safety-related activities. In 2024, two new resident inspectors reported for duty at LANL. These positions have been vacant for several months and this is the first time the DNFSB has had three resident inspectors at LANL.

The resident inspectors are tasked with providing real-time information gathered through their safety oversight to the Board and its headquarters staff. Although resident inspectors provide this information for further evaluation and DNFSB engagement, they also frequently perform safety oversight that identifies issues that do not require engagement from the Board or its headquarters staff. These issues are frequently resolved on a staff-to-staff level without further elevation through providing informal and actionable feedback to site personnel that improves nuclear safety. Many of these are captured in the resident inspector weekly reports.

Resident inspectors also perform coordinated reviews of operational topics to monitor safety conditions within the defense nuclear complex. These focus area reviews provide an opportunity to expand or refresh resident inspector knowledge of key safety practices and related requirements because they review DOE and consensus standards as they develop the review scope, methodology, and questions. The resident inspectors share both improvement opportunities and good practices identified within the complex with DOE leadership to spur actions to resolve problems and advance ideas that foster overall safety improvement. The Associate Technical Director for Field Operations briefs appropriate DOE headquarters personnel on the results to improve their awareness of safety conditions within the complex.

During calendar year 2024, Field Operations performed six focus area reviews:

Human Performance Improvement Focus Area Review

The resident inspectors reviewed the processes used at each site for linking causes and error precursors for safety events to corrective actions and assessed whether sites were using the underlying human performance data to promote organizational and departmental level changes in human performance. The review determined that DOE's support contractors could be more proactive in their use of event cause information to identify error precursor trends and then target their use of human performance improvement tools to prevent future events. On the other hand, the resident inspectors also noted that DOE's contractors routinely collect cause information, and most sites are taking steps to implement more powerful issue management software. The resident inspectors viewed both activities as positive, noting that robust implementation of the updated issue management software could enable improvements in identifying and managing problematic causal trends. This review also triggered specific improvement actions. At one site, a contractor started identifying and recording error precursor information during the causal analysis process so that the information would be available for future trend analyses and a second contractor expanded their use of error precursor data as part of their ongoing trend analysis effort.

Lightning Protection System Focus Area Review

The resident inspectors evaluated lightning protection systems within the defense nuclear complex to assess design, condition, and maintenance, and perform detailed walkdowns at select facilities that rely on lightning protection systems to perform credited safety functions. The review concluded that facilities classified as "explosives facilities" appear to have the most robust maintenance and inspection programs for their lightning protection systems and have few issues. However, other facilities that require lightning protection systems but are not classified as "explosive facilities" vary significantly in their performance of maintenance, inspections, and technical coverage. In some cases, required systems are not installed or are in poor condition, with the resident inspector walkdowns identifying numerous discrepancies between the system drawings and current configurations, including missing or broken components, and structures or components breaching the zone of protection. The resident inspectors noted that management at the Savannah River Tritium Enterprise has initiated improvements to their lightning protection system in response to concerns communicated by the Board to DOE in an August 2, 2022, letter to the Secretary of Energy. Additionally, two different DOE support contractors at the Hanford Site initiated actions to address concerns raised by the resident inspectors during the review. Based on the overall conditions found, the DNFSB staff will conduct a broader review of lightning protection systems in 2025.

Figure 57. Discharge pipes (left) and metal scaffold pipe (right) located above air terminals.

Facilities in Surveillance and Maintenance Mode Focus Area Review

The resident inspectors conducted a review of facilities that are in surveillance and maintenance mode or infrequently entered. The goal of the review was to ensure that contamination within these facilities is adequately contained and that the potential hazards to workers, the public, and the environment are eliminated or mitigated and controlled. Where feasible, the resident inspectors performed their evaluation by participating in periodic routine inspections of the facility. In cases where entry was not feasible, the resident inspectors reviewed available reports from past inspections or surveillances. This effort concluded

that the scope of surveillances is often insufficient. In many cases, the periodic surveillances rarely went beyond a defined tour path that did not include large areas of the facility. Contamination surveys were not sufficient to evaluate contamination spread within the facility. Lastly, actions to resolve conditions that can cause contamination migration or structural degradation, such as water intrusion, are frequently delayed. Based on the results of the review, the resident inspectors provided suggestions to DOE for improving surveillance of inactive or infrequently-entered facilities. At the Hanford Site, the contractor responsible for periodic assessment of inactive facilities modified their procedure, expanded the scope of their inspections, and improved their documentation of identified surveillance issues.

Figure 58. Water intrusion into facilities in surveillance and maintenance mode.

On-the-Job Training Focus Area Review

The resident inspectors evaluated on-the-job training at DOE defense nuclear facilities to determine its effectiveness and to identify opportunities for improving on-the-job training by identifying weak performance areas and best practices. This review determined that contractor training programs do not always use on-the-job training guides and that improvements in this area would enhance the consistency and effectiveness of training. Additionally, reviewers at most sites identified shortcomings in either instructor qualification or performance. Only one site routinely assesses on-the-job training. The resident inspectors observed that DOE should consider stronger oversight in these areas to improve performance by ensuring closer adherence to required training standards. The resident inspectors also noted that strong, centrally managed training programs appear to yield better results than those that are managed at the facility level. The resident inspectors noted that several sites have developed or are developing cold laboratories, mockups, and simulators, which effectively enhance training while providing an error-tolerant environment that minimizes potential safety issues. This is a best practice in that it allows for the ability to safely exercise complex, non-routine, or emergency operations that can preclude unsafe errors during actual operations.

Transuranic Waste Storage Focus Area Review

Transuranic waste storage facilities are common across the defense nuclear complex, and they can represent a significant worker safety risk, and in some cases risk to the public. This focus area review provided a comparative evaluation of nuclear safety controls associated with transuranic storage and handling. The resident inspectors compared information collected from the various facilities to identify best practices or areas where additional evaluation may be warranted. The effort concluded that controls to ensure radioactive material inventories are maintained within safe limits were generally robust. However, the schedule for updating statistical information in response to inventory changes appeared to lack a rigorous technical basis across the facilities. The resident inspectors found that all evaluated facilities had adequate container integrity programs; however, the inspection frequency and sample rate varied significantly, as did waste container spacing and stacking heights. Further, the resident inspectors noted that none of the facilities comply with DOE's most recent safety standards for transuranic waste storage facilities, although several have implementation plans in place. Implementation of these standards would improve the overall safety posture of the transuranic waste facilities.

Figure 59. Shipment preparation at the Radioactive Assay Nondestructive Testing Facility

Non-conformance Reports Focus Area Review

Requirements for control of nonconforming items are implemented throughout the DOE complex; however, these requirements lack specificity, which leads to variability in how requirements are implemented at each site. The resident inspectors gathered data to assess how nonconforming items are identified, controlled, and dispositioned across the defense nuclear complex, and to determine whether the site processes are adequate to preclude the use of nonconforming items, which can degrade safety systems if installed. Overall, the resident inspectors concluded that the nonconformance processes reviewed seem adequate, but noted that the quality, level of detail, and adequacy of technical justification in nonconformance documentation varied significantly. The establishment of robust DOE guidance for justifying nonconformance dispositions could improve the consistency of implementation of the nonconformance processes across the complex.

APPENDIX A: Board Recommendations

Recommendations Open in 2024

Recommendation 2023-1, *Onsite Transportation Safety* (REMAINS OPEN)

Safety Concern—The Defense Nuclear Facilities Safety Board (DNFSB or Board) identified significant safety issues with the Los Alamos National Laboratory's (LANL) transportation safety document, stemming in part from weaknesses in the safe harbors that govern transportation safety document development. The safety issues were particularly concerning given the high material-at-risk, the proximity of the onsite transportation routes to the public, and the nature of several credible accident scenarios. The Board's recommendation is intended to strengthen DOE's guidance related to onsite transportation of nuclear materials and to address deficiencies in LANL's transportation safety document to ensure adequate protection of health and safety.

Current Status—On May 3, 2024, the Department of Energy (DOE) accepted the recommendation and on October 7, 2024, transmitted the implementation plan. Per the implementation plan, DOE has already completed sub-recommendation 1.b, specifically implementing compensatory safety measures at LANL. Additionally, DOE has begun work on the extent-of-condition review and expects to complete the formal report documenting the results of this review in 2025. The DNFSB remains actively engaged with DOE's progress toward execution of the implementation plan.

Assessment—The Board responded to DOE's implementation plan on December 20, 2024, and was encouraged by DOE plans to revise the relevant directives, ensure the LANL transportation safety document is revised, and conduct an extent-of-condition review. However, the Board noted the planned actions for the independent causal analysis did not address the entirety of the underlying safety issue related to DOE oversight as described in the recommendation.

Historical Information—Following a 2021 safety review of the LANL transportation safety document, the Board identified safety issues with both the LANL transportation safety document and the safe harbors that govern development of onsite transportation safety documents under 10 CFR 830. The Board documented these safety issues in a letter to the Secretary of Energy dated January 6, 2022. DOE responded on September 13, 2022, stating its agreement with, and plans to address, the Board's safety concerns. However, DOE's response only partially addressed the safety concerns identified by the Board, so the DNFSB continued to evaluate DOE's subsequent actions.

The National Nuclear Security Administration (NNSA) management and operating contractor at LANL implemented compensatory safety measures for onsite transportation of radioactive materials in March 2023, following a letter of direction from the NNSA Los Alamos Field Office. The LANL contractor formally incorporated the compensatory measures into revisions of the LANL transportation safety document and technical safety requirements, which the field office approved in August 2023, with two conditions of approval. These measures and

conditions of approval represented an improvement in the safety of onsite transportation of radioactive materials at LANL; however, more work was necessary to ensure the LANL transportation safety document appropriately identified all hazards, analyzed all pertinent accident scenarios, and evaluated the effectiveness of all credited safety controls.

NNSA had approved the LANL contractor's deficient transportation safety document on the basis that it met the applicable safe harbors for safety analysis identified in 10 CFR 830. Until DOE revises the safe harbors for onsite transportation of radioactive materials to provide clear and effective safety requirements, the risk remains that LANL or other defense nuclear sites may regress to inadequate transportation safety documents that fail to provide an effective set of safety controls. Therefore, on January 26, 2024, the Board issued Recommendation 2023-1, *Onsite Transportation Safety*. The recommendation identified the following safety issues: (1) the LANL transportation safety document requirements and their implementation do not ensure that onsite transportation activities at LANL are conducted in a manner that ensures adequate protection of public health and safety; (2) the requirements of the safe harbors do not ensure that onsite transportation activities are conducted in a manner that ensures adequate protection of public health and safety; and (3) DOE failed to address known safety deficiencies in its safe harbors for onsite transportation of radioactive materials and neglected to take timely action to correct the safety issues with the LANL transportation safety document.

The Board recommended that DOE: (1) revise the LANL transportation safety document to address the safety concerns identified in the Recommendation and to comply with a revised safe harbor methodology; (2) ensure compensatory safety measures remain in place until implementation of the LANL transportation safety document; (3) rewrite DOE safe harbors for onsite transportation; (4) change DOE Standard 1104, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, to incorporate requirements and guidance for DOE review and approval of transportation safety documents; (5) conduct an extent-of-condition review of transportation safety documents for DOE sites with defense nuclear facilities to identify any near-term actions necessary to ensure safety until the safe harbors are revised and implemented; and (6) perform an independent causal analysis for the safety issues identified in the recommendation, including the effectiveness of DOE oversight of contractor transportation safety documents, DOE's management of its onsite transportation directives, and DOE's evaluation of and actions in response to the safety issues identified in prior Board correspondence on onsite transportation safety.

Recommendation 2020-1, *Nuclear Safety Requirements* (REMAINS OPEN)

Safety Concern—DOE governs the safe operations of its nuclear facilities through 10 CFR 830, *Nuclear Safety Management*, and associated DOE directives and standards. Recommendation 2020-1 was issued in February 2020 to highlight concerns with DOE's existing nuclear safety requirements, DOE's plans to change those requirements, and DOE's approach to aging infrastructure management. Given the state of aging infrastructure within the defense nuclear complex and DOE's plans to construct new defense nuclear facilities, the Board recommended that DOE revise its nuclear safety requirements set to include key safety concepts, some of which were only defined in ambiguous guidance documents. Overall, Recommendation 2020-1 provides recommendations in the following areas: aging infrastructure, hazard

categories, DOE approvals, evaluation of safety basis preparation and review processes, and safety basis process and requirements.

Current Status—DOE has transmitted eleven of seventeen implementation plan deliverables to the Board. The DNFSB remains actively engaged with DOE's progress toward execution of the remaining deliverables. For example, the Board provided feedback on DOE directives related to the recommendation in a November 2024 letter, and through written comments on these directives.

Assessment—DOE's actions in response to Recommendation 2020-1 have been mostly positive and are poised to improve critical aspects of DOE's requirements and guidance governing nuclear safety. However, DOE's response to elements of the recommendation related to aging infrastructure management require continued leadership attention. DOE's main commitment in this area was to execute a benchmarking review to identify best practices and process enhancements regarding management of aging infrastructure. DOE completed this benchmarking review in 2023, and consistent with its implementation plan, shared the results across DOE and began implementation of the identified best practices and process enhancements in 2024. In 2023, the Board highlighted concerns with DOE's planned and completed actions to address the aging infrastructure sub-recommendation. In 2024, the Board initiated an aging infrastructure management campaign, including a public hearing and staff-to-staff workshop, to strengthen focus on this important topic and help inform the development of potential safety improvements to DOE's programs (see additional details in the Aging Infrastructure Management Oversight Campaign section of this report).

Historical Information—In February 2020, the Board issued Recommendation 2020-1, *Nuclear Safety Requirements*. The recommendation is intended to strengthen the regulatory framework of DOE, including 10 CFR 830, *Nuclear Safety Management*, and relevant DOE directives and standards. The Board revised and reaffirmed Recommendation 2020-1 in June 2021.

In September 2021, the Secretary of Energy accepted Recommendation 2020-1. DOE issued its implementation plan for Recommendation 2020-1 on June 27, 2022. The Board responded on August 18, 2022, stating that while DOE's implementation plan does not fully endorse some actions recommended by the Board, execution of the plan could result in safety improvements to DOE's nuclear safety framework consistent with the objectives of the recommendation. The Board further noted that achievement of those objectives would be contingent on DOE executing the implementation plan with the goal of addressing the Board's safety concerns.

Recommendation 2019-2, *Safety of the Savannah River Tritium Facilities* (REJECTED)

Safety Concern—The Board issued Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, due to several credible accident scenarios that could result in high radiological dose consequences to workers from a tritium release. The Tritium Facilities lack adequate safety controls to prevent or mitigate these high dose consequences. As a result, the

Board recommended that DOE implement near-term compensatory measures, identify robust long-term controls, and enhance the emergency preparedness program.

Current Status—Since 2019, DOE has taken steps to improve safety at the Tritium Facilities including implementing new physical controls that help reduce risk. However, most long-term control upgrades are still years away. Further, DOE planned to improve safety by constructing a new facility known as the Tritium Finishing Facility, but that project remains on hold.

Assessment—In the DNFSB's assessment, DOE still has not shown that its proposed and ongoing plans will result in sufficient improvement to the safety posture of the tritium facilities. The contractor's strategy for reducing dose consequences may not address all accident scenarios with the potential for high dose consequences, and DOE has not yet committed to pursuing any of the potential physical upgrades identified from this initiative. Further, DOE has placed the Tritium Finishing Facility on hold for several years to focus resources to other projects, delaying the reduction in risk from completing that facility. The DNFSB remains concerned about safety vulnerabilities at the Tritium Facilities and continues to engage with DOE about actions to strengthen safety.

Historical Information—On June 12, 2019, the Board issued Recommendation 2019-2, because of the high dose consequences to workers that could occur from several accident scenarios that were not adequately controlled. On September 10, 2019, DOE rejected Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, on the grounds that it was already addressing the Board's safety concerns with proposed and ongoing actions. The Board reaffirmed the recommendation on December 5, 2019, and DOE rejected the reaffirmed recommendation on January 3, 2020.

In December 2019, the National Nuclear Security Administration (NNSA) approved a new combined documented safety analysis for the Savannah River Site (SRS) tritium facilities that contained some improvements but did not address all the DNFSB's safety concerns. Specifically, the calculated dose consequences for co-located workers impacted by major accidents involving the tritium facilities were still unacceptably high (based on DOE's own safety requirements); calculated dose consequences for the public challenged DOE's evaluation guideline for consideration of safety class controls; and no new controls had been identified and implemented that reduce the calculated dose consequences to acceptable levels in accordance with DOE's safety directives. Moreover, the tritium enterprise contractor (with NNSA's consent) stated it would not implement improved safety controls identified in the new combined safety basis until 2024 and would not implement any compensatory measures to ensure safety in the interim. Safety management programs that could help mitigate accident consequences, such as the site's emergency preparedness and response program, had not been tested to demonstrate their effectiveness for a major accident involving the tritium facilities.

On July 13, 2021, the Board held a public hearing focused on these concerns. NNSA previously directed the tritium enterprise contractor to develop a risk reduction strategy for co-located workers impacted by major accidents involving the SRS tritium facilities. Shortly before the Board's public hearing, NNSA approved the contractor's strategy to reduce the risks

presented by several postulated accidents at the tritium facilities. The actions in the strategy focused on either refining the accident analysis parameters to reduce the calculated consequences or completing calculations to determine whether existing structures could survive accident conditions to either be credited in the safety basis or to be factored into potential development of new physical controls. Most of the proposed actions were analytical reductions in accident consequence calculations. Unless done in conjunction with physical modifications to install or upgrade engineered controls, the revised consequence calculations do not represent actual improvements to safety.

On May 10, 2022, the DNFSB observed SRS's site annual emergency exercise. The exercise scenario involved an explosion at the Tritium Extraction Facility and a release of tritium oxide. The exercise tested the ability of the site emergency response organization to respond to radiation exposures greater than five rem total effective dose and tritium exposures outside the tritium facilities' fence line, including collection of radiological bioassay samples from potentially exposed workers to determine which workers may be at risk of a significant tritium uptake. Demonstration of these capabilities was responsive to concerns described in the Board's recommendation and discussed during the Board's July 13, 2021, public meeting and hearing.

In 2022, the DNFSB conducted a series of safety reviews aimed at identifying opportunities to strengthen the engineered and administrative safety controls at the Savannah River Tritium Enterprise that protect the workers and the public. On July 26, 2022, the Board communicated to DOE its findings from a structural evaluation of the 296-H tritium stack that challenged the assumptions of the combined safety basis that collapse of the stack would not impact a nearby tritium storage vault. On August 11, 2022, the Board transmitted a letter to the NNSA Administrator detailing concerns with an unanalyzed accident progression in which tritium was released and subsequently drawn into a tritium processing building by the building's ventilation system on January 30, 2022. The DNFSB also completed safety reviews of the electrical systems and the implementation of safety management programs and specific administrative controls at the tritium facilities.

In 2023, the DNFSB conducted a series of interactions to evaluate NNSA's progress to date. The Board reviewed NNSA's safety improvements at the Savannah River Tritium Enterprise during its site visit in May 2023, when NNSA provided an update on many of the initiatives. On October 4, 2023, the Board followed up on its site visit with a letter to the Secretary of Energy establishing a reporting requirement for DOE to provide an annual report and briefing starting within six months and focused on DOE's progress on safety improvements at the Savannah River Tritium Enterprise.

After the Board's site visit, the NNSA associate administrator for environment, safety, and health traveled with a team to SRS to discuss nuclear activities and issues and identified several safety basis topics for further evaluation. The Board was encouraged by NNSA headquarters' engagement to drive these longstanding safety issues toward resolution.

In 2024, the Board received the first annual briefing from DOE regarding progress on safety improvements at the Savannah River Tritium Enterprise. DOE described recent initiatives such as installation of fire barriers in a storage location for tritium containers, which reduces the

risk of tritium release due to a fire. DOE also discussed improvements in the emergency preparedness program, which helps ensure that the site can respond effectively to potential accident situations to protect the public and workforce. The Board continued to emphasize the importance of additional improvements at the Savannah River Tritium Enterprise.

In July 2024, after re-evaluating the contractor's previous analysis about the tritium re-entry event described in the Board's letter of August 11, 2022, NNSA's Savannah River Field Office directed the contractor to re-perform the analysis. The contractor subsequently declared a potential inadequacy in the safety analysis and a positive unreviewed safety question determination. The Board is encouraged by the field office's engagement and intends to continue monitoring the implementation of the re-analysis into the hazard analysis and safety basis.

In 2024, the contractor for the Savannah River Tritium Enterprise implemented the combined tritium facilities documented safety analysis, which contains some improvements but does not address all the DNFSB's concerns. Examples of improvements include elevating some safety management programs to specific administrative controls, no longer crediting emergency preparedness for reductions in calculated dose consequences, and implementing updated dispersion modeling parameters. The new documented safety analysis also partially addressed concerns identified in the Board's July 26, 2022, letter to the Secretary of Energy regarding the potential for the 296-H stack to collapse and impact the nearby tritium storage vault. The DNFSB continues to monitor DOE's progress toward mitigation or prevention of such an accident scenario. The DNFSB has initiated a review of the documented safety analysis that continues into next year.

The DNFSB continued observing emergency preparedness drills and exercises at SRS. A key concern from Recommendation 2019-2 was the ability of the site to respond in a major emergency, given the unique safety risk at the Savannah River Tritium Enterprise and proximity to large populations onsite. Specifically, the DNFSB was concerned that SRS had not tested its emergency response for a major accident that results in a mass casualty situation. In 2024, SRS performed a more complex mass casualty drill that simulated exceeding the ability of onsite resources to respond. The DNFSB was encouraged that SRS challenged itself with the complex postulated scenario, allowing for identification of areas for improvement and experience with more complicated and realistic situations. The DNFSB continues to emphasize the need to drill and exercise additional complex, major accident scenarios.

The DNFSB continued to review and evaluate NNSA's co-located worker dose reduction strategy for short-term and long-term measures to prevent or mitigate the potential for high radiological consequences. The DNFSB also initiated a review of the emergency preparedness program and continues to monitor site efforts to develop, test, and implement a site evacuation and relocation plan.

The DNFSB continues to evaluate NNSA's progress toward completion of its proposed and ongoing safety actions, and to evaluate whether those actions will effectively address safety issues at the SRS tritium facilities. The DNFSB has shared its concerns with NNSA leadership

and remains concerned with the risk to workers and the public associated with postulated accident scenarios at the Savannah River Tritium Facilities.

Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR Part 830 Implementation at the Pantex Plant* (CLOSED January 30, 2025)

Safety Concern—The Board issued Recommendation 2019-1 to address numerous legacy Pantex Plant safety issues—including inadequately controlled hazards with severe consequences to both the workforce and public and necessary infrastructure improvements (e.g., replacement of wood-framed false ceilings in certain cells to eliminate potential impact scenarios to nuclear explosives)—and highlight the need for operational and tooling process enhancements. Such safety improvements can also positively influence mission performance, minimizing downtime due to facility and equipment degradation, or recovery from abnormal situations.

Current Status—On January 30, 2025, the Board issued a letter and report to the Acting Secretary of Energy following its review of the B61 Hazard Analysis Report. In this letter, the Board closed Recommendation 2019-1 given the completed safety improvements and noted a few additional safety concerns that will require further consideration and action from NNSA. These areas of concern include: (1) design feature implementation; (2) special tooling performance criteria; and (3) procedural compliance assumptions within the safety bases.

Assessment—NNSA has corrected many of the safety issues outlined in Recommendation 2019-1. These actions have resulted in the Pantex Plant applying necessary controls to protect the workforce and public, implementing needed infrastructure enhancements, and improving nuclear explosive operations and the special tooling program.

Historical Information—On February 20, 2019, the Board issued Recommendation 2019-1 and identified the following safety issues: (1) portions of the safety basis for Pantex Plant nuclear explosive operations do not meet 10 CFR 830, including high-consequence hazard scenarios that are not adequately controlled; (2) multiple components of the process for maintaining and verifying implementation of the Pantex Plant safety basis are deficient; and (3) the Pantex Plant federal and contractor organizations have been unable to resolve known safety basis deficiencies.

The Board recommended that DOE: (1) implement compensatory measures to address all deficiencies described within the recommendation's appendices; (2) perform an extent-of-condition evaluation of the Pantex Plant safety basis and implement subsequent corrective actions to ensure compliance with DOE regulations and directives; (3) implement actions to ensure process design and engineered controls eliminate or protect the nuclear explosives from impact and falling technician scenarios, including those identified in the recommendation's enclosure; (4) ensure the design, procurement, manufacturing, and maintenance of special tooling is commensurate with its safety function; and (5) train safety basis personnel to ensure future revisions to the safety basis comply with 10 CFR 830 requirements.

DOE accepted the recommendation on April 16, 2019, and transmitted its implementation plan on July 16, 2019. Upon review, the Board found that the "language and

terms of the implementation plan in fact reject significant parts of the recommendation," and reaffirmed Recommendation 2019-1 in a letter dated August 22, 2019, to the Secretary of Energy. In a public meeting on December 12, 2019, NNSA personnel committed to revise the implementation plan to address the Board's concerns. NNSA transmitted the revised implementation plan to the Board on June 5, 2020, and briefed the Board on the revised plan on August 4, 2020. In a September 16, 2020, letter, the Board informed the Secretary of Energy that the revised implementation plan addressed the Board's concerns with the original plan, and that the Board found the revised implementation plan to be responsive and indicative of DOE's acceptance of Recommendation 2019-1. The Board's letter emphasized that the frequent and constructive staff-level interactions during the revision process of the implementation plan greatly facilitated productive discussions and resulted in a product that addressed the safety recommendations. The Board also advised DOE to consider adding or expanding the use of engineered controls such as transfer carts, where applicable, to reduce hazards by eliminating both hand lifts of tools and swing arms in tooling.

On June 15, 2023, NNSA transmitted a revised implementation plan, modifying two deliverables associated with establishing special tooling performance criteria in Pantex Plant safety basis documents. The changes resulted from merging these initiatives with a broader effort, which included establishing performance criteria for all design features and specific administrative controls. Given the expanded scope, rather than providing all the upgraded safety basis documents as initially planned, NNSA revised the implementation plan to instead provide the revised B61 Hazard Analysis Report as a model, along with a schedule to upgrade the remaining safety basis documents, including NNSA's review and approval of those documents.

On January 16, 2024, NNSA transmitted a letter to the Board noting that NNSA and its contractor had completed all 69 deliverables identified in the revised implementation plan. Within the letter, NNSA noted that it would be performing an effectiveness review of all actions taken during execution of the revised implementation plan; furthermore, the Pantex Plant would continue to upgrade and improve the remaining safety basis documents. During a Board visit to the Pantex Plant in April 2024, the NNSA Pantex Field Office and the Pantex Plant contractor management briefed the Board on NNSA's implementation of commitments made in response to Recommendation 2019-1. Following this visit, on June 3, 2024, the Board sent a letter to the Secretary of Energy requesting a briefing from NNSA on the results of the effectiveness review within 60 days of completion of the review. NNSA concluded the effectiveness review on October 28, 2024, and provided the briefing to the Board on December 10, 2024.

The DNFSB continued to review completed actions resulting from Recommendation 2019-1 throughout 2023 and 2024. For example, the Board issued letters on January 4, 2023, to the NNSA Administrator and April 9, 2024, to the Secretary of Energy summarizing conclusions from its evaluation of closure documentation for various legacy conditions of approval and planned safety improvements—which have remained open for more than a decade—and projects to replace wood-framed false ceilings in two nuclear explosive cells. Additionally, the DNFSB assessed the B61 Hazard Analysis Report—among one of the last deliverables—which constituted the first safety basis document that incorporates safety improvements resulting from Recommendation 2019-1 and other Pantex Plant safety basis enhancement efforts. This safety

basis review effort is described in greater detail in the Pantex Plant section of this report. Overall, the DNFSB found that NNSA has mostly corrected the safety basis issues outlined in Recommendation 2019-1 on this weapon program but did identify a few safety concerns requiring further action. NNSA and its contractor continue to apply similar improvements to the several remaining Pantex Plant safety basis documents with a planned completion of December 2025.

Recommendation 2012-1, *Savannah River Site Building 235-F Safety* (CLOSED May 28, 2025)

Safety Concern—Building 235-F at SRS is a facility built in the 1950s that supported various nuclear material production and storage missions over the years. All missions were completed in the early-2000s, but residual plutonium-238 material remained in some process enclosures, which could be released in a fire, putting nearby workers in danger. In 2012, the Board identified safety concerns related to these hazards, issuing Recommendation 2012-1 to address these concerns.

Current Status—At present Building 235-F is deactivated and in surveillance and maintenance mode. DOE is performing design and safety analysis work to support eventual decommissioning. Contractor personnel are required to perform structural integrity inspections every five years and the next inspection is scheduled for February 2027. Contractor personnel also implement the Enclosure Integrity Program, which consists of periodic radiological inspections (annually), visual inspections (annually), and enclosure leak testing (every 3 years or more frequently, as needed). The last facility entry and inspection occurred on May 20, 2024, during which contractor personnel identified two instances of minor in-leakage, one each into the Plutonium Fuel Form Facility and the Plutonium Experimental Facility enclosures. While enclosure in-leakage could indicate a source for spread of contamination (e.g., if ventilation is lost), there was no indication of such contamination spread at this time. As a result, DOE intends to seal the leaks during the next planned entry and perform additional enclosure leak testing again in 2025. DOE conducted its annual brief to the Board on August 15, 2024. The Board closed Recommendation 2012-1 on May 28, 2025.

Assessment—The DNFSB understands and supports DOE's approach to monitor conditions in the facility, particularly in the performance of structural integrity and radiological condition inspections, to ensure that safety risk is sufficiently mitigated for the remaining life of the facility. While the nature of the concern has not fundamentally changed, the significance of the concern has diminished over the years due to the efforts by DOE to reduce hazards and make progress toward eventual decommissioning. However, until associated hazards are fully eliminated, the DNFSB will continue to evaluate these monitoring efforts, along with design progress supporting eventual decommissioning of the facility.

Historical Information—In May 2012, the Board issued Recommendation 2012-1, *Savannah River Site Building 235-F Safety*, which recommended several actions that DOE should take to improve the Building 235-F safety posture. In response, DOE developed an implementation plan and completed several actions to improve the safety of Building 235-F, including removing some material-at-risk, combustibles, and ignition sources.

In May 2020, DOE developed a revised implementation plan outlining significant changes to the overall strategy used to address the hazards in Building 235-F, which focused on eliminating fire risks instead of removing additional material-at-risk. DOE subsequently indicated to the Board that all actions identified in the revised implementation plan were completed on June 22, 2020.

On November 2, 2021, the Board established a new reporting requirement for an annual report and briefing regarding: (1) progress made to deactivate and decommission Building 235-F; (2) results of radiological surveys and inspections to verify that contamination is not spreading; (3) status and schedule for establishing a final end state determination with regulatory authorities; (4) results of structural integrity inspections, and any corrective actions identified and implemented from these inspections; and (5) any changes to the status of the E-5 ventilation system and sand filter, including any maintenance activities performed. DOE conducted the second annual briefing under the new reporting requirement to the Board on July 13, 2023, addressing requested elements. This included the results of structural and radiological inspections and an updated timeline for decommissioning activities.

Appendix B: Substantive Board Correspondence Sent to DOE in 2024

The table below summarizes substantive Board correspondence sent to DOE in 2024. All Board correspondence is available on the public website (www.dnfsb.gov), which aids in enhancing the DNFSB's public outreach.

Table B-1. *Substantive Correspondence to DOE in 2024*

Correspondence	
January 5	Software quality assurance of continuous air monitors for the Lawrence Livermore National Laboratory Recovery Glovebox Line
January 19	Chemical compatibility program for Transuranic Waste at NNSA facilities at LANL
January 24	DOE Order 251.1D, *Departmental Directives Program*
January 26	Recommendation 2023-1, *Onsite Transportation Safety*
February 12	Fire protection program at the Pantex Plant
April 9	Pantex Plant false ceiling replacement
April 10	Glovebox safety and glovebox glove integrity programs at LANL
May 15	Continuous air monitor system for the Waste Isolation Pilot Plant Safety Significant Confinement Ventilation System
June 3	Maintenance practices for electrical cable systems in the DOE defense nuclear complex
June 3	Follow up from the Board's visit to the Pantex Plant in April 2024
June 4	2023 Annual Safety System Oversight Award
June 4	2023 Facility Representative of the Year
June 14	SRS Facility Representative program
July 17	Plutonium storage container fire testing
July 25	Safety design basis documents for projects in the Nevada National Security Sites Enhanced Capabilities for Subcritical Experiments
August 13	Lithium-ion batteries in uninterruptible power supplies at the Nevada National Security Sites Device Assembly Facility
October 3	Hanford Site Low-Activity Waste Facility maintenance program
November 13	Criticality accident alarm system at the Savannah River Plutonium Processing Facility
November 15	DOE Order 421.1, *Nuclear Safety Basis*
December 6	DOE's application of Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*
December 17	DOE Order 151.1E, *Comprehensive Emergency Management System*
December 20	Response to the DOE Implementation Plan for Recommendation 2023-1, *Onsite Transportation Safety*

Appendix C: List of Illustrations

Appendix D: List of Tables

Appendix E: Acronym List

CFR	Code of Federal Regulations
CD	Critical Decision
DAF	Device Assembly Facility
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
INL	Idaho National Laboratory
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Sites
PULSE	Principal Underground Laboratory for Subcritical Experimentation
SNL	Sandia National Laboratories
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TRU	Transuranic
WIPP	Waste Isolation Pilot Plant
Y-12	Y-12 National Security Complex