Defense Nuclear Facilities Safety Board
32nd Annual Report to Congress
April 2022

Required by Section 316 of the
Atomic Energy Act of 1954, as amended

"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"
42 USC § 2286a(a)

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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

Month xx, 2022

To the Congress of the United States:

The Defense Nuclear Facilities Safety Board (Board) is pleased to submit its *32nd Annual Report to Congress* for calendar year 2021. The Board 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 Department of Energy (DOE) defense nuclear facilities.

During 2021, the Board continued to fulfill its public health and safety mission while addressing challenges with the coronavirus disease 2019 (i.e., COVID-19) pandemic. As an expertise-based safety oversight agency, the Board's ability to perform its mission is dependent on its ability to ensure the safety and well-being of its workforce. The Board has demonstrated its effectiveness while adapting to flexible employee work schedules. During this time, the Board also made substantial progress in developing a memorandum of understanding with DOE to provide a stronger foundation for mutual communication, transparency, and information-sharing. The memorandum of understanding was substantially completed during calendar year 2021, and it was signed by the Deputy Secretary of Energy and the Chair of the Board on February 17, 2022.

On February 21, 2020, the Board issued Recommendation 2020-1, *Nuclear Safety Requirements*. The Board intended for the recommendation to strengthen DOE's regulatory framework, including 10 Code of Federal Regulations Part 830, *Nuclear Safety Management*, and relevant DOE orders and standards. The Board received DOE's response rejecting most of the recommendation in June 2020. On June 1, 2021, the Board reaffirmed the recommendation with revisions. In September 2021, DOE accepted the recommendation and agreed to address the technical concerns raised by the Board.

In the recommendation the Board expressed its concern with the current state of the infrastructure supporting DOE's defense nuclear facilities and concluded that expression of concern with the first sub-recommendation:

> *[The Board recommends that DOE] develop and implement an integrated approach—including requirements—for the management of aging infrastructure that includes formal processes to identify and perform infrastructure upgrades necessary to ensure facilities and structures, systems, and components can perform their safety functions.*

DOE needs a strong regulatory framework to maintain the functionality and reliability of the aging infrastructure that supports its defense nuclear facilities. While DOE has project plans to replace some aging facilities, the completion of those actions will not happen for many years. In the meantime, the current facilities that DOE relies upon will continue to age and there will be increasing maintenance challenges associated with their engineered systems. In particular, the Board is concerned about the robustness of those safety systems and support systems whose degradation can impact the safety of continued operations. Currently, DOE lacks a formal, complex-wide regulatory structure and process for identifying, prioritizing, and performing defense nuclear facilities and safety upgrades to aging infrastructure necessary for the adequate protection of the public and workers. The Board will work with DOE as it develops its implementation plan for addressing the aging infrastructure and other safety framework issues raised in the Board's Recommendation 2020-1.

As required by 42 United States Code § 2286e(a), this report describes the Board's accomplishments, current safety initiatives, assessments regarding improvements in the safety of defense nuclear facilities, unresolved safety issues, and more detail regarding the Board's interface with DOE and its execution of its mission.

Respectfully submitted,

Joyce L. Connery
Chair

c: The Honorable Jennifer Granholm

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EX. Executive Summary

Under the Atomic Energy Act of 1954, as amended, the Defense Nuclear Facilities Safety Board (DNFSB or Board) is charged with providing independent safety oversight of the Department of Energy's (DOE) defense nuclear facilities complex—a complex with the mission to design, manufacture, test, maintain, and decommission nuclear weapons, as well as other national security priorities. 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 issues of adequate protection of public health and safety at DOE defense nuclear facilities.

The Board prioritizes its safety oversight activities based on risk to the public and workers, types and quantities of nuclear and hazardous material at hand, and hazards of the operations involved. This annual report summarizes the Board's significant safety oversight initiatives and some high-priority safety issues at defense nuclear facilities subject to the Board's oversight during 2021. Foremost among these initiatives and issues were:

- ***Nuclear Safety Management***—On February 21, 2020, the Board issued Recommendation 2020-1, *Nuclear Safety Requirements*. The recommendation is intended to strengthen DOE's regulatory framework, including 10 Code of Federal Regulations (CFR) 830, *Nuclear Safety Management*, and relevant DOE orders and standards. The Board received DOE's response rejecting most of the recommendation on June 11, 2020. On June 1, 2021, the Board reaffirmed Recommendation 2020-1, with revisions reflecting DOE's response to the original and completion of the rulemaking for 10 CFR Part 830. On September 8, 2021, the Secretary of Energy provided her final decision to the Board accepting Recommendation 2020-1. In an October 14, 2021, letter to DOE, the Board acknowledged DOE's acceptance of the recommendation, while noting that some DOE responses do not fully embrace actions recommended by the Board. DOE is currently developing an implementation plan to meet the objectives of the Board's recommendation.

- ***Pantex Conduct of Operations and Training & Qualification***—In recent years, the Pantex Plant has experienced a series of events related to the safe conduct of operations, including multiple occurrences that led to technical safety requirement violations. Based on these events and safety concerns shared with the Board's staff by Pantex employees, the Board evaluated conduct of operations and the training and qualification programs at the Pantex Plant, evaluated safety documentation, held discussions with the National Nuclear Security Administration (NNSA) and contractor management, and conducted on-site and remote interviews with more than 30 Pantex employees. Based on this evaluation, the Board transmitted a letter to the Secretary of Energy on June 9, 2021, identifying safety issues related to organizational culture, training program content, training implementation in training facilities and on the production line, non-standard training processes, conduct of operations implementation, and disciplined operations specialist resources. The NNSA Administrator responded to this letter in August 2021, committing to address

nearly all the specific safety issues and identifying actions that should drive safety improvement over time.

- ***Safety Controls at the Savannah River Site Tritium Facilities***—NNSA rejected Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, on September 10, 2019—and rejected the Board's reaffirmed Recommendation on January 3, 2020—on the grounds that it was already addressing Board's concerns with proposed and ongoing actions. The Board has continued to follow the status of the actions that NNSA stated would address the Board's concerns with safety at the Savannah River Site tritium facilities. On July 13, 2021, the Board held a public hearing focused on these concerns. The contractor for the Savannah River Site tritium facilities developed a strategy, approved by NNSA shortly before the Board's July 2021 hearing, to reduce the risks presented to co-located workers by several postulated accidents at the tritium facilities. Testimony of NNSA officials at the hearing confirmed that while NNSA approved a new combined safety basis for the Savannah River Site tritium facilities in 2019, it has no plans to implement improved safety controls from the new safety basis until 2025 and it has not implemented any compensatory measures to ensure safety in the interim. The Board continues to evaluate NNSA's progress towards completion of its proposed and ongoing safety actions, and to evaluate whether those actions will effectively address safety issues at the Savannah River Site tritium facilities. The Board has shared its concerns with NNSA leadership.

- ***Onsite Transportation Safety***—The Board completed a review of the safety basis for onsite transportation of nuclear materials at Los Alamos National Laboratory and DOE's directives governing safety analyses for onsite transportation activities during calendar year 2021. The Board transmitted a letter to the Secretary of Energy on January 6, 2022, detailing safety concerns with the lack of requirements and detailed guidance for developing transportation safety documents and with the inadequate level of technical analysis of the hazards and accident scenarios for onsite transportation at Los Alamos National Laboratory. Given the allowable material-at-risk for each transfer and the proximity of transport routes to the site boundary, the unmitigated consequences from various credible accidents are high to workers at Los Alamos National Laboratory and to the offsite public. The Board's letter requested a briefing and written report from DOE on these safety concerns.

- ***Hazards Associated with the Material-at-Risk at Savannah River Site***—The Board issued Recommendation 2012-1, *Savannah River Site Building 235-F Safety*, on May 9, 2012. The recommendation identified the need for actions to reduce hazards associated with material-at-risk that remains as residual contamination within Building 235-F. 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 ignitions sources. In 2020, DOE revised the implementation plan and informed the Board that it had completed all actions identified in the revised plan. Overall, the Board is encouraged by the progress made toward reducing the risk and improving the safety posture at Building 235-F; however, the latest Building 235-F safety basis contains deficiencies that make it

inconsistent with DOE standards. To ensure consistency with DOE standards, the Board advised DOE to upgrade the safety classification of key controls. This safety issue is documented in more detail in a Board letter to the Secretary of Energy dated November 2, 2021, as well as Appendix A of this report. Building 235-F is scheduled to complete deactivation in 2022, with the timeline for eventual decommissioning to be determined following regulatory review of DOE's engineering evaluation and cost analysis.

- ***Safety of Solid Nuclear Waste Operations***—DOE has experienced two significant waste events in the past decade—one in 2014 at the Waste Isolation Pilot Plant and another in 2018 at Idaho National Laboratory—in which waste drums released radiological materials due to energetic chemical reactions involving the waste. More recently, other unexpected events involving DOE's waste have raised Board questions about the safety of solid nuclear waste operations across DOE's defense nuclear facilities. As a result, the Board has continued to evaluate how DOE analyzes hazards and implements controls at facilities that generate, process, and store radioactive waste, with an emphasis on the updated requirements in DOE Standard 5506-2021, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*. The Board issued a letter on July 26, 2021, on Standard 5506 highlighting the positive working relationship between the DOE team and the Board's staff, the noticeable improvements in the then-draft standard, and two significant unresolved safety issues. The Board plans to follow DOE's implementation effort closely to ensure that the improvements that were incorporated into the revised standard are implemented across the complex, resulting in increased safety of solid nuclear waste operations.

  In a related, parallel effort, on September 24, 2020, the Board issued Technical Report 46, *Potential Energetic Chemical Reaction Events involving Transuranic Waste at Los Alamos National Laboratory*, to the Secretary of Energy. In the report, the Board determined that safety bases for Los Alamos National Laboratory facilities do not consistently or appropriately consider a potential energetic chemical reactions involving transuranic waste. The Secretary of Energy responded to Technical Report 46 in a letter dated March 30, 2021, stating that DOE is adequately and consistently controlling transuranic waste hazards at Los Alamos National Laboratory and will use the Board's technical report to aid DOE's review of a recent unexpected sparking event that occurred in waste at the laboratory. The Board is continuing to evaluate the Secretary's response to Technical Report 46, as well as both the Office of Environmental Management's and NNSA's safety-related corrective actions and lessons learned that DOE developed in response to the technical report and the subsequent Los Alamos waste sparking event.

- ***Hanford Tank Farms Safety Basis Review***—On September 15, 2021, the Board sent a letter to the Secretary of Energy providing the results of its review of the documented safety analysis for Hanford's tank farms facility and transmitting Technical Report 48, *Hanford Tank Farms Safety Basis Review*. The Board found that the tank farms safety basis relies upon a dated methodology and lacks sufficient

documentation to support its conclusions regarding safety risk to the workers and the public.

The Board noted that a modern, updated safety basis will be necessary to ensure a smooth transition to the next phases of tank farm operations, involving changing tank waste conditions and increased operational pace as the Waste Treatment and Immobilization Plant's Low Activity Waste Facility starts up in late 2023. The current tank farms safety basis is written to the 1994 version instead of the 2014 version of DOE Standard 3009, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. The safety analyses in the tank farms safety basis would benefit from the additional rigor and structure of the 2014 revision.

- ***Seismic Hazard Assessments***—On June 10, 2021, the Board sent a letter to the Secretary of Energy, which included Technical Report 47, *Seismic Hazard Assessments*. The letter and report highlight the Board's safety concerns with the process of periodically assessing the seismic hazard at DOE sites to ensure that credited seismic controls are analyzed using the latest information and will perform their safety functions when needed. Reliable seismic safety controls are important because radiological releases during a seismic event have the potential to cause significant consequences.

  On December 14, 2021, DOE responded to the Board and committed to the following: provide direction to site offices to verify that unreviewed safety question procedures adequately cover new natural phenomena hazards assessments; take DOE action when site offices are not in compliance with natural phenomena hazards requirements; and review applicable DOE directives to evaluate if improvements are needed. DOE plans to brief the Board in early 2022 on its response.

- ***New Facilities and Projects Supporting Modernization of the Strategic Deterrent***—NNSA continues its efforts to meet pit production mission requirements through design and construction projects at Los Alamos National Laboratory and the Savannah River Site. In 2021, NNSA approved Critical Decision-1, *Approve Alternative Selection and Cost Range,* for the Los Alamos Plutonium Pit Production Project and the Savannah River Plutonium Processing Facility. The Los Alamos Plutonium Pit Production Project is a major modification to the Plutonium Facility at Los Alamos National Laboratory that will install and upgrade equipment to increase pit production capabilities up to 30 pits per year. The Savannah River Plutonium Processing Facility is a new facility that repurposes the partially constructed building for the Mixed Oxide Fuel Fabrication Facility to produce up to 50 pits per year.

  In 2021, the Board conducted conceptual design reviews of these two projects. The Board identified safety challenges that should be addressed as these projects advance. For example, the Los Alamos Plutonium Pit Production Project relies on existing safety controls in the Plutonium Facility that are unable to survive an earthquake accident. NNSA has initiated several separate projects to address these safety system deficiencies; however, the future safety control strategy is not well defined. The

Board also identified eight safety observations with the conceptual design for the Savannah River Plutonium Processing Facility.

The Board conducted conceptual design reviews on three other new design and construction projects that achieved the Critical Decision-1 milestone. These projects are the Surplus Plutonium Disposition and Tritium Finishing Facility projects at the Savannah River Site, and the Enhanced Capabilities for Subcritical Experiments project at the Nevada National Security Site's U1a Complex. The Board identified safety observations during the review of the Tritium Finishing Facility and Surplus Plutonium Disposition projects that should be addressed as the designs progress.

The table below summarizes substantive Board communications in 2021. All Board correspondence is available on the public website (www.dnfsb.gov), which aids in enhancing the Board's public outreach.

Substantive Communications in 2021

Congressional and Intergovernmental Outreach	
February 16	Briefing to Senate Armed Services Committee, Subcommittee on Strategic Forces on legislation
April 13	Briefing to the House Armed Services Committee on Waste Isolation Pilot Plant shipments
May 5	Briefing to the Senate Appropriations Committee Subcommittee on Energy and Water Development on the Memorandum of Understanding with DOE
October 19	Briefing to the House and Senate Appropriations Committees Subcommittees on Energy and Water Development on current and projected DNFSB staffing
November 12	Associate technical director briefing to the New Mexico Legislature's Radioactive and Hazardous Waste Committee
Letters	
January 19	DOE nuclear facility hazard categorization standards
January 22	Summary of standards reviews that the Board conducted in fiscal year 2020 and a list of standards to review in fiscal year 2021
February 8	Review of DOE Standard 1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*
February 11	DOE nuclear criticality safety program and DOE evaluation of criticality safety programs across the complex
June 9	NNSA actions to address the issues raised in the Board's review of Training and Qualification Program and Conduct of Operations Implementation at the Pantex Plant
June 9	Reliability of safety structures, systems, and components at three facilities at the Los Alamos National Laboratory
June 15	Critical Decision-1 milestone for the Tritium Finishing Facility at the Savannah River Site
June 15	Weapon response technical basis at Sandia National Laboratories and opportunities for improvement

Letters (*continued***)**	
July 7	Criticality hazards of the out-of-service systems with uranium holdup located in Building 9212 at the Y-12 National Security Complex
July 26	Concerns and planned implementation of the revised DOE Standard 5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*
August 13	The 2018 failure of the safety instrumented alarm system at the Waste Isolation Pilot Plant and DOE's subsequent response/recovery actions
August 26	Safety questions pertaining to the safety basis at the Nevada National Security Site's Radioactive Waste Facilities
September 8	DOE's plan for safely managing nuclear waste materials containing mixtures of nitric acid or nitrate salts with polysaccharides
September 8	Safety basis of the Savannah River Site H-Canyon Exhaust Tunnel
October 14	Secretary's final decision on Recommendation 2020-1, *Nuclear Safety Requirements*
November 2	Safety basis for the Savannah River Site's Building 235-F
November 2	Emergency management program at Hanford
November 10	Quality assurance requirements for Pantex Plant construction projects
November 16	Safety basis for the Hanford Site's Central Waste Complex
November 24	Critical Decision-1 for the Los Alamos Plutonium Pit Production Project
December 1	Safety of co-located workers at the Nevada National Security Site's U1a Complex
Technical Reports	
June 10	*Seismic Hazard Assessments* (DNFSB/TECH-47)
September 15	*Hanford Tank Farms Safety Basis Review* (DNFSB/TECH-48)
Public Meeting and Hearing	
July 13	The Status of the Savannah River Site
Recommendation	
June 1	Reaffirmation of Board Recommendation 2020-1, *Nuclear Safety Requirements*

In 2021, the Board's correspondence was accessed more than 4,667 times via its public website. The Board held one public meeting and hearing, and seven closed meetings and nonpublic collaborative discussions. The July 13, 2021, public meeting and hearing was accessed 378 times. In addition to the letters, technical reports, and recommendation, the Board publishes resident inspector weekly reports for most DOE sites subject to the Board's jurisdiction and monthly reports for the remainder. The table below provides information on the number of times resident inspector weekly reports and other publications were accessed via the public website in 2021.

This annual report organizes the Board's oversight activities into four areas: nuclear weapon operations; defense nuclear waste operations; design and construction of new defense nuclear facilities and major modifications to existing facilities; and safety standards and programs. Appendix A summarizes the status of all Board recommendations open in 2021.

Access of Board Publications via Public Web Site in 2021

Type of Publication	Number of Times Documents Were Accessed
Resident Inspector Weekly Reports, Hanford Site	471
Resident Inspector Weekly Reports, Savannah River Site	683
Resident Inspector Weekly Reports, Los Alamos National Laboratory	1,017
Resident Inspector Weekly Reports, Y-12 National Nuclear Complex and Oak Ridge National Laboratory	1,154
Resident Inspector Weekly Reports, Pantex Plant	533
Letters	4,667
Technical Reports	451
Recommendations	1,775
Meetings	600
Closed Meetings	171

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I. The Board's Statutory Mission

Congress established the Defense Nuclear Facilities Safety Board (Board) in 1988 as an independent federal agency within the executive branch of the government, subject to congressional oversight and direction. The Board consists of up to five members, who are appointed by the President, subject to confirmation by the Senate, and are required to 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." The Board is a collegial agency, meaning that its actions are determined by the Board as a whole. The Board's Chair serves as the chief executive officer and performs this function subject to Board policies.

The Board's essential mission is to provide independent analysis, advice, and recommendations to the Secretary of Energy to inform the Secretary, in his or her role as operator and regulator of Department of Energy (DOE) defense nuclear facilities, in providing adequate protection of public health and safety, which includes the health and safety of workers. The term "defense nuclear facilities" is defined in the Atomic Energy Act of 1954, as amended. It includes 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). Defense nuclear facilities under Board jurisdiction do not include two major classes of government-regulated nuclear facilities: DOE's civilian nuclear projects and commercial nuclear facilities regulated by the Nuclear Regulatory Commission. The Board's safety oversight also does not extend to the US Navy's nuclear propulsion program or to environmental hazards regulated by other federal and state agencies. The table at the end of this section lists the major sites that the Board oversees.

The Board's oversight mission covers all phases in the life of a defense nuclear facility: design, construction, operation, and decommissioning. Congress granted the Board a suite of statutory tools to carry out its mission. Principal among these is the Board's authority to issue formal recommendations to the Secretary. The Atomic Energy Act requires the Secretary to either accept or reject a Board recommendation, and in the case of an acceptance, to write and execute an implementation plan. In the case of a rejection, the Secretary must report to the relevant congressional committees the reasoning for the rejection. This process all takes place on the public record. In addition to issuing recommendations that require a secretarial response, the Atomic Energy Act requires the Board to review and evaluate DOE requirements and standards affecting safety at defense nuclear facilities. Evaluation of these safety standards may result in recommendations or other appropriate analysis and advice provided to DOE.

To obtain information in service of its oversight responsibilities, the Board is empowered to hold public hearings (and subpoena witnesses or documents, if necessary), conduct investigations, levy reporting requirements, and obtain information and documents needed for the Board's work from DOE and its contractors. DOE is required by law to grant the Board prompt and unfettered access to such facilities, personnel, and information as the Board considers necessary to carry out its responsibilities. In addition, the Board welcomes information from interested members of the public who have reason to believe an unsafe condition may exist at a defense nuclear facility. These safety allegations come most frequently from DOE employees or contractors who have relevant expertise and access to specific defense nuclear facilities. The Board fully evaluates each of these allegations and follows up using the

complete range of statutory powers at its disposal. Finally, the Board has resident inspectors stationed at several defense nuclear facilities. These resident inspectors provide real-time information to the Board regarding operations and safety issues at their respective facilities.

Congressional Directives

Since its creation in 1988, the Board has received direction from Congress related to internal management, its relationship with DOE, and specific safety issues at defense nuclear facilities. In recent years, Congress has directed the Board via authorizations and appropriations legislation, and related congressional reports. The status of current items is summarized below.

Executive Director of Operations

The National Defense Authorization Act (NDAA) for fiscal year 2020 created a new senior executive service (SES) position at the Board. The executive director of operations is responsible for the day-to-day operations of the agency, provides supervision to technical and administrative staff, and performs other duties delegated by the Chair. The Board's first executive director of operations began working at the agency in January 2021.

During 2021, the agency worked to integrate the new executive director of operations position into the agency. This included realigning functions from other offices–specifically, the equal employment opportunity and directives programs, along with executive secretary, congressional affairs, public affairs, intergovernmental affairs, the Office of Inspector General/Government Accountability Office liaison, internal communications, and strategy and performance. The Office of the Executive Director of Operations was formally established in August 2021 as the newest of the Board's administrative units, joining the Office of the General Manager, the Office of the Technical Director, and the Office of the General Counsel.

Nonpublic Collaborative Discussions

The NDAA for fiscal year 2021 included a change to the Atomic Energy Act allowing Board members to hold "nonpublic collaborative discussions" without following the requirements of the Government in the Sunshine Act, so long as certain requirements are met. Since passage of the 2021 NDAA, the Board has held six nonpublic collaborative discussions on a variety of topics. Summaries of these discussion topics are available on the Board's public website. The allowance for nonpublic collaborative discussions has facilitated candid discussion among Board members while still ensuring public transparency. In addition, nonpublic collaborative discussions have supported the Board's efforts over the past year on matters ranging from negotiating a memorandum of understanding with DOE to the oversight and safety of particular DOE facilities.

Minimum Staffing Level

On multiple recent occasions, Congress directed the Board to maintain adequate staffing levels to ensure that it can carry out its important mission. Specifically, in the NDAA for fiscal year 2020, Congress directed the Board to maintain at least 100 full-time employees for fiscal year 2020. Additionally, in the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2021, Congress directed the Board to ensure a minimum of 110 full-time

employee equivalents with a focus on maintaining appropriate technical capabilities. The Board is committed to maintaining adequate staffing to ensure robust oversight of DOE, consistent with Congress's direction. To that end, the Board has been aggressively recruiting for new staff members.

In 2021 the Board had 103 full-time equivalents for fiscal year 2021 (and 105 total positions filled as of December 31), with 13 new hires and eight separations. This was a net increase of nine personnel from fiscal year 2020, when it had ninety-four personnel onboard. The Board also contracted for additional human resources expertise to assist with human capital management, including recruiting and retention in fiscal year 2022.

With respect to administrative staffing, the Board made significant progress. It filled its remaining managerial vacancies within the Office of the General Manager and has filled most of its remaining staff roles. Within the Office of the Executive Director of Operations, a Board operations specialist was selected to join the agency during the latter part of 2021 and will support further enhancement to the executive secretary and internal communications functions.

Based on the agency's evaluation of resident inspector staffing, the Board continued to have a target of 13 resident inspectors for the defense nuclear complex. The Board began fiscal year 2021 with nine resident inspectors. Deployment of new resident inspectors to Los Alamos National Laboratory, Hanford, and Savannah River Site was delayed due to a surge in COVID-19 cases in late 2020 and early 2021 as well as the need to relocate headquarters personnel to a DOE site and turn over their current responsibilities. Due to the departure of a resident inspector at Pantex in March 2021, the overall need for resident inspectors increased to four during the year. Furthermore, resident inspectors from Los Alamos National Laboratory and Savannah River Site began acting in associate technical director positions in May 2021, creating temporary vacancies at those sites. The Board provided onsite coverage of the Pantex Plant with a new resident inspector who reported for duty in July 2021, supplemented with headquarters staff details and visits. A new Hanford resident inspector reported for duty in July 2021. Savannah River Site had two new resident inspectors begin work in the later part of 2021.

The Board established a new SES role of associate technical director for Field Operations to supervise the resident inspectors and train new inspectors. A candidate was selected for this role in late 2021. The Board also authorized an SES role of associate technical director for Nuclear Facilities Infrastructure and Projects. The Board is actively recruiting additional personnel to fill this senior executive service role and other remaining vacancies throughout the organization.

Memorandum of Understanding

Congress directed the Board to work with DOE to develop a bilateral memorandum of understanding to address ongoing interface issues between the two agencies. The need for a memorandum of understanding was highlighted by the 2018 National Academy of Public Administration report, *Defense Nuclear Facilities Safety Board Organizational Assessment*, and in late 2020 by the Government Accountability Office. Both the Board and DOE have committed to developing a memorandum of understanding and have met regularly on its development. While the memorandum of understanding was substantially completed during

calendar year 2021, it was signed by the Deputy Secretary of Energy and the Chair on February 17, 2022.

Strategic Plan

Following review of the 2018 National Academy of Public Administration report, the Board revised its strategic plan in November 2019, for fiscal years 2018–2022. The revised strategic plan followed a reassessment of the Board's goals and objectives, with an eye to improving interactions among staff, management, and the Board. The Board developed the revised strategic plan with an iterative process that engaged a broad swath of its employees, in addition to obtaining valuable input from the National Academy of Public Administration. In 2021, the Board initiated discussions for updating its strategic plan, and intends to move forward with this during 2022.

Revision of Board Policies, Directives, and Operating Procedures

The Board approved a *Board Policy Statement on Recommendations,* which updated a policy originally issued in 1990. This policy on the development of recommendations to the Secretary of Energy outlines the formulation of potential recommendations, the use of closed meetings and/or nonpublic collaborative discussions for the purposes of discussing potential recommendations, the transmittal of approved draft and final recommendations, actions in the event of a DOE rejection of a recommendation, the evaluation of DOE implementation plans for recommendations, and the assessment for closure of recommendations.

The agency is also working to update directives consistent with Board policies and legal requirements, using the new Executive Director of Operations structure to evaluate, update, and reissue directives and operating procedures in concert with the other offices. These directives provide guidance necessary to the Board and staff to execute laws, regulations, executive orders, or the Board's policy.

Management Improvements

Information Technology Enhancements

During the past year, the Board accomplished and initiated multiple information technology improvements and cybersecurity enhancements. Beginning with a laptop refresh, the agency delivered new laptops and mobile phones to all employees, allowing for an upgrade to a newer operating system platform and implementation of multi-factor authentication for security enhancements. These actions also enabled transition to cloud-based file backups, which eliminated the risk of losing agency data and records. The agency recruited a new chief information officer and a new chief information security officer, leading the way for enhancements to system and user monitoring, which will permit additional multi-year cybersecurity enhancements. The agency is now on a path to implementing security and system improvements mandated by executive orders and Congress such as internet protocol version 6 (IPv6), preservation of log data, zero-trust architecture, high-value asset analysis, Federal Information Technology Acquisition Reform, supply chain risk management, and continuous diagnostics and mitigation. The agency entered into a contract for information technology surge support to make substantial progress on these important efforts in fiscal year 2022.

Enhanced Collaboration with Stakeholders

The Board has further strengthened its work with key external stakeholders. During the year, the Board and staff engaged with key congressional staff and several senior DOE leaders, including the Secretary of Energy, NNSA Administrator, deputy secretary of energy, principal deputy administrator, assistant secretary of energy for congressional and intergovernmental affairs, associate under secretary of energy for environment, health, safety and security, and director of enterprise assessments. Additionally, the staff and Board members engage with local community stakeholders and interest groups when possible. The COVID-19 pandemic and minimum travel made this more difficult, but, when possible, the Board engaged virtually with stakeholders.

Table 1. *Major Sites Subject to the Board's 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 Site	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	Maintenance 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

II. Aging Infrastructure

In Recommendation 2020-1, *Nuclear Safety Requirements*, the Board expressed its concern with the current state of the infrastructure supporting DOE's defense nuclear facilities and concluded that expression of concern with the first sub-recommendation:

> *[The Board recommends that DOE] develop and implement an integrated approach—including requirements—for the management of aging infrastructure that includes formal processes to identify and perform infrastructure upgrades necessary to ensure facilities and structures, systems, and components can perform their safety functions.*

DOE needs a strong regulatory framework to maintain the functionality and reliability of the aging infrastructure that supports its defense nuclear facilities. The amount of time and the resources necessary to repair or replace all inadequate assets supporting its defense nuclear facilities are significant, and while DOE builds new facilities or upgrades existing facilities, existing facilities continue to age. The issues created by aging infrastructure need to be strategically managed on a continual basis. However, DOE lacks a formal, complex-wide regulatory structure and process for identifying, prioritizing, and performing upgrades necessary for the adequate protection of the public and workers. The Board will work with DOE as it develops its plan for addressing these aging infrastructure concerns raised in the Board's Recommendation 2020-1.

When DOE first issued 10 CFR Part 830, most of its defense nuclear facilities were already a few decades old, and DOE had launched an effort to construct new facilities to replace them, of which the Replacement Tritium Facility at the Savannah River Site (now known as Building 233-H) is an example. Nearly three decades after construction and startup of the replacement facility, DOE continues to rely upon some older facilities to support its tritium operations and will continue to do so. Even after the newer Tritium Finishing Facility is scheduled to begin operations, DOE will continue to rely upon other aged tritium facilities.

Similarly, despite building the Uranium Processing Facility at the Y-12 National Security Complex, DOE intends to continue operating two associated 50-plus year-old facilities for another several decades to support its production commitments for national security purposes.

As facilities age, concerns develop over whether they can still be safely operated and appropriately maintained. Safety structures, systems, and components may degrade and not be able to reliably perform their safety functions. Replacement parts and instrumentation may become obsolete. DOE contractors might continue to update their defense nuclear facility safety bases without fully recognizing the effects of aging on the reliability of the safety systems; the need for refurbishment or replacement of those systems; the integrity of the structures; or the importance of a backfit analysis for equipment important to safety. Aging effects are especially concerning for passive features (e.g., facility structures and fire walls) that may not be required to be surveilled to ensure they can perform their safety functions.

In addition, as the infrastructure supporting safety systems (e.g., utilities and site services) ages, it may reduce the reliability of safety systems or increase the rate at which the

safety systems are challenged. Supporting utilities and services may suffer increased failure rates and extended downtimes. DOE has taken action to address specific issues at particular sites, such as the Extended Life Program at Y-12 National Security Complex. Efforts such as this program are laudable, but a systematic approach is required to address the needs across the complex.

In a 2019 report[1], DOE's Infrastructure Executive Committee noted that "the deferred maintenance trend for active facilities" had "hovered around $6B" between 2014 and 2018. Also, the report noted that, of DOE's 79 core capabilities, 9 were potentially at risk due to inadequate infrastructure, including 4 core capabilities related to defense nuclear facility infrastructure and operation. DOE has taken actions to stabilize what had been an increasing trend in the annual deferred maintenance figures, but it has been unable to make significant reductions.

The NNSA Administrator acknowledged the challenges NNSA faces regarding its aging infrastructure in her April 11, 2018, testimony to the US Senate Committee on Appropriations, Subcommittee on Energy and Water Development: "NNSA's infrastructure is in a brittle state that requires significant and sustained investments over the coming decade to correct. There is no margin for further delay in modernizing NNSA's scientific, technical, and engineering capabilities, and recapitalizing our infrastructure needed to produce strategic materials and components for US nuclear weapons."

During 2019 and 2020, NNSA reassessed its core capabilities and the associated real property assets using a new, more accurate NNSA-wide methodology for assessing the condition of its facilities and their replacement plant value. While the new methodology improves NNSA's understanding of its facilities' conditions, the results indicated that facility conditions were less adequate and deferred maintenance costs were higher than NNSA's previous analyses.[2]

DOE's Office of Environmental Management also has facilities and sites with long-term missions that are dependent on aging infrastructure. However, its approach to managing infrastructure differs from that of NNSA in that it relies on individual field office organizations to manage the real property assets under their responsibility and there is no enterprise level assessment of the condition of that infrastructure.

[1] *Annual Infrastructure Executive Committee Report to the Laboratory Operations Board*, Department of Energy, April 2019.
[2] *Master Asset Plan (MAP), 2021*; NNSA Office of Safety, Infrastructure, and Operations, Undated.

III. Oversight Planning and Priorities

As indicated in Section I of this report, under the Atomic Energy Act of 1954, as amended, the Board is charged with providing independent safety oversight of DOE's defense nuclear facilities complex—a complex with the mission to design, manufacture, test, maintain, and decommission nuclear weapons, as well as other national security priorities. 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 issues concerning adequate protection of public health and safety at DOE defense nuclear facilities.

In recent years, DOE, and NNSA, in particular, have seen significant budget increases to support modernization of the strategic deterrent. This has translated into significant defense nuclear programs that require sufficient and ongoing oversight to ensure safety. Accordingly, the Board's safety oversight requirements are increasing and need to be properly prioritized to protect public health and safety. Some of these programs include plutonium pit production at Los Alamos National Laboratory and the Savannah River Site, tritium extraction at the Savannah River Site, uranium production at the Y-12 National Security Complex, weapons assembly and disassembly at the Pantex Plant, and subcritical experiments at the Nevada National Security Site. In addition to direct support of the strategic deterrent, the Board provides safety oversight of defense nuclear facilities that handle radiological waste that dates to the Manhattan Project and the Cold War, along with waste streams that results from sustainment and modernization efforts. These include tank waste cleanup projects at Hanford and the Savannah River Site and transuranic waste disposal at the Waste Isolation Pilot Plant.

In addition to the modernization programs planned or underway, there are significant safety risks associated with the old and failing infrastructure at defense nuclear facilities. NNSA said in May 2021 that about 60 of its facilities are greater than 40 years old and more than 50 percent of these facilities are in poor condition. The safety oversight that the Board provides helps DOE to better understand the potential impact of these defense nuclear facilities on public health and safety so it can take action to reduce safety risks. To fulfill its mission, the Board assigns technical staff teams to near-continuous monitoring of major startup, testing, restart, and other activities at selected DOE sites.

The agency's annual work plan is based on the Board's strategic plan and defense nuclear facilities safety oversight mission. The work plan is developed to achieve the strategic objective of completing timely, high-quality safety reviews that identify and analyze safety issues and best practices and search for similar challenges across DOE's defense nuclear complex. The Board prioritizes its safety oversight activities based on risk to the public and workers, the types and quantities of nuclear and hazardous material present, and the hazards of the operations involved. Sections IV through VIII below summarize the Board's most significant safety oversight activities during 2021 in the following four areas: nuclear weapon operations; nuclear waste operations; infrastructure and DOE projects; and nuclear safety framework, programs, and standards. Appendix A summarizes the status of all Board recommendations open in 2021.

IV. Nuclear Weapon Operations

In 2021, the Board performed nuclear safety oversight of high-priority operations within the nuclear weapons complex. The Board's oversight priorities were based on the nuclear safety risk of proposed and ongoing activities. For Los Alamos National Laboratory, the Pantex Plant, the Savannah River Tritium Enterprise, and the Y-12 National Security Complex, the Board maintained full-time resident inspectors to monitor operations. Cognizant engineers on the Board's headquarters staff are dedicated to monitoring Lawrence Livermore National Laboratory, Nevada National Security Site, and Sandia National Laboratories.

Pantex Plant

Conduct of Operations and Training & Qualification

The Pantex Plant has experienced a series of events related to the safe conduct of operations in recent years, including multiple occurrences that led to violations of technical safety requirements. Based on these events and safety concerns that Pantex employees shared with the Board's staff, the Board began an evaluation of conduct of operations and training and qualification programs at the Pantex Plant in 2020. As part of this review, the Board's staff assessed safety program documentation and discussed resulting questions with the NNSA field office and Pantex contractor's personnel. Additionally, the Board's staff conducted on-site and remote interviews with more than 30 Pantex employees, gathering feedback on these safety programs and discussing areas for improvements. Based on this evaluation, the Board identified safety issues related to organizational culture, training program content, training implementation in training facilities and on the production line, non-standard training processes, conduct of operations implementation, and disciplined operations specialist resources.

On June 9, 2021, the Board transmitted a letter to the Secretary of Energy requesting a report on the status of actions to holistically address these safety issues, as well as how these actions will be maintained during the upcoming contract transition. The NNSA Administrator responded to this letter on August 5, 2021, committing to address nearly all the specific safety issues and identifying actions that should drive safety improvement over time.

The Board and its staff remain engaged in evaluating the effectiveness of these actions, devoting particular attention in 2021 to assessing near-term actions at Pantex to address the adverse trend in safe conduct of operations until the long-term actions specified in NNSA's response letter can take hold. In 2022, the Board will continue to assess the effectiveness of these actions to improve safety and verify that NNSA ensures the actions continue through the upcoming transition of the Pantex contract.

Quality Assurance of Structural Repairs

From 2019 through 2020, the Board conducted a review of construction quality assurance for high-pressure fire loop lead-in replacement in the 12-96 nuclear explosive cell at Pantex. The Board had previously identified deficient quality assurance for reinforced concrete construction on similar work for two of the 12-98 cells in 2016. On August 6, 2020, the Board issued a letter to the Secretary of Energy with safety concerns regarding lack of proper identification and control of safety basis and quality assurance requirements for Pantex construction projects that persisted

since the 12-98 project. On December 16, 2020, NNSA responded with a letter that agreed with the Board's safety concerns and identified corrective actions to resolve them. During 2021, the Board reviewed deliverables associated with these corrective actions and found that they resolved the safety concerns. The Board issued a letter to the NNSA Administrator on November 10, 2021, noting that its safety concerns had been resolved and that the resulting safety improvements would help protect against misidentification of safety basis requirements, quality requirements, and system boundaries on future construction projects.

Staging of Nuclear Weapon Pits

From 2020 through 2021, the Board conducted a review of nuclear weapon pit staging at the Pantex Plant. More than two decades ago, the Board had issued Recommendation 1999-1, *Safe Storage of Fissionable Material Called "Pits,"* which centered on the need to store pits in containers that would protect against degradation of the pits' corrosion-resistant cladding. In response to Recommendation 1999-1, DOE committed to repackaging pits into containers featuring a sealed insert filled with inert gas to protect the pit cladding. In closing Recommendation 1999-1 in 2005, DOE indicated it had completed repackaging almost all pits at Pantex into sealed insert containers. However, the Board's recent assessment found that the population of pits in storage containers without inner sealed inserts increased from 8 percent to 14 percent of the total inventory between 2014 and 2021, even as the total inventory of pits increased. Of note, the Board identified that pits from disassembly and dismantlement campaigns have accumulated in these unsealed containers.

Figure 1. *Pit Storage Container with Packing Material and Sealed Insert*

The observed trend reflects a relaxation in packaging requirements by the design agencies and a focus at Pantex on priorities other than pit packaging. Unsealed containers without an inner sealed insert do not protect against corrosion or confine any radioactive material released by a breached pit. The pits in unsealed containers are exposed to air, along with moisture and chlorides from fiberboard packing material. These conditions can lead to degradation and breach of a pit in containers and facilities without confinement barriers. The Board communicated its

findings to NNSA in a January 6, 2022, letter and requested that NNSA provide a report in response.

Hazard Analysis Reports for Nuclear Explosive Operations

On August 24, 2021, NNSA submitted a proposed revision to DOE Limited Standard 3016, *Hazard Analysis Reports for Nuclear Explosive Operations*, into the DOE Review and Comment Process. This safety standard applies to the conduct of hazard analyses and preparation of hazard analysis reports for nuclear explosive operations conducted by NNSA. In the revision, NNSA proposed to substantially increase the weapon response screening threshold for the probability of events with high-order consequences (i.e., inadvertent nuclear detonation and aerosolized dispersal of special nuclear material) for nuclear explosive operations in the ultimate user configuration. The weapon response screening threshold dictates when Pantex should consider implementing safety class controls. As a result, the proposed change could lead to an increase in accepted risk for operations at Pantex (e.g., moving nuclear explosives during lightning warnings). The Board's staff discussed concerns with potential safety impacts of the proposed revision to the standard with NNSA personnel and formally transmitted comments capturing these concerns in October 2021. The Board plans to evaluate how NNSA resolves the comments in 2022.

Weapon Response Development

In 2021, the Board concluded a review of Sandia National Laboratories' weapon response process and resulting technical bases. This process is part of the underpinning of the safety basis for nuclear explosive operations at Pantex. For additional information, see the entry, *Design Agency Weapon Response Technical Bases*, below in the Sandia National Laboratories section of this report.

Los Alamos National Laboratory

Review of Credited Safety Systems in Defense Nuclear Facilities

During 2021, the Board's staff completed a review of 10 selected safety systems from three defense nuclear facilities at Los Alamos National Laboratory: The Weapons Engineering Tritium Facility, the Plutonium Facility, and the Transuranic Waste Facility. The staff concluded that these safety systems were able to reliably perform their credited safety functions. In a June 9, 2021, letter to the Secretary of Energy[3], the Board provided several safety observations that offered Los Alamos National Laboratory an opportunity to strengthen its implementation of requirements that support safety system reliability.

In addition to these observations, the Board noted its concern with the rigor and level of safety system oversight being performed by the NNSA Los Alamos Field Office due to the lack of qualified safety system oversight personnel. NNSA and its contractor generally agreed with the Board's findings and began development of a prioritized safety action list to address them.

[3]*Adequacy of Safety Structures, Systems, and Components at LANL*, Defense Nuclear Facilities Safety Board. June 9, 2021.

Figure 2. *Los Alamos National Laboratory Plutonium Facility (on the left)*

Revised Plutonium Facility Safety Basis and Associated Challenges

Over the past several years, Los Alamos National Laboratory has been working to develop a modern safety basis for the Plutonium Facility that is compliant with DOE Standard 3009-2014. This effort must overcome several challenges. First, as noted in the Board's letter dated November 15, 2019, several safety systems in the Plutonium Facility have known deficiencies that prevent them from being credited to function in earthquake scenarios, including the confinement ventilation system. As noted in the Board's letter dated November 24, 2021, NNSA's Los Alamos National Laboratory contractor plans to upgrade elements of the ventilation system by 2025, but the end-state of the system and how the system will be credited in the safety basis are not well defined. Therefore, the Plutonium Facility safety basis will continue to rely on the building to provide passive confinement of radiological material released during a post-seismic fire event.

In 2021, the Board's staff monitored Los Alamos National Laboratory's efforts to update the methodology for calculating the leak path factor used to estimate the amount of radioactive material that would escape the Plutonium Facility during a post-seismic fire event. NNSA initiated these efforts partially in response to the Board's Technical Report 44, *Los Alamos National Laboratory Plutonium Facility Leak Path Factor Methodology*, which detailed safety issues with the leak path factor methodology used in the current Plutonium Facility safety basis.

In April 2020, NNSA's Los Alamos National Laboratory contractor submitted working documents that describe the updated methodology to the NNSA Los Alamos Field Office. The contractor is continuing to refine these working documents and associated computer models to support development of the new safety basis for the Plutonium Facility. In November 2021, the contractor delayed its timeline for submitting the new safety basis to NNSA from March 2022 to January 2023. The ongoing review of this effort by the Board's staff indicates that challenges remain to finalize the updated leak path factor calculation and that additional attention is needed to ensure this effort will adequately support the new safety basis. NNSA's decisions on the suite

of engineered safety controls required to provide adequate protection of the public depend on the completion of a technically justified, conservative leak path factor calculation for the Plutonium Facility.

The Plutonium Facility safety basis upgrade is progressing in parallel with Los Alamos National Laboratory's efforts to support NNSA's pit production mission. As noted in the Board's letter dated November 24, 2021, the Los Alamos Plutonium Pit Production Project is a major modification to the Plutonium Facility that will install new gloveboxes and equipment to support increasing the capacity for pit production from 10 to 30 pits per year (see Section VI, *Infrastructure and DOE Projects*, below in this report). This project will be executed concurrently with ongoing operations and includes hazards that are outside of the current safety basis. NNSA's Los Alamos National Laboratory contractor plans to develop the safety basis for the pit production project in parallel with development of the new Plutonium Facility safety basis. This approach will require close coordination between these efforts. The Board will continue to follow NNSA's efforts to address these challenges and develop a modern and robust Plutonium Facility safety basis.

Onsite Transportation Safety

Under 10 CFR Part 830, onsite transportation of nuclear materials at DOE sites may be conducted either in accordance with Department of Transportation regulations or under a documented safety analysis known as a transportation safety document. In 2021, the Board's staff completed a review of Los Alamos National Laboratory's transportation safety document and identified significant safety issues with both the transportation safety document and DOE's directives governing safety analyses for onsite transportation activities. Specifically, the Board is concerned with the lack of requirements and detailed guidance for meeting applicable 10 CFR Part 830 requirements in developing transportation safety documents. Additionally, the Board is concerned with the level of technical analysis of hazards and accident scenarios in the approved transportation safety document for Los Alamos National Laboratory. Given the allowable material-at-risk for each onsite transfer and the proximity of transport routes to the site boundary, the unmitigated consequences from various credible accidents are high to both workers at Los Alamos National Laboratory and the offsite public. The Board communicated these concerns to the Secretary of Energy in a letter dated January 6, 2022, requesting a briefing and report from on DOE's evaluation of these safety concerns.

Y-12 National Security Complex

Nuclear Criticality Safety Program and Disciplined Operations

The July 25, 2019, Board letter detailed deficiencies in the performance of the Y-12 contractor's nuclear criticality safety program, continuing discoveries of unexpected uranium accumulation in equipment and process areas, and insufficient oversight of nuclear criticality safety at Y-12 by the NNSA Production Office. Since then, the Board has continued to monitor and evaluate elements of the Y-12 nuclear criticality safety program. During 2020 to 2021, the Board observed a trend of infractions related to the Y-12 nuclear criticality safety program, especially regarding implementation of the Large Geometry Exclusion Area Program (which is relied upon in certain areas to ensure that leaks and spills of fissile material solutions will not lead

to a nuclear criticality accident), characterization and control of fissile material in out-of-service equipment, and the discipline of operations needed to effectively implement the nuclear criticality safety program.

The Board requested a briefing by the NNSA Production Office on the health, oversight, and improvement of the Y-12 criticality safety program; response to recent criticality safety infractions and contamination events; disciplined operations; and impacts of the upcoming transition to a new contractor.

On April 8, 2021, the NNSA Production Office and the Y-12 contractor briefed the Board on the requested topics. NNSA Production Office leadership noted its higher expectations for depth and frequency of safety oversight, pushing for continuous improvements in the nuclear criticality safety program, and building on lessons learned. NNSA Production Office leadership also stated that the Y-12 nuclear criticality safety program is being implemented in a manner that ensures safe operations and is improving. The Board remains concerned that, notwithstanding its engagement with site leadership, there have been continued operational safety incidents at Y-12, including events in which ineffective communication among the contractor's organizational elements played an important role. The Board is continuing to monitor the sustainability and effectiveness of improvement actions by the NNSA Production Office and the Y-12 contractor.

Figure 3. *Rolling Roadblock During Onsite Transportation of Confinement Vessel at Los Alamos National Laboratory*

Fissile Material in Out-of-Service Equipment in Building 9212

The Board's staff completed a review of the nuclear criticality hazards of the out-of-service equipment in Building 9212 at Y-12 National Security Complex. Beginning in 2017, Y-12 personnel discovered enriched uranium accumulation in several processing areas in Building 9212. The Y-12 contractor initially conducted an extent-of-condition review of uranium

accumulations that focused on active processes. After concluding the extent-of-condition review for active processes, the contractor conducted an extent-of-condition review for uranium accumulation in out-of-service equipment, starting in Building 9212 and expanding to other facilities. This review discovered 151 out-of-service systems and components in Building 9212, of which 48 systems and components were not bounded by an existing nuclear criticality safety evaluation. The Board's staff reviewed the nuclear criticality hazards of the out-of-service equipment with uranium holdup in Building 9212, nuclear criticality safety evaluations and supporting analyses for select out-of-service equipment, and related entries in the Y-12 issues management system.

The Board issued a letter to the Secretary of Energy on July 7, 2021, noting the continued discoveries of legacy items with unknown amounts of uranium, including out-of-service items, indicate that the federal and contractor entities at Y-12 have not comprehensively identified and addressed the causes for the failures to properly manage out-of-service equipment with uranium holdup, which could lead to similar situations in the future. The Board observed that Y-12 was not optimizing its issues management system and lacked rigor in its safety requirements for closure of issues. The continued discovery of legacy out-of-service items indicates weaknesses in the initial process and scope of the extent-of-condition review and incomplete knowledge of conditions on the plant floor.

Contract Transition at the Y-12 National Security Complex

The Y-12 National Security Complex and Pantex Plant are expected to transition to a new contractor in 2022. The Board plans to monitor and oversee contract transition plans and activities to ensure the continued safety of nuclear operations and to verify that NNSA sustains ongoing corrective actions for safety deficiencies, including organizational culture issues, through the transition and that the safety issues are not compounded by contract transition. Specific to Y-12, the Board plans to focus on ensuring proper transition of current safety issues and priorities to the new contractor leadership, ensuring lessons learned from past safety issues are retained, and ensuring corrective actions to improve nuclear criticality safety and disciplined operations continue to be effective and sustainable.

Savannah River Site

Savannah River Tritium Facilities

The Board remains concerned with the risk to workers and the public associated with postulated accident scenarios at the Savannah River Tritium Facilities. On July 13, 2021, the Board conducted a virtual public meeting and hearing on the status of the Savannah River Site that included a public meeting session on the NNSA Savannah River Field Office operations and a public hearing session on the safety posture of the Savannah River Tritium Facilities. The virtual public meeting session on NNSA Savannah River Field Office operations focused on lessons learned and best practices for minimizing nuclear safety impacts after working in a constrained environment for an extended period. The virtual public hearing session on the tritium facilities focused on the Board's concerns with safety of the facilities, articulated by the Board in Recommendation 2019-2, which DOE rejected.

The contractor for the Savannah River Tritium Enterprise facilities developed a risk-reduction strategy for co-located workers potentially impacted by accidents involving those facilities, approved by NNSA Savannah River Field Office shortly before the Board's hearing. The NNSA witnesses discussed completed actions from that plan, most of which were analytical in nature, and provided general timelines for other improvements, including physical modifications. NNSA witnesses at the hearing confirmed that while NNSA approved a new combined safety basis for the Savannah River Site tritium facilities in 2019, there are no plans to implement improved safety controls from the new safety basis until 2025, and no compensatory measures have been implemented to ensure safety in the interim.

The Board is concerned whether sufficient actions are being implemented to address the safety issues at the Savannah River Site tritium facilities. This topic is covered in more detail in Appendix A, Board Recommendations.

Nevada National Security Site

Alternate Location for the Co-Located Worker at the U1a Complex

NNSA is installing new capabilities at the Nevada National Security Site U1a Complex as part of the Enhanced Capabilities for Subcritical Experiments project to support its Stockpile Stewardship Program. The project consists of three subprojects, which NNSA has determined to be major modifications[4] to the existing facility. NNSA is developing the safety analyses associated with these projects by following the requirements and guidance in DOE Standard 3009-2014.

In a letter to the Secretary of Energy dated December 1, 2021, the Board communicated its concerns with NNSA incorrectly using a provision in DOE Standard 3009-2014 in developing the safety basis for the Enhanced Capabilities for Subcritical Experiments project. NNSA advised the Nevada National Security Site contractor to use the provision to move the assumed location of the co-located worker[5] for a seismic-initiated explosion scenario in the safety analyses for the U1a Complex projects. NNSA advised the contractor to perform the consequence calculations for workers at the Area 6 construction facilities (see Figure 4 below), where the doses would be below the threshold that would require designing the credited safety controls at the U1a Complex to a higher pedigree.

The Board's letter advised NNSA that the cited provision was inapplicable and that, furthermore, there are workers closer to the postulated accident location than the Area 6 construction facilities (e.g., personnel in the U1a Complex administrative trailers). The Board's letter advised that if NNSA concludes that the contractor's proposed safety controls for the seismic-initiated explosion scenario are adequate, then NNSA should consider approving an equivalency or exemption request to DOE's seismic design requirements, rather than moving the co-located worker's assumed location.

[4]DOE Standard 1189-2016, *Integration of Safety into the Design Process*, defines a major modification as a modification that "substantially change[s] the existing safety basis for the facility."
[5]DOE Standard 3009-2014 defines the co-located worker as a hypothetical individual assumed to be 100 meters from the facility where the accident occurs.

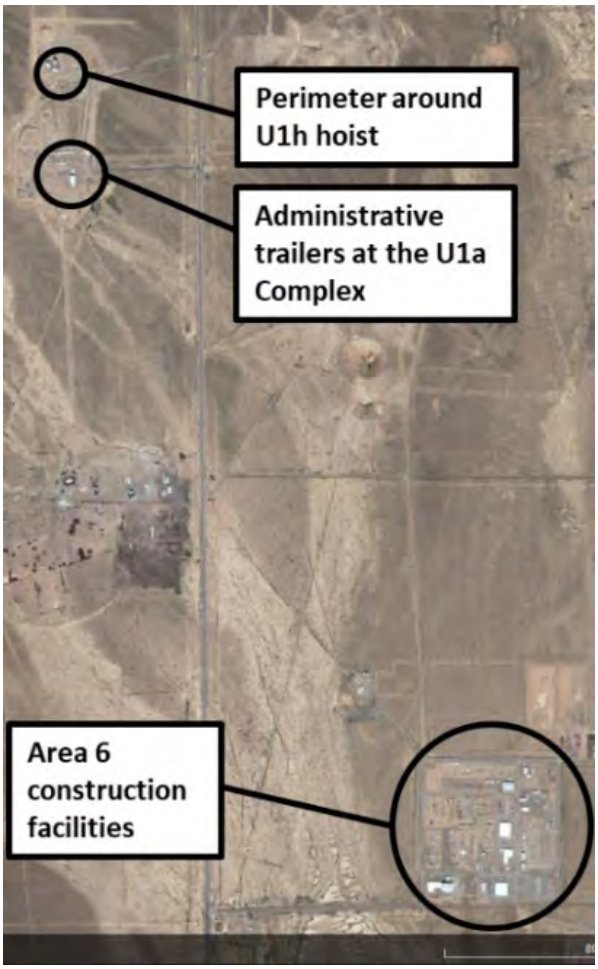

Figure 4. *Aerial View of the U1a Complex and Area 6 Construction Facilities*

The Board's letter also advised NNSA and its contractor to reduce the hazards of operations at the U1a Complex by completing the initiative to procure a more robust shipping container for subcritical experiments that would protect radiological material from insults, including seismic-initiated events, during onsite transfers. Lastly, the Board advised DOE to consider revising DOE Standard 3009-2014 to ensure that accident scenarios with high consequences to the co-located worker are appropriately analyzed and controlled.

Sandia National Laboratories

Design Agency Weapon Response Technical Bases

During 2021, the Board and its staff continued oversight of weapon response technical basis information developed by NNSA's nuclear weapon design agencies. The design agencies use this information in generating weapon response summary documents for incorporation into the safety bases for nuclear explosive operations at the Pantex Plant. The Board and its staff evaluated the adequacy of the design agency documentation; design agency processes for generating and reviewing the documents; implementation of DOE Standard 3016, *Hazard Analysis Reports for Nuclear Explosive Operations*; and NNSA oversight of the process.

This year, the Board concluded a review of the weapon response process and resulting technical bases for the B61, W80, and W88 weapon programs at Sandia National Laboratories in New Mexico. In a June 15, 2021, letter to the Secretary of Energy, the Board noted that Sandia National Laboratories' weapon response evaluations and the underlying technical basis documents for these programs were thorough, technically defensible, and sufficient to support the control section at the Pantex Plant for the responses for which Sandia National Laboratories were responsible. The Board did identify some opportunities to bolster the weapon response development process and technical basis information. Furthermore—like the Board's conclusions in a June 23, 2020, letter on Los Alamos National Laboratory's weapon response process—the Board found that NNSA did not perform detailed safety oversight of weapon response development at Sandia National Laboratories. The Board stated that NNSA should consider how to best improve federal oversight of this process to address this weakness and encouraged NNSA to establish requirements for federal safety oversight of the weapon response process. In response, NNSA chartered a weapon response oversight evaluation team to assess the current NNSA structure and processes for conducting safety oversight of the weapon response development processes. The Board plans to monitor progress of this initiative in 2022.

Technical Area V—Conduct of Operations Review

In July 2021, members of the Board's staff conducted an on-site review of conduct of operations at Technical Area V defense nuclear facilities. The Board's staff reviewed conduct of operations associated with the in-service fuel element inspections at the Annular Core Research Reactor, reviewed plans to inspect unirradiated fuel elements at the Auxiliary Hot Cell Facility, conducted interviews with Annular Core Research Reactor and Auxiliary Hot Cell Facility staff, and discussed hoisting and rigging procedures for critical lifts in Technical Area V. This review is continuing into 2022 as the Board's staff evaluates the effectiveness of Sandia National Laboratories' corrective actions for a series of events during hoisting and rigging activities at the Annular Core Research Reactor.

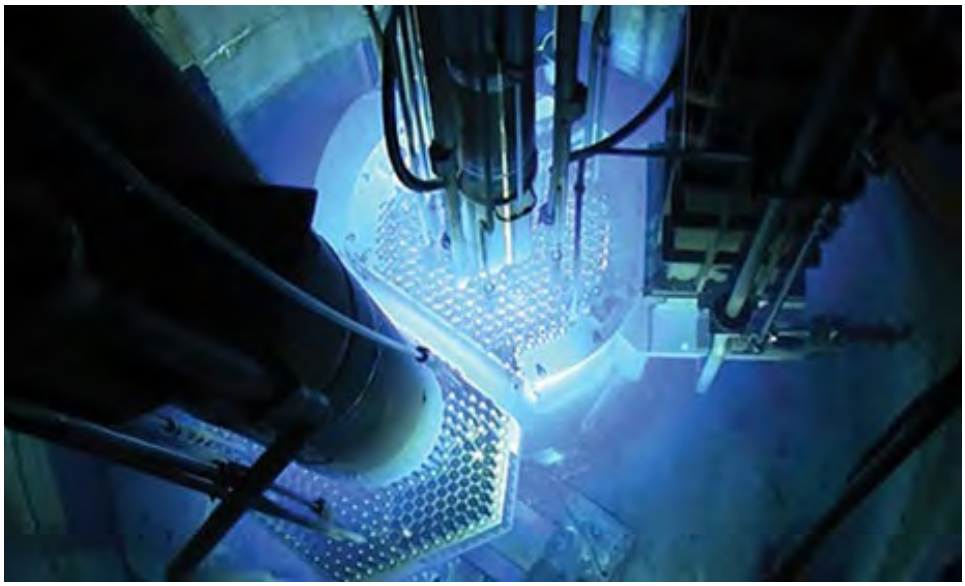

Figure 5. *Annular Core Research Reactor with the Fueled Ring External Cavity II (lower left) Coupled to the Core (center)*

Lawrence Livermore National Laboratory

Building 332 Recovery Glovebox Line Safety Basis Review

In 2021, Lawrence Livermore National Laboratory completed installation of the Recovery Glovebox Line in the Plutonium Facility (Building 332). This glovebox line is a set of three gloveboxes that combine several chemical processes already conducted in Building 332. The Recovery Glovebox Line is designed to recover and purify plutonium from residues using aqueous processing of impure oxides, salt-containing materials, metal scrap, residues on equipment, and solutions.

The Board's staff is reviewing revisions to the documented safety analysis and technical safety requirements for Building 332 to incorporate the hazards and controls associated with the Recovery Glovebox Line. In 2022, the Board's staff will complete its evaluation and provide safety oversight as readiness preparations are completed and operations commence.

Figure 6. *Glovebox Line 1 of the Recovery Glovebox Line*

V. Defense Nuclear Waste Operations

In 2021, the Board performed nuclear safety oversight of high priority Office of Environmental Management operations within the nuclear weapons complex. The Board based its oversight priorities on the nuclear safety risk of proposed and ongoing activities. For the Hanford and Savannah River sites, the Board maintained full-time resident inspectors to monitor operations. For selected sites at which Environmental Management operations are not the primary activity, such as Oak Ridge National Laboratory and Los Alamos National Laboratory, the Board maintained coverage using resident inspectors assigned nearby and dedicated members of the Board's headquarters staff. Cognizant engineers on the Board's headquarters staff are dedicated to monitoring Idaho National Laboratory and the Waste Isolation Pilot Plant.

Safety of Solid Nuclear Waste

DOE has experienced two significant waste events in the past decade—one in February 2014 at the Waste Isolation Pilot Plant and another in April 2018 at Idaho National Laboratory—in which waste drums released radiological materials due to energetic chemical reactions involving the waste. To review:

- The 2014 Waste Isolation Pilot Plant radiological release event involved Los Alamos National Laboratory waste with inappropriately remediated nitrate salts. The waste underwent an autocatalytic runaway reaction in the Waste Isolation Pilot Plant underground that ruptured the drum and spread radioactive contamination, leading to a three-year shutdown of the facility. An extent-of-condition review identified many additional non-compliant remediated nitrate salt waste containers. Prior to the event, more than 100 of these non-compliant containers had been shipped to the Waste Control Specialists' facility for temporary storage at Andrews, Texas. A DOE-sponsored integrated project team including relevant hazardous waste regulators and Nuclear Regulatory Commission representatives continue to work on a safe disposition path for these remaining drums.

- The 2018 Idaho National Laboratory event involved the over-pressurization of four containers of solid radioactive waste in the Radioactive Waste Management Complex. The over-pressurization ejected the container lids and spread radiological material within the facility.

More recently, other events have raised Board questions about the safety of solid nuclear waste operations. These events include an unexpected sparking event involving pyrophoric materials during waste packaging at the Plutonium Facility at Los Alamos National Laboratory (refer to Section IV of this report) and a uranium reaction event at Idaho National Laboratory (discussed in the Idaho National Laboratory portion of this section of this report).

As a result, the Board has continued to evaluate how DOE analyzes hazards and implements controls at defense nuclear facilities that generate, process, and store radioactive waste. Since the event at the Waste Isolation Pilot Plant, the Board has communicated several

safety issues and deficiencies to DOE in a technical report[6] issued on March 15, 2018, a letter[7] on October 18, 2019, and a public hearing[8] on June 20, 2019.

Specifically, the Board identified the need for DOE to revise DOE Standard 5506, *Preparation of Safety Basis Documents for Transuranic Waste Facilities*, which is intended to provide detailed guidance for consistently analyzing hazards and selecting controls for transuranic waste activities. DOE subsequently began the process of revising DOE Standard 5506 in 2019. On January 29, 2020, the Board issued a letter to the Secretary of Energy highlighting specific areas of safety concern that DOE should address during the revision process. Over the course of 2020 and early 2021, the Board's staff worked with the DOE team that was revising DOE Standard 5506 to resolve the concerns highlighted in the letter, as well as additional safety concerns that the Board's staff provided via the DOE review, comment, and approval system. The DOE team adequately addressed most of the Board's comments. The Board issued a letter on July 26, 2021, on Standard 5506 highlighting the positive working relationship between the DOE team and the Board's staff as well as the significant improvements contained in the then draft standard, most notably:

- New requirements for waste generator sites to identify potential undesired chemical reactions; and

- Updated methods for estimating the severity of potential accidents, informed by the 2014 Waste Isolation Pilot Plant event and 2018 Idaho National Laboratory event.

In its letter, however, the Board also noted two significant unresolved safety issues—underestimation of release fractions for deflagrations and a non-conservative assumption for fuel pool fires—and requested a DOE briefing on these concerns as well as DOE's plans for implementing the standard.

DOE briefed the Board in response to this request on September 24, 2021, noting that the Office of Environmental Management and NNSA had recently sent memoranda to field offices requiring that they identify any gaps between current safety basis documents and the requirements in the revised Standard 5506 by early 2022. The Board plans to follow this effort closely to ensure that the improvements that were incorporated into the revised DOE Standard 5506 are implemented across the complex, resulting in increased safety of solid nuclear waste.

In a related, parallel effort, on September 24, 2020, the Board issued Technical Report 46, *Potential Energetic Chemical Reaction Events involving Transuranic Waste at Los Alamos National Laboratory*, to the Secretary of Energy. This report built upon previous Board efforts and provided a site-specific case study of how the safety bases for several different facilities at Los Alamos National Laboratory treat the hazards posed by energetic chemical reactions.

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[6]Technical Report 43, *Deficiencies in DOE Standard 5506-2007, "Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, Defense Nuclear Facilities Safety Board, February 2018.
[7]*Flammable Gas Hazards Associated with Solid Waste*, Defense Nuclear Facilities Safety Board, October 18, 2019.
[8]*Public Hearing on Safety Management of Waste Storage and Processing in the Defense Nuclear Facilities Complex*, Defense Nuclear Facilities Safety Board, June 20, 2019.

In the report, the Board determined that these safety bases do not consistently or appropriately consider a potential energetic chemical reaction involving transuranic waste. Examples include:

- Hazard analyses lack systematic evaluations of the chemical compatibility of transuranic waste streams.

- Accident analyses are not bounding, assume inappropriate initial conditions, and do not defensibly estimate the quantity of radioactive material that may be released due to an energetic chemical reaction. As such, additional credited safety controls may be necessary to protect workers and the public.

- Some facilities store transuranic waste without any engineered controls beyond the waste container, meaning that some accidents may not have their consequences sufficiently mitigated.

The Secretary of Energy responded to Technical Report 46 in a letter dated March 30, 2021, stating that DOE is adequately and consistently controlling transuranic waste hazards at Los Alamos National Laboratory and will use the Board's technical report to aid DOE's review of the unexpected sparking event that occurred in waste at the laboratory in 2021. The Board is currently evaluating the Secretary's response to Technical Report 46 and the safety-related corrective actions and lessons learned that resulted from the sparking event. The Board believes that DOE's Office of Environmental Management has planned and is taking appropriate action in response to the safety issues raised in the technical report. Planned safety-related actions by NNSA merit further discussion, and NNSA has indicated that supplemental information will be available to the Board in early 2022.

In conclusion, the safety of solid nuclear waste continues to be a topic of Board interest. Rigorous, timely implementation of updated requirements in DOE Standard 5506-2021 will allow for energetic chemical reactions to be properly analyzed and controlled at the facilities that generate the waste as well as during certification and subsequent storage at the Waste Isolation Pilot Plant.

Savannah River Site

July 13, 2021, Board Public Meeting and Hearing—Oversight of Environmental Management Operations

As part of the Board's virtual public meeting and hearing on the status of the Savannah River Site, the Board held two sessions related to Environmental Management operations and site programs under the purview of the Savannah River Operations Office. The virtual public meeting session focused on lessons learned and best practices for minimizing nuclear safety impacts after working in a constrained environment for an extended period. The virtual public hearing session included a discussion of the technical staffing levels required to ensure effective federal safety oversight of defense nuclear facilities at Savannah River Site. This discussion highlighted DOE's retention challenges and the need for staffing increases to meet the expected

future increases in operational demands, which the Board captured in its August 11, 2021, follow-up letter to DOE.

Safety Basis of the H-Canyon Exhaust Tunnel

The Board has engaged with DOE since 2015 regarding concerns over the capability of the H-Canyon Exhaust Tunnel to perform its credited safety-class confinement function during and after a design basis seismic event. In 2019, DOE approved an alternate safety strategy that no longer relies on the H-Canyon Exhaust Tunnel to mitigate the calculated dose consequence after a seismic event. The alternate safety strategy instead relies on reduced material-at-risk, structural integrity of the process vessels containing radioactive materials, and a portable compressed air system to purge generated flammable gases. The Board reviewed the H-Canyon facility safety basis that implements this strategy and identified several shortcomings, which were shared in an advice letter to the Secretary of Energy dated September 8, 2021. In particular, the Board identified that the proposed strategy does not demonstrate that the material-at-risk and associated calculated consequence values are bounding. Additionally, the post-seismic purge air system relies on a general service portable air compressor and power supply that are not functionally classified as safety significant, and therefore may not be able to reliably remove flammable gases during and after a seismic event.

Degradation of the H-Canyon exhaust tunnels is continuing and the Board advised DOE and its contractor to develop a conservative estimate for the end of life for the tunnels. The Board also shared safety concerns regarding the lack of margin for the tunnels related to static loads and emphasized that DOE needs to establish a rigorous monitoring program to detect excessive wall movements, an indicator of the beginning of tunnel failure.

Waste Processing Facility Operations

The Savannah River Site's Salt Waste Processing Facility commenced operations with radioactive materials in late 2020. As the facility neared completion of its first year of operations, the Board initiated a review to evaluate the overall formality and safety of nuclear operations and maintenance activities. The safety review was scoped to assess implementation of basic conduct of operations and maintenance principles, with specific focus areas that included radiological controls, readiness to execute abnormal operating procedures, control room operations, general procedural compliance, and work planning and control. The Board identified numerous best practices that were aligned with good conduct of operations principles, which DOE and its contractor should continue to reinforce. The Board also identified weaknesses in technical safety requirement implementation, the quality of some technical procedures, the application of the unreviewed safety question process, and the general rigor associated with addressing minor facility deficiencies. The Board's staff communicated these observations to the facility manager and DOE facility representatives. In 2022, the Board's staff will present findings from the safety review to the Board for its consideration.

Building 235-F Safety Basis

The Board continued to work closely with DOE personnel throughout 2021 as efforts to address safety concerns related to the hazards associated with plutonium 238 hold-up material in

Building 235 F at Savannah River Site progressed. The Board is keeping Recommendation 2012-1, *Savannah River Site Building 235-F Safety,* open, and remains concerned about the alignment of the Building 235-F safety basis with DOE requirements, as communicated in a November 2, 2021, letter to the Secretary of Energy. This topic is covered in more detail in Appendix A: Board Recommendations.

Hanford Site

At the Hanford Site, the Board continued to provide safety oversight of several design and construction projects intended to support the disposition of radioactive waste stored in 177 underground tanks, including multiple components of the Waste Treatment and Immobilization Plant. For additional information on these design and construction projects, see the Waste Treatment and Immobilization Plant entry in Section VI of this report. The Board also focused on safety oversight of important deactivation and decommissioning efforts in progress at several locations across the site. Additionally, the Board remains involved in overseeing the continued safe storage of solid and liquid waste on site pending its ultimate disposition.

Documented Safety Analysis for Hanford's Tank Farms Facility

On September 15, 2021, the Board sent a letter to the Secretary of Energy providing the results of its safety review of the documented safety analysis for Hanford's tank farms facility and transmitting Technical Report 48, *Hanford Tank Farms Safety Basis Review*. The Board found that the tank farms safety basis relies upon a dated methodology and lacks sufficient documentation to support its conclusions regarding safety risk to the workers and the public. The Board is concerned that the safety basis does not provide DOE with sufficient information to accurately assess the consequences of accidents that could affect the public.

The Board noted in Technical Report 48 that a modern, updated safety basis will be necessary to ensure a smooth transition to the next phases of tank farm operations, which will involve changing tank waste conditions and an increased operational tempo as the tank farms mission expands and the Waste Treatment and Immobilization Plant's Low Activity Waste Facility starts up in late 2023.

Lastly, the Board observed that while DOE most recently revised DOE Standard 3009 in 2014, the current tank farms safety basis is written to the 1994 revision of the standard (through Change Notice 3 issued in 2006). The safety analyses in the tank farms safety basis would benefit from the additional rigor and structure of the 2014 revision of the standard. It would be prudent for DOE to update the safety analysis methodology within the tank farms safety basis in accordance with DOE's most current guidance.

Current Tank Farm Operations

The tank farm facility mission is to safely manage and treat approximately 56 million gallons of mixed radioactive and chemical waste. The waste is stored underground in 149 single-shell tanks and 28 double-shell tanks.

Figure 7. *Hanford Tank Farms Aerial Overview*

The single shell tanks are beyond their useful life, and despite previous stabilization efforts, which removed most liquids from the tanks, some of the single-shell tanks are leaking liquid waste to the environment. This year, the B-109 tank became the latest single-shell tank to be classified as an assumed leaking tank with an active leak. Between 1968 and 1986, DOE built the double-shell tanks that are used on the site. The aging single-shell tanks were subsequently stabilized by transferring all pumpable liquids to the double-shell tanks. Retrieval of the sludge and saltcake that remained behind in the single-shell tanks involves mobilizing the waste by using pressurized water directed through robotic sluicing equipment, then pumping the slurry to a double-shell tank for safe storage.

Tank Side Cesium Removal System Startup

As has been reported previously (see also the discussion in Section VI of this report), since initial design efforts began, numerous technical issues have arisen at the Waste Treatment and Immobilization Plant, which are primarily related to the Pretreatment and High-Level Waste facilities. DOE has implemented a modified strategy to focus on bringing the Low-Activity Waste facility on line first, processing feed provided directly from the tank farms, and bypassing the Pretreatment facility.

DOE has selected a subset of tanks as the targets for this strategy. The Tank Side Cesium Removal system will be used to pretreat liquid waste prior to its transfer from the tank farms to the Low-Activity Waste facility. The pretreatment process first uses a filter to remove any solids entrained in the liquid, and then removes cesium using an ion exchange process. DOE plans to treat one million gallons using the tank-side system and store the treated product in Tank AP-106 prior to the start of vitrification operations. This volume and the waste that operators will continue to pretreat after the vitrification plant begins operating are expected to keep the plant glassifying low-activity waste for its first four years of operation. Additional pretreatment equipment is expected to be designed, installed, and placed in operation before the end of the four-year period supported by the current system.

Throughout 2021, the Board has been following closely DOE's efforts to install the Tank Side Cesium Removal System, complete acceptance testing, and satisfy all readiness requirements for startup of operations. The Board noted only minor safety concerns that were adequately addressed by site personnel. DOE appears to be on schedule to begin tank-side operations early in calendar year 2022. As noted in last year's annual report, the Board has already weighed in on the safety basis being developed for the Low-Activity Waste facility. DOE expects to start up this vitrification facility by the end of calendar year 2023.

Central Plateau Cleanup

The Central Plateau at Hanford contains former plutonium processing and refining facilities and waste disposal sites, primarily located within the 200 East and 200 West areas. Among these facilities are canyons, the Solid Waste Operations Complex, and the burial grounds. Current activities at the Central Plateau are focused on safety risk reduction, in the forms of removing and remediating nuclear and chemical hazards, interim maintenance and stabilization of facilities, and safe interim storage or disposal of waste products.

Deactivation and Decommissioning of the Plutonium Finishing Plant

Considering the contamination spread events observed in 2017, the Board continued to provide safety oversight of deactivation and decommissioning activities at the Plutonium Finishing Plant throughout 2021. Following the end of operations at the facility in 1989, it represented one of Hanford's most significant hazards with respect to the potential for radioactive material release. Demolition work at the facility began in 2016 and concluded in November 2021. Key metrics associated with Plutonium Finishing Plant's demolition are removal of more than 90 structures as well as disposal of more than 14,000 tons of waste, 232 gloveboxes and ventilation hoods, 35,800 linear feet of asbestos insulation, 1.5 miles of ventilation piping, and 8,900 feet of ventilation duct.

Figure 8. *Plutonium Finishing Plant in 2016*

Figure 9. *Plutonium Finishing Plant in 2021*

Building 324 Progress

In November 2009, DOE discovered that radioactive contamination had migrated into the soil underneath the B-Cell of Building 324. DOE paused the in-progress deactivation and decommissioning project until it could remediate the condition and remove the environmental hazard. In 2019, the contractor began preparatory building stabilization activities that required disturbing the contaminated soil. In November 2019, contractor management stopped all work except minimum-safe operations in Building 324 radiological areas in response to a skin contamination event and an observed negative trend—an increasing rate of contamination control incidents. Consequently, DOE directed that work in radiologically contaminated areas within the facility remain paused until the contractor developed corrective actions, briefed DOE, and obtained concurrence on a path forward.

In 2021, the Board's safety oversight of DOE's ongoing soil retrieval activities focused on the contractor's completion of corrective actions to address the contamination control issues. In March, the contractor completed its corrective actions and resumed work in Room 18, where many of the contamination events occurred. The Board observed that this work was conducted using revised work instructions that substantially improved contamination control, entry and exit controls, and processes for use of personal protective equipment. The changes also included improved dust suppression equipment that is now used during micropile drilling activities, and revised procedures that incorporated many lessons learned identified from the 2019 contamination events.

The Board has closely followed the work resumption activities, observing that contamination control related to ongoing work activities has noticeably improved. The Board continues to monitor ongoing work activities with a focus on contamination control, hazard identification and communication, and effective contractor management of identified safety concerns. Additionally, the Board is monitoring ongoing design work related to the potential changes in the structural support strategy.

Figure 10. *Building 324*

Safety Basis for the Hanford Site's Central Waste Complex

On November 16, 2021, the Board sent a letter with an enclosed report to the Secretary of Energy detailing the results of its review of the safety basis for Hanford's Central Waste Complex. The Board identified several weaknesses and areas for improvement in the safety basis, including a non-conservative assessment of the consequences of an accidental material release from the facility. The Board recognized that DOE and its contractor were in the process of updating the waste complex's safety basis, intending for its report to inform the development of that revision.

Emergency Management Program at Hanford

On November 2, 2021, the Board sent a letter to DOE providing the results of its safety review of the emergency management program at Hanford and presenting information for DOE's use in executing continuous improvement efforts. In the letter, the Board observed that the Hanford site emergency management program is mature and adequately prepared to respond to emergency conditions. The Board noted that DOE relies heavily on contractor support in the execution of federal oversight processes. The contractor that supports DOE oversight is the same contractor that provides emergency management services, which raises questions regarding the independence of DOE's programmatic oversight. Ensuring the independence of oversight would help DOE remain fully cognizant of the health of the emergency management program. Additionally, the Board stated the DOE should consider implementing additional improvements in communication infrastructure and processes to strengthen onsite emergency response capability. Lastly, the Board pointed out that elimination of the use of dress rehearsal drills that practice similar or identical exercise scenarios prior to evaluated exercises would provide a more accurate picture of site emergency management proficiency.

Los Alamos National Laboratory

Most operations at Los Alamos National Laboratory fall under the purview of NNSA and are discussed in Section IV of this report. However, the laboratory has a dedicated field office reporting to the Office of Environmental Management, with its own contractor. Regarding this field office and contractor, the Board has continued to focus on a review of transuranic waste generation, processing, and storage operations at Los Alamos National Laboratory, as well as the status of the safety basis associated with the laboratory's Area G.

On September 24, 2020, the Board issued Technical Report 46, *Potential Energetic Chemical Reaction Events involving Transuranic Waste at Los Alamos National Laboratory*, to the Secretary of Energy. Safety actions associated with Technical Report 46 continued throughout 2021. This topic is discussed in the entry Safety of Solid Nuclear Waste earlier in this section of this report.

Potential Energetic Chemical Reaction Events Involving Transuranic Waste

As noted above, defense nuclear waste operations at Los Alamos National Laboratory are performed by two different contractors, one that is responsible for waste generated in support of the NNSA mission, and another that is responsible for the Office of Environmental Management legacy waste cleanup mission.

The Environmental Management contractor is responsible for operating the Area G waste facility. Over the past two years, DOE and its contractor have identified numerous safety issues with the outdated Area G safety basis. In response, the contractor restricted Area G operations in early 2021. In October 2021, DOE approved supplemental safety basis documents that specified more than 40 new safety controls, most of which are administrative in nature. These temporary measures will remain in place until the contractor develops and DOE approves a new safety basis that is compliant with DOE Standard 3009-2014, which is expected to be accomplished in 2022. In 2021, the Board initiated a review of the supplemental safety basis documents and the current Area G safety posture. The Board will continue this review and review the new safety basis when it is submitted to DOE for approval.

As indicated in the discussion of Technical Report 46, which appears earlier in this section of the report, the Board believes that DOE's Office of Environmental Management has planned and is taking appropriate action in response to the safety issues raised in the technical report. The Board's letter of September 8, 2021, which evaluated the technical basis for a Carlsbad Field Office direction letter on waste containing mixtures of nitric acid or nitrate salts with polysaccharides, is also discussed in sections addressing Safety of Solid Nuclear Waste and the Waste Isolation Pilot Plant. It is particularly relevant to operations at Los Alamos National Laboratory. For example, the laboratory remains one of the primary users of polysaccharides (i.e., cheesecloth) wipes to clean up spills involving plutonium and nitric acid. These are similar to the waste type (generated at Los Alamos) that was involved in the 2014 Waste Isolation Pilot Plant radiological release event that led to a three-year shutdown of the Waste Isolation Pilot Plant.

Nevada National Security Site

While most operations at Nevada National Security Site fall under the purview of NNSA and are discussed in Section IV of this report, DOE's Office of Environmental Management has a small but active portfolio of operations that fall within its scope at the site.

Radioactive Waste Facilities Safety Basis

The Board completed a review of the safety basis for the Radioactive Waste Facilities at Nevada in 2021. In a letter dated August 26, 2021, the Board communicated the safety issues that were identified during this review to the Secretary of Energy. These safety issues included deficiencies in safety basis submittals and federal reviews, continued delays in submitting a fully developed annual safety basis update, lack of a required formal process for handling noncompliant waste, and improper implementation of a specific administrative control. In the letter, the Board requested a report and brief within 90 days on the actions NNSA has taken or plan to take to ensure that the site contractor is submitting high quality safety basis documents and that the identified technical issues in the safety basis are addressed.

On November 10, 2021, NNSA[9] responded to the Board's letter and provided the requested report. In the report, NNSA described corrective actions that the site contractor is implementing to improve the quality of safety basis documents, plans to update each facility's safety basis to modern directives, and plans to address the technical issues in the facility safety basis. NNSA plans to provide the companion briefing to the Board in early 2022.

Figure 11. *Low-Level Waste Disposal Activities at the Radioactive Waste Management Complex*

[9]While the Radioactive Waste Facilities have a DOE Office of Environmental Management mission (i.e., disposing of low-level and mixed low-level radioactive waste), the NNSA Nevada Field Office provides nuclear safety support and is responsible for approving the safety basis.

Oak Ridge Environmental Management

In 2021, the Board conducted routine safety oversight of the Oak Ridge Office of Environmental Management's efforts to process and clean up defense legacy waste. DOE has some operations that fall within this scope at Oak Ridge National Laboratory. They range from sorting, processing, and shipping activities at the Transuranic Waste Processing Center to removal of uranium-233 stored in Building 3019, which involves associated discrete processing campaigns housed in Building 2026.

Building 2026 Oak Ridge Oxide Processing Campaign

In 2019, the Board evaluated the safety basis of the Oak Ridge Oxide Processing Campaign in Building 2026, transmitting a letter on December 4, 2019, to the Secretary of Energy, which identified a safety concern due to an incomplete criticality safety analysis. During 2021, the Board's staff provided routine safety oversight of operations at Building 2026. DOE successfully completed the Oak Ridge Oxide Processing Campaign in October 2021.

Building 2026 Initial Processing Campaign

A second campaign, known as the Initial Processing Campaign at Building 2026 will process uranium-233 stored in Building 3019 that was not suitable for inclusion in the oxide processing campaign completed in October 2021. DOE and its contractor plan to start this campaign in early 2022. The Board has been monitoring equipment procurement and installation, as well as safety basis development, and plans to evaluate operational readiness review activities for this campaign in Building 2026.

Idaho National Laboratory

In 2021, the Board's main interest at Idaho National Laboratory concerned DOE's efforts to start radiological operations at the Integrated Waste Treatment Unit. The Board also prioritized interactions with Idaho National Laboratory to discuss lessons learned from the 2018 drum over-pressurization event, and how those lessons enhance safety practices and procedures for current transuranic waste operations. The latter interest is discussed in more detail in the entry Safety of Solid Nuclear Waste earlier in this section of this report.

Integrated Waste Treatment Unit

The Integrated Waste Treatment Unit is designed to process approximately 900,000 gallons of liquid radioactive sodium-bearing waste, which is now stored at the Idaho Nuclear Technology and Engineering Center tank farm, as well as newly generated liquid waste from the center. Processing operations have not yet begun, so the facility is still radiologically clean.

Before the Integrated Waste Treatment Unit can process radiological materials, operators must first demonstrate process safety and reliability using a non-radiological simulant, which will be accomplished via a confirmatory run. Unforeseen process challenges with the granulated activated carbon beds inside the facility, and other challenges, delayed the confirmatory run beyond the close of 2021.

Revised DOE schedules call for the simulant confirmatory run to occur in the first quarter of 2022. A contractor readiness assessment and federal readiness assessment will follow the confirmatory run to demonstrate full plant operability and preparedness for radiological operations. The Board will continue monitoring activities leading to the start-up of the Integrated Waste Treatment Unit's radiological operations.

Handling of Solid Nuclear Waste

On April 24, 2021, Idaho National Laboratory personnel responded to an energetic event in the Accelerated Retrieval Project VIII Retrieval Area that had been identified by the video-based fire detection system. The video showed several short-lived fire or sparking events involving uranium (specifically, "roaster oxide"). This roaster oxide material was exhumed in early 2020 and then transferred to the Retrieval Area in October 2020. The waste was staged in arrays of trays, awaiting a disposal campaign for processing roaster oxides. While fire or sparking events involving uranium are expected operational events in the Retrieval Areas, the Board identified this event for further evaluation based on its potential relevance to the larger Safety of Solid Nuclear Waste initiative already under way. It may also drive a need to reconsider controls put in place in response to the laboratory's April 2018 waste drum over-pressurization event.

The Board's staff formally interacted with Idaho National Laboratory federal and contractor personnel multiple times during 2021 to discuss this event, and waste containers at the Radioactive Waste Management Complex that have elevated levels of flammable gas, as well as transuranic waste management operations in general. During these interactions, the Board's staff discussed potential improvements to site practices for handling transuranic waste with DOE and contractor personnel, leading to observed changes in operational safety and procedural compliance. The Board will continue to work with its DOE counterparts to inform safety practices at the laboratory, and to gather further data to inform its review of the safety of solid waste operations across the complex.

Waste Isolation Pilot Plant

The Board continued to provide oversight of Waste Isolation Pilot Plant operations, the National Transuranic Program, and construction projects intended to increase underground ventilation, including the Utility Shaft Project and the Safety Significant Confinement Ventilation System Project. Construction projects are discussed in detail in Section VI of this report. In the interim, Waste Isolation Pilot Plant management is preparing to bring the 700C Fan, an unfiltered exhaust fan, back on-line under specific operating conditions to improve underground airflow.

Resumption of Operation of the 700C Fan

In 2014, DOE and its contractor suspended use of the 700C fan after the radiological release event in the Waste Isolation Pilot Plant underground. Since that time, operations in the underground have been constrained due to the reduction in ventilation airflow. Restarting the 700C fan will help maintain a safe working environment for workers in the underground until the Safety Significant Confinement Ventilation System can be constructed and brought on-line. Use

of the 700C fan increases airflow in the underground from 170,000 to 240,000 cubic feet per minute. Because the 700C fan does not provide for filtration of exhaust air, DOE will not use it during waste emplacement activities.

The Board's staff closely followed two tests as part of the restart plan for the 700C fan. The primary objective of the first test was to ensure that the 700C fan's operation did not result in an unfiltered radiological release and was completed in January 2021. The primary objective of the second test was to ensure that the unfiltered underground ventilation system is properly balanced before returning the 700C fan to full operation and was completed in November 2021.

Based upon a preliminary assessment, the tests met all restart plan objectives. DOE and its contractor are currently completing an analysis of the collected test data. DOE and its contractor intend to return the 700C fan to full operation in 2022.

The December 9, 2018, Failure of the Safety Instrumented Alarm System

On August 13, 2021, the Board transmitted a report on a Board's staff review of the December 2018 failure of the safety instrumented alarm system at the Waste Isolation Pilot Plant, and of DOE's subsequent response/recovery actions. The safety review focused less on the system fault and the initial response and more on the follow-on actions and the quality controls associated with the actions. Following interactions with DOE and its contractors throughout 2019 and 2020, the Board's staff team grouped and categorized its 27 safety observations under event investigation, software management and control, log-keeping, Occurrence Reporting and Processing System reporting, work control documents, and engineering oversight.

Initially, DOE and its contractor were slow to acknowledge the review team's observations as potential safety issues. Ultimately, albeit more than a year later, DOE chartered its own assessment team, which came to the same conclusions, agreeing, in whole or in part, with all 27 safety observations as well as self-identifying 19 additional related issues. Since then, DOE and its contractor have been proactive in dealing with the safety observations and appear to be actively implementing the feedback and improvement element of their integrated safety management system. Recent leadership changes within site federal and contractor staff, as well as more productive interactions internally and externally, appear to be promising. Overall, however, DOE continues to struggle with safety oversight at the Waste Isolation Pilot Plant due in part to staffing shortfalls, particularly with respect to facility representatives and safety system oversight personnel.

Nitric Acid/Nitrate Salts with Polysaccharides

On September 8, 2021, the Board transmitted a letter to DOE discussing the DOE Carlsbad Field Office's direction letter that provided a methodology for evaluating waste containing mixtures of nitric acid or nitrate salts with polysaccharides, the same waste type that was involved in the 2014 Waste Isolation Pilot Plant radiological release event that led to a three-year shutdown of the Waste Isolation Pilot Plant. The DOE Carlsbad Field Office had concluded that such waste would not undergo autocatalytic runaway reactions after the waste had been aged for a specified time under specific conditions. The Board found that the DOE letter lacked the

technical basis to support that conclusion. The Board's findings were consistent with the conclusions of a DOE-sponsored technical review team assigned to evaluate disposal pathways for the inappropriately remediated nitrate salt waste stored at the Waste Control Specialists facility in Andrews, Texas. As a result, this type of waste may not be acceptable for disposition at Waste Isolation Pilot Plant unless additional technical justification is provided, controls are implemented, or the waste is treated.

The Board's September 8, 2021, letter requested that DOE provide a report and briefing that described its plan for safely managing these types of waste materials across the complex. DOE provided a briefing to the Board in December 2021, after which the Board extended the deadline for the written report into early 2022 to allow DOE to resolve this safety issue in a more comprehensive manner. Following the briefing to the Board, DOE revised its direction letter to its certified programs to: remove all references to wheat-based sorbents that were applicable to inappropriately remediated nitrate salts; remove citations to difficult waste team reports, DWT-RPT-005 and DWT-RPT-006; revert to the risk-based requirements stated in the direction letter dated April 16, 2018; and establish an explicit sunset criterion to preclude applicability of the letter to waste generated after May 31, 2022. This action was notable for its explicit response to several of the safety issues raised by the Board.

VI. Infrastructure and DOE Projects

The Board's Policy Statement-6, *Policy Statement on Oversight of Design and Construction of Defense Nuclear Facilities*, established in July 2017, provides the current approach the Board takes to review the design and construction of DOE defense nuclear facilities. The Board evaluates staff analyses, along with other sources of data such as input from resident inspectors, Board member field visits, DOE project status briefings, and Board hearings, to form the basis for identifying any nuclear safety deficiencies to DOE.

Major design and construction projects under the Board's evaluation in 2021 are listed in the following table. The substantive review activities of the design and construction projects performed in 2021 are discussed in detail below.

Table 2. *Design and Construction Projects under Evaluation in 2021*

Project Name	Location	Status of Project	Status of Review
Waste Treatment and Immobilization Plant, All Facilities (i.e., overall progress)	Hanford	Concurrent design and construction	Ongoing—project letters issued on 10/12/2017, 05/09/2019, 10/07/2019, 11/18/2019, 06/25/2020, 10/14/2020
Waste Treatment and Immobilization Plant, Analytical Laboratory	Hanford	Complete, ready for operations	Ongoing
Waste Treatment and Immobilization Plant, Low-Activities Waste Facility	Hanford	Construction complete, testing in progress	Ongoing—project letter issued 06/25/2020
Waste Treatment and Immobilization Plant, High-Level Waste Facility	Hanford	Concurrent design and construction	Ongoing—project letters issued 05/09/2019, 10/14/2020
Waste Treatment and Immobilization Plant, Pretreatment Facility	Hanford	On hold, designated technical issues resolved	Ongoing—project letter issued 11/18/2019
Tank Side Cesium Removal System	Hanford	Construction and testing	Ongoing
Los Alamos Plutonium Pit Production Project	Los Alamos National Laboratory	Conceptual design	Ongoing—project letter issued on 11/24/2021
Enhanced Capabilities for Subcritical Experiments Project	Nevada National Security Site	Various	Ongoing
Tritium Finishing Facility	Savannah River Site	Conceptual design	Ongoing—project letters issued on 6/15/2021

Project Name	Location	Status of Project	Status of Review
Savannah River Plutonium Processing Facility	Savannah River Site	Conceptual design	Ongoing
Surplus Plutonium Disposition Project	Savannah River Site	Conceptual design	Ongoing
Safety Significant Confinement Ventilation System	Waste Isolation Pilot Plant	Final design	Ongoing—project letters issued on 03/26/2018, 08/27/2019
Uranium Processing Facility	Y-12 National Security Complex	Construction	Ongoing—project letter issued on 06/26/2017

Hanford Site, Waste Treatment and Immobilization Plant

The tank farms at the Hanford Site near Richland, Washington, contain 56 million gallons of radioactive and toxic waste stored in 177 underground tanks. In the late 1990s, DOE began work on the Waste Treatment and Immobilization Plant intended to immobilize the Hanford tank waste. This radiochemical processing plant consists of four primary facilities: Pretreatment, Low-Activity Waste, High-Level Waste, and the Analytical Laboratory. As initially designed, all waste first would be processed through the Pretreatment facility, where it would be separated into two streams: low-activity waste and high-level waste. These two waste streams then would be solidified into glass in stainless steel containers at the Low-Activity Waste and High-Level Waste facilities, respectively. DOE will dispose of the low-activity waste glass on-site and will ship the high-level waste glass offsite for permanent disposal once a national repository is available.

Since initial design efforts began, numerous technical issues have arisen at the Waste Treatment and Immobilization Plant, primarily related to the Pretreatment and High-Level Waste facilities. The Board now considers many of these safety issues to be resolved. DOE has also modified its strategy to focus on bringing the Low-Activity Waste facility online first to process feed provided directly from the tank farms and bypass the Pretreatment facility.

Updated Preliminary Documented Safety Analysis for High-Level Waste Facility

In February 2021, DOE issued a revised preliminary documented safety analysis for the High-Level Waste facility. Among other updates, the revision included changes related to resolution of Board-identified safety issues regarding unanalyzed melter accidents, the hydrogen control strategy, and seismic qualifications of safety-related controls. In a letter transmitted on May 9, 2019, the Board agreed that DOE identified acceptable strategies for resolution of these safety issues, but noted that, in some cases, further analysis would validate or clarify assumptions underpinning those strategies.

In 2021, the Board's staff reviewed the revised preliminary documented safety analysis and focused on the proposed hydrogen control strategy, the supporting analysis, the volcanic ashfall safety strategy, the chemical safety management program, and fire protection. The staff concluded that the project personnel had made considerable progress in resolving technical and

safety issues at the High-Level Waste facility. Some challenges remain to finalize the hydrogen control strategy, and additional work is needed to finalize the facility safety basis and design to ensure adequate protection of co-located workers.

Los Alamos National Laboratory, Los Alamos Plutonium Pit Production Project

The Los Alamos Plutonium Pit Production Project is a major modification to the Plutonium Facility at Los Alamos National Laboratory intended to increase production capabilities from 10 to 30 pits per year. The project scope includes decontamination, decommissioning, and equipment installation and upgrades. The project requires installation of approximately 60 new pieces of equipment, including gloveboxes, dropboxes, transfer boxes, hoods, and radiography. Other activities include removal and replacement of interior laboratory walls and connection and/or disconnection of utilities and facility support systems (including the fire suppression, criticality alarm, and site paging systems). On April 27, 2021, the Deputy Secretary of Energy approved Critical Decision-1, *Approve Alternative Selection and Cost Range*, for the project.

In 2021, the Board's staff reviewed the project's conceptual design package, including the safety design strategy, conceptual design reports for decontamination, decommissioning, and installation of gloveboxes and equipment, and supporting calculations. In its letter dated November 24, 2021, the Board concluded that the conceptual design package was adequate and provided observations to help strengthen the project's safety design strategy in future revisions.

The Board's staff also reviewed Los Alamos National Laboratory's plans for upgrading deficient Plutonium Facility safety systems. While the system upgrades are outside the scope of the Los Alamos Plutonium Pit Production Project, they are existing safety controls that interface with the project and are important to the overall safety posture of the facility. NNSA and its contractor clarified their position that a safety class, seismically qualified ventilation system is only a goal and not a fully scoped and funded set of projects. NNSA's Los Alamos National Laboratory contractor plans to upgrade some components of the system to meet seismic requirements, but the end-state of the system, and how the system will be credited in the safety basis are not well defined. In the Board's letter to the Secretary of Energy dated November 24, 2021, the Board requested a report within 90 days that describes DOE's strategy for upgrading and crediting the ventilation system.

While the ventilation system end-state is unclear, NNSA's Los Alamos National Laboratory contractor is planning several projects to upgrade and modernize other safety systems in the Plutonium Facility to meet seismic requirements by 2026, including the fire suppression system, the facility control system, emergency power, uninterruptible power supply, the instrument air system, and many of the gloveboxes. These upgrades will improve the safety posture of the Plutonium Facility.

Nevada National Security Site, Enhanced Capabilities for Subcritical Experiments

NNSA performs subcritical experiments at the U1a Complex in support of the Stockpile Stewardship Program. In 2014, NNSA identified the need for higher energy x-ray diagnostics to measure the final stages of implosion using plutonium and a neutron diagnostic to infer neutron

multiplication during an implosion. The Enhanced Capabilities for Subcritical Experiments project consists of three subprojects:

- *Advanced Sources and Detectors Project*—A major equipment installation project that will install a high-energy linear accelerator (referred to as Scorpius) capable of producing four pulsed radiographs that can obtain experimental data further into the implosion event than existing diagnostic equipment;

- *Z-Pinch Experimental Underground System Test Bed Project*—A major modification to the U1a Complex that will repurpose the existing drifts to create a new experiment room and install the Neutron Diagnosed Subcritical Experiments equipment; and

- *U1a Complex Enhancements Project*—A major modification to the U1a Complex that includes the design, mining, and infrastructure needed to support the new diagnostic capabilities. This project includes creation of a new experiment room and new safety controls.

In 2021, the Board's staff reviewed the safety design strategy for the U1a Complex Enhancements Project and concluded that it is appropriate for the conceptual design stage of the project per DOE Standard 1189-2016, *Integration of Safety into the Design Process*, requirements.

Savannah River Site, Tritium Finishing Facility

NNSA plans to construct the Tritium Finishing Facility at the Savannah River Site to replace key capabilities currently located in H-Area Old Manufacturing—a 1950s vintage building that does not fully comply with current industry codes and standards. The capabilities of the Tritium Finishing Facility will include reservoir acceptance, reservoir assessment, assembly, pre-loading, and packaging and shipment. In 2018, NNSA placed the project on hold due to funding constraints. In December 2019, NNSA approved Critical Decision-1, *Approve Alternative Selection and Cost Range*, for the Tritium Finishing Facility, marking the completion of the project definition phase and the conceptual design. The Board notes that the Tritium Finishing Facility is currently not projected to begin operations until sometime between 2031 and 2033, and even then, it will not replace the facilities that contain the largest fraction of readily dispersible tritium at the Savannah River Site.

In 2021, the Board completed a review of the conceptual safety basis and design documents associated with the Critical Decision-1 milestone. The objective of this effort was to understand NNSA's approach to the Tritium Finishing Facility's safety strategy, control selection, and design of key structures, systems, and components, as well as to evaluate NNSA's efforts in early integration of safety into the facility design. The Board provided the results of this review to DOE in a letter dated June 15, 2021. The Board identified safety observations in several key areas: confinement strategy, hazard and accident analysis, identification and classification of controls, code of record, software quality assurance, and the tracking of open items. NNSA should address these observations as the design matures to ensure that the Tritium Finishing Facility meets DOE's safety requirements, given the facility's importance to NNSA's safety strategy for the Savannah River Tritium Enterprise. The Board and its staff will continue

to evaluate the facility design as it develops and are planning a focused review when it reaches 30 percent completion, followed by continued oversight at subsequent design milestones and start-up and operations.

Savannah River Site, Savannah River Plutonium Processing Facility

The 2018 Nuclear Posture Review 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 plans to use the partially constructed Building 226-F located in F-Area of the Savannah River Site for a new plutonium pit production facility. Building 226-F was originally designed for the Mixed Oxide Fuel Fabrication Facility project, which is now canceled. NNSA is repurposing Building 226-F as the Savannah River Plutonium Processing Facility designed to produce 50 of the required plutonium pits per year. On June 25, 2021, the Deputy Secretary of Energy approved Critical Decision-1, *Approve Alternative Selection and Cost Range*, for the Savannah River Plutonium Processing Facility, marking the completion of the project definition phase and the conceptual design. NNSA stated in its Critical Decision-1 approval letter that it estimates project completion between fiscal years 2032 and 2035.

Figure 12. *Savannah River Site Building 226-F*

In 2021, the Board completed an independent review of the conceptual design and safety basis documents associated with the Critical Decision-1 milestone. The objective of the review was to understand and evaluate how NNSA integrated safety into the design of the facility. In a January 24, 2022, letter, the Board identified eight safety observations that should be addressed as the project advances into preliminary design to further improve safety at the facility. The Board plans to conduct follow-up safety reviews as the project advances into preliminary design.

Savannah River Site, Surplus Plutonium Disposition Project

The Surplus Plutonium Disposition Project, currently in the conceptual design phase, involves a major modification to Building 105-K in the K-Area Complex, an existing Hazard Category 2 nuclear facility, 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 by expanding the capability to disposition surplus weapons-grade plutonium using the dilute and dispose approach. The four primary activities to be covered by the Surplus Plutonium Disposition Project are: (1) un-package plutonium oxide, (2) dry blend plutonium oxide with adulterant, (3) perform non-destructive assay and package, and (4) prepare diluted plutonium oxide for shipment. Critical Decision-1, *Approve Alternative Selection and Cost Range*, milestone was achieved in October 2019, and the project has advanced to approximately 60 percent design completion as of 2021.

During 2021, the Board's staff conducted a detailed conceptual design review of the project, concluding that the overall hazard analysis and control strategy was adequate at the Critical Decision-1 milestone; however, additional analysis is needed to fully support the safety conclusions presented in current safety basis documentation. For example, additional safety analyses are needed to support design of the fire suppression system and the analysis of hydrogen detonations inside gloveboxes. The Board provided these observations to DOE in a letter dated January 6, 2022. The Board also highlighted several other elements of its review that resulted in resolution at the staff-to-staff level. The Board continues to engage with DOE as it prepares to conduct an upcoming technical independent project review and annual peer review of the project.

Waste Isolation Pilot Plant, Safety Significant Confinement Ventilation System and Utility Shaft

The Board and DOE have been corresponding on various aspects of the overall effort to improve underground ventilation at the Waste Isolation Pilot Plant since the 2014 accident (the release of radiological materials due to energetic chemical reactions in waste drums). The Safety Significant Confinement Ventilation System project is just one component of DOE's plan. The confinement ventilation system is designed such that it will mitigate design basis accidents with high unmitigated dose consequences to the facility and co-located workers. DOE and its contractors and sub-contractors have made some progress this year in construction of the Salt Reduction Building and the New Filter Building. The contractor completed erecting the Salt Reduction Building's main support walls and roof, as well as the sub-grade foundation for the New Filter Building. The Board continues to monitor this DOE project closely.

Y-12 National Security Complex, Uranium Processing Facility

Construction of the Uranium Processing Facility officially began in 2018. The project has made significant progress toward completion in 2021. Notably, all three of the main structures are nearing completion and project personnel have begun installation of equipment for uranium processing. Project personnel are procuring safety related equipment to be installed in the Main Processing Building and the Salvage and Accountability Building (the Mechanical and Electrical Building is the third main structure).

The Board's staff has continuously monitored the project, including several site visits to observe the progress of construction and gather updated information. The project has reached several major milestones related to factory acceptance testing for safety-related equipment. The Board's staff is currently conducting a safety review of factory acceptance testing, which is scheduled to conclude at the beginning of 2022.

Figure 13. *Safety Significant Confinement Ventilation System Construction*

Figure 14. *Uranium Processing Facility Construction*

VII. Nuclear Safety Framework, Programs, and Standards

A robust nuclear safety framework is fundamental to safe operations at DOE defense nuclear facilities. DOE establishes this framework in rules, directives, and technical standards. In 2021, the Board continued to focus on DOE's overall safety framework, safety management programs, and the effectiveness of standards. The Board communicated to DOE on several cross-cutting safety areas including the nuclear safety requirements, seismic hazard assessments, and emergency preparedness and response. The Board also continued to review and comment on DOE directives that define nuclear safety requirements for the safety of transuranic waste, hazard categorization, and nuclear safety analysis. The Board will continue to prioritize cross-cutting safety areas that impact nuclear safety across the defense nuclear complex.

Nuclear Safety Framework

Recommendation 2020-1, Nuclear Safety Requirements

The Board issued Recommendation 2020-1, *Nuclear Safety Requirements*, on February 21, 2020, with the intent of strengthening DOE's nuclear safety regulatory framework including 10 CFR Part 830, *Nuclear Safety Management*, and relevant DOE orders and standards. The Board received DOE's response rejecting most of the recommendation on June 11, 2020. The Board originally issued Recommendation 2020-1 while DOE was revising 10 CFR Part 830, and DOE subsequently issued the revised final rule in October 2020. The Board conducted a virtual public meeting on December 4, 2020, during which members of the Board's technical staff presented information regarding the final version of the revised 10 CFR Part 830 and the status of issues in the recommendation.

On June 1, 2021, the Board reaffirmed Recommendation 2020-1. The Board revised the recommendation to reflect DOE's response to the original and completion of the rulemaking for 10 CFR Part 830. The Board recommended DOE take the following actions:

- *Aging Infrastructure*—DOE lacks a formal, complex-wide regulatory structure for identifying, prioritizing, and performing safety upgrades necessary for the adequate protection of the public and workers. The Board recommended that DOE develop requirements for aging management, including a formal process for identifying and performing infrastructure upgrades that are necessary to ensure facilities and structures, systems, and components can perform their safety functions.

- *Hazard Categories*—Deficiencies, inconsistencies, and non-conservatisms in DOE's safety standards could lead to inappropriate hazard categorization, inadequate safety analyses, and identification of inadequate controls for the protection of workers and members or the public. The Board recommended that DOE revise DOE Standard 1027-2018, *Hazard Categorization of DOE Nuclear Facilities*, mandate use of the 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.

- *DOE Approvals*—DOE may miss opportunities to identify negative effects of minor changes over time, latent defects in supporting analyses, or other documented safety analysis quality issues. The Board recommended that DOE establish a required periodic review of contractor documented safety analyses to ensure they meet the requirements of 10 CFR Part 830.

- *Evaluation of Safety Basis Preparation and Review Processes*—It is important that DOE fully understand any issues contributing to ineffective documented safety analysis preparation and review to ensure that DOE-approved safety bases continue to provide adequate protection of the public. The Board recommended that DOE conduct an independent review of contractor and federal processes to identify and evaluate the 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*—Improvements to DOE's nuclear safety framework are needed to ensure adequate implementation. Lack of implementation requirements leads to inconsistent safety basis implementation across the complex. The Board recommended that DOE incorporate specific implementation requirements for unreviewed safety questions, technical safety requirements, and specific administrative controls in its regulatory framework, including 10 CFR Part 830.

On September 8, 2021, the Secretary of Energy provided her final decision to the Board accepting Recommendation 2020-1. In an October 14, 2021, letter, the Board acknowledged DOE's acceptance of the recommendation, while noting that some DOE responses do not fully embrace actions recommended by the Board. DOE is currently developing an implementation plan to meet the objectives of the Board's recommendation.

Seismic Hazard Assessments

The Board's staff completed a complex-wide review of implementation of the requirements in DOE Order 420.1C, *Facility Safety*, to periodically assess the seismic hazard. For defense nuclear facilities, seismic accidents have the potential to cause significant safety consequences to the public. The DOE process for periodically assessing the seismic hazard ensures that credited seismic controls are analyzed using the latest information and will perform their safety functions when needed.

On June 10, 2021, the Board sent a letter to the Secretary of Energy, which included Technical Report 47, *Seismic Hazard Assessments*. The letter and report highlight the Board's concerns with the process of periodically assessing the seismic hazard at DOE sites. Specifically, the Board identified the following issues: sites have not implemented the required unreviewed safety question process to assess the impacts of an increased seismic hazard on safety controls; most site field offices have not approved seismic hazard assessments and subsequent analyses as required by DOE Order 420.1C; sites have been slow to analyze the impact of an increased seismic hazard on safety controls; and DOE's directives lack sufficient guidance and standardization on conducting seismic hazard assessments.

In the June 10, 2021, letter, the Board requested a report and brief on actions DOE plans to take to ensure the identified safety issues do not reoccur in future implementation of the process. On December 14, 2021, DOE responded to the Board's questions with a written report. In its response, DOE committed to the following: direction to site offices to verify that unreviewed safety question procedures adequately cover new natural phenomena hazards assessments; DOE action when site offices are not in compliance with natural phenomena hazards requirements; and review of applicable DOE directives to evaluate if improvements are needed. DOE plans to brief the Board in early 2022 on its response.

Nuclear Safety Programs

DOE Oversight

In 2019, the Board's staff began a review of DOE's safety oversight across the defense nuclear complex, including DOE's methods to evaluate the effectiveness of its oversight activities. The Board's staff gathered information and conducted interactions with multiple DOE headquarters organizations and field offices, including the Office of Enterprise Assessments, the Office of Environmental Management, NNSA, the NNSA Production Office at the Y 12 National Security Complex, and the Carlsbad Field Office. In addition, the Board's staff interviewed personnel from each of the organizations to gain insight on day-to-day safety oversight responsibilities.

The purpose of these interactions was to better understand the current DOE safety oversight framework and practices for implementing DOE oversight requirements. Within each of the organizations, the Board's staff focused on integrated safety management, issues management systems, performance measures, oversight activity planning, and workforce staffing. The Board's staff also evaluated how DOE organizations interact and leverage assessment information. In 2021, the Board's staff completed the safety review interactions and conducted several factual accuracy discussions with DOE offices to communicate its observations. In 2022, the Board's staff will present findings of the safety review to the Board for its consideration

Nuclear Criticality Safety

After the closure of Recommendation 97-2, *Continuation of Criticality Safety at Defense Nuclear Facilities in the Department of Energy (DOE) Complex*, the Board requested that DOE provide an annual report and briefing on the status of the nuclear criticality safety programs across the defense nuclear complex. On February 11, 2021, the Board updated this reporting requirement for fiscal year 2020 to request a briefing on how DOE and NNSA headquarters systemically evaluate criticality safety programs across the complex and how they are addressing known criticality safety challenges at specific sites. DOE provided this briefing to the Board on June 9, 2021.

The Board subsequently identified improvements to the annual report and communicated them to the Secretary of Energy on January 6, 2022. The Board letter requested an annual report and briefing focused on the following: results of the annual report, DOE headquarters' evaluation of criticality safety programs across the complex, and recent issues, corrective

actions, and improvements since the last briefing. The report covering the fiscal year 2021 results and its associated briefing are due on March 31, 2022, and May 15, 2022, respectively.

DOE Emergency Preparedness and Response

Throughout 2021, restrictions related to the COVID-19 pandemic continued to affect the ability of DOE sites to fully conduct in-person drills and exercises for emergency response. Accordingly, members of the Board's staff monitored the periodicity of field drills and exercises being performed at DOE sites and the qualifications and proficiency of emergency responders. Members of the Board's staff observed emergency response drills and exercises at Pantex and Sandia National Laboratories to evaluate the current competencies and capabilities for emergency response at those sites, in addition to routine oversight performed by the Board's resident inspectors.

In 2021, members of the Board's staff conducted a targeted safety review of the emergency preparedness and response program at the Hanford site, with a focus on sitewide integration of and coordination between the various implementing contractor organizations. The Board's staff noted that emergency responder communications lacked standardized processes and relied on personally owned communication devices. Additionally, the Board's staff identified actions that could be taken to improve the independence of federal oversight by the Richland Field Office. On November 2, 2021, the Board issued a letter to the Secretary of Energy communicating these details.

Reactive Materials at Y-12 National Security Complex

The Board's staff evaluated reactive hazards associated with enriched uranium purification and recovery processes at the Y-12 National Security Complex. Y-12 personnel have made several changes in the process used to recover enriched uranium materials. Since calendar year 2017, several containers with briquettes and chips experienced thermal runaway reactions in storage and in recovery operations at Y-12. These process changes resulted in poor chip quality and low metal yield due to change of solvent, as well as uranium build-up at unknown process locations that were not well-monitored.

The Board's staff interacted with the NNSA Production Office and its contractor in 2021 to discuss concerns associated with reactive hazards for these materials. During these discussions, Y-12 personnel presented improvements to the enriched uranium recovery and purification process in the areas of training, configuration management, process engineering, and process reviews. The Board's staff review continues into 2022.

Pantex External Dosimetry Program

In the fall of 2019, the Pantex contractor identified age-related degradation of a thermoluminescent dosimeter reader that impacted the ability to monitor the exposure of Pantex workers to ionizing radiation form nuclear weapon components and radiography equipment. In the summer of 2020, the Pantex contractor determined that all thermoluminescent dosimeter readers at Pantex were inoperable and decided to address the problem by consolidating the Pantex and Y-12 external dosimetry programs into a combined program operated by Y-12. During 2021, the Board's staff reviewed the failure of the external dosimetry program at Pantex,

with the objective of identifying opportunities for improvement to help prevent similar problems at Pantex and throughout the DOE defense nuclear complex. During the review, the Board's staff identified that NNSA and its contractor did not recognize and respond to weaknesses in the external dosimetry program, including significant personnel turnover, aging equipment, lack of timely contract maintenance support, and the unavailability of replacement equipment. The Board's staff also identified lessons learned related to oversight by the NNSA Production Office. The Board's staff will complete its evaluation in 2022.

Figure 15. *Thermoluminescent Dosimeter to Monitor External Radiation Dose*

DOE Safety Software Central Registry

The DOE Safety Software Central Registry is currently a database of eight software packages that DOE has evaluated against software quality assurance requirements. DOE contractors use these software packages for purposes such as estimating the consequences of potential accidents. The central registry also includes guidance from DOE on how to use the software. Per DOE Standard 3009-2014, DOE encourages its contractors to use the software in the central registry.

In 2021, members of the Board's staff conducted a review of the central registry. The Board's staff determined that DOE has struggled to maintain the central registry, leading to the use of grossly outdated versions of software for safety-related calculations. While this is not optimal, the staff is not currently aware of any calculations that are erroneous as a result. DOE is aware of its difficulties in maintaining the central registry and has begun an effort to re-assess and potentially reform the central registry. In 2022, the Board's staff will continue to evaluate DOE's plans for improving the central registry.

Directives in Contracts

In 2020, the Board's staff began a review of the DOE process to incorporate new and revised DOE directives in site contracts across the defense nuclear complex. In 2021, the Board's staff gathered information and conducted interactions with multiple DOE field offices, including the Environmental Management and NNSA Los Alamos field offices, the Hanford Office of River Protection, and the Savannah River Operations Office. The purpose of these interactions was to better understand the process that site offices use to review, update, and implement DOE directives in site contracts. The Board's staff also conducted interactions with the Office of Management and the Office of Nuclear Safety at headquarters to understand the DOE decision process to revise directives and to invoke safety-related technical standards. In 2022, the Board's staff will continue to consolidate and evaluate the data gained in the interactions and present findings to the Board for its consideration.

Nuclear Safety Standards

Review and Comment in Calendar Year 2021

In 2021, the Board's staff conducted several reviews of DOE directives and technical standards that were being developed or revised in DOE's review, comment, and approval process. In addition to the standards and orders listed below, the Board's staff reviewed the following: NNSA Supplemental Directive 452.2, *Nuclear Explosive Safety Evaluation Process*; DOE Limited Standard 3016, *Hazard Analysis Reports for Nuclear Explosive Operations*; DOE Handbook 1224, *Hazard and Accident Analysis Handbook*; and DOE Handbook 3010, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. The Board's staff provided comments to DOE that would enhance the directives and technical standards and will continue the effort in 2022.

Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities

The Board worked closely with DOE on an update to DOE Standard 5506-2021, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*. The Board issued a letter on July 26, 2021, highlighting the positive working relationship between the DOE team and the Board's staff, significant improvements of the then draft standard, and two significant unresolved safety issues. The Board plans to follow DOEs implementation effort to ensure that the improvements that were incorporated into the revised Standard 5506 are implemented across the complex, resulting in increased safety of solid nuclear waste (see the entry Safety of Solid Nuclear Waste in Section VII of this report).

DOE Nuclear Facility Hazard Categorization

On January 19, 2021, the Board transmitted a letter and report to the Secretary of Energy documenting concerns with the three standards that DOE allows its contractors to use when performing nuclear facility hazard categorization: DOE Standard 1027-1992, DOE Standard 1027-2018, and NNSA Supplemental Directive 1027. The Board advised the Secretary to discontinue the use of NNSA Supplemental Directive 1027 because its methodology is not technically justified and it is superseded by DOE Standard 1027-2018; to update DOE Standard 1027-2018 to address the multiple deficiencies described in the letter's enclosure; and to ensure that changes in methodology introduced in DOE Standard 1027-2018 and NNSA Supplemental Directive 1027 have not caused the under-categorization of existing DOE facilities. This Board letter also served as the basis for sub-recommendation 2 in Board Recommendation 2021-1, *Nuclear Safety Requirements*.

In response to the Board's letter, DOE revised NNSA Supplemental Directive 1027 in May 2021 to address some of the Board's concerns. The Board and its staff will evaluate any additional actions DOE takes on this topic.

Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities

In 2019, DOE issued DOE Standard 1228, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*, to provide an acceptable methodology for the preparation of documented safety analyses for Hazard Category 3 nuclear facilities. In 2020, the Board evaluated the standard for compliance with 10 CFR Part 830. The Board also compared DOE Standard 1228-2019 to DOE Standard 3009-2014 to ensure consistency with that approved safe harbor standard. The Board's review found that the new standard contains inconsistencies with DOE Standard 3009-2014 that could lead to development of documented safety analyses that lack appropriate rigor, and that do not identify complete control sets for the protection of the public and workers. The Board also found that DOE Standard 1228-2019 is inconsistent with 10 CFR Part 830 in its use of the graded approach to develop a documented safety analysis. The Board issued a letter and report to the Secretary of Energy on February 8, 2021, transmitting these safety concerns.

Planned Review in Calendar Year 2022

In 2021, the Board's staff reviewed preliminary drafts of the revision of DOE Standard 1066, *Fire Protection*, the development of a new handbook to replace EH-0545, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities*, and revision of DOE Order 425.1, *Verification of Readiness to Start Up or Restart Nuclear Facilities*. In 2022, the Board plans to review these directives and technical standards in DOE's online review, comment, and approval process, as well as evaluate other DOE directives that have complex-wide effects and those that establish controls for high-hazard activities. These safety reviews will include DOE Order 435.1, *Radioactive Waste Management*, and DOE Standard 1129, *Tritium Handling and Safe Storage*. The Board may elect to add reviews of DOE directives as it deems appropriate.

VIII. Field Operations

The Board stations full-time resident inspectors at the Hanford site, the Los Alamos National Laboratory, the Pantex Plant, the Savannah River Site, and the Y-12 National Security Complex to monitor operations. In 2021, the Board assigned new resident inspectors at the Hanford site and the Pantex Plant and two new resident inspectors at the Savannah River Site. This allowed the Board to increase the size of the Hanford and the Savannah River Site offices to three resident inspectors each. To increase the pool of possible resident inspector candidates, the Board also began directly hiring employees to be resident inspector rather than solely relying on internal transfers. This allowed the Board to hire two resident inspectors with extensive field operations and nuclear weapons experience. Furthermore, the Board conducted several interviews in 2021 to identify candidates to fill existing and anticipated resident inspector vacancies and will be making several offers in early 2022.

In 2021, the Board organized the resident inspectors under the new Field Operations group to standardize their training and oversight. All new resident inspectors complete 21 training modules to improve their understanding of safety systems and safety management programs and to learn how to conduct effective field oversight. The number of available training modules doubled in 2021. In addition, these training modules are conducted online and recorded to allow other members of the Board's technical staff to increase their knowledge of nuclear operations. In 2021, the resident inspectors also began conducting focused reviews on a particular topic at each of the resident inspector sites every six weeks. These topics have included fire impairments, failed personnel protective equipment, DOE staffing, and facility leaks that involve nuclear material. The resident inspectors routinely provide Board members with briefings on their individual site safety observations and overall safety trends in the DOE complex. The Board's staff also shares these observations with DOE headquarters and site managers.

Board Recommendations

Recommendations Open in 2021

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

On February 21, 2020, the Defense Nuclear Facilities Safety Board (Board) issued Recommendation 2020-1, *Nuclear Safety Requirements*. The recommendation is intended to strengthen the regulatory framework of the Department of Energy (DOE), including 10 Code of Federal Regulations (CFR) Part 830, *Nuclear Safety Management*, and relevant DOE orders and standards. The Board received DOE's response rejecting the majority of the recommendation on June 11, 2020. The Board originally issued Recommendation 2020-1 while DOE was revising 10 CFR Part 830, and DOE subsequently issued the revised final rule in October 2020.

On June 1, 2021, the Board reaffirmed Recommendation 2020-1. The Board revised the recommendation to reflect DOE's response to the original and completion of the rulemaking for 10 CFR Part 830. On September 8, 2021, the Secretary of Energy provided her final decision to the Board accepting Recommendation 2020-1. In an October 14, 2021, letter to DOE, the Board acknowledged DOE's acceptance of the recommendation, while noting that some DOE responses do not fully embrace actions recommended by the Board. DOE is currently developing an implementation plan to meet the objectives of the Board's recommendation.

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

The National Nuclear Security Administration (NNSA) rejected Recommendation 2019-2, *Safety of the Savannah River Site Tritium Facilities*, based on the statement that it is already addressing Board's concerns with proposed and ongoing actions. The Board's staff and NNSA personnel differ significantly on the perception of the risk to workers and the public associated with the Savannah River Site tritium facilities. In the Board's assessment, NNSA's proposed and ongoing plans will not result in sufficient improvement to the safety posture of the tritium facilities. On July 13, 2021, the Board held a public hearing session focused on specific proposed and ongoing actions to address concerns detailed in Recommendation 2019-2. The status of those actions and the Board's assessment of their effectiveness in addressing the issues of adequate protection identified in the Board's Recommendation are summarized below.

In December 2019, NNSA approved a new combined documented safety analysis for the Savannah River Site tritium facilities. The new documented safety analysis contains some improvements but does not address all the concerns detailed in Recommendation 2019-2. Specifically, the calculated dose consequences for co-located workers impacted by major accidents involving the tritium facilities are still unacceptably high (based on DOE own safety requirements); calculated dose consequences for the public challenge DOE's evaluation guideline for consideration of safety class controls; and no new controls have been identified and implemented that reduce the calculated dose consequences to acceptable levels in accordance with DOE's safety directives. Furthermore, safety management programs that could help mitigate accident consequences, such as the site's emergency preparedness and response program, have not been tested to demonstrate their effectiveness for a major accident involving the tritium facilities. The Savannah River Site contractor has recently developed an evacuation

and re-location plan for emergency preparedness but still needs to validate the plan via a field exercise. Moreover, the contractor for the Savannah River Site tritium facilities (with NNSA's consent) will not implement improved safety controls identified in the new combined safety basis until 2025 and has not implemented any compensatory measures to ensure safety in the interim.

NNSA directed the contractor to develop a risk reduction strategy for co-located workers impacted by major accidents involving the tritium facilities and approved the contractor's strategy shortly before the Board's July 13, 2021, public hearing. The actions in the strategy focus on either refining the accident analysis parameters to reduce the predicted consequences or completing calculations to determine whether existing structures can be credited to reduce the calculated consequences in the safety basis. Most of the proposed actions do not represent actual improvements to safety, but rather analytical reductions, unless done in conjunction with physical modifications to install or upgrade engineered controls. The contractor does not expect to complete all these actions until 2025. The Board is evaluating the effectiveness of the proposed and ongoing actions and continues to encourage DOE to implement timely improvements in the safety posture at the Savannah River Site tritium facilities.

Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR Part 830 Implementation at the Pantex Plant (REMAINS OPEN)*

On February 20, 2019, the Board issued Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR Part 830 Implementation at the Pantex Plant*. The recommendation identified the following safety issues: (1) portions of the safety basis for Pantex nuclear explosive operations do not meet 10 CFR Part 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 safety basis are deficient; and (3) the Pantex 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 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 Part 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. 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.

NNSA completed a number of the plan's deliverables in 2020–2021 and is working to complete all of the identified safety improvements by September 2023. Currently, Pantex has completed 63 of the 69 deliverables committed to in NNSA's implementation plan. The Board continues to review actions and deliverables associated with the revised implementation plan. In particular, the Board's staff in 2021 commenced a review of closure documentation for various legacy conditions of approval for safety basis submittals and planned safety improvements that have remained open for more than a decade. The Board and its staff will continue this review and continue to evaluate the effectiveness of NNSA's implementation plan deliverables, during 2022.

Recommendation 2012-1, *Savannah River Site Building 235-F Safety (REMAINS OPEN)*

A decade ago, the Board had identified safety concerns related to the hazards associated with plutonium 238 hold-up material in Building 235-F at the Savannah River Site. At present, Building 235-F is scheduled to complete deactivation in 2022, with the timeline for eventual decommissioning to be determined following regulatory review of DOE's engineering evaluation and cost analysis.

The Board issued Recommendation 2012-1, *Savannah River Site Building 235-F Safety*, on May 9, 2012, which documented the Board's concerns and recommended several actions 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. The revised implementation plan focused on eliminating fire risks instead of removing additional material-at-risk. DOE also formally ceased material-at-risk removal activities and downgraded existing safety controls in response to a revised accident analysis. On June 22, 2020, DOE sent a letter to the Board, stating that DOE "has completed all actions identified in the Department's May 2020, revised Implementation Plan in response to the Recommendation 2012-1."

The Board reviewed DOE's revised implementation plan per the Board's Policy Statement 1, *Criteria for Judging the Adequacy of DOE Responses and Implementation Plans for Board Recommendations*[10], and the revised safety basis, submitting its findings to the Secretary of Energy in letters dated December 23, 2020, and November 2, 2021. Overall, the Board is encouraged by the progress made toward reducing the risk and improving the safety posture at

[10] The Board's Policy Statement 1 has since been superseded by a replacement policy approved on April 19, 2021.

Building 235-F. However, the latest Building 235-F safety basis contains deficiencies that make it inconsistent with DOE standards.

The Board believes that bringing the safety basis into compliance with DOE standards would require upgrading key elements of the fire protection program to a specific administrative control and may include upgrading defense-in-depth controls such as the E-5 ventilation system and sand filter to safety significant. Classifying this ventilation system as safety significant would provide continued assurance of worker safety across the range of postulated accident scenarios.

Given the concerns described in the recent Board letters, the Board requested that DOE provide an annual briefing and report on the status of Building 235-F deactivation and decommissioning activities. On April 27, 2021, DOE completed its first annual briefing to the Board on Building 235-F. Briefing topics included: deactivation progress, results of recent radiological surveys, status of determining the end state for Building 235-F, and DOE's safety basis strategy. DOE is scheduled to deliver its next annual report and briefing by August 12, 2022, as documented in the Board's December 2, 2021, letter to the Secretary of Energy.

AFFIRMATION OF BOARD VOTING RECORD

SUBJECT: 32nd Annual Report to Congress

Doc Control#: 2022-100-0018

The Board acted on the above document on 04/14/2022. The document was Approved.

The votes were recorded as:

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIPATING	COMMENT	DATE
Joyce L. Connery	✔	☐	☐	☐	☐	04/14/2022
Thomas Summers	✔	☐	☐	☐	☐	04/14/2022
Jessie H. Roberson	✔	☐	☐	☐	☐	04/14/2022

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

Shelby Qualls

Executive Secretary to the Board

Attachments:

1. Voting Summary
2. Board Member Vote Sheets

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Joyce L. Connery

SUBJECT: 32nd Annual Report to Congress

Doc Control#: 2022-100-0018

DATE: 04/14/2022

VOTE: Approved

COMMENTS:

None

Joyce L. Connery

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Thomas Summers

SUBJECT: 32nd Annual Report to Congress

Doc Control#: 2022-100-0018

DATE: 04/14/2022

VOTE: Approved

COMMENTS:

None

Thomas Summers

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: Jessie H. Roberson

SUBJECT: 32nd Annual Report to Congress

Doc Control#: 2022-100-0018

DATE: 04/14/2022

VOTE: Approved

Member voted by email.

COMMENTS:

None

Jessie H. Roberson