DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

April 9, 2024

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

Dear Secretary Granholm:

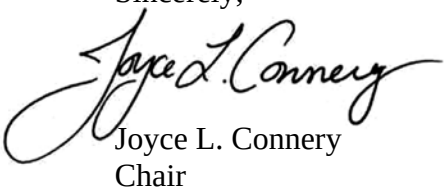
The Defense Nuclear Facilities Safety Board (Board) has followed the U.S. Department of Energy's (DOE) progress in replacing wood-framed false ceilings in two nuclear explosive cells at the Pantex Plant (Pantex) over the years. The replacement of these ceilings had been identified as a planned improvement in the Pantex safety basis since 2007 and was completed in 2023. The Board commends DOE for completing this important safety improvement and satisfying a commitment made in response to Board Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*.

The Board reviewed quality assurance measures applied to ceiling replacement activities and evaluated oversight of the construction subcontractor provided by the National Nuclear Security Administration (NNSA) Production Office and the site contractor, Consolidated Nuclear Security, LLC (CNS). Overall, the Board found CNS and its construction subcontractor applied appropriate quality assurance measures during these construction activities. The review did identify opportunities for safety improvement, which are provided in the enclosed staff report for DOE's information and use. The Board concludes that CNS continues to make improvements to its construction quality assurance practices. CNS conducted a thorough assessment of the Board's safety concerns and is taking appropriate corrective actions.

During the review, the Board identified that cast iron fittings were used in the replacement deluge fire suppression systems for the two cells, counter to requirements and guidance in DOE directives. Cast iron fittings generally have poor seismic performance and their failure can result in an impaired fire suppression system after an earthquake. While the Pantex safety basis does not currently consider post-seismic fire scenarios to be credible, failed fire suppression piping can pose an impact hazard to nuclear explosive operations. CNS has identified that cast iron fittings were also installed on recent construction projects in some nuclear explosive bays at Pantex. NNSA and CNS took appropriate actions by declaring a potential inadequacy of the safety analysis, imposing operational restrictions, performing a sitewide extent of condition review, and prohibiting the use of cast iron fittings on upcoming construction projects.

On May 12, 2016, the Board identified a similar safety concern regarding the presence of cast iron fittings in the fire suppression system at Los Alamos National Laboratory's (LANL) Plutonium Facility. Based on the Pantex and LANL safety concerns, the Board advises DOE to communicate the issue complex-wide and to take further actions to understand the extent to which cast iron fittings exist in defense nuclear facility fire suppression systems requiring post-seismic performance capability. This could be readily accomplished through use of an Operating Experience Level 1 or 2 document per DOE Order 210.2A, *DOE Corporate Operating Experience Program*.

Sincerely,



Joyce L. Connery
Chair

Enclosure

c: The Honorable Jill Hruby, Administrator, NNSA
Mr. Jason Armstrong, Manager, NNSA Pantex Field Office
Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

March 3, 2024

Pantex Plant 12-44 False Ceiling Replacement Review

Summary. The Defense Nuclear Facilities Safety Board's (Board) staff performed a review of the false ceiling replacement for two nuclear explosive cells, 12-44 Cells 5 and 6, at the Pantex Plant (Pantex). Replacement of these ceilings, which had been identified as a planned improvement in the Pantex safety basis since 2007 [1], began in April 2022 and was completed in March 2023. Replacement of the wood-framed false ceilings satisfies, in part, a commitment by the Department of Energy (DOE) to the Board to close legacy safety basis conditions of approval in response to Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant* [2].

The staff team performed a detailed review of the project deliverables, including construction work packages, purchase order documentation, quality assurance records, commercial grade dedication (CGD) test reports, and design and analysis documentation. In addition, the staff team observed the progress of construction, from demolition of the previous wood-framed ceilings through construction of the new metal ceilings. The staff team focused primarily on 12-44 Cell 5 project deliverables; however, the staff team observed ceiling replacement activities for both 12-44 Cells 5 and 6, as well as 12-44 Cell 8 (a nuclear material operations facility).

Overall, the staff team found that the Pantex site contractor—Consolidated Nuclear Security, LLC (CNS)—and its construction subcontractor applied appropriate quality assurance practices to this project. During the review, the staff team identified opportunities for safety improvements, which are discussed in detail later in this report. CNS personnel were highly receptive to the observations from the staff team and conducted their own internal assessment in response to this feedback.

Background. The Board's staff has been following efforts by the National Nuclear Security Administration (NNSA) and CNS to replace the wood-framed false ceilings at 12-44 Cells 5 and 6 at Pantex. A previous management and operating contractor planned to accomplish the replacement as part of the Production Cells Upgrade Project in 2005–2006; however, due to funding issues, only 12-44 Cells 2 through 4 were upgraded at that time. CNS replaced the false ceilings in 12-44 Cells 5 and 6 in 2023. Figure 1 shows a completed ceiling. The following sections provide background on the 12-44 cells and recent construction review activities by the Board's staff at Pantex.

Figure 1. *Upgraded False Ceiling within a 12-44 Nuclear Explosive Cell*

12-44 Cells—The 12-44 cells are the oldest nuclear explosive cells at Pantex. 12-44 Cells 1 through 6 were constructed in the mid-1950s, and 12-44 Cell 8 was constructed in 1968. 12-44 Cell 1 has not been used for operations since an accidental tritium release event in 1989 [3]. Nuclear explosive cells consist of a round room where the main operations occur, a personnel corridor, equipment and personnel interlocks, and side support rooms for mechanical equipment, special tooling staging, and special nuclear material staging. The Pantex safety basis credits the cell structure as a safety class design feature [4]. The false ceiling in the round room supports the safety class deluge fire suppression system and non-credited ventilation ductwork, electrical conduit and lighting, high explosive contaminated vacuum piping, and compressed air lines.

Since the false ceilings are suspended above nuclear explosive operations and support the safety class fire deluge systems, the ceilings are also credited as safety class. The Pantex safety basis requires that all appurtenances and systems within nuclear explosive facilities be qualified to withstand the design basis performance category (PC)-3 earthquake[1] and not result in a falling hazard to operations below. Prior to replacement of the wood-framed false ceilings, a separate wet pipe fire suppression system was needed above the wood ceilings to suppress a potential

[1] Performance categories are assigned for existing facilities based on potential consequences from an unmitigated accident, in accordance with DOE Standard 1021-1993, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*. Performance categories are assigned based on the least severe (PC-1) to the most severe (PC-4) unmitigated accident consequences. PC-3 is the highest designation assigned to DOE non-reactor facilities.

ceiling fire; this system was in addition to the deluge system that the ceiling supported. Since the new false ceilings in the 12-44 cells are constructed of metal, there is no longer a need for a separate wet pipe system above the ceiling.

In 2005–2006, a previous management and operating contractor implemented the Production Cells Upgrade Project for the 12-44 cells. Upgrades included replacement of wood-framed ceilings, round room structural slabs, wet pipe and deluge fire suppression systems, electrical systems and lighting, ventilation equipment, compressed air systems, high explosive contaminated vacuum systems, and blast proof wall penetrations [5]. That project was divided into two phases: Phase 1 was to upgrade 12-44 Cells 2 through 4, and Phase 2 was to upgrade 12-44 Cells 5 and 6. Due to funding issues, Phase 2 was never completed. Thus, upgrading 12-44 Cells 5 and 6 has been identified in the Pantex safety basis as a planned improvement since 2007. Figure 2 shows the wood-framed ceiling of a 12-44 cell just prior to demolition as part of the Production Cells Upgrade Project.

Recent Staff Construction Reviews—For the past decade, the Board and its staff have closely followed the progress of safety-related construction activities at Pantex. In 2016, the Board's staff conducted a structural infrastructure review at Pantex. During that review, the staff team evaluated repairs being made to the structural slabs of 12-98 Cells 2 and 4 as part of high-pressure fire loop (HPFL) lead-in replacement activities. The staff team identified that improper quality assurance practices were applied, including procuring mechanical rebar splices without performing CGD activities and using rapid set concrete to expedite schedule. Subsequent testing

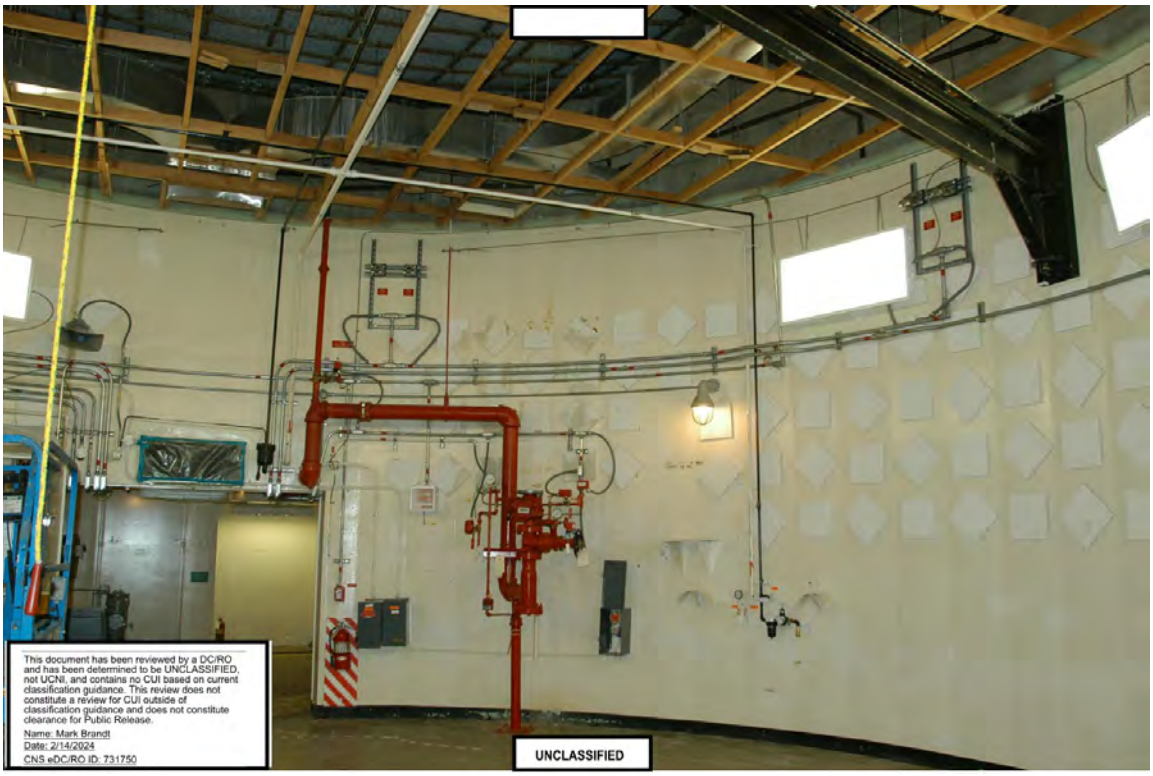


Figure 2. *Wood Framing of a False Ceiling Prior to Demolition*

by CNS confirmed the rapid set concrete had inadequate strength. As a result, CNS directed its subcontractor to demolish the repair and applied strengthened quality assurance practices during the re-repair. The issues from the 12-98 lead-in replacement originated from CNS incorrectly defining the safety class structure system boundaries and not applying requirements from American Society of Mechanical Engineers (ASME) nuclear quality assurance (NQA) standard NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications* [6], to the project. CNS reported this incident in the DOE Occurrence Reporting and Processing System (ORPS) [7] and published a lesson learned [8].

The Board's staff conducted a follow-on review in 2019–2020 focused on the HPFL lead-in replacement for the 12-96 nuclear explosive cell. Overall, the Board's staff observed significant improvements in quality assurance practices on the 12-96 project, although some issues remained related to identification and control of safety basis and quality assurance requirements on construction projects. A Board letter and report to the Secretary of Energy, dated August 6, 2020, includes a summary of the Board's review of the 12-98 and 12-96 lead-in replacements [9]. On December 16, 2020, NNSA issued a letter to the Board agreeing with the Board's safety concerns and identifying corrective actions [10]. The Board agreed with the proposed corrective actions and subsequent improvements CNS made to its construction management processes and stated that it considered the safety issue closed in a letter to NNSA on November 10, 2021 [11].

From 2021 to 2022, the Board's staff conducted a review of the Pantex welding program. The review examined quality assurance aspects of procuring and handling welding electrodes and welded products (e.g., special nuclear material containers and special tooling), as well as safety-related welding for facility upgrades (repairs and seismic upgrades) and special tooling modifications. The review did not examine subcontractor welding quality assurance. Overall, this review found CNS was implementing a robust welding program at Pantex. The Board communicated opportunities for safety improvement from this review in a letter and report sent to NNSA on February 24, 2023 [12].

Lastly, in 2022, while performing a walkdown of seismic upgrades in a 12-104 nuclear explosive bay as part of routine safety oversight, a Board's staff member identified a disconnected engineered electrical bond in the facility's equipment interlock. This bond is a credited safety class feature to prevent lightning ingress into the main operations room of the facility. From the subsequent event investigation, CNS determined that the bond had been disconnected as part of a construction activity to replace a fire penetration seal. The engineered bond was not identified in the work scope and should not have been altered by the construction subcontractor without authorization. As a result, CNS reported this incident in ORPS [13] and performed a causal analysis [14]. CNS acknowledged shortcomings in the work package (i.e., it did not identify the bond as a peripheral feature that might interfere with the fire penetration seal replacement activity) as well as the failure of return-to-service walkdowns to identify the disconnected bond after construction activities were completed. The causal analysis identified improvements that CNS subsequently made to work planning and facility walkdown processes for return-to-service activities, and the need for construction subcontractors to follow the formal installation change request process.

CNS Quality Assurance Program—CNS implements ASME NQA-1[2] requirements on nuclear facility construction projects through several governing documents and processes. The CNS quality assurance program is defined in E-SD-0002, *Quality Assurance Program Description* [15], which identifies key quality assurance activities and discusses organizational roles and responsibilities. The CNS CGD process is described in E-SD-2024, *Commercial Grade Dedication Program* [16]. Construction subcontractors work under their own quality assurance and CGD programs, which CNS approves.

Other CNS procedures that apply to the 12-44 false ceiling replacement project cover topics such as the following: execution/oversight of projects, evaluation/approval of suppliers, receipt inspections, management of non-conforming items, and storage of NQA-1 materials. The CNS Quality Approved Supplier List (QASL) identifies approved suppliers and the due dates for those suppliers to be either requalified or removed from the list. CNS qualifies suppliers for the QASL either through CNS supplier audits or third-party audits.

The construction subcontractor for the 12-44 ceiling replacement is on the CNS QASL, as are the suppliers from whom the subcontractor and CNS procured construction materials. For the 12-44 false ceiling replacement, the construction subcontractor either performed CGD activities itself or used outside certified testing laboratories to conduct those activities. CNS supervised all construction subcontractor CGD testing activities to assure subcontractor compliance with quality requirements.

Staff Review. To follow up on past construction quality assurance issues at Pantex, the staff team performed a detailed review of a construction work package for the 12-44 false ceiling replacement project. The scope of the recent upgrades at 12-44 Cells 5 and 6 included replacement of the wood false ceiling, deluge fire suppression system, electrical and ventilation equipment above the ceiling, compressed air system, and high explosive contaminated vacuum system. The staff team reviewed quality assurance aspects of the work package and evaluated enhancements CNS made to facility return-to-service practices. In addition, the staff team also reviewed design and analysis documentation and drawings associated with false ceiling replacement activities. The goal of the review was to confirm that CNS remains on a path of continuing improvement for construction quality assurance. The staff team reviewed project deliverables including: purchase order documentation from local, non-NQA-1 suppliers; procurement records from approved NQA-1 suppliers; CGD plans; CGD test records; testing calibration records; material test reports; material and equipment custody reports; installation records; weld records; and welding electrode storage records.

The staff team performed its on-site review the week of September 11, 2023. The review also included numerous staff observations of the demolition of the wood ceilings and construction of new ceilings from April 2022 through March 2023. During the September 2023 visit, the staff team discussed lines of inquiry with CNS and NNSA Production Office personnel, examined completed ceilings, and visited the construction subcontractor's on-site storage location for welding electrodes.

[2] The version currently implemented by CNS is NQA-1-2008, with the NQA-1a-2009 and NQA-1b-2011 addenda.

Staff Observations. The staff team identified opportunities for safety improvement in the following areas: (1) improper use of cast iron fittings in fire suppression system piping, (2) use of uncalibrated time measurements, (3) CGD by hydrostatic testing only, (4) modification of calibration records, (5) missing or inconsistent quality assurance records, (6) analysis errors, and (7) welding electrode storage practices. CNS conducted a follow-on assessment to address concerns identified during the staff team's review [17], and the staff team found CNS's assessment to be thorough. The staff team agrees with the corrective actions CNS identified. In addition, the staff team found that CNS and the subcontractor effectively implemented corrective actions to address past deficiencies with facility return-to-service practices. The staff team's observations and CNS's corrective actions from the 12-44 false ceiling replacement review are discussed below.

Cast Iron Fittings—During the review, the staff team questioned why the construction subcontractor used cast iron fittings in the new deluge fire suppression systems, contrary to the requirements and guidance in DOE directives. DOE Standard 1066-2023, *Fire Protection* [18], states, "[t]he following sprinkler components should not be used:…Cast iron pipe fittings," and DOE/EH-0545, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities* [19], considers cast iron as an outlier material and discourages its use. However, DOE/EH-0545 states that cast iron fittings may be considered acceptable if they can be shown to be subject to low seismic and impact loads.

For the nuclear power industry, Electric Power Research Institute (EPRI) report NP-6041 [20] notes, "the use of cast iron pipe is a potential problem since it does not have the strength or ductility of steel, and usually has low capacity connections." EPRI report 1019199, *Experience-Based Seismic Verification Guidelines for Piping and Tubing* [21], states: "[t]he materials used in the piping system must not be susceptible to brittle fracture under seismic loading. Of particular concern is the use of brittle piping materials such as fiberglass, PVC [polyvinyl chloride], cast iron or cast iron valve bodies. Such materials have failed in past strong motion earthquakes." EPRI report 1019199 also provides historical examples of cast iron component failures from seismic events.

CNS further investigated the concern and determined that the presence of cast iron fittings in cell fire risers could pose an impact hazard to nuclear explosive operations in the 12-44 Cell 5 and 6 round rooms (main operations areas) during a seismic event. Unlike other nuclear explosive cells at Pantex where fire risers are in support areas outside the round room, the 12-44 cells' deluge riser assemblies are located within the round rooms. In January 2024, CNS determined a potential inadequacy of the safety analysis existed [22], held an investigation and critique, and filed an occurrence report [23], categorizing the event as 3A2(L)—i.e., a "violation or noncompliance of a credited hazard control."

CNS subsequently determined the concern represented an unreviewed safety question [24] and conducted a causal analysis. CNS implemented operational restrictions that require nuclear explosives, nuclear materials, and explosives within the falling distance of the deluge riser to be in a transportable configuration (e.g., within an enhanced transportation cart). In addition, CNS is prohibiting the use of cast iron fittings on upcoming construction projects. Figure 3 shows a cell deluge riser from a 12-44 cell.

CNS has since determined cast iron fittings were also installed in new risers in four nuclear explosive bays in Building 12-104 and a corridor through which nuclear explosives pass. Although the risers for nuclear explosive bays are in the equipment interlock where nuclear explosives pass for a short period of time in an approved transportation configuration, the Pantex safety basis identifies seismic qualification of appurtenances in both interlocks and main operating bays as a planned improvement. CNS determined that changes made to site-wide and project-specific specifications allowed cast iron fittings to be installed on new construction projects [25]. CNS believes this allowance was introduced into specifications in 2017; however, CNS is still evaluating the timeline. CNS is currently investigating why these changes were made and what process was followed to approve them.

The CNS assessment conducted in response to this review identified that the use of cast iron fittings did not meet NQA-1, Requirement 3 for design control. As a follow-up, the Board's staff is considering plans to evaluate the extent to which cast iron fittings exist within fire protection systems at other DOE sites.

Figure 3. *12-44 Cell Fire Suppression Deluge Riser*

Uncalibrated Time Measurements—During the review, the staff team identified that the subcontractor conducted certain CGD tests using uncalibrated time measuring equipment, and CNS agreed this practice should not have occurred. These tests included those of compressed air pressure regulators, compressed air valves, and pull tests on ceiling hatch doors. The compressed air system is a credited design feature in the Pantex safety basis [26] that is required to not fragment below a certain pressure[3], and this safety function is verified by pressure testing. This pressurization testing demonstrates the tested components do not pose a fragmentation hazard to nuclear explosives co-located in the same operational area. As for door hatches, the CGD testing plan requires a timed pull test as part of confirming the door does not pose a falling hazard to operations below. The staff team recognizes that aside from these limited examples of CGD testing deficiencies, most tests were conducted with properly calibrated and controlled equipment.

The CNS assessment for this concern identified that the use of uncalibrated time measuring equipment did not meet NQA-1, Requirement 12 for control of measuring and test equipment. Specifically, NQA-1 states: "[t]ools, gages, instruments, and other measuring and test equipment used for activities affecting quality shall be controlled, calibrated at specific periods, adjusted, and maintained to required accuracy limits." CNS is updating its sitewide construction master specifications to clarify that only calibrated equipment should be used. CNS also recognized that its supervision of subcontractor CGD testing should have identified this testing deficiency, particularly since CNS considers itself to be the accredited testing laboratory for subcontractor CGD tests. Lastly, the CNS Quality organization plans to communicate to other CNS organizations the importance of understanding and complying with testing calibration requirements.

Hydrostatic Testing—The staff team identified that CNS CGD plans for fire protection fittings no longer require the verification of material chemical composition [27] [28]. Instead, CNS solely relies on the final constructed system to pass a hydrostatic test to demonstrate adequacy of the subcomponents, such as the fittings. However, a local supplier provided fittings for the false ceiling replacement and did not provide documentation to demonstrate traceability to the manufacturer. In the absence of such documentation, the hydrostatic test does not provide sufficient evidence for CGD, as it only evaluates the ability to withstand a static load. It does not verify other required material properties, such as ductility and corrosion resistance. Material traceability or verification of material chemical composition is needed to provide assurance of fitting composition. Verification of material composition would, for example, be important for distinguishing fittings made of malleable iron and a less favorable material such as cast iron, both of which could pass a hydrostatic test.

Calibration Records—The staff team identified several calibration records that the construction subcontractor had altered without concurrence from the accredited laboratory that performed the calibration service. CNS informed the staff team that it approved the extended expiration date for items it considered as not vulnerable to wear or change (e.g., calibrated weights or threaded gauges). CNS agreed that the subcontractor should not have altered the original calibration records and instead should have included the justification for extending the

[3] The upper pressure limit of the Pantex Zone 12 South compressed air system is protected by safety class rupture discs and pressure relief valves near the system compressors.

due date as an attachment to the calibration records. CNS has instructed the subcontractor to not alter original calibration records in the future.

Quality Assurance Records—The staff team identified inconsistencies between some quality assurance records. For example, certain CGD tests were performed outside the range that a CGD plan specified (e.g., hydrostatic test pressure for fittings were conducted at pressures greater than the range specified in CGD plans). The staff team found that further actions could be taken to ensure CGD plans, testing procedures, and final test reports are consistent, and differences are documented/justified as part of the final work package deliverable.

In addition, the staff team identified examples of missing quality assurance records, including certain calibration and material testing records. However, most documentation was included in the final work package, and CNS later located the missing items. Based on these observations, CNS recognized it did not meet NQA-1, Requirement 17 for control of quality assurance records and that it should have identified the missing records during its own review. CNS developed a corrective action to reinforce that CNS organizations involved in testing and acceptance activities should verify completeness and accuracy of construction deliverables.

Errors in Analysis—During a review of design calculations [29] [30] [31] [32], the staff team identified misapplication of scaling factors in the analysis of self-tapping screws. These screws are the primary fasteners used to connect the ceiling's cold-formed steel framing members. Per manufacturer data sheets, certain cited strength values for self-tapping screws can be scaled based on the strength of the base metal (i.e., the material being screwed into). An example of this is pull-out strength, where a higher base metal strength would result in a higher pull-out strength.

The staff team identified that scaling factors based on base metal strength were applied to the ultimate shear strength capacity checks for screws, which is inappropriate. CNS agreed this scaling should not have been performed, updated the affected analyses, and verified that design conclusions were not affected. CNS stated that the updates to the calculations will prevent reoccurrence of the error in future analyses since the corrected calculations would be consulted prior to performing similar analyses.

Subcontractor Rod Oven Room—NQA-1 low hydrogen electrodes are required to be held in a certain temperature range to prevent introduction of moisture that could degrade weld quality. The construction subcontractor for the false ceiling replacement project stores welding electrodes in its Amarillo warehouse and stages them in its on-site laydown yard trailer prior to use. While the subcontractor receives an indication of loss of power at its warehouse, it does not have any indicator of loss of power to its laydown yard trailer. The staff team identified that the subcontractor could benefit from additional measures to provide indications of loss of power to its trailer electrode oven; this could be beneficial if there are extended periods where the trailer is not regularly visited.

Conclusion. Overall, the staff team found CNS and its subcontractors applied appropriate quality assurance practices for the 12-44 cells false ceiling replacement project. Although the review identified several observations that can improve quality assurance on future

construction projects, the staff team concludes that CNS continues to make improvements to its construction quality assurance practices. CNS conducted a thorough assessment of the staff team's safety concerns and is taking appropriate corrective actions. As for the use of cast iron fittings within fire protection systems, the staff team agrees with CNS's path forward to no longer use these in new construction projects. The staff team will continue to follow Pantex's progress in resolving this issue for facilities where cast iron fittings already have been installed. As a follow-up, the Board's staff is considering plans to examine the extent to which cast iron fittings have been installed at defense nuclear facilities at other DOE sites. It would be prudent for DOE to perform similar extent of condition activities.

References

[1] Consolidated Nuclear Security, LLC, *Letter to J. Armstrong, Assistant Manager for Nuclear Safety and Engineering, National Nuclear Security Administration Production Office, regarding legacy conditions of approval and planned improvement upgrades*, February 28, 2019.

[2] Defense Nuclear Facilities Safety Board, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*, Recommendation 2019-1, February 20, 2019.

[3] Pacific Northwest National Laboratory, *Pantex Plant Cell 12-44-1 Tritium Release: Re-Assessment of Environmental Doses For 1990 to 1992*, March 1994.

[4] Consolidated Nuclear Security, LLC, *(U) Bays and Cells SAR*, AB-SAR-333384, Rev. 166, December 13, 2023.

[5] BWXT Pantex, *Building 12-44 Production Cells Upgrade Phase 1 Cells 2-4 As-Constructed Drawings*, December 18, 2006.

[6] American Society of Mechanical Engineers, *Quality Assurance Requirements for Nuclear Facility Applications*, NQA-1-2008 (w/ 2009 and 2011 addenda).

[7] Department of Energy, *Zone 12 South facility return to work identified concrete quality problem*, ORPS Final Report NA--NPO-CNS-PANTEX-2016-0030, July 21, 2016.

[8] Department of Energy, *Design changes must be formally reviewed, even when the change is from reduced requirements*, DOE Lessons Learned PMLL-2016-PTX-OTH-10857, December 1, 2016.

[9] Defense Nuclear Facilities Safety Board, *Letter to D. Brouillette, Secretary of Energy, regarding quality assurance measures applied to 12-96 lead-in replacement*, August 6, 2020.

[10] National Nuclear Security Administration, *Letter to T. Summers, Acting Chairman of the Defense Nuclear Facilities Safety Board, regarding safety issues with identification and control of requirements for Pantex construction projects*, December 16, 2020.

[11] Defense Nuclear Facilities Safety Board, *Letter to J. Hruby, Administrator of the National Nuclear Security Administration, regarding closure of safety issues for identification and control of requirements for Pantex construction projects*, November 10, 2021.

[12] Defense Nuclear Facilities Safety Board, *Letter to J. Hruby, Administrator of the National Nuclear Security Administration, regarding a review of safety-related welding at Pantex*, February 24, 2023.

[13] Department of Energy, *Engineered Bond Not Connected (Zone 12)*, ORPS Report NA--NPO-CNS-PANTEX-2022-0034, March 8, 2022.

[14] Consolidated Nuclear Security, LLC, *E-5293, Causal Analysis and Plan*, February 2022.

[15] Consolidated Nuclear Security, LLC, *Quality Assurance Program Description*, E-SD-0002, Rev. 6, October 12, 2020.

[16] Consolidated Nuclear Security, LLC, *Commercial Grade Dedication Program*, E-SD-2024, Rev. 2, February 14, 2023.

[17] Consolidated Nuclear Security, LLC, *Issues resulting from Defense Nuclear Facilities Safety Board review of 12-44 Cell 5 ceiling replacement*, Organizational Surveillance Report AS-8015, Rev. 0, January 31, 2024.

[18] Department of Energy, *Fire Protection*, DOE Standard 1066-2023, June 9, 2023.

[19] Department of Energy, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities*, DOE/EH-0545, March 1997.

[20] Electric Power Research Institute, *A Methodology for Assessment of Nuclear Power Plant Seismic Margin*, NP-EPRI-6041, Rev. 1, August 1991.

[21] Electric Power Research Institute, *Experience-Based Seismic Verification Guidelines for Piping and Tubing*, Report 1019199, September 18, 2009.

[22] Consolidated Nuclear Security, LLC, *12-44-5 Fire Suppression Riser*, PX-5993, Potential Inadequacy of the Safety Analysis Notification, January 10, 2024.

[23] Department of Energy, *Deficient Seismic Qualification of Fire Risers in specific facilities*, ORPS Report NA--NPO-CNS-PANTEX-2024-0013, January 18, 2024.

[24] Department of Energy, *Positive Unreviewed Safety Question (PUSQ) for deficient seismic qualification of fire risers in specific facilities*, NA--NPO-CNS-PANTEX-2024-0019, January 29, 2024.

[25] Consolidated Nuclear Security, LLC, *12-44 False Ceiling Replacement*, Specification SPC V12044-F-0004, Issue 0, April 6, 2021.

[26] Consolidated Nuclear Security, LLC, *Technical Safety Requirements for Pantex Facilities*, RPT-SAR-199801, Rev. 497, February 15, 2024.

[27] Consolidated Nuclear Security, LLC, *Commercial Grade Dedication Plan: Fittings, Class 150 & 300 Malleable Iron*, CGD-17-295, Issue 6, June 1, 2022.

[28] Consolidated Nuclear Security, LLC, *Commercial Grade Dedication Plan: Cast Iron Flanged Fittings and Flanges*, CGD-18-088, Issue 2, October 10, 2019.

[29] Consolidated Nuclear Security, LLC, *12-44 Cells 5,6, and 8: False Ceiling Supports*, DAC-2432, March 31, 2021.

[30] Consolidated Nuclear Security, LLC, *12-44 Cells 5,6, and 8: Typical Duct, Conduit, and Pipe Supports Above the False Ceiling*, DAC-2433, March 31, 2021.

[31] Consolidated Nuclear Security, LLC, *12-44 Cells 5, 6, and 8: Fire Pipe Supports Above the False Ceiling*, DAC-2434, March 31, 2021.

[32] Consolidated Nuclear Security, LLC, *12-44 Cells 5, 6, and 8: Typical Light Support to False Ceiling Structure*, DAC-2435, March 31, 2021.