DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

February 12, 2024

The Honorable Jill Hruby
Administrator
National Nuclear Security Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Administrator Hruby:

The Defense Nuclear Facilities Safety Board (Board) recently conducted a review of the fire protection program at the Pantex Plant. The review evaluated the adequacy of the program—including associated safety requirements; fire hazard analyses; fire prevention practices; fire protection system inspection, testing, and maintenance; and fire department response—against U.S. Department of Energy (DOE) and industry standards.

Overall, the Board found that Pantex is implementing an adequate fire protection program, with all expected major components, consistent with DOE safety requirements and expectations. The review identified opportunities for improvement and several best practices, which are discussed in the enclosed report for the National Nuclear Security Administration's information and use.

Sincerely,

Joyce L. Connery
Chair

Enclosure

c: The Honorable Jennifer Granholm, Secretary of Energy
Ms. Teresa Robbins, NNSA Production Office Manager
Mr. Jason Armstrong, NNSA Production Office Manager at Pantex
Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

November 8, 2023

Review of the Pantex Plant Fire Protection Program

Summary. Members of the Defense Nuclear Facilities Safety Board's (Board) staff conducted a review of the Pantex Plant fire protection program, with a focus on (1) program administration; (2) fire hazard analyses; (3) wildland fire; (4) fire protection system inspection, testing, and maintenance; (5) high pressure fire loop performance and upgrades; (6) administrative controls; and (7) emergency services.

The staff review team found the program to be adequately established and generally functioning well. The staff review team did identify some opportunities for improvement related to fire protection system impairments, false alarms, and requirements for manual fire extinguisher use within the Pantex technical safety requirements (TSR).

Background. On March 28–31, 2022, the staff review team met on-site with personnel from the Pantex management and operating contractor, Consolidated Nuclear Security, LLC (CNS), and the National Nuclear Security Administration Production Office (NPO) to discuss detailed lines of inquiry related to the fire protection program, visit applicable facilities, and observe fire department response during an emergency exercise.

The staff review team had numerous follow-up questions, requiring the team to request and review a significant number of additional documents. The staff review team followed up with a March 29, 2023, teleconference with NPO and CNS personnel. The staff review team also held factual accuracy teleconferences on July 12 and July 26, 2023, to ensure that the team properly characterized its observations.

Discussion. The staff review team identified the following opportunities for improvement:

Fire Protection System Impairment Communication—Pantex currently uses a continuously updated form, *Fire System Impairment Status Report*, PX-5699, to track fire protection system impairments [1]. Due to the way this form is maintained, the notification to the Emergency Services Dispatch Center (ESDC) on impairments is not always timely. Consequently, communications of impairment changes among CNS Fire Protection Engineering, the Impairments and Restoration Group, and ESDC sometimes experience notification lag. CNS stated that when notification lag has occurred, it was typically on the order of a day or so between the start of impairment and the time of notification.[1]

[1] The staff team found that impairments to nuclear facility systems require additional clearances/reviews and are much less likely to experience delayed communication of impaired status.

Knowledge of impaired systems and alarms is particularly important to ESDC, as these could delay or hamper emergency response. For example, an impaired fire hydrant could affect emergency responders if they attempt to use it because they are unaware that it is out of service. CNS is undertaking a new effort to separate fire alarm signal issues that directly impact dispatch from other impairments. This effort includes repurposing form PX-5699 to include only fire alarm signal information, as well as continued use of a new separate fire protection engineering spreadsheet to track system impairments. CNS's goal is to provide immediate notification to ESDC for all fire system impairments. The staff review team agrees with this goal given the potential impact on emergency response.

In addition to delays in notifying ESDC, the current impairment data categorization is not conducive to prioritize repairs. For example, there is little differentiation between short-term and long-term impairments, which can be used as a part of prioritization. Figure 1 shows the length of impairments in the short-term, long-term, and fire hydrant categories from Pantex impairment data. As seen in Figure 1, there is significant overlap in the length of impairments considered "short-term" and "long-term." The fire hydrant category in the figure demonstrates that these impairments could be considered either short- or long-term.

Poor categorization of impairments can hamper proper prioritization of repairs to impaired systems. CNS stated that a part of the new effort to track impairments will include redefining what constitutes a short- or long-term impairment, as well as additional categorization. CNS has already made some improvements to impairment data categorization, such as removing abandoned systems from the long-term category. The staff review team agrees with this approach and considers that additional study of impairment data categorization could further improve prioritization of repairs.

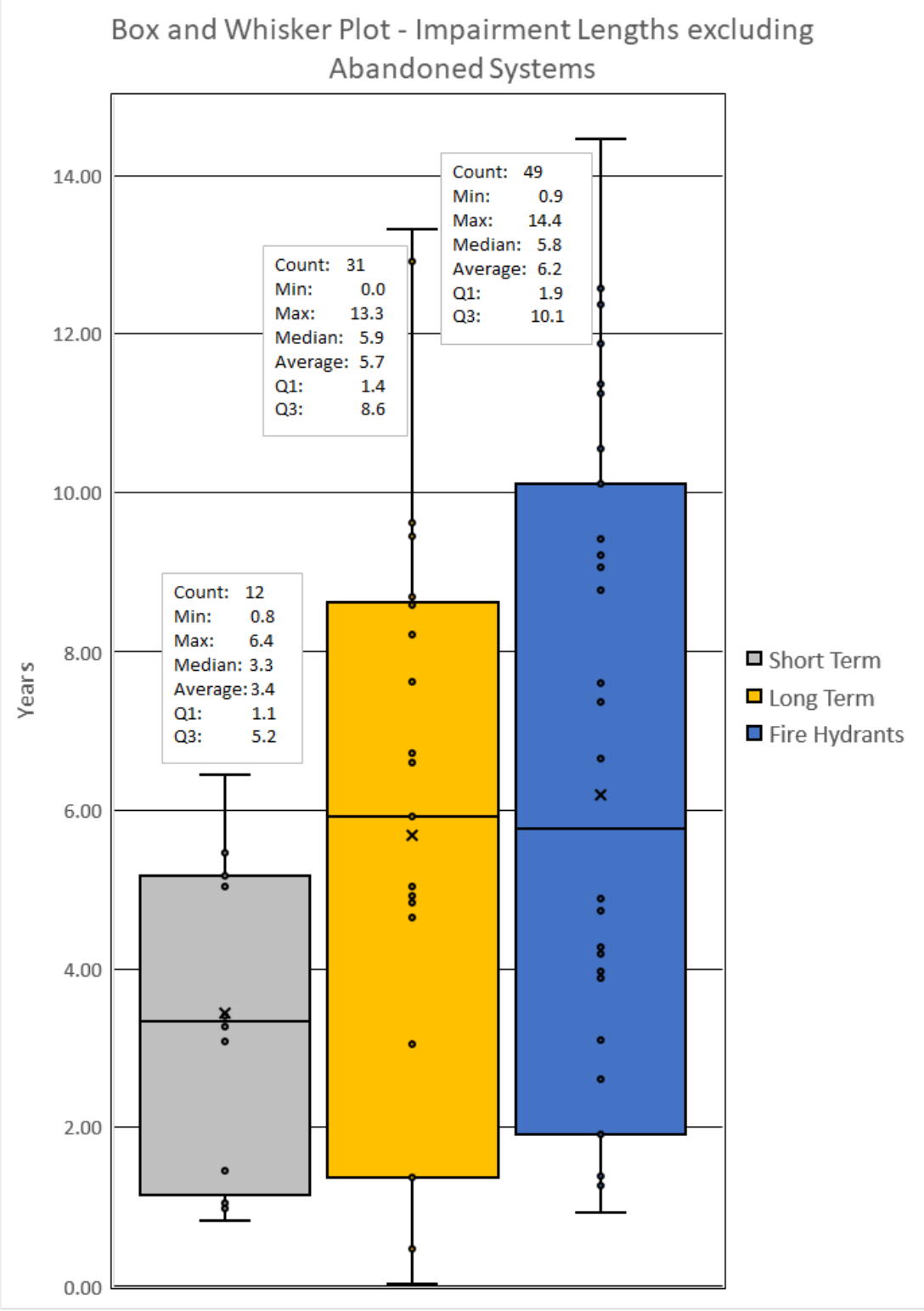

Figure 1. *Comparison of Short-Term and Long-Term Impairments*

Unresolved Signals Disposition—The number of facilities with unresolved signals has been consistently unsatisfactory per site goals.[2] Unresolved signals are fire alarm-type signals that are active but have not yet been addressed. Typically, these signals are trouble or supervisory conditions such as ground faults or valve monitoring problems, as opposed to alarms. In the summer of 2022, CNS implemented an updated prioritization scheme and dedicated a crew of craft workers to resolving fire protection system issues, including unresolved signals. Under this updated scheme, the number of facilities with unresolved signals has been reduced through a combination of correcting problems and temporarily suppressing signals. This suppression method, termed "resistoring out" in the impairment data, involves installing an end-of-line resistor in the device wiring circuit to force the device to report a normal condition to the fire alarm panel.

The primary concern with suppressing a fire alarm trouble or supervisory signal is that the status of the device will no longer be known, which could delay notification of a pending problem or system degradation. For example, a low-pressure switch on a dry pipe sprinkler system provides an indication that the system is losing pressure and could trip soon. If this occurred during winter, the tripped valve could charge the system with water in very cold conditions, potentially leading to pipe freeze. Notification would only occur via a flow switch when water is already moving into the cold pipes. CNS stated that most of the cases in which end-of-line resistors have been installed are for difficult to repair issues and consist mostly of tamper switches on post indicator valves for the underground fire mains. In this case, the tamper switch will not report when the valve is closed; however, the valves can be administratively controlled (i.e., locked open) and are less of a concern than other devices such as the pressure switch example mentioned above.

The monthly metrics data report from April 2023 [2] states that 35 of 54 devices with end-of-line resistors installed were for post indicator valves. Some of the remaining 19 devices from the report are devices other than valve tamper switches, which may not have available administrative controls that are as easy and effective as the one for valves. The staff review team is aware that NPO is actively engaged with CNS in addressing the number of unresolved signals.

High Number of False Alarms—The percentage of Pantex fire department calls that are false alarms is high compared to national data provided by the National Fire Protection Association (NFPA). Table 1 provides basic data on the number of Pantex fire department calls and false alarms between 2017 and 2021. Depending on whether mutual aid calls are included in Pantex false alarm data, the percentage of calls that are false alarms ranged between 32 and 58 percent from 2017 to 2021. (Note that the percentage of calls that are false alarms is greater when mutual aid calls are excluded.)

[2] The number of facilities with unresolved signals had typically been much greater than the goal of 30. After implementation of an updated prioritization scheme in 2022, the number of facilities decreased steadily to between 15 and 20 in early 2023. CNS subsequently lowered the goal to 17 facilities with unresolved signals.

Table 1. *Pantex False Alarm Data 2017-2021*

Year	False Alarms	Total Annual Calls	Total Annual Calls without Mutual Aid Calls	False Alarm % (all calls)	False Alarm % (without mutual aid calls)
2017	179	369	308	49	58
2018	125	387	303	32	41
2019	154	409	331	38	47
2020	116	358	296	32	39
2021	171	406	314	42	55

NFPA collects annual nationwide fire department response statistics, including the number of false alarm responses. Between 1980 and 2021, the percentage of fire department responses attributed to false alarms has varied from 7 percent to 11 percent of all responses in any given year [3]. Between 2017 and 2021, the percentage of alarm responses attributed to false alarms was 7 to 8 percent, which is less than that observed at Pantex.

NFPA response statistics also include a broad category entitled "All Other Responses" with examples such as smoke scares and lockouts, which could include some false alarms. Between 1980 and 2021, the percentage of fire department responses included in this category has varied from 10 percent to 18 percent of all responses in any given year. Though all responses in this category are very unlikely to be considered the result of false alarms, adding the "all other responses" to the false alarm responses yields a maximum possible nation-wide nuisance alarm response of approximately 26 percent. This false alarm response rate is still lower than the 32 to 58 percent observed at Pantex.

Minimizing false alarms is important because they could delay response to an actual emergency if they occur at the same time. Time taken to respond to false alarms could also be better spent on other endeavors such as training or inspections. CNS stated that the main sources of false alarms at Pantex are water flow alarms associated with system surges and dry pipe trips, inadvertent duct smoke detector alarms, manual fire alarm pull station malfunctions, and fire panel malfunctions. CNS stated that it has made progress in reducing false alarms associated with water flow alarms, which constitute the bulk of false alarms at the site. However, even with this reduction, the false alarm rate is still high and warrants further investigation to determine whether the rate can be reduced.

Use of Manual Fire Extinguisher in TSRs—The current TSRs for Pantex [4] incorporate an operator action of manually extinguishing a fire in defense nuclear facilities. The TSRs should not rely on operator actions that are broadly considered optional (i.e., fighting a fire). TSR section 5.7.33.7.1.b states the following operator actions for personnel routinely performing work in the facility:

> *If the fire has not involved nuclear material, personnel* ***should attempt to extinguish*** *the fire using a fire extinguisher or other method and move any [Thermally Sensitive Components (TSCs)] away from the fire; or* ***if unable to extinguish the fire****, move the TSCs away from the fire, manually activate the Deluge Fire Suppression System, if one exists, and if the bay inner interlock door can close, close the door, and evacuate the facility* [emphasis added].

The training materials for this TSR [5, 6] incorporate similar "should attempt to extinguish" language, which suggests an expectation that personnel will attempt to extinguish some fires. However, the site fire extinguisher training [7] uses the more permissive language: "Personnel **may choose** to extinguish the fire or evacuate the facility" [emphasis added]. The fire extinguisher training is consistent with traditional fire protection philosophy, which emphasizes that attempting to manually extinguish a fire is a personal choice.

CNS reiterated that personnel always have a choice whether to attempt to extinguish the fire or to evacuate the facility. For nuclear explosive facilities, if personnel are uncomfortable attempting to extinguish a fire, they are allowed to evacuate and manually activate the deluge suppression system. At the time of this review, CNS was revising the TSRs to remove this requirement and provided a proposed safety basis change package to NPO for review. If approved, CNS plans to implement the requirement changes in 2024.

Observations. During its review, the staff team also identified the following:

Fire Hazard Analysis (FHA) Discussion of Building Code Occupancy—FHAs for 12-116 [8] and 12-104 [9] do not currently include a discussion in Chapter 2 on occupancy type, area/height limitations, and required separations as they relate to the International Building Code and/or Uniform Building Code. These FHAs inappropriately conclude that the facility construction meets requirements of national consensus codes (including building codes) without including this discussion. This approach is also inconsistent with other Pantex FHAs, which include the information. For example, the 12-64 FHA [10] includes a detailed discussion on International Building Code occupancy types in the facility. This discussion includes the potential application of high-hazard (H-3), storage (group S), and industrial (F-2) occupancies, with a focus on the presence of explosives or other operations. Specific height and area limitations are also described along with required fire separations for these occupancy types. This staff observation is not meant to convey a building code-compliance issue with 12-116 and 12-104, but rather that the FHA discussion on these topics is incomplete.

Confusing Presentation of Metrics for Preventive Maintenance (PM)—The monthly report of fire protection metrics notes fire system PM activity in terms of "Overdue PMs," "New PMs," "Completed PMs," and "Cancelled PMs." Figure 2 shows an example of the presentation of monthly PM metrics.

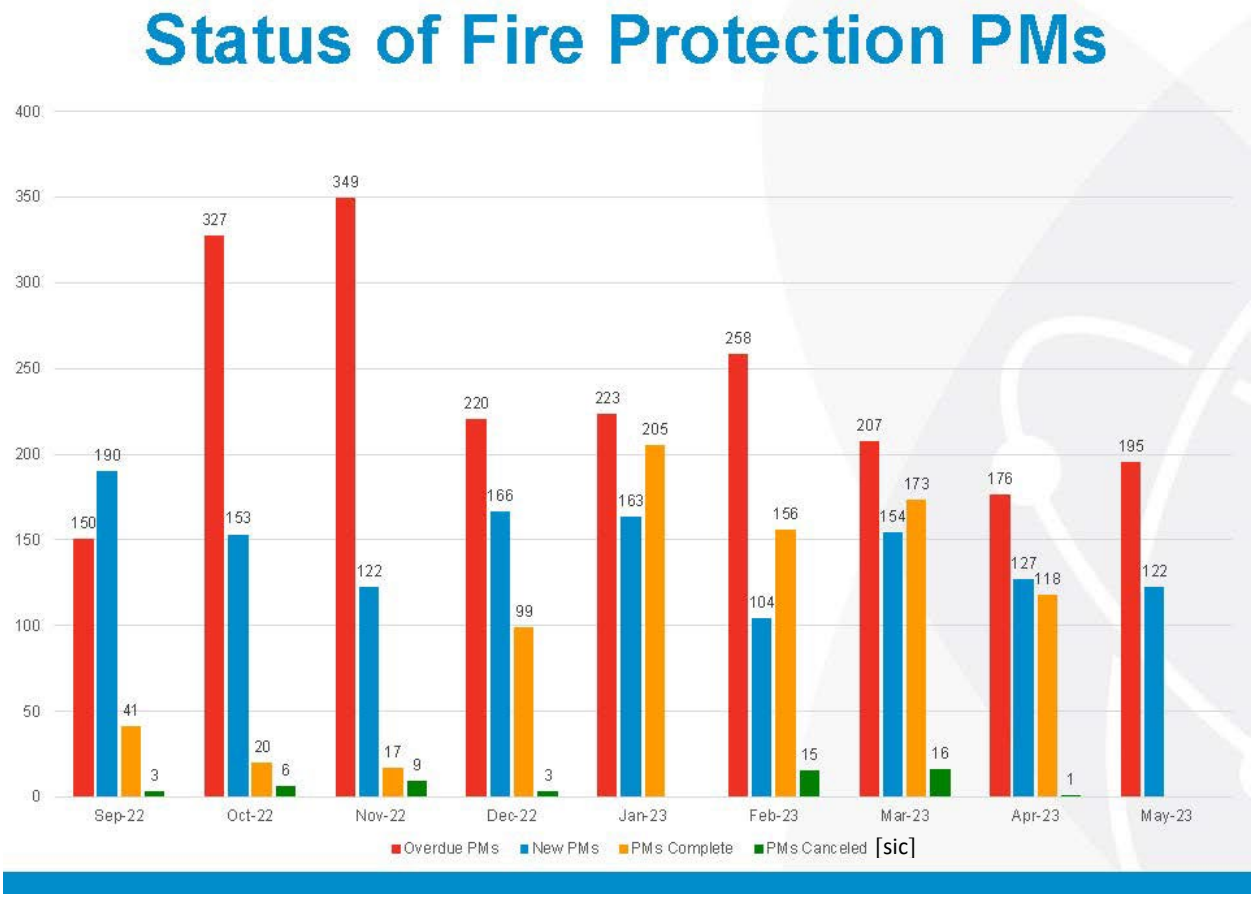

Figure 2. *Categorization of Preventive Maintenance in Monthly Metric Report [2]*

As suggested by the category title "Cancelled PMs," it appears that CNS cancelled fire protection maintenance activities on a regular basis. CNS clarified that the category of "Cancelled PMs" in the Pantex site fire protection maintenance data consists of two subcategories:

1. Nested maintenance tasks that are conducted as part of longer-period activities. For example, quarterly maintenance tasks may be conducted as part of semi-annual and annual tasks, so those quarterly tasks are cancelled within the maintenance tracking system.

2. Scheduled maintenance tasks that are cancelled within the system and subsequently not performed.

CNS stated that most, if not all, "Cancelled PMs" fall into the first category, and that no systems in defense nuclear facilities fell into the second category. While the staff review team now understands this nuance, CNS should consider revising the presentation of PM data in the monthly metric report to more clearly depict how many PMs are cancelled and not performed.

Misalignment of Combustible Control Procedure and Combustible Loading Dispositions (CLD)—There is general alignment with the CLDs and the combustible control procedure, P7-0040 [11]. However, there are some instances where P7-0040 lists a combustible standoff distance but there does not appear to be any related distance provided in the CLD. To ensure fire safety is maintained, the technical basis for combustible standoff distances must be properly documented. Examples where CLDs omit standoff distances used in P7-0040 include CLD-005, *LINAC Bays Combustible Loading Disposition* [12], and CLD-006, *Mass Properties Combustible Loading Disposition* [13].[3] CNS stated that the information in procedure P7-0040 is accurate and that some CLDs require updating to match this document. CNS is undertaking a broader look at CLDs and is updating them as a part of a combustible controls safety basis improvement initiative.

Fire Alarm Ground Fault Testing—The annual fire alarm maintenance procedure [14] does not include testing of alarm functions during a system ground fault condition, as required by NFPA 72 [15]. To ensure proper operation of fire alarm systems, testing required by NFPA 72 must be performed. CNS stated that this test is conducted only during initial system acceptance but agreed that NFPA 72 could be interpreted to require this test annually. CNS is seeking a formal interpretation from NFPA on this issue and will determine a path forward once NFPA provides an answer.

Best Practices. The staff review team identified the following best practices and improvements implemented prior to and during the course of this review.

Fire Damper Evaluation and Documentation—In 2014, Pantex declared a TSR violation when a fire protection engineer discovered no fire damper within the task exhaust duct that breached a credited fire barrier within a special nuclear material facility. As a corrective action, Pantex conducted extent of condition reviews that identified other missing fire dampers within defense nuclear facilities and safety concerns over maintaining difficult-to-access dampers. Over several years, Pantex evaluated each credited fire damper to determine an appropriate path forward and implemented solutions, which included installation of new dampers, improving access to existing dampers, and providing technical justifications where new dampers would not be installed.

The staff review team has been following this effort closely and found the ultimate solutions to be appropriate and now nearly complete. CNS is working to incorporate the remaining technical justifications into some FHAs for not installing new fire dampers in certain locations. Of note, CNS has modified three FHAs to incorporate detailed disposition of fire damper issues into the text, including the FHAs for 12-44 [16], 12-64 [10], and 12-86 [17]. For other FHAs—i.e., the FHAs for 12-84 [18], 12-85 [19], 12-96 [20], 12-98 [21], 12-99 [22], and 12-104 [9]—CNS has appended a detailed fire damper checklist (form PX-4453) containing similar information to that incorporated into the 12-44, 12-64, and 12-86 FHAs. CNS plans to

[3] Omitted standoff distances in CLD-005 include those for empty, approved non-combustible containers, including associated foam lining/packaging and Celotex packing material, and items in Section 4.2.38. Omitted standoff distances in CLD-006 include those for the PCMA computer terminal and associated combustibles; empty approved containers opened with packaging material exposed; HFE-7100 IPA solvent (nonflammable) in Repipet II container with plastic dispenser; and gloves and packaging materials.

incorporate the detailed information from the PX-4453 forms into the body of the FHAs during the next update.

Fire Suppression System Maintenance Procedure Updates—CNS is revising the series of fire suppression system maintenance procedures to incorporate various improvements. For example, CNS intends to:

- Use the NFPA 25 [23] pressure-change threshold for investigating potential problems (i.e., 10 percent change from prior test versus the previous 20 psi threshold). CNS has since implemented this change within the applicable maintenance procedures.

- Incorporate locations to record observed pressures in the procedure. CNS stated that this has been completed for the 12-44 procedures. The semi-annual, annual, and five-year maintenance procedures for other facilities are in the process of being updated.

- Incorporate specific valve identifiers in procedures. The configuration-controlled drawings for fire suppression systems and valves in the field are being updated to include specific valve labels as the Bay and Cell Upgrade Project progresses. CNS stated that all procedures have been updated to include specific valve identifiers, with the exception of 12-44 Cells 2, 3, and 4.

FHA Preparation Guide Updates—CNS has improved the preparation guide for updating FHAs at Pantex. Specifically, the guide [24] now describes the need to analyze the fire vulnerability of critical safety systems, as well as detail the protection of ventilation inlets from wildland fire embers.

Suppression System Freeze Protection—After a site freeze event in February 2021, CNS implemented specific preventive measures to address freezing of water-based fire suppression systems. These measures include providing additional heating or draining sprinkler systems in applicable locations. CNS has installed additional permanent heating in some facilities and will employ temporary heating in other facilities when necessary. CNS would drain systems as a last-resort effort. For defense nuclear facilities with safety-related sprinkler systems covered by TSRs, entry into limiting conditions for operation would be required when impairing the system. This limiting condition for operation includes the following required actions:

- Placing material-at-risk into a safe and stable configuration;

- Taking other actions as necessary to protect material-at-risk from fire events in the affected area;

- Establishing a fire watch or reducing/removing/containerizing combustibles; and

- Placing the facility in maintenance mode.

The staff review team is aware that use of these compensatory measures for freezing conditions has not been required generally within defense nuclear facilities at Pantex (with the current exception of 12-64), as their fire suppression systems are less likely to be subjected to freezing conditions.

High Pressure Fire Loop (HPFL) Monitoring—CNS actively monitors the status of the HPFL system, including valve status and leak rate, which helps to ensure that the required water pressure and flow rate are available to defense nuclear facilities. The site tracks valve closures using a digital "HPFL Status Board"[4] that shows the impact of closures on the system. In addition to the status board, the CNS Fire Protection Engineering group maintains a complete hydraulic model of the system [25], which allows an assessment of valve closure impacts. CNS also has live leak rate monitoring capability to ensure that HPFL issues are detected before the system approaches its TSR leak rate operability limit of 200 gallons per minute.[5]

Fire Department Staff Involvement—The Pantex Fire Department has endeavored to involve staff in the fire protection program, which helps to bolster staff buy-in. Postings of monthly fire department metrics have been prominently displayed in the main fire house for communication to staff. The department also involved staff in selecting options for new apparatus, to best serve the needs of the responders.

Conclusions. The staff review team found that Pantex is implementing an adequate fire protection program, with all expected major components, consistent with DOE requirements and expectations. The review team identified some opportunities for improvement—related to fire protection system impairments, false alarms, and TSR requirements for manual fire extinguisher use—as well as observations and best practices.

[4] The HPFL Status Board is maintained by the Operations Center and is verified at least weekly by the CNS Fire Protection Engineering group.

[5] Typically, the leak rate is 30-40 gallons per minute. When the leak rate rises above this threshold, CNS initiates an investigation into the cause.

References

1. Consolidated Nuclear Security, LLC, *Fire System Impairment Status Report*, PX-5699, Issue No. 6, Accessed November 2, 2022.

2. Hahn, Justin, *Monthly NPO Fire Protection Meeting – April 2023*, Consolidated Nuclear Security, LLC, April 2023.

3. National Fire Protection Association, *Fire Department Calls*, https://www.nfpa.org/News-and-Research/Data-research-and-tools/Emergency-Responders/Fire-department-calls, National Fire Protection Association, Quincy, MA, Accessed May 24, 2023.

4. Consolidated Nuclear Security, LLC, *Technical Safety Requirements for Pantex Facilities*, RPT-SAR-199801, Revision 466, January 17, 2022.

5. Consolidated Nuclear Security, LLC, *TSR Control Training*, CR 541.45, Revision 015, August 30, 2021.

6. Consolidated Nuclear Security, LLC, *Infrastructure TSR Controls*, CR 190.62, Revision 06A, August 16, 2021.

7. Consolidated Nuclear Security, LLC, *Fire Extinguisher Safety Training*, JT 60.21, Revision 000, September 12, 2019.

8. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12116 Special Nuclear Material (SNM) Component Staging Facility*, FHA-12116, Issue No. 010, July 12, 2022.

9. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Building 12-104 High Explosives Subassembly Facility*, FHA-12104, Issue No. 006B, March 22, 2022.

10. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-064 Assembly and Staging Bays*, FHA-12064, Issue No. 007, May 12, 2022.

11. Consolidated Nuclear Security, LLC, *Combustible Material Controls*, P7-0040, Issue BO, June 20, 2022.

12. Consolidated Nuclear Security, LLC, *LINAC BAYS Combustible Loading Disposition*, CLD-005, Issue No. 005, April 8, 2020.

13. Consolidated Nuclear Security, LLC, *MASS PROPERTIES Combustible Loading Disposition*, CLD-006, Issue No. 007, June 28, 2021.

14. Consolidated Nuclear Security, LLC, *Electrician's Fire Protection System, Annual, Building 12-44*, TP-MN-03468, Issue 33, July 5, 2022.

15. National Fire Protection Association, *NFPA 72 - National Fire Alarm and Signaling Code*, National Fire Protection Association, Quincy, MA, 2022 edition.

16. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Building 12-44 Cells 002-006 Assembly/Disassembly of Weapons*, FHA-12044 C002-006, Issue No. 007, April 12, 2022.

17. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-086 SNM Component Requalification & Inert Assembly and Testing Facility*, FHA-12086, Issue No. 005B, July 8, 2022.

18. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-084 Assembly Bays*, FHA-12084, Issue No. 007B, March 17, 2022.

19. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-085 Nuclear Explosive Cell*, FHA-12085, Issue No. 006F, March 17, 2022.

20. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-096 Nuclear Explosive Cell*, FHA-12096, Issue No. 009A, March 21, 2022.

21. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-098 Nuclear Explosive Cells*, FHA-12098, Issue No. 006D, March 21, 2022.

22. Consolidated Nuclear Security, LLC, *Fire Hazard Analysis for Bldg 12-099 Assembly/Disassembly Bays*, FHA-12099, Issue No. 007B, March 22, 2022.

23. National Fire Protection Association, *NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, National Fire Protection Association, Quincy, MA, 2023 edition.

24. Consolidated Nuclear Security, LLC, *Guide for the Preparation of Fire Hazards Analysis*, DESKAID-0110, Issue No. 010, April 2020 (estimated).

25. Consolidated Nuclear Security, LLC, *Hydraulic Calculations for Nuclear Facilities Supplied by the HPFL*, EC-08-020, CM Issue No. 001, April 13, 2022.