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**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



May 10, 2022

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

Dear Secretary Granholm:

The Defense Nuclear Facilities Safety Board (Board) conducted a review of the breakdown of Pantex's external dosimetry program that occurred in 2020. The Board identified opportunities for improvement related to both the federal oversight and contractor management of the Pantex external dosimetry program.

The Board determined that the oversight strategy employed by the National Nuclear Security Administration (NNSA) Production Office failed to recognize and provide a preemptive response to address the weaknesses that led to the breakdown of the Pantex external dosimetry program. In addition, the Pantex contractor management strategy was inadequate in responding to early indications of weaknesses in the program, including significant personnel turnover, aging equipment, lack of timely contract maintenance support, and the unavailability of replacement equipment.

NNSA should identify the causes and develop lessons learned regarding the breakdown of the external dosimetry program at Pantex. The Department of Energy (DOE) should communicate these lessons learned across the complex as there are other cases where DOE is relying on aging safety equipment. The enclosed report provides additional details from the Board's review that will assist NNSA in this effort.

Beyond this safety issue, the Pantex Plant has demonstrated challenges in recognizing and preemptively responding to issues, including safety basis documentation content and quality¹, an adverse trend in conduct of operations², and construction quality assurance³. These challenges indicate the need for NNSA to reassess and bolster its oversight strategy to ensure that similar issues are adequately addressed and future potential programmatic breakdowns are prevented. This is particularly important at this time, before and during the upcoming

¹ Board Recommendation 2019-1, *Uncontrolled Hazard Scenarios and 10 CFR 830 Implementation at the Pantex Plant*, February 20, 2019.

² Board Letter to Secretary of Energy, *Pantex Training, Qualifications, and Conduct of Operations*, June 9, 2021.

³ Board Letter to Secretary of Energy, *Structural Quality Assurance of High Pressure Fire Loop Lead-in Repairs at Pantex Plant Cells*, August 6, 2020.

management and operating contract transition, to ensure that the impending changeover does not compound these safety concerns or allow corrective actions to be lost.

DOE's standard for external dosimetry programs, DOE-STD-1095-2018, Department of Energy Laboratory Accreditation Program for Personnel Dosimetry contains a weakness that exacerbated the challenges at Pantex. Compliance with this standard is required to achieve accreditation in accordance with DOE's Laboratory Accreditation Program (DOELAP), which is required by 10 Code of Federal Regulations (CFR) 835, Occupational Radiation Protection. Section 4.7(c) of 10 CFR 835 requires that external dosimetry programs establish "documented provisions to utilize the services of another DOELAP accredited laboratory in an emergency." However, there are no requirements that those provisions be periodically exercised to ensure compatibility between the two programs. If Consolidated Nuclear Security, LLC (CNS) had tested and demonstrated its emergency backup plan with Nevada National Security Site, it could have identified the weaknesses that, if corrected, could have reduced the negative impact of the external dosimetry equipment failures.

In response to the Pantex dosimetry issues, CNS established an enterprise approach to addressing its external dosimetry needs at Pantex and Y-12. Lessons learned from the external dosimetry breakdown warrant attention to prevent recurrence of similar circumstances for the CNS Enterprise program.

Pursuant to 42 United States Code § 2286b(d), the Board requests that NNSA provide the Board with a written report and briefing—within 90 and 120 days of receipt of this letter, respectively—on lessons learned from the Pantex external dosimetry program breakdown and actions to prevent recurrence at Pantex and other defense nuclear facilities.

Sincerely,


Joyce L. Connery
Chair

Enclosure

c: The Honorable Jill Hruby
Ms. Teresa Robbins
Mr. Matthew Moury
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

January 10, 2022

Breakdown of the Pantex External Dosimetry Program

Summary. The Defense Nuclear Facilities Safety Board's (Board) staff review team completed a safety review of breakdown of the Pantex external dosimetry program that resulted in the program's inability to perform its safety management function. The safety review objective was to evaluate the breakdown of the Pantex external dosimetry program and identify opportunities for improvement from the situation.

Based on discussions with the National Nuclear Security Administration (NNSA) Production Office (NPO) and the Pantex contractor, Consolidated Nuclear Security, LLC (CNS), and a review of documents [1 – 7], there are several opportunities for improvement regarding the Pantex external dosimetry program. These improvements may be applicable to external dosimetry programs across the complex and should be considered for other safety programs.

CNS could have prevented the programmatic issues that manifested in 2019 if it had identified and responded to early indications of weaknesses in the Pantex external dosimetry program, including personnel turnover, aging equipment, lack of timely contract maintenance support, and the lack of available replacement equipment. CNS has now established an enterprise-level approach to addressing its external dosimetry needs (i.e., using the Y-12 external dosimetry program equipment across both sites) [8]. The CNS enterprise external dosimetry program would benefit from additional assessments of staffing support, aging equipment, maintenance support, and viability of back-up plans. NPO should also apply lessons learned to ensure that safety oversight strategies are adjusted to prevent the recurrence of degradation issues like those of the CNS enterprise external dosimetry program, as well as in other safety programs.

Department of Energy's (DOE) standard for external dosimetry programs, DOE-STD-1095-2018 [9] contains a weakness that exacerbated the challenges at Pantex. Compliance with this standard is required to achieve accreditation in accordance with DOE's Laboratory Accreditation Program (DOELAP), which is required by 10 Code of Federal Regulations (CFR) 835 [10]. Section 4.7(c) of 10 CFR 835 requires that external dosimetry programs establish "documented provisions to utilize the services of another DOELAP accredited laboratory in an emergency." However, there are no requirements to ensure compatibility between the two external dosimetry programs such as periodically exercising the document provisions between the two DOELAP accredited facilities to ensure compatibility between the two dosimetry programs. If CNS had tested and demonstrated its emergency backup plan, it could have identified the weaknesses that, if corrected, could have reduced the impact that the external dosimetry equipment failures had on its ability to process dosimeter data read by the Nevada National Security Site (NNSS).

Background. All four Pantex thermoluminescent dosimeter (TLD) readers were purchased in 1979 and had been in operation since 1980 [1]. In the fall of 2019, CNS identified age-related degradation problems with the TLD readers that impacted the ability to monitor external radiation doses for Pantex workers. In June 2020, CNS identified that all four Panasonic TLD readers at Pantex were inoperable and began pursuing alternative options.

DOE-STD-1095-2018 requires that external dosimetry programs “have documented provisions to utilize the services of another DOELAP accredited laboratory in an emergency” [9]. Pantex had an agreement in place with NNSS to provide those services to Pantex [11]. In June 2020, Pantex requested that NNSS read Pantex’s first quarter 2020 dosimeters. Both sites used similar equipment, but each used different methods and parameters to calibrate the systems. The NNSS results were therefore inconsistent with Pantex operations, and CNS determined that Pantex TLD data read by the NNSS external dosimetry system could not be easily converted to doses for the workforce.

In July of 2020, CNS decided to consolidate the Pantex and Y-12 external dosimetry programs into a CNS enterprise external dosimetry program serviced by Y-12 [12]. This decision precluded the need to update or replace the existing equipment at Pantex. Table 1 provides a summary of key events.

The review team held two virtual interactions with CNS and NPO personnel on April 29, 2021 and August 26, 2021 regarding CNS’s responses to the staff’s agenda on the Pantex external dosimetry program. On May 10, 2021, the review team had a separate virtual meeting with NPO to discuss agenda questions related to NPO’s oversight responsibilities and strategies prior to, during, and following breakdown of the Pantex external dosimetry program. On June 23, 2021, the staff had a second virtual meeting with NPO to further discuss NPO written responses and proposed future actions.

As part of this review, the staff team considered the role of the DOELAP program within DOE’s radiation protection regulatory and oversight framework. According to DOE Standard 1095-2018, *Department of Energy Laboratory Accreditation Program for Personnel Dosimetry* [9]:

DOELAP accreditation involves performance testing of dosimeters and the documentation of program elements important to the long-term quality assurance of a dosimetry program and its ability to accurately measure, record, and report occupational whole body and extremity dose. Performance testing of dosimeters is conducted in a laboratory setting by the PTL. DOELAP does not evaluate the adequacy of a dosimetry program to accurately measure occupational dose in actual work environments encountered at DOE sites. (Emphasis added.)

Essentially, DOELAP accreditation provides assurance to DOE that a site’s external dosimetry program can accurately and reliably measure and record an exposure to a specified radiation field in a laboratory setting. The cognizant field office is responsible for oversight of a contractor’s processes for applying the accredited system to the work environment; assigning

dose of record to individuals; and the overall management of the routine dosimetry distribution, collection, processing, and record-keeping systems.

Staff Review. The review team evaluated the following information related to the Pantex external dosimetry program:

- Documentation and records,
- Discrepancies for the 2020 Pantex TLD readings by NNSS,
- Adequacy of staffing resources,
- Management of the Dosimetry Quality Assurance Program,
- Adequacy of compliance with 10 CFR 835[10], and
- NPO oversight.

Breakdown of Pantex External Dosimetry Equipment—Pantex had contracted with Radiation Detection Company (RDC) to provide routine in-house cleaning, calibration, maintenance, and scheduled servicing from Panasonic for regular preventive maintenance of Pantex’s external dosimetry equipment. Routine maintenance and servicing of equipment is addressed in the CNS external dosimetry technical basis document [13]. Due to lack of prioritization and delays in the procurement process, CNS did not renew the Pantex external dosimetry maintenance contracts in a timely manner between 2015 and 2020.

Despite the lack of maintenance, CNS had determined that the external dosimetry equipment was functioning adequately, given that there had not been any significant or obvious issues prior to 2019. Although issues began arising in early 2019 (e.g., issues that were corrected through cleaning and calibrations), during staff interactions, CNS stated in March 2019 that there was no need to replace the four TLD readers, based on the equipment’s past performance.

Pantex personnel observed significant issues with the Pantex Panasonic TLD readers in the fall of 2019 when reading the third quarter TLDs and were unable to diagnose and resolve the problem, so they contacted their maintenance provider, RDC. RDC determined the likely cause of the problem was age-related degradation of key electronic circuit boards within the Panasonic TLD reading equipment causing intermittent issues.

RDC informed Pantex external dosimetry personnel that replacement dosimeters and parts for the Panasonic readers would no longer be manufactured by the vendor after December 2019. Additionally, CNS recognized that the excess reader parts that Pantex was getting from the Savannah River Site were not compatible with the Pantex Panasonic TLD readers. In December 2019, following RDC maintenance work, the Pantex TLD readers again failed during pre-operational quality control checks and calibration. This caused a delay in processing monthly and quarterly TLDs.

Pantex personnel contacted NNSS for assistance since NNSS is designated as the emergency backup external dosimetry processing facility for Pantex and uses the same type of TLD readers as Pantex. NNSS subject matter experts determined that the TLD readers required cleaning. After NNSS personnel cleaned and calibrated the readers in January 2020, Pantex personnel still experienced a higher-than-expected percentage of abnormal external dosimetry readouts and attempted unsuccessfully to repair the equipment. CNS then declared the Pantex Panasonic TLD readers inoperable in June 2020. The 2019 and 2020 failures of the Pantex external dosimetry TLD readers resulted in:

- Delays in reading TLDs, which postponed personnel dose reports for Pantex workers, visitors, and environmental area monitoring,
- Increases in uncertainty in the accuracy of the results,
- Changes to the Pantex external dosimetry program in 2020 to ease the burden on the external dosimetry system that included reduction in the number of employees required to wear TLDs, and
- Limitations on the issuance and availability of dosimeters for employees and visitors.

Table 1. *Major Events Impacting Pantex Panasonic TLD External Dosimetry Program*

Time Period	Event
Early 2019	CNS experienced cleaning and calibration problems with its four TLD readers, but was able to recover functionality
Fall of 2019	CNS experienced multiple TLD equipment functional failures and was unable to diagnose and resolve problems [12]
	CNS contacted its maintenance vendor who identified the cause as age-related degradation of key electronic circuit boards; the maintenance vendor implemented repairs to the equipment
December 2019	TLD readers again failed to operate properly [12]
	NNSS provided technical assistance and cleaning to the failed TLD readers
January 2020	Abnormal external dosimetry readouts obtained from NNSS, and CNS unable to correct [12]
June 2020	CNS declared all four TLD readers inoperable [12]
July 2020	CNS enterprise external dosimetry program initiated with Y-12 providing external dosimetry services to Pantex [8]

Discrepancies for the 2020 Pantex TLD Readings by NNSS—After NNSS had processed Pantex’s first quarter 2020 dosimeters, CNS discovered that even though Pantex and NNSS use the same equipment, the systems were set up and maintained differently, which resulted in differences in the corrected element readings that affected the accuracy of the dose algorithm output. Although there was an agreement in place for the two sites to support each other per DOELAP requirements, the contractors had not conducted comparison tests of the two systems. DOELAP does not require testing to verify compatible dose assignments based on site specific

algorithm and instrument variability in readout of dosimeters. Software algorithm and calibration techniques are specific to each facility.

Due to instrument and algorithm differences, the calculated doses from the raw data of NNSS-read TLDs yielded dose results greater than would be expected for the work being done by the wearer, thereby requiring investigation. CNS conducted multiple tests to evaluate the differences between the NNSS and Pantex equipment [14] and concluded that the individual whole body radiation dose assigned to everyone was conservative and represented a higher value than prior assigned values from the Pantex site external dosimetry system. NNSA contracted with Stanford Dosimetry, LLC. to review and process the data generated by NNSS external dosimetry readings [15]. NNSA then contracted with Lawrence Livermore National Laboratory to perform an independent review of the Stanford Dosimetry, LLC report [16]. Pantex accepted the Stanford recommendations for the dose readings. Pantex reported that no individual approached the CNS administrative whole body dose level of 750 mrem per year. The review team evaluated the reports and data associated with Pantex's approach to assigning doses to the workers during the first, second, and third calendar quarters of 2020 [14] but could not definitively confirm Pantex's conclusion that all assigned doses were conservative. However, the review team does agree that it is unlikely that any worker dose exceeded the CNS administrative level.

Adequacy of Knowledge Management Processes—CNS Pantex has had a significant turnover in key external dosimetry program leadership personnel in the last three years. The staff turnover at Pantex resulted in a loss of corporate knowledge and experience in operating and maintaining the external dosimetry equipment. As a result, when the aged TLD readers failed to function during the last quarter of 2019, Pantex had to rely on NNSS personnel for the following activities: repairing the Pantex TLD readers, conducting the training for new Pantex external dosimetry staff, and assisting in the re-calibration of the TLD readers.

CNS confirmed to the Board's staff that the loss of key personnel contributed to the degradation of the Panasonic TLD readers. In particular, the Pantex external dosimetry manager with many years of experience with the TLD readers retired in July 2019.

Management of the Dosimetry Quality Assurance Program—DOE-STD-1095-2018 [9] provides details regarding the quality assurance program for an accredited personnel external dosimetry program. The review team noted that a November 25, 2019, CNS assessment of the external dosimetry program [15] in accordance with the standard concluded that the program was satisfactory; however, items were identified that needed to be addressed. These items included: lack of quality policy, failure to conduct annual audits, lack of technical basis for annealing dosimeters, and the failure of blind dosimeter testing to comply with STD-1095-2018. The assessment did not identify the equipment risks and the lack of a fully demonstrated and tested emergency back-up external dosimetry system.

CNS conducted the assessment before the June 2020 decision to terminate external dosimetry processing at Pantex. The Board's review team reviewed the actions provided by CNS to address the observations listed above. The CNS assessment team concurred on these actions, except the blind dosimeter testing. However, closure of the CNS actions failed to

address the primary issues resulting in the ultimate breakdown of the external dosimetry program.

NPO Oversight—Although some information was available in late 2019 that suggested potential issues with the Pantex external dosimetry program, NPO did not adjust the risk ranking assigned to the external dosimetry program in its site integrated assessment plan (SIAP). This meant that NPO did not significantly modify its oversight strategy to account for emerging information and events. NPO personnel reported that they had no records of the last time they had conducted a formal assessment with a scope that included the Pantex external dosimetry program; instead, they relied on assessments by DOELAP or CNS as indicators of program health. DOELAP assessments are chartered on accuracy and repeatability of hardware and software systems in assignment of dose, and not the management or efficiency of the program by the contractor. DOELAP does not evaluate the overall management of the system or represent a substitute for federal oversight, which is the responsibility of CNS and NPO, respectively.

NPO's oversight strategy primarily involved continuous oversight activities (e.g., staff-to-staff engagement followed by elevation of any issues) rather than formal assessments. Neither CNS nor NPO currently have a system health metric to gauge the health of the Pantex external dosimetry programs.

Presently, NPO relies on CNS to identify trends and present information regarding the corrective action program. NPO does not have a proactive process to review CNS's trends to identify issues that may adversely impact the external dosimetry program. NPO submitted a "letter of concern" to CNS in January 2020 for the Pantex external dosimetry program after the identification of a high rate of abnormal readings; however, NPO did not pursue proactive assessments to evaluate contractor performance in this area.

NPO recognized that its oversight strategy did not identify and preemptively address the external dosimetry program breakdown. Consequently, NPO is considering the need to reassess the risk ranking for the enterprise external dosimetry program and other elements of safety management programs during the next SIAP. For FY 2022, NPO has elevated the risk ranking for the CNS enterprise external dosimetry program and informed the review team that it plans to conduct assessments of the program and its associated aged equipment.

Discussion. The staff identified opportunities for improvement in the areas of CNS's management of the Pantex external dosimetry program and NPO's oversight that contributed to the breakdown of the Pantex external dosimetry program.

CNS Management of Pantex External Dosimetry Program—CNS management did not maintain proactive measures or implement effective corrective actions to prevent the ultimate breakdown of the Pantex external dosimetry program. CNS did perform an assessment in 2019; however, the findings and corrective actions did not prevent the inoperability of the TLD readers and did not adequately identify significant threats to the program. CNS management did not ensure the contingency plan—use of NNSS readers—was a viable option. In addition, CNS's lack of a knowledge management plan in a time of significant staff turnover prevented adequate planning and response by the external dosimetry program leadership.

Inadequate CNS management of the program resulted in delays in personnel external dosimetry reports for the Pantex workers, visitors, and environmental monitoring. These delays may have negatively impacted the external dosimetry tracking of certain site operations as required by 10 CFR 835 [10]. For its newly implemented enterprise external dosimetry program that covers both Pantex and Y-12, CNS management should consider: (1) using system health metrics specific to the external dosimetry program; (2) enhancing the program's routine maintenance practices; (3) proactively replacing aging equipment; (4) strengthening self-assessments; (5) enhancing technical staffing, succession planning, and contingency planning for the program; and (6) exercising external dosimetry program contingency plans.

NPO Oversight of Pantex External Dosimetry Program—NPO's oversight strategy did not adequately identify and preemptively address the breakdown of the Pantex external dosimetry program. Breakdown of the external dosimetry program, in turn, negatively impacted Pantex's radiation monitoring capabilities.

The review team concluded that information was available in late 2019 to suggest potential issues with the Pantex external dosimetry program, before the programmatic degradation occurred in 2020. However, NPO did not modify its oversight strategy to include formal assessments to account for emerging information and events. The review team concluded that the external dosimetry program would have benefitted from formal assessments, additional oversight activities, and routine attention. NPO should develop measures based on the breakdown of the Pantex external dosimetry program to ensure that oversight strategies are adjusted to prevent recurrence of similar issues, or breakdowns in other programs. Additionally, Pantex and Y-12 would benefit from a formal assessment of the newly implemented enterprise external dosimetry program.

NPO did not direct CNS to conduct a root cause analysis to identify all underlying reasons for degradation of the Pantex external dosimetry program. Such an analysis could ensure these causes are identified and actions are put in place to ensure that similar issues do not emerge within the enterprise external dosimetry program. NPO also confirmed that it presently does not proactively trend data from the CNS corrective action system database to identify risk in the areas of radiation safety or external dosimetry.

Neither NPO nor CNS used system health metrics (e.g., on staffing or equipment operability) to indicate the functionality and level of performance for the program. NPO and CNS could benefit from such a metric, which would aid in early identification of equipment and programmatic problems especially given the recent modifications to external dosimetry program responsibilities between sites. Examples of possible metric data include number of operational TLD readers, number of technical staff positions filled and vacant, availability of spare parts, number of failed quality control readings, number of dosimeters that do not meet quality control criteria, and number of open corrective actions impacting operation of the external dosimetry program.

Conclusion. The Pantex external dosimetry program had several latent issues (e.g., personnel turnover, inadequate knowledge management, obsolete equipment, lack of timely

contract maintenance support, and lack of availability of equipment parts) in 2019 and 2020. If CNS had recognized or planned for these issues earlier, it could have mitigated the 2020 programmatic issues resulting from breakdown of the external dosimetry system.

The Pantex external dosimetry program would have benefitted from additional federal assessments, oversight activities, and attention. NPO should identify and apply lessons learned from the breakdown of the external dosimetry program to ensure that oversight strategies are adjusted to prevent recurrence. NNSA in general and NPO should consider how it will adopt these measures to prevent similar difficulties with other radiation safety programs. In addition, it would be prudent for NNSA to conduct a general assessment of the health of the radiation protection safety management program at Pantex and Y-12.

Further, DOE's standard for external dosimetry programs, DOE-STD-1095-2018 [9] contains a weakness that exacerbated the challenges at Pantex. Compliance with this standard is required to achieve accreditation in accordance with DOELAP, which is required by 10 CFR 835 [10]. Section 4.7(c) of the standard requires that external dosimetry programs establish "documented provisions to utilize the services of another DOELAP accredited laboratory in an emergency." However, there are no requirements that those provisions be periodically exercised to ensure consistent external dosimetry results between the two or more site programs.

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