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**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



November 28, 2018

The Honorable James Richard Perry
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Perry:

The Defense Nuclear Facilities Safety Board completed a review of the Nuclear Criticality Safety Program at the Los Alamos National Laboratory (LANL). During the course of this review, the Board identified five safety items:

- Lack of concrete milestones in corrective action initiatives
- Inadequate staffing in the nuclear criticality safety division
- Inadequate plan-of-the-day documentation
- Instances of poor operational quality
- Repetitive corrective actions

While the National Nuclear Security Administration and LANL together have made progress in improving the Nuclear Criticality Safety Program, significant work remains to enable the organizations within LANL that develop and implement criticality safety requirements to achieve compliance with applicable industry standards and perform their important safety function.

Yours truly,

A handwritten signature in black ink that reads "Bruce Hamilton".

Bruce Hamilton
Chairman

Enclosure

c: The Honorable Lisa Gordon-Hagerty
Mr. William S. Goodrum
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Enclosure

August 14, 2018

Los Alamos National Laboratory Nuclear Criticality Safety Program

The Department of Energy's (DOE) *2016 Annual Metrics Report on Nuclear Criticality Safety Programs* [1], dated February 1, 2017, rated the Los Alamos National Laboratory (LANL) Nuclear Criticality Safety Program (NCSP)* as "does not meet expectations," but included the following disclaimer:†

The overall rating of [does not meet expectations] is a snapshot of the state of the program evaluated against requirements. The program remains noncompliant in several areas and compensatory measures remain in place to ensure safety in operations. It is important to note that the overall rating is [needs improvement] when comparing the program against program improvement goals.

The staff team agrees with this assessment. The LANL NCSP continues to be non-compliant with applicable DOE and industry standards [2] [3] [4]. Until LANL resolves programmatic non-compliances through improvement plan initiatives, it will continue to operate with elevated risk. LANL has implemented compensatory measures to mitigate that risk. The staff team believes that these compensatory measures and existing criticality safety controls, if fully and properly implemented, will ensure that the laboratory is safe to continue operations within its current mission scope. LANL's operations organizations have significant challenges related to proper implementation of established criticality safety controls, despite improvements in specific areas outlined at the end of this report. Recent operational events demonstrate that previously identified institutional issues (e.g., failure to adhere to postings and procedures) still exist in the plutonium facility (PF-4). Improvement of the NCSP will be further challenged by the National Nuclear Security Administration's (NNSA) plans for increased production goals in the coming years, the upcoming change in LANL's management and operating contractor, and recent changes in the management of the Nuclear Criticality Safety Division (NCSD).

Background. Prior to 2005, LANL's NCSP was primarily expert-based and highly dependent on the knowledge and experience of its criticality safety staff. In 2005, NNSA performed an assessment [5] and determined that LANL's expert-based NCSP was not compliant with applicable DOE requirements and industry standards. In 2006, in response to NNSA's review, LANL developed an improvement plan that was intended to align LANL's NCSP with

* In this report, "NCSP" refers to the complete implementation of criticality safety evaluations, controls, procedures, and conduct of operations. In this regard, NCSP is not limited to simply the personnel and products of the Nuclear Criticality Safety Division (NCSD), but also includes the implementation of controls by operations divisions. Requirements contained in standards such as American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8.19-2014 apply to organizations outside the NCSD.

† While the most recent metrics report does not contain this exact language, the report's conclusions regarding the LANL NCSP are the same [16].

applicable requirements. LANL's primary objective was to establish compliant Criticality Safety Evaluations (CSEs) for all operations through the execution of this plan. Due to a variety of issues, including staffing shortages, LANL never fully executed this improvement plan and consequently never brought the program into compliance.

In May 2013, the Board's staff reviewed the LANL NCSP. The staff identified several concerns, including fissile material operations (FMOs) with inadequate (i.e., not compliant with applicable standards) or nonexistent CSEs, improper flowdown of controls from CSEs to operating procedures and area postings, and inadequate fissile material labels. The Board communicated these and other items to DOE in a July 15, 2013, letter [6]. The Appendix to this report provides an update on LANL's actions to address some of these items.

On June 27, 2013, the LANL director paused all programmatic activities in PF-4 to focus on addressing criticality safety concerns identified by internal and external assessments. On November 20, 2013, the director authorized resumption of many low-risk operations, such as work with small samples or non-destructive assay; however, most programmatic operations remained paused. About a year after the pause, LANL and NNSA instituted a formal restart project for some of PF-4's operations in accordance with DOE's requirements for restart (i.e., DOE Order 425.1D, *Verification of Readiness to Start Up or Restart Nuclear Facilities*). This process culminated with the authorization of pyrochemical operations in September 2016, at which point LANL declared that the restart project was complete. LANL has since restarted several higher-risk operations, such as aqueous chloride processing and electrorefining, with restrictive material limits.

Given that the LANL NCSP remains non-compliant with modern standards, the objectives of the Board staff's most recent review were to: 1) determine if LANL's current Program Improvement Plan (PIP) and other improvement initiatives are adequate to set the LANL NCSP on a path to compliance with applicable industry and DOE standards, and 2) determine if LANL's current practices, controls, and compensatory measures are adequate to ensure that LANL can conduct operations safely while its NCSP is non-compliant.

Adequacy of Improvement Initiatives. In February 2016, after more than a decade of criticality safety improvement plans and assessments, and recognizing that corrective actions were needed to address deficiencies in its program, LANL implemented the current PIP. This improvement plan superseded all previous plans, and has since had two revisions (in February 2017 [7] and December 2017 [8]). LANL's current approach is to revise the plan annually with updated progress. As detailed below, the Board identified two safety items related to this topic: LANL's lack of concrete milestones, and the scarcity of criticality safety resources available to complete objectives needed to address the deficiencies identified.

Safety Item: Safety Observation – Lack of Concrete Milestones—LANL is progressing slowly on improving the criticality safety program. The staff team notes that the most recent annual update to the PIP [8] does not contain any hard milestones. NNSA's Los Alamos Field Office (NA-LA) and LANL personnel simply re-evaluate goals each year, on the grounds that projecting out-year milestones is not meaningful given the uncertainty in staffing. Therefore, the PIP is not an effective means to drive changes to known programmatic challenges.

Safety Item: Safety Observation – NCSD Staffing—LANL developed a staffing plan at the end of 2013 indicating the need for at least 25.25 full-time, qualified employees (FTE) to adequately support operations and bring the program into compliance with American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8.19 [9]. As of October 2018, LANL’s NCSD employed a total of 25 full-time FTEs (11 fully qualified, 8 task qualified, and 6 in-training), further supplemented by 8 FTE of subcontractors. While LANL has made some improvements in terms of full-time staffing (supplemented by part-time subcontractors), NCSD is still short of achieving that established 25.25 full-time, qualified FTE target. NCSD still has significant challenges in hiring, qualifying, and retaining sufficient personnel to accomplish corrective actions and support safe operations.

Analysis—At the beginning of fiscal year 2018, 242 CSEs (out of approximately 400) remained non-compliant with modern standards [8]. One of LANL’s primary goals is to eventually ensure that all operations are captured under modern, compliant CSEs. Until that time, LANL has instituted compensatory measures (i.e., the 2007 *Augmented Limit Review* and 2014 *Evaluation of the Safety of the Situation*) to supplement current technical evaluations and ensure that operations can be performed safely [10] [11]. These compensatory measures mean that many operations are carried out using limits close to single parameter limits as discussed in ANSI/ANS-8.1-2014. These measures, if properly implemented, are sufficient to ensure safety at LANL until such FMOs are brought into alignment with modern standards. It is possible for LANL to operate safely without a compliant NCSP; however, any significant changes to operations or increase in operating tempo could make it more difficult to operate safely with this non-compliant NCSP. Additionally, as non-compliances linger without concrete goals for completion, LANL risks fostering a culture of “normalization of deviation” in which noncompliance becomes regarded as the norm.

During discussions with the staff team, the previous NCSD leader estimated that accomplishing the entire PIP will require approximately 25 person-years of effort in addition to what is needed to support operations. Given the magnitude of work estimated for PIP completion and the status of progress towards completing individual PIP goals, the staff team has little confidence that LANL can achieve compliance with applicable standards in less than five years. Additionally, per LANL and DOE’s design, the PIP focuses on NCSD and the generation of criticality safety requirements and documentation, and does not necessarily address issues related to conduct of operations and implementation of criticality safety requirements (those issues are addressed in other corrective action initiatives). As discussed below, the staff team believes that current deficiencies within the operations divisions present some of the biggest hurdles to bringing the NCSP into compliance with modern standards.

Operations and Implementation of Criticality Safety Requirements. LANL’s 2017 *PF-4 Conduct of Operations Sustainment/Improvement Plan*, hereafter referred to as the “2017 ConOps Plan” states that “more than 20 readiness reviews...of PF-4 operations conducted over the past three years have provided evidence that a significant culture change has taken place in the PF-4 workforce” [12]. Recent operational events and the staff team’s independent analysis, as detailed in this paper, do not support this conclusion. However, both LANL and NA-LA are taking action to address these deficiencies. LANL is still executing the 2017 ConOps Plan, and

NA-LA, with support from NNSA headquarters personnel, has embarked on a campaign to provide enhanced oversight of operations in PF-4. The initial focus of this campaign is to increase federal presence to assess the implementation of controls and conduct of operations, as well as to establish and monitor an effective set of metrics related to these areas.

From observations made during this review, the Board identified three safety items related to this topic: a less than adequate plan-of-the-day, contrast in operational quality between assessments and normal operations, and repetitive corrective actions.

Safety Item: Safety Observation – Plan-of-the-day—The PF-4 plan-of-the-day does not accurately reflect the activities that are actually performed on a given day. The plan-of-the-day authorizes LANL personnel to work jobs during broad windows, sometimes up to one year. Without accurate lists of work being performed, management, oversight, and NCS D personnel do not have efficient tools for prioritizing floor presence. Further, without an accurate listing of work, jobs are more likely to conflict, resulting in operational difficulties or abnormal conditions. For example, on June 13, 2018, workers performing different jobs in PF-4 simultaneously transferred material to the same drop box using the facility trolley line, exceeding the material limits for that drop box. An accurate and better-detailed plan-of-the-day could have helped to avoid this situation. Finally, an accurate plan-of-the-day is necessary for emergency response. As an example, during a criticality accident alarm drill, the staff team observed that emergency operations center personnel could not use the plan-of-the-day as a tool to locate the simulated accident. Personnel did not have an alternative method to quickly pinpoint the accident location. In a real emergency, this delay could impact facility personnel’s ability to respond to the accident.

Safety Item: Safety Observation – Contrast in Operational Quality—Plutonium casting operations successfully underwent a federal readiness assessment in April 2016. Members of the Board’s staff providing oversight of the assessment noted that the quality of the conduct of operations was generally very high. On August 16, 2017, the staff team observed an actual plutonium casting operation. Of note, the operations crew was largely the same group that was present during the April 2016 casting operations readiness assessment. The staff team noted that the quality and formality of operations during the August 16, 2017, casting operation was similar to that of the federal readiness assessment. The operations crew used the criticality safety posting (CSP) to ensure compliance with applicable criticality safety limits.

On August 17, 2017, a process deviation occurred in the PF-4 casting room during a material movement. The operations crew—comprising the same personnel the staff team observed the day prior—did not use a required “use every time” (UET) attachment to the procedure [13]. As a result, the operations crew did not properly use the CSP to check the inventory of the destination glovebox before introducing an object. The destination glovebox already contained plutonium metal, and the material movement therefore resulted in an overmass condition not allowed under the destination glovebox’s CSP [14].

On May 17, 2018, workers placed a container of plutonium salts in a glovebox where the CSP only allowed plutonium oxide or metal. The workers involved in the event stated that they believed the salts were allowed because the CSP did not explicitly forbid them. Notably,

operations in this particular room successfully completed two federal readiness assessments. LANL management learned that workers routinely stored salts in this glovebox, even though the operation includes a different glovebox that allows salt storage.

The contrast between the high level of performance demonstrated during formal assessments and the deficient performance exhibited in several subsequent events highlights a disparity between work that is overseen by management and work that is not. This disparity in operational quality indicates that LANL's workforce has not fully internalized the importance of following established criticality safety practices at all times. Recognizing these challenges, LANL increased management presence in the facility during select operations. However, while this may improve the quality of those specific operations for which management is present, it does not address the underlying concern of what transpires in the absence of management.

Safety Item: Safety Observation – Repetitive Corrective Actions—After the 2013 operations pause, LANL issued the 2014 *TA-55 Criticality Safety and Conduct of Operations Improvement Plan*, hereafter referred to as the “2014 ConOps Plan,” as a corrective action for conduct of operations deficiencies existing at the time. LANL declared this plan complete in September 2015, and closed the actions in its tracking system. Following the August 2017 casting overmass event, LANL issued the 2017 ConOps Plan. These plans share many of the same goals and recommended actions, indicating that previous corrective actions did not result in sustained improvements to the conduct of operations at PF-4. While the 2014 ConOps Plan may have been effective for operations staff at the time, it is the staff team's opinion that the plan did not appropriately institutionalize improvements to prevent LANL's current staff from making similar mistakes. For example, as part of the 2014 ConOps Plan, LANL performed an analysis to determine the proper application of the UET designation for all procedures used during the readiness process, including those for material movements [15]. Development and promulgation of requirements for performance of UET and reference procedures appears again in the 2017 ConOps Plan [12]. Further, revision of the worker training and qualification process is a goal in both plans as well; many of the specific actions meant to achieve this goal, including use of cold facilities for training, are nearly identical [12] [15]. The need to clarify the process for declaring potential nuclear criticality safety deviations also appears in both plans [12] [15].

Conclusion. LANL is still struggling to address identified deficiencies related to the NCSP. The NCSD is still understaffed and lacks clear milestones to work off the backlog of non-compliant CSEs and other documentation. While the staff team believes that LANL's current criticality safety controls and compensatory measures, if properly implemented, are adequate to ensure safety under current operations, LANL has recently experienced difficulties implementing criticality safety requirements in general. It will be especially important for DOE and LANL to understand and rectify these deficiencies, particularly given the planned increase in mission-related production and the upcoming transition to a new management and operating contractor.

Appendix: Status of Previously Identified Safety Items

In its 2013 letter to the Department of Energy (DOE), the Defense Nuclear Facilities Safety Board (Board) identified several safety items related to the Los Alamos National Laboratory (LANL) Nuclear Criticality Safety Program (NCSP). After reviewing the NCSP, the staff team concludes that LANL has addressed the specific items contained in this appendix.

Safety Item – Criticality Safety Evaluation Quality—American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8.1-2014, states that, for all operations with fissile materials, “it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions.” During the 2013 review, the staff team noted that technical evaluations for many fissile material operations (FMOs) had unanalyzed or inadequately analyzed credible abnormal conditions, rendering those evaluations non-compliant with ANSI/ANS-8.1. A major goal of LANL’s improvement plan is to ensure that criticality safety evaluations (CSEs) for all operations meet this standard. The staff team analyzed several FMOs with recently completed CSEs and found that the reviewed CSEs meet ANSI/ANS-8.1-2014, and are of higher quality and rigor than evaluations authored prior to the 2013 pause. The staff team therefore concludes that LANL has addressed concerns related to CSE quality. As noted in the body of this report, however, many operations still rely on legacy, non-compliant evaluations.

Safety Item – Flowdown of Controls from Evaluations into Procedures and Postings—During the staff’s 2013 review of the NCSP, the team identified numerous instances where procedures and postings governing FMOs did not comply with requirements in ANSI/ANS-8.1 or ANSI/ANS-8.19 [6]. Since then, LANL has revised site procedures in an attempt to align these facets of its NCSP with guidance in these standards. The staff team now concludes that, while opportunities for improvement remain, recently authored procedures and postings align much more closely with applicable guidance in the ANS standards. The staff team therefore concludes that LANL has addressed concerns related to flowdown of criticality safety controls into procedures and postings. The staff team notes, however, that the continued use of some legacy postings (which still are used widely in the plutonium facility) introduce issues related to clarity and consistency of verbiage throughout the facility. Further, as noted in the body of this report, recent instances have shown that LANL struggles to properly implement controls as described on postings.

Safety Item – Fissile Material Labels—During the 2013 review, the staff noted two distinct concerns in this area: labels were often ambiguous, illegible, or unclear; and labels did not contain sufficient information to facilitate compliance with criticality safety limits [6]. Based on the 2017 review, the staff team concludes that current practices and guidance, if properly implemented, will help ensure compliance with ANSI/ANS-8.19-2014, which states that “fissile material shall be identified and tracked by effective methods appropriate to the activity or process.” The staff team therefore concludes that LANL has addressed concerns related to fissile material labels.

References

- [1] Department of Energy, *2016 Annual Metrics Report to the DNFSB on Nuclear Criticality Safety Programs*, 2017.
- [2] American Nuclear Society, *ANSI/ANS-8.1-2014, Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*, 2014.
- [3] American Nuclear Society, *ANSI/ANS-8.19-2014, Administrative Practices for Nuclear Criticality Safety*, 2014.
- [4] Department of Energy, *DOE-STD-3007, Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities*, 2007.
- [5] National Nuclear Security Administration, *Technical Evaluation of the Los Alamos National Laboratory Nuclear Criticality Safety Program*, 2005.
- [6] Defense Nuclear Facilities Safety Board, *Criticality Safety at Los Alamos National Laboratory*, 2013.
- [7] Los Alamos National Laboratory, *Nuclear Criticality Safety Program Improvement Plan, R1*, 2017.
- [8] Los Alamos National Laboratory, *Nuclear Criticality Safety Program Improvement Plan, R2*, 2017.
- [9] Los Alamos National Laboratory, *NCS-PLAN-13-001, Nuclear Criticality Safety Staffing Plan*, 2013.
- [10] Los Alamos National Laboratory, *Augmented Limit Review*, 2007.
- [11] Los Alamos National Laboratory, *TA55-ESS-14-002-R3, Evaluation of the Safety of the Situation for Potential for Criticality in a Glovebox due to Fire Water*, 2014.
- [12] Los Alamos National Laboratory, *ADPSM-17-022, PF-4 Conduct of Operations Sustainment / Improvement Plan*, 2017.
- [13] Los Alamos National Laboratory, *TA55-DOP-016-R18, TA-55 Material Staging, Handling, and Movement*, 2016.
- [14] Los Alamos National Laboratory, *LA-CP-17-20507, August 2017 TA-55 Over-Mass Condition Causal Analysis*, 2017.
- [15] Los Alamos National Laboratory, *TA-55 Criticality Safety and Conduct of Operations Improvement Plan*, 2014.
- [16] Department of Energy, *2017 Annual Metrics Report to the DNFSB on Nuclear Criticality Safety Programs*, 2018.