



The Secretary of Energy

Washington, DC 20585

March 30, 2021

The Honorable Joyce Connery
Chair
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Chair Connery:

Enclosed is the Department of Energy's (DOE or Department) responsive report to the questions posed in the Board's September 24, 2020, request letter and as amplified by its Technical Report 46, *Potential Energetic Chemical Reaction Events Involving Transuranic Waste at Los Alamos National Laboratory*.

As further explained in the enclosed report, DOE is adequately and consistently controlling the hazards associated with the transuranic waste container population at the Los Alamos National Laboratory. The Department appreciates and is acting on the advice contained in Technical Report 46 to improve its management of the waste. For example, we are using the Board's report to aid in our review of the recent event involving titanium on filters as we look to continuously improve our waste management program. We have captured the broader implications of the Board's concerns within our current efforts to revise DOE Technical Standard 5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, and will engage with the Board's staff as we finalize the revision.

We appreciate the Board's advice and assistance in improving the safety of our transuranic waste management. If you have any questions, please contact Brenda Hawks (DOE's Office of Environmental Management), at (865) 805-0391, or Jeffrey Roberson (DOE's National Nuclear Security Administration), at (240) 394-0598.

Sincerely,

A handwritten signature in black ink, appearing to read "J. Granholm".

Jennifer Granholm

Enclosure

1. INTRODUCTION

This Report is provided in response to the Defense Nuclear Safety Board's (DNFSB or Board) September 24, 2020, request for a report that addresses the two following questions: "(1) whether the hazards associated with the current transuranic waste container population at Los Alamos National Laboratory are consistently and adequately controlled and DOE's basis for this position; and, (2) whether the revision to DOE Standard 5506 will address the broader implications of these concerns, as they are applicable to other DOE sites." There are four nuclear facilities at Los Alamos National Laboratory (LANL), which generate, handle and/or store, and ship transuranic (TRU) waste. These are Technical Area (TA)-55, which houses Plutonium Facility (PF)-4; the Chemical and Metallurgy Research (CMR) facility (TA-3); the Transuranic Waste Facility (TWF) (TA-63); and Area G (TA-54). The first three facilities are managed by LANL TRIAD National Security, LLC, (LANL TRIAD). The fourth, Area G, is managed by Newport News Nuclear BWXT (N3B) (LANL N3B). TA-55 and CMR generate, handle, and store TRU waste. TWF and Area G handle and store TRU waste generated at TA-55 and CMR. Area G also generates new waste containers because of TRU waste processing to achieve compliance with the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WAC). Area G is discussed separately from the facilities managed by LANL TRIAD.

The Defense Nuclear Facility Safety Board (DNFSB) examined the documents that govern nuclear safety at the LANL TRIAD and LANL N3B nuclear facilities of interest. These documents are collectively called the "safety basis" for the facilities managed by LANL TRIAD and LANL N3B. They consist, for each facility, of a DOE-approved Documented Safety Analysis (DSA) and associated hazard controls at LANL TRIAD facilities and a Basis for Interim Operations (BIO) and associated hazard controls at LANL N3B facilities. The BIO and DSA identify and analyze hazards within the facility that could cause a release of radioactive material. The safety bases include the Technical Safety Requirements (TSRs) that consolidate the controls derived in either the DSA or the BIO to prevent releases of radioactive material. The Department of Energy (DOE) approved the safety basis documents, and the controls described in these documents must be complied with pursuant to 10 C.F.R. Part 830, *Nuclear Safety Management*.

The DNFSB detailed its concerns in the DNFSB Technical Report, *Potential Energetic Chemical Reaction Events Involving Transuranic Waste At Los Alamos National Laboratory* (DNFSB Tech-46), regarding the LANL TRU waste storage facilities' safety bases and the treatment of postulated energetic chemical reactions within a TRU waste drum in several specific topical areas, including the hazards and accident analyses, which are the bases for the selection of controls to protect against a given hazard. The DNFSB also identified specific drums in residence at LANL nuclear facilities that the Board believes may require additional controls to protect against radioactive material release. Finally, the DNFSB expressed concerns about the adequacy of the guidance provided in DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, which guides the development of safety bases for facilities whose missions involve TRU waste.

No issues with TRU waste containers that have completed formal independent evaluation executed under the WIPP Waste Acceptance Criteria Compliance Program were identified.

The WIPP Waste Acceptance Criteria Program includes an Enhanced Acceptable Knowledge process certification prior to any container being authorized for shipment to WIPP that protects containers shipped and stored at the WIPP site.

2. LANL TRU WASTE HAZARD CONTROLS FOR INCOMPATIBLE CHEMICALS

The nuclear facilities' safety bases were reviewed for analysis of releases of radioactive material due to incompatible chemicals in TRU waste drums. The safety basis for each facility contain an analysis of pressurized releases due to ignition of hydrogen, which can be generated when radioactive material is combined with chemicals containing hydrogen, including water. They also contain analyses of slow pressurization events due to the gradual reaction of incompatible chemicals, such as might occur with chemicals in low concentrations or small quantities. Based on the analyses, when TRU waste drums are gradually pressurized, they fail at an internal pressure of about 14 pounds per square inch gauge (psig). With rapid pressurization events similar to those that occurred at WIPP and Idaho National Laboratory (INL), incompatible chemicals reacted violently and rapidly over-pressurized the drums, causing the drums to fail. The fraction of the radioactive material in the drum (referred to as the Material-at-Risk or MAR) released as respirable radioactive material (of a size that can be taken in and retained by a human respiratory tract) is referred to as the release fraction (RF). The RF is approximately 10 times higher with the higher-pressure release (>25 psig) versus the lower-pressure releases (<25 psig).

The LANL TRIAD generator facilities, TA-55 and CMR, analyzed a high-pressure release from a TRU waste drum due to the presence of highly concentrated nitric acid together with materials made from a plant source (polysaccharides), such as cheese cloth. This combination of chemicals, which could react and rapidly pressurize a drum, was identified as a concern for the entire DOE Complex in 2019, and it has, therefore, received special attention. As a result, both CMR and TA-55 have imposed specific controls prohibiting a combination of these two chemicals within TRU waste drums. Subsequently, both LANL TRIAD and LANL N3B reviewed documentation for drums generated prior to 2019 to ensure that no TRU waste drums in the current inventory contain collocated polysaccharides and high molarity nitric acid.

DNFSB Tech-46 concludes that a bounding event, whereby a combination of any number of incompatible chemicals cause rapid over-pressurization of a TRU waste drum, has not been appropriately analyzed and controlled at LANL. However, it is important to note that the requirement to analyze hazards that could result in release of radioactive material at DOE nuclear facilities does not apply to hazards that are not present in the facility. For example, there is no requirement to analyze the hazards associated with explosives in facilities that do not handle explosives. After careful evaluation, LANL TRIAD knows of no other chemical incompatibility hazards within TRU waste drums that can lead to a rapid over-pressurization of a drum requiring additional controls at LANL TRIAD facilities, other than the example cited above. Because of the DNFSB letter, LANL TRIAD has entered the Potential Inadequate Safety Analysis (PISA) process and made a commitment to perform an extent of condition review of waste streams for chemical compatibility issues, including the recent issue regarding small amounts of titanium

particles entrained in HEPA filters, to verify and validate this assertion. Any candidate chemical compatibility issues identified in this review that have the potential for a rapid over-pressurization of a drum will receive additional controls, such as those discussed above, for the nitric acid/polysaccharide combination.

The personnel at LANL TRIAD responsible for waste management have evaluated all waste streams for chemical incompatibility. LANL TRIAD has an established process that ensures that new or modified operations do not begin until changes have undergone review for the potential to create incompatibilities in the waste stream generated by the process. The materials considered in the waste stream include any chemical used or introduced into the process. This review, referred to as a chemical compatibility evaluation (CCE), is performed to determine if potential combinations could result in a chemical reaction. The list of chemicals and other materials potentially present in a waste stream is the basis for the CCE. Current information from the CCE is maintained in a database that is available for review by LANL waste management personnel trained in waste issues, and by personnel representing the future disposal site, specifically WIPP. When the components of a process are presented to be packaged as waste, an inspection of each component is performed by LANL waste management personnel to ensure that everything has been described and evaluated as part of the waste stream.

Subsequently, during the placement of waste into a container, LANL waste management personnel and personnel representing the disposal site visually examine each component of the waste stream. Each item is listed on a questionnaire, which is recorded in the main database documenting the contents of each drum. Based on the current nature of the process at LANL TRIAD facilities, no chemical incompatibilities that could lead to rapid over-pressurization of a TRU waste drum other than the one discussed above have been identified. Postulated low-pressure releases and hydrogen deflagration events have been evaluated in safety basis documents, and controls are in place based on these analyses. One of the controls is the Waste Management Program that includes multiple checks and balances on the waste generation process to prevent both low-pressure releases and hydrogen deflagration events, as analyzed in the safety bases. For example, waste specialists visually examine every waste item prior to its packaging in a TRU waste drum to ensure that no incompatible chemicals are put into the same drum.

The DSA for the LANL TRIAD storage facility, TWF, analyzes low energy chemical incompatibility events as design basis accidents and includes TSR controls for these events. The TWF DSA does not analyze chemical incompatibilities that have the potential for a rapid over-pressurization of a drum. Drums are not opened or re-packaged at TWF and the control for high energy chemical incompatibility events that have the potential for rapid over pressurization of a drum is a TSR LCO that requires a verification review on incoming drums. The DSA explicitly acknowledges that the waste generation process prevents the potential for high energy chemical reactions. These processes are why an energetic chemical event is not analyzed at TWF and why the safety basis control is the verification receipt. As waste is received at TWF, LANL TRIAD personnel examine the documentation generated by the packaging process to ensure that all evaluations have been performed and that incompatible chemicals have not been introduced. As no drums containing incompatible chemicals that have the potential for rapid-over pressurization of a drum are allowed at TWF, analysis of this hazard is not required.

At LANL N3B managed Area G, the posture is different due to the legacy TRU waste stored at the facility, which represents decades of operations at LANL TRIAD facilities. As such, thousands of TRU waste containers are stored at Area G, which were not evaluated under the current processes relied upon by LANL TRIAD. Additionally, the Area G safety basis does not acknowledge or analyze the potential for receipt of a non-compliant TRU waste container. As such, and unlike the TWF safety basis, at Area G there are no “prior to receipt” TSR level controls to assure verification of TRU waste characterization processes. Finally, a review of the Area G BIO revealed that there is no analysis for a rapid pressurization event at >25 psig. Because the containers involved in the event at WIPP came from Area G waste process lines, a non-credible argument cannot be used, and this event needs to be included, at a minimum, in hazard identification and analysis. Because of these concerns, LANL N3B declared a PISA on December 3, 2020. Immediate compensatory measures have been developed, which direct a specific action should a container of concern be discovered now or during ongoing/future extent of condition reviews. These compensatory measures include overpacking and storage in Dome 54-0375, which has continuous air monitoring, and fire suppression and detection.

For future remediation lines at Area G, containers are identified and evaluated by Waste Engineering and documented in waste processing plans. All waste processing plans are independently reviewed by the Central Characterization Program (CCP). The waste processing plans serve as input data to LANL N3B change control processes. As such, these documents support the completion of safety basis impact reviews and, if necessary, inform hazard analysis in safety basis development. If additional constituents are being added into the waste, a CCE is performed addressing the additional chemicals that are being added. These processes are evaluated through the Hazardous Operations Process identified in N3B-AP-P300-1, *Integrated Work Control Process*.

3. MULTIPLE LAYERS OF PROTECTION PREVENT RELEASE OF RADIOACTIVE MATERIAL FROM TRU WASTE DRUMS

This discussion specifically addresses the controls for the hazards presented by incompatible chemicals in TRU waste drums. The DNFSB notes that the DOE requires multiple layers of defense against release of radioactive material. However, the Board expressed concern that, in some cases, for drums stored outside filtered ventilation, the drums themselves, which have vents to prevent pressurization, are the only controls.

The DNFSB reviewed the inventory of TRU waste drums in storage at LANL nuclear facilities. They identified 91 containers: 62 drums at LANL TRIAD managed facilities; and 29 containers at LANL N3B managed at Area G. These identified containers had the potential for combustible content and sufficient amounts of radioactive material to be of concern if released by an energetic chemical reaction. For the LANL TRIAD managed waste containers, none of the drums were known to contain incompatible chemicals. Nonetheless, the DNFSB suggested that these 62 drums should be secured in a special storage location with fire suppression and confinement ventilation.

For these particular drums, by the time LANL TRIAD received the DNFSB report, approximately one-third of the drums in question had already undergone additional reviews for

chemical compatibility by personnel from the disposal site and had been accepted for disposal at WIPP. The documentation for the remaining drums was reviewed by LANL TRIAD waste management personnel. Because there are no incompatible chemicals within the inventories of these drums, there is no identified potential for an energetic chemical reaction in any of these drums. Therefore, these drums are safely and securely stored in their current configuration.

For the LANL N3B-managed containers, 13 of the 29 containers reviewed by DNFSB staff had been approved for shipment to WIPP, and 4 of 13 have been shipped. The remaining 16 containers were immediately overpacked and moved to Dome 54-0375 pending evaluations on these containers. Dome 54-0375 provides additional controls for continuous air monitoring and fire protection than other storage locations. LANL N3B has continued to evaluate these 16 containers and currently 13 of the 16 have no potential for energetic reaction and require no additional protection. The remaining three will need additional waste processing.

At LANL TRIAD, other TRU waste drums have been generated and stored since the DNFSB reporting requirement was issued. These may be stored in places where there is no confinement ventilation. In addition to the drums themselves, there are other controls influencing the safe storage of these drums, including the controls associated with compliance with the hazardous waste laws. Other safety management programs are in place that help to prevent or mitigate the consequences of accidental release of radioactive material. These measures include training and qualification of workers, emergency response programs, requirements to conduct work using approved procedures, and chemical safety programs. These measures, taken together, provide assurance that the safety of the public and of worker is protected.

At LANL N3B, the 29 containers identified by the DNFSB have been examined. The following is a summary of the current status:

- Four containers have been transported to WIPP for disposal;
- Seventeen containers are fully certified through the WIPP CCE Process and approved for shipment;
- Three containers are included on a draft Basis of Knowledge (BoK) exempt memo for certification;
- One container was identified as a cemented matrix based on High Energy Real Time Radiography and does not present concerns of a release of radioactive material;
- Three containers are currently overpacked and waiting in a remediation line for processing; and,
- One container is awaiting BoK review as potential excess Portland cement was used, which is not WIPP approved.

In addition, LANL N3B has undertaken additional extent of condition reviews, examining the entire Area G above ground TRU waste inventory. The review excluded specific waste streams, robust containers (e.g., Type B containers, TRUPACT), and containers with PE-Ci (plutonium equivalent curies) values less than 1.3. LANL N3B recognizes that in postulating events similar to those at WIPP and INL, the extent of cause is not limited to the specific chemical combinations discovered post-event. As such, LANL N3B has appropriately taken a

conservative posture in reviewing its own TRU waste inventory. Because of reviews performed to date, LANL N3B has identified containers (drums and Standard Waste Boxes [SWBs]) with the following contents of concern, in addition to those identified by the DNFSB report, currently segregated and stored in Dome 54-0375:

- Four containers with nitrated anion resin-direct loaded drums into SWBs; and,
- Eight containers that have been identified as of potential concern due to the lack of historical information and unknown absorbents (e.g., SWheat[®] or Wastelock 770) used in historical processing lines.

Evaluation of the current inventory by LANL N3B continues, with an additional extent of condition on containers that have a PE-Ci value less than 1.3. Immediate compensatory measures will be implemented if additional containers of concern are identified.

4. CONCERNS WITH DOE-STD-5506

DOE's Office of Environmental Management (EM) has reviewed DNFSB Tech-46 and associated concerns related to DOE-STD-5506-2007. A revision to this Standard is underway, and EM and DNFSB staff have interacted openly on a regular basis for the past year regarding planned improvements and changes. As part of the DOE-STD-5506-2007 revision, DOE has carefully considered DNFSB staff comments from the Review and Comment system (REVCOM) comments, along with previous DNFSB communications and issues articulated in correspondence, including:

- Board letter to DOE dated May 29, 2020, regarding the WIPP DSA;
- Board letter to DOE dated January 29, 2020, regarding areas of concern with DOE STD-5506-2007;
- Public hearing on safety management of waste storage and processing in the defense nuclear facilities complex held June 20, 2019;
- Board letter to DOE dated March 12, 2019, regarding flammable gas hazards in waste containers; and,
- Technical Report 43 dated March 15, 2018, which expressed concerns regarding DOE Standard 5506-2007 by the Board staff.

The draft revision to DOE-STD-5506-YR includes new provisions related to chemical reactions and associated energetic hazards. This includes the addition of postulated chemical-initiated events that must be considered as part of the minimum set of accidents analyzed in DSAs. Guidance is also provided on systematic evaluations of chemicals and potential incompatibilities in wastes using the same CCE methodologies required by WIPP. While this formal process is a requirement of the National TRU Program prior to shipment of wastes, the draft Standard recommends it be incorporated earlier, during the DSA development.

Additional guidance on estimating accident source terms associated with various chemical reaction events, including quantitative airborne release fraction recommendations, has been added in the draft revision to DOE-STD-5506-YR, along with explicit discussion of recent

chemically-initiated events at WIPP and INL. Control strategies described in the standard for various hazards have also been expanded to protect against energetic chemical reactions.

Concerns identified in DNFSB/Tech-46 are encompassed within written Board staff comments received during the DOE REVCOM process on the draft DOE-STD-5506-YR, or by earlier informal comments received during the past year from interactions with the Board staff as the draft revisions are being developed. DOE and Board staff continue to work toward resolutions of these comments, resulting in an improved Standard that addresses the various concerns related to chemical reactions. The writing team has processed over 380 written comments on the draft standard and expects that the resultant updated draft standard will be returned into the DOE REVCOM process in early this month.

5. CONCLUSION

Adequate controls are in place to prevent incompatible chemicals from being co-located within TRU waste drums at LANL facilities. Due to the nature of processes at LANL TRIAD, there are no chemical incompatibility hazards that could lead to rapid over-pressurization of a TRU waste drum, other than the one discussed above, with special controls in place for management of these containers. LANL TRIAD has committed to doing an extent of condition review of waste streams to verify and validate this assertion. The Waste Management Program credited in the safety bases and implemented at waste generator facilities contains numerous check points and evaluations that prevent both hydrogen deflagrations and low energy chemical incompatibilities. A number of other controls, considered defense-in-depth, also work to prevent these types of accidents. These include the drums themselves, which have vents to prevent pressurization, and the controls associated with various safety management programs that help to ensure the safety of the public and workers. The upcoming revision of DOE-STD-5506 will address the broader concerns of the DNFSB.

TRU waste stored at Area G represents decades of operations at current and decommissioned LANL TRIAD facilities. As such, the contents of associated waste containers vary due to process specifics and mission changes over the years. Because of this variability, a different approach is required in addressing these TRU waste containers. As a result of the WIPP and INL events, the Area G safety basis cannot conclude that a similar event is not credible at Area G. Because the containers may have been filled prior to processing activities at Area G (e.g., during generation at a LANL TRIAD facility), the Area G safety basis may need to drive TSR-level controls to verify container contents and supporting documentation prior to receipt at the facility. This determination will be made as a result of a safety analysis performed for resolution of the aforementioned LANL N3B PISA declaration. LANL N3B is performing ongoing extent of condition reviews of the current above ground waste inventory in response to the conclusions presented in DNFSB Tech-46. Considering an expanded extent of cause, LANL N3B has declared a PISA and is taking conservative action to isolate and provide layers of confinement for any containers that have been determined to present a chemical incompatibility concern not addressed in the currently implemented safety basis.