DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

March 28, 2016

The Honorable Ernest J. Moniz
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Moniz:

The Department of Energy (DOE) strategy for preventing recurrence of the 2014 radiological release event at the Waste Isolation Pilot Plant (WIPP) needs to be improved prior to resuming transuranic waste receipt and disposal activities. We understand that to preclude a repeat event, WIPP's upgraded Documented Safety Analysis will rely on improvements to DOE's process for verifying that transuranic waste complies with WIPP's Waste Acceptance Criteria (WAC). While work is underway to strengthen the WAC compliance process, DOE management has not formally documented its plan for defining and implementing these crucial process improvements.

Additional attention is warranted to ensure WAC compliance and verification improvements are effectively and expeditiously planned, reviewed, and implemented. The enclosed staff report is also provided for your information and use as you continue efforts to resume safe transuranic waste activities at WIPP.

Sincerely,

Joyce L. Connery
Chairman

Enclosure

c: Dr. Monica Regalbuto
Mr. Todd Shrader
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

January 13, 2016

MEMORANDUM FOR: S. A. Stokes, Technical Director

COPIES: Board Members

FROM: B. Broderick, P. Meyer, A. Battaglia, and S. Sircar

SUBJECT: Waste Isolation Pilot Plant Documented Safety Analysis

This report documents a review of the Waste Isolation Pilot Plant (WIPP) Documented Safety Analysis (DSA) conducted by members of the staff of the Defense Nuclear Facilities Safety Board (Board). On December 9–10, 2015, the staff review team met with representatives from the Department of Energy's (DOE) Carlsbad Field Office and Nuclear Waste Partnership, LLC (NWP), to discuss ongoing efforts to revise the WIPP DSA. NWP personnel are in the final stages of developing Revision 5 of the DSA in accordance with DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. This DSA revision is intended to address safety basis deficiencies identified during DOE investigations of the salt haul truck fire and radiological release accidents that occurred at WIPP in February 2014.

The staff review identified one significant issue that appears to warrant additional DOE management attention. The staff team identified several other issues that DOE and NWP personnel agreed to address before finalizing the DSA. Members of the Board's staff will continue to monitor these issues until they are effectively resolved.

Issue Warranting Additional DOE Attention - Exothermic Reactions Involving Future Waste Receipts. In its Phase II report, the DOE Accident Investigation Board examining the WIPP radiological release concluded the event was caused by an exothermic reaction inside a drum. The affected drum over-pressurized, displaced its lid, and energetically expelled transuranic waste. Prior to this event, the WIPP Waste Acceptance Criteria (WAC) prohibited generator sites from shipping ignitable waste forms to WIPP; however, the existing WAC compliance verification program failed to detect the creation of ignitable waste at Los Alamos National Laboratory (LANL), or prevent its shipment to WIPP.

Other LANL-generated drums containing potentially ignitable waste forms exist underground at WIPP behind steel bulkheads. The draft DSA analyzes postulated accidents involving exothermic reactions in these existing drums. The draft DSA does not, however, analyze the possibility that an exothermic reaction could occur in a drum arriving at WIPP in the future. DOE and NWP personnel argue that improvements to the WIPP WAC and/or WAC compliance program will reliably prevent exothermic reactions in future waste receipts. As a result, DOE and NWP representatives conclude that crediting WAC compliance as an assumed initial condition in the DSA is sufficient to eliminate the need to analyze this potential accident.

Since the draft DSA relies solely on WAC compliance to prevent exothermic reactions in future waste receipts, it is crucial for improvements to the WAC compliance program to be rigorously planned and effectively implemented. Chapter 18 of the draft DSA describes some aspects of a strengthened WAC compliance program. However, many of the most vital elements of the WAC compliance verification process are beyond the scope of the WIPP DSA since they apply to transuranic waste generator sites and fall under the purview of DOE's National Transuranic (TRU) Program. National TRU Program personnel are currently devising improvements to the broader WAC compliance verification regime, but these plans are not yet fully developed and documented. Since the quality and character of these improvements will ultimately determine the adequacy of the preventive control strategy critical to the WIPP DSA, additional DOE management attention is necessary to ensure WAC compliance improvements are adequately planned, documented, and implemented.

The staff review team notes that verifying compliance with the WAC's chemical property restrictions requires diligent record keeping and strict procedural adherence by waste generators and careful evaluation by specialized reviewers. Processes that rely heavily on human performance are susceptible to human error; therefore, the staff team believes it would be prudent for DOE and NWP management to explore defense-in-depth measures that enhance WIPP's capability to detect and respond to problems caused by unexpected failures in the WAC compliance program.

Issues Pending Resolution. During the review, DOE and NWP representatives agreed that a number of issues raised by the staff team required remedial action. For these issues, DOE and NWP personnel proposed resolution strategies that, once effectively implemented, should correct the deficiencies. In several cases, DOE reviewers independently identified similar issues and had already prompted NWP analysts to initiate corrective actions. The staff review team will continue to monitor the following issues until effective resolution has been verified:

Material at Risk (MAR) Assumptions—Radiological consequence calculations in the draft DSA include MAR values computed using a statistical methodology outlined in DOE-STD-5506-2007, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*. The Standard 5506 methodology uses an algorithm to generate MAR values based on the number of containers assumed to be impacted by postulated accidents and knowledge of the transuranic waste inventory. The draft DSA does not establish any controls to ensure the actual MAR involved in WIPP operations is less than the statistically derived MAR values assumed in the safety analysis.

The staff review team found that the lack of administrative MAR control appears to conflict with Section 4.3.2 of DOE-STD-5506-2007, which states:

"Special attention should be given to whether the scope of container activities could unintentionally concentrate problematic containers, thereby invalidating the MAR methodology. If this situation exists, an administrative control will be required to protect assumptions of the hazard analysis."

The staff team independently analyzed actual waste configurations emplaced in WIPP's underground panels to determine if clusters of problematic waste containers could produce more

severe releases and higher consequences than assumed in the draft DSA. The staff team used the lube truck pool fire scenario postulated in the draft DSA as the basis for the independent analysis and calculated radiological release source terms for appropriately sized pool fires in each underground room and panel location. The staff analysis used the same analytical assumptions on damage ratios, airborne release fractions, and respirable fractions as the draft DSA. The results of this analysis identified clusters of problematic containers that would result in higher source terms (i.e., more severe releases with higher consequences) than analyzed in the draft DSA.

Based on this analysis of historical waste emplacement at WIPP, the staff team concludes there is a high likelihood that future waste operations will unintentionally concentrate problematic waste containers and create the potential for accidents with higher consequences than those analyzed in the draft DSA. In response to these findings, DOE and NWP representatives stated they would reevaluate the MAR assumptions in the DSA and evaluate the need to establish administrative MAR controls to protect key analytical assumptions.

Exothermic Reactions Involving Existing Waste—WIPP underground Panels 6 and 7 house LANL-generated waste drums that may be susceptible to exothermic reactions. WIPP personnel have installed steel bulkheads with flexible rubber flashing to partition off areas where these drums are located. The draft DSA assumes these bulkheads would confine roughly 90% of the radiological material made airborne by an exothermic reaction release. With the bulkheads in place, the draft DSA concluded that an exothermic reaction would result in low radiological consequences to facility workers and determined that no additional safety significant controls were needed to protect underground personnel.

For exothermic reactions involving emplaced drums, the staff review team found that NWP safety analysis calculations indicate that bulkhead confinement alone is insufficient to prevent the migration of high concentrations of airborne radiological material to areas where facility workers may be present. These high airborne concentrations could result in significant radiological exposures to underground workers. Exacerbating this hazard, facility workers may not recognize the presence of dangerous conditions, since they cannot observe an exothermic reaction occurring on the opposite side of a steel bulkhead, and the draft DSA does not credit any monitoring equipment to detect an ongoing release and initiate worker evacuation. As a result of these findings and similar observations by DOE reviewers, NWP representatives agreed that facility worker consequences are high for this postulated accident and that additional credited safety controls are needed.

Seismically Induced Fires in the Waste Handling Building—The draft DSA postulates a seismic accident where falling debris from Waste Handling Building appurtenances impacts staged waste containers and ignites a small fire that compromises confinement seals on four containers. Calculated collocated worker consequences for this event do not exceed 100 rem Total Effective Dose (TED), so the draft DSA does not require any mitigative controls to be qualified to perform post-seismic safety functions.

Accident scenarios in the draft DSA are analyzed using computational methods and conventions from DOE-STD-5506-2007. The staff review team found that a peculiarity in Standard 5506 conventions for analyzing fires results in collocated worker consequences exceeding 100 rem TED if just two containers (rather than the four assumed in the draft DSA)

are impacted by the seismically induced fire. This situation conflicts with Section 3.2.1 of DOE-STD-3009-2014 which requires a DSA to analyze the highest consequence scenario when initiating events (e.g., earthquakes) could lead to a range of postulated accidents. Based on this finding, DOE and NWP personnel agreed that the analytical assumptions and parameters for the seismically induced fire scenario need to be reevaluated.

Waste Shaft Falls with Subsequent Pool Fires—Safety analysis calculations that support the draft DSA postulate several accident scenarios where vehicle mishaps lead to waste containers or heavy equipment falling long distances down the waste shaft and causing radiological releases. These accidents involve two release mechanisms—mechanical impact from the fall down the waste shaft and thermal impact from a pool fire assumed to form at the bottom of the shaft from fuel spilled from the fallen vehicle. One postulated accident scenario involves a vehicle falling from the surface onto waste containers located roughly 2,000 feet below. Another scenario involves a vehicle loaded with waste containers falling roughly 100 feet from the underground waste station into the waste shaft sump. Of these two waste shaft fall scenarios, the DSA analyzes only the 100-foot fall event and concludes that unmitigated offsite consequences do not exceed 5 rem TED. Since unmitigated consequences do not challenge the DOE Evaluation Guideline, safety class controls were not considered.

Section 3.2.1 of DOE-STD-3009-2014 requires DSAs to analyze the representative scenario that results in the highest consequence. For accident scenarios involving waste shaft falls with subsequent pool fires, analyzed consequences are highly dependent on the amount of material assumed to be ejected from waste containers upon impact because this unconfined material then burns readily in the pool fire. The postulated accident scenario involving the 2,000-foot shaft fall would cause a higher energy impact with more material ejection and a higher consequence than the 100-foot fall scenario. If the DSA analyzed the 2,000-foot fall scenario, as required by Standard 3009, the unmitigated offsite consequence would likely challenge the DOE Evaluation Guideline and require consideration of safety class controls. Based on this finding, DOE and NWP representatives agreed to reevaluate the DSA scenario involving a waste shaft fall with subsequent pool fire to ensure its consequences are bounding.

Conclusion. DOE and NWP personnel have made important strides in improving the WIPP DSA. DOE management's decision to require the use of DOE-STD-3009-2014 in revising the DSA is particularly commendable. For the issues described above with a defined path to resolution, the staff team will review the final version of DSA Rev. 5 submitted to DOE to confirm that all issues have been effectively addressed. Most importantly, the staff review team believes that additional attention is needed to ensure that improvements to the WAC compliance verification process are effectively planned, reviewed, and implemented to reliably prevent radiological releases from exothermic reactions involving transuranic waste containers received in the future at WIPP.