

Bruce Hamilton, Chairman
Jessie H. Roberson
Joyce L. Connery

**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



May 29, 2020

The Honorable Dan Brouillette
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Brouillette:

The Defense Nuclear Facilities Safety Board has completed a review of the Waste Isolation Pilot Plant safety basis. Each defense nuclear facility's safety basis defines the requirements and limits for safe operations. As identified in the enclosed report and in previous correspondence, the Board has observed challenges with DOE sites maintaining updated safety basis documents. The enclosed report is for your information and use.

Yours truly,

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

Bruce Hamilton
Chairman

Enclosure

c: Mr. William I. White
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

March 26, 2020

Waste Isolation Pilot Plant Documented Safety Analysis Review

Summary. A staff team from the Defense Nuclear Facilities Safety Board (Board) reviewed the Waste Isolation Pilot Plant (WIPP) documented safety analysis (DSA), technical safety requirements (TSR), and supporting calculations. The staff team identified four safety items related to the analysis and control selection for accident scenarios involving a waste shaft pool fire, waste conveyance overtravel, underground roof fall, and repeat energetic exothermic event. The staff team is also concerned about the adequacy of defense-in-depth measures for undesired waste reactions and lack of appropriate personnel for federal oversight of contractor activities associated with the WIPP safety basis.

Background. WIPP performs a crucial role for the Department of Energy (DOE) in dispositioning transuranic waste in a deep geologic repository. Safe operations at WIPP allow DOE to reduce the risk of transuranic waste storage at sites across the DOE complex. In 2016, DOE upgraded the WIPP DSA in accordance with DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, including improvements to address deficiencies identified during DOE's investigations of the salt haul truck fire and radiological release accidents that occurred at WIPP in February 2014¹.

The staff team reviewed the current WIPP safety basis documents, including changes from the 2016 version. The staff team completed its initial review and transmitted an agenda to the Carlsbad Field Office (CBFO) in July 2019. CBFO requested that the staff team refocus the review on the changes proposed for revision 7 of the DSA, which it expected Nuclear Waste Partnership, LLC (NWP), to submit for federal approval in the near term. However, NWP delayed submittal of revision 7 due to emerging work. In the interim, CBFO and NWP personnel supported teleconferences for some agenda topics on July 31, 2019, and September 5, 2019. The staff team updated the agenda based on these interactions and performed the onsite review with CBFO and NWP personnel during the week of November 18, 2019. A follow-up teleconference was required on December 4, 2019, to complete the review.

Discussion. The staff team identified four specific areas where DOE should improve safety basis analyses and controls. The staff team also concluded that DOE should consider defense-in-depth measures for undesired waste reactions and should continue to supplement and strengthen federal oversight of NWP efforts to keep the WIPP safety basis up to date.

¹ WIPP Accident Investigation Board reports dated March 2014, April 2014, and April 2015.

Waste Shaft Pool Fire—The staff team concluded that the WIPP safety basis analysis for a pool fire in the waste shaft is inadequate and that DOE should consider an additional control to prevent the fire portion of this accident scenario. The scenario involves a drop of a transuranic waste load (four overpacked standard waste boxes and a facility pallet) onto a conveyance loaded with a 300-gallon fuel tank, or the drop of a forklift carrying a 300-gallon fuel tank onto a conveyance loaded with transuranic waste. The events involve drops in the waste shaft of more than 2000 feet. In either case, the transuranic waste/facility pallet or forklift/fuel tank impact the waste hoist conveyance with high kinetic energy causing impact and fire release mechanisms. Two key assumptions involved in this analysis are the damage ratio during the impact and the amount of waste that burns outside of a container during the pool fire. The WIPP DSA assumes that only 50 percent of waste is involved in the impact (damage ratio provided by overpacked containers that protect the waste²) and only 2.5 percent of the waste burns outside of a container (the remainder of the waste burns inside a container).

The staff team concludes that the assumptions for the impact damage ratio and the waste fraction that burns outside of a container are not reasonably conservative based on the kinetic energy involved in a drop of greater than 2000 feet. The staff team's analysis indicates that the dose consequences may challenge or exceed the DOE Standard 3009-2014 evaluation guideline. The pool fire part of the scenario is a significant contributor to the overall dose consequence, especially as the fraction of waste that burns unconfined (i.e., waste that burns outside of a container) increases. The hazard for this scenario decreases significantly without a pool fire. The staff team notes that NWP normally transports the 300-gallon fuel tank to the underground on the salt hoist. Therefore, taking this into account, instituting a safety control that precludes fuel tank transport on the waste hoist would not have significant operational impacts.

In 2019, NWP identified a potential inadequacy of the safety analysis (PISA) and unreviewed safety questions (USQ) associated with transport of the 300-gallon fuel tank. NWP identified the USQ based on the potential to increase dose consequences associated with a pool fire in the waste handling building. The initial PISA compensatory measures restricted 300-gallon fuel tank movement in several areas including the waste conveyance. However, the NWP proposed resolution of this issue, submitted in an evaluation of the safety of the situation in July 2019, does not resolve the staff's concerns about the safety analysis and controls for a pool fire in the waste shaft.

Due to the hazard associated with a pool fire and the uncertainty in the analysis, the staff team concludes DOE should consider a specific administrative control (SAC) that prohibits transport of the fuel tank on the waste hoist.

Waste Conveyance Overtravel—The staff team identified that the WIPP hazard analysis does not include all unique and representative accident scenarios for the waste hoist. The staff reviewed potential failure modes for the waste hoist and is concerned that

² DOE-STD-5506, Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities, indicates a damage ratio of 0.5 is "believed to be a reasonably conservative estimate" for overpacked containers. However, the standard does not provide a basis for this assumption and it may not be appropriate for impact events with high kinetic energy.

inadvertent conveyance overtravel at the top of the shaft during a waste transfer may damage the hoist ropes resulting in a waste drop (i.e., drop of the waste conveyance loaded with waste containers). The system design description for the waste hoist and the DSA chapter 2 description identify the potential for the waste conveyance impact with “the crash beams, which might result in breaking of the head ropes³.” This scenario is not included in the hazard analysis. Evaluation of hazard scenarios prompts NWP to identify appropriate safety controls that could be included in the DSA. Based on the consequences from similar scenarios, worker impacts from the overtravel scenario require safety significant controls.

During the review, CBFO personnel indicated that the safety-significant Lilly controller and brake system would prevent upward overtravel scenarios. However, the staff team notes that the DSA does not list this capability among the functional requirements and performance criteria identified for the waste hoist brakes, and there are no associated TSR controls or surveillances to ensure the operability of this function. The staff team concludes that identification of the scenario in the hazard analysis will help ensure proper identification of safety controls and functions in the DSA and TSRs.

Underground Roof Fall—The staff team concludes that the safety basis assumptions for an underground roof fall and impact on waste containers are not reasonably conservative in the WIPP safety basis. The current safety basis does not evaluate a roof fall for the full length of a room. However, roof falls extending the length of a room appear credible based on past failures experienced in the underground. Ground control actions in the underground help reduce the likelihood of a large roof failure; however, ground control may not prevent roof falls once areas above emplaced waste are no longer accessible. Staff evaluation of the consequences of a large roof failure (i.e., the length of a room) suggests that the WIPP safety basis should identify safety significant controls for this scenario. The staff team notes that safety controls (e.g., ventilation system) are available to mitigate the consequences for this accident scenario.

Repeat Energetic Exothermic Event—A page change to the DSA in 2019 deleted a design feature that required isolation structures (i.e., robust noncombustible barriers) for segregating non-compliant containers in WIPP panel 6 and panel 7 in room 7. The change also eliminated a SAC that required continuous air monitoring to detect a material release from these panels. CBFO approval of this change noted that the isolation structures “should be graded as safety significant (SS) since they prevent significant consequence to the FW [facility worker] and CW [collocated worker].” However, CBFO approved this change and noted that the “barriers are not required to be SS and are protected at a level commensurate with their importance.”

NWP requested this change because personnel cannot inspect the isolation structures after personnel emplace waste that blocks access to the structure. The staff team agrees that it is an appropriate practice to inspect a design feature; however, the staff team concludes the safety significant role of these barriers remains relevant and appropriate. There are additional safety basis options (e.g., a SAC to install and verify adequacy of new barriers as personnel emplace waste in panel 7) that would ensure the needed safety control is in place.

³ Underground Hoisting System – System Design Description, Revision 13, 1/18/2017, Section 3.6

Undesired Waste Reactions—As noted in the Board’s letter and report dated March 28, 2016, the WIPP DSA relies on the waste acceptance criteria (WAC) program to prevent undesired waste reactions. DOE’s National Transuranic Program, which executes this program at generator sites, relies on waste analyses and specialized chemical reviews that have improved since the radiological release accident that occurred at WIPP in February 2014. However, developing adequate knowledge of waste container contents and evaluating all hazardous chemical reactions is difficult and susceptible to human error.

The WIPP DSA does not include unmitigated analysis of undesired waste reactions because it assumes the WAC will not fail. DSA analysis of these scenarios would lead DOE and NWP to consider measures that provide additional defense-in-depth in case there is a failure in the WAC program. Such measures could include continuous air monitoring of radiological conditions in the underground that enhance WIPP’s capability to detect and respond to unexpected failures in the WAC compliance program⁴.

Federal Oversight—During completion of this review, CBFO personnel requested to postpone interactions with the Board’s staff. In addition, CBFO personnel did not discuss some topics in the agenda in depth during the onsite interaction despite completion of two teleconferences in advance. CBFO indicated that the delays in interactions and detailed discussions were due to CBFO’s and NWP’s focus on ongoing safety basis changes and other emergent work.

The staff team observed that there have been significant delays in completing the WIPP DSA annual updates, with the last federal approval of a DSA annual update occurring in February 2018. As of today, CBFO has not approved the evaluation of the safety of the situation that NWP submitted in July 2019, as discussed above. CBFO was also not aware that NWP cancelled the temporary controls that NWP established at the time it determined that the associated PISA and USQ existed. The staff team notes that CBFO has vacancies in the safety programs division and therefore relies on DOE headquarters to supplement federal capability for specific safety basis reviews. The staff team is concerned that a lack of appropriately trained and qualified resources is adversely affecting federal oversight of the WIPP safety basis process.

Conclusion. The staff team concludes that the DSA and supporting documents include adequate analyses and controls for safe operations at WIPP with the exception of four safety items for which DOE should improve the safety analyses and controls. The staff team also concludes that DOE should consider defense-in-depth measures for undesired waste reactions and continue to supplement and strengthen federal oversight of contractor efforts to maintain the WIPP safety basis up to date until additional resources and capability exist at CBFO.

⁴ The staff notes that waste generator sites process and store waste that may not comply with the WIPP WAC and, therefore, each generator site needs to ensure that its safety basis includes the analysis and identification of appropriate safety controls for undesired waste reactions.