

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

**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



January 29, 2020

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

Dear Secretary Brouillette:

The Department of Energy is in the process of revising DOE Standard 5506, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*. This standard, originally issued in 2007, specifies how DOE sites should analyze and control the hazards involved with DOE's transuranic waste. The revision to this standard is central to DOE's efforts to prevent radiological release events similar to those that occurred in February 2014 at the Waste Isolation Pilot Plant and in April 2018 at the Idaho National Laboratory. We discussed the importance of DOE Standard 5506 during our public hearing on June 20, 2019.

Over the last several months, our staff has engaged with DOE staff working on the revision to the standard. We appreciate the transparency shown by DOE. Our specific areas of concern regarding transuranic waste are included in the enclosure. These concerns were previously provided through staff-level engagement with DOE. We also plan to provide comments on the revised standard as part of DOE's formal review and comment process (RevCom).

Yours truly,


Bruce Hamilton
Chairman

Enclosure

c: Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Areas of Concern related to DOE Standard 5506

Chemical Reaction Events. In recent years, the Department of Energy (DOE) has experienced two notable events in which drums containing solid nuclear waste were breached due to unexpected chemical reactions that occurred within the wastes. One event occurred in February 2014 at the Waste Isolation Pilot Plant (WIPP) [1], and the other occurred in April 2018 at the Idaho National Laboratory (INL) [2]. Both events involved the release of radioactive wastes from the drums.

After the WIPP event, DOE initiated some important actions that were mainly focused on ensuring that waste generator sites do not ship potentially reactive waste to WIPP [3]. There was a less consistent approach for preventing undesired chemical reactions at the generator sites, as illustrated by the INL 2018 event. The revision of DOE Standard 5506 [4] is an opportunity to identify requirements to ensure that chemical reaction hazards are appropriately analyzed and controlled at generator sites. Therefore, the Defense Nuclear Facilities Safety Board (Board) is concerned about how the standard will address the following areas:

Chemical Compatibility Evaluations—The 2007 version of DOE Standard 5506 does not require a chemical compatibility evaluation to identify potential undesired chemical reactions. After the 2014 WIPP event, DOE began requiring chemical compatibility evaluations using a specified methodology before waste generator sites can ship waste to WIPP [5]. However, generator sites may generate, process, and store wastes indefinitely without performing this evaluation.

The Board concludes the revision to Standard 5506 would be enhanced by including requirements, methods, and criteria for a chemical compatibility evaluation that is documented, comprehensive, and performed at the generator sites regardless of when or whether the waste is intended to be shipped to WIPP. One critical topic is the analysis of waste with uncertain composition. The 2018 INL event demonstrates the importance of this topic. The contractor-led investigation found that beryllium carbide could have played a key role in that event [6], but DOE contractors had not previously identified this chemical as being within the waste.

The evaluations should be able to identify a broad set of adverse conditions, such as generation of heat, gases, corrosive vapors, and shock-sensitive materials. Ideally, an evaluation would consider not just interactions between different chemicals within the waste itself, but also reactions involving the container, air, and moisture. Another consideration is that waste may change over time as it reacts or degrades. Chemicals (including those thought to be only present in trace amounts) should only be excluded from evaluation with technical justification.

Defensible Release Fractions—An important step in safety analysis is the estimation of the potential consequences of postulated events. To guide this consequence analysis, DOE Standard 5506 specifies release fractions for various waste types involved in different types of postulated accidents. The DOE investigation for the 2014 WIPP event found that more radiological material was released than would be expected based on the release fractions in the existing standard [1]. The Board is not aware of DOE performing a similar analysis of the release from the INL event. The Board advises DOE to incorporate information about the release fractions from both events into the standard.

Controls for Chemical Reaction Events—The revised standard should address controls for chemical reaction events. If the chemical compatibility evaluation identifies potential hazards, possible measures could include placing the waste in locations with confinement ventilation, cooling and monitoring the waste, processing existing waste to make it less hazardous, or changing the process to generate a less hazardous waste.

The Board also notes the inherent challenges in performing an accurate chemical compatibility evaluation, particularly for wastes of uncertain composition. Therefore, application of the defense-in-depth approach would help reduce the risks involved in managing such waste. DOE Standard 3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* [7], states that the “identification of hazard controls shall incorporate a defense-in-depth approach that builds layers of defense against release of radioactive or other hazardous materials so that no layer by itself, no matter how effective, is completely relied upon.” Currently, DOE often stores waste in locations without confinement ventilation, and sometimes without capability for timely detection of release events that are not directly observed by workers.

Flammable Gas Hazards. The 2007 version of Standard 5506 does not clearly state that a deflagration of flammable gases can occur in a vented container [8]. However, if flammable gases are generated more quickly than they can be vented, a flammable condition could be reached. As the Board [9] and DOE [10] have noted, INL has had several vented drums that contained flammable concentrations of gases. If there is an ignition source, a deflagration could occur; DOE has historically experienced container deflagrations [11-13]. Therefore, the Board advises that the revised standard discuss deflagrations in vented containers. Considerations include how quickly flammable gases are generated and vented, measurement of flammable gas concentrations, controls to minimize ignition potential, and controls to mitigate the consequences of deflagrations. In addition, the Board plans to evaluate DOE’s response to the October 18, 2019, Board letter [14] that requests information relevant to this topic.

Container Performance. Standard 5506 includes assumptions about how waste containers (e.g., drums, boxes, overpack containers) perform in fire and deflagration scenarios. Chapter 4 of the Board’s Technical Report 43 notes areas where these assumptions are unsupported [8]. For example, the standard states that 25 percent of top-tier drums will eject their lids in a pool fire. However, the historical tests that informed this assumption may not have had configurations (e.g., closure torque) that meet modern requirements. DOE’s recent testing showed a higher likelihood of lid loss. The assumptions in the standard should have a conservative and defensible technical basis reflecting available data. In some other cases, additional experimental campaigns may be appropriate to inform future revisions of Standard 5506.

Implementation of the Standard. Given the potential major changes to the standard and the information gathered from the two recent events, the Board concludes that an urgent approach to implementation of an updated Standard 5506 is warranted. As DOE finalizes the revision of Standard 5506, the Board plans to evaluate DOE’s approach for applying the revision, including ensuring that facilities implement any necessary additional controls in a timely manner.

References

- [1] Department of Energy, *Accident Investigation Report Phase 2, Radiological Release Event at the Waste Isolation Pilot Plant, February 14, 2014*, Office of Environmental Management, 2015.
- [2] Idaho Cleanup Project, *Formal Cause Analysis for the ARP V (WMF-1617) Drum Event at the RWMC*, RPT-1659 Revision 1, 2019.
- [3] Department of Energy Carlsbad Field Office, “Appendix H, Enhanced Acceptable Knowledge”, in *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, DOE/WIPP-02-3122 Rev 9, 2018.
- [4] Department of Energy, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, DOE-STD-5506-2007, 2007.
- [5] Department of Energy Carlsbad Field Office, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, DOE/WIPP-02-3122 Rev 9, 2018.
- [6] Idaho Cleanup Project Core, *Technical Analysis of Drum Lid Ejections-ARP V*, RPT-1662, 2018.
- [7] Department of Energy, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, DOE-STD-3009-2014, 2014.
- [8] Defense Nuclear Facilities Safety Board, *Deficiencies in DOE Standard 5506-2007, Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, DNFSB/TECH-43, 2018.
- [9] Defense Nuclear Facilities Safety Board, *Idaho Waste Drums with Elevated Methane Concentrations*, Letter to Secretary of Energy James R. Perry, Department of Energy, March 12, 2019.
- [10] Griffin, J.C., Associate Principal Deputy Assistant Secretary for Field Operations, Department of Energy Office of Environmental Management, Letter to Defense Nuclear Facilities Safety Board, May 7, 2019.
- [11] Silva, M., *An Assessment of the Flammability and Explosion Potential of Transuranic Waste*, Environmental Evaluation Group, EEG-48, 1991.
- [12] Department of Energy, *Pressure buildup and release from a 55-gallon drum of MTC 219 material*, Fernald Environmental Management Project, Occurrence Report EM-ORO--WMCO-FEMP-1991-0004, 1991.
- [13] Department of Energy, *Ignition of Hydrogen Gas in Lidded Drum*, Fernald Environmental Management Project, Occurrence Report EM-ORO--WMCO-FEMP-1992-0065, 1993.
- [14] Defense Nuclear Facilities Safety Board, Letter to Secretary of Energy James R. Perry, Department of Energy, October 18, 2019.