DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

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 conducted a review of the safety basis at the Solid Waste Management Facility (SWMF) located at the Savannah River Site. For certain fire scenarios, the safety basis credits a two-hour response time by the fire department, and this assumption is used as a basis for limiting a radiological release from a fire affecting transuranic (TRU) waste located on storage pads to two hours. However, SWMF lacks fire detection capability throughout the facility and has limited staffing hours. Thus, SWMF could experience a fire that goes undetected for more than two hours, which would affect more material at risk, resulting in a higher dose consequence than what is documented in the safety basis.

Pursuant to 42 U.S.C. § 2286a(a), the Board is providing advice in the form of the enclosed report, which includes details on the deficiency noted above and other items identified during the recent review, for your information and use.

Yours truly,

Bruce Hamilton
Acting Chairman

Enclosure

c: Mr. Mark Do

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

February 1, 2018

MEMORANDUM FOR: S.A. Stokes, Technical Director

COPIES: Board Members

FROM: K. Amundson

SUBJECT: Fire Detection and Response Time at the Solid Waste Management Facility at the Savannah River Site

This report documents an issue with crediting the fire department response at the Solid Waste Management Facility (SWMF). The SWMF documented safety analysis (DSA) credits a fire department response time to protect the assumption that a release would be limited to two hours during a fire event. The fire department response time is cited as a significant contributor to defense-in-depth, beyond material at risk-based specific administrative controls, to limit the dose consequences from a propagating fire on transuranic (TRU) waste storage pads [1]. In order for the fire department to respond in a timely manner, it must be notified of a fire. SWMF lacks fire detection throughout the facility and the facility is only staffed Monday through Thursday during normal working hours, nominally from 0500 to 1700.

Without the ability to detect and notify the fire department of a fire, assumptions in the DSA concerning limited fire duration and fire propagation cannot be protected. Additional concerns are that the TRU pads lack a fire suppression system and TRU waste drums are stored on pallets composed of combustible high density polyethylene (HDPE) material.

Background. SWMF provides permanent disposal, interim storage, characterization, and shipment of radioactive, mixed, and hazardous wastes generated by and received at Savannah River Site (SRS). The SWMF processes mainly are located in E Area, with a portion in H Area, which is near the center of SRS. The total radionuclide inventory at SWMF is less than 475,000 Plutonium-239 Equivalent Curies (PEC). A maximum of 50,000 PEC is buried waste at closed SWMF facilities. Up to 400,000 PEC is in TRU/mixed TRU waste operational facilities, and the remaining inventory is in the low level/mixed low level waste operational and active disposal facilities [1].

The Defense Nuclear Facilities Safety Board's (Board) staff's review of the SWMF focused on the 11 TRU pads, located in E Area, that are used for storage of radioactive, mixed, and hazardous wastes. The SWMF safety basis establishes the allowable material at risk in operating SWMF TRU waste facilities as 400,000 PEC, with up to 325,000 PEC allowed to be outside concrete overpack containers. Most TRU pads have weather enclosures, which protect the waste containers (primarily steel boxes, concrete containers, and steel drums) that are outside concrete culverts from rain and other weather related effects [1].

Crediting Fire Department Response Time. For low- and moderate-intensity propagating fires, Section 4.2.2.1.1 of the SWMF *Consolidated Hazards Analysis* states, "After two hours, either fire department intervention or activation of the site Emergency Response Program is credited with stopping propagation or sheltering onsite receptors" [2]. The SWMF DSA also credits a two-hour response time from the fire department as a significant contributor to defense-in-depth to limit fire propagation on TRU waste storage pads, therefore limiting the amount of material at risk (MAR) susceptible to release during postulated fire accidents (See Table B-1, *Mitigated Hazard Evaluation Table,* of the DSA) [1].

SWMF does not have fire detection systems in most facility locations, including the TRU waste storage pads and the facility is only staffed Monday through Thursday for nominally 12 hours per day and thus detection or identification of a fire cannot be guaranteed. While Centerra, the protective force contractor, performs security inspections of the SWMF during off hours, these security inspections are periodic and do not cover every TRU pad. Given these conditions, the two-hour response time assumption cannot be protected during unstaffed periods.

The SWMF DSA also assumes a two-hour aerodynamic re-suspension (entrainment) duration in mitigated fire analyses, while the unmitigated analyses use an eight-hour entrainment. The basis for reducing the entrainment duration in the mitigated analyses is the two-hour emergency response [3]. Without a fire detection system to protect the two-hour emergency response time, it is possible for the entrainment time to exceed two hours, potentially increasing dose consequences to levels exceeding the 100 rem threshold to the co-located worker for some fire events in the Mitigated Accident Analysis [4, 5].

The July 22, 2017, heavy equipment fire in a non-radiological area at SWMF illustrates this concern. The fire department responded promptly to the fire after being notified by personnel at a nearby facility that fortuitously observed heavy smoke over SWMF [6]. Had the fire occurred at night when observation of smoke would have been difficult, it is possible that the fire would have burned undetected for an unknown period of time. Therefore, if a fire can burn and propagate for greater than two hours, MAR in excess of that considered in the DSA could be involved, increasing the dose consequence of the analyzed fire events.

Combustible Pallets—Additionally, the SWMF uses pallets composed of combustible HDPE materials to store TRU waste drums. SRS testing determined that HDPE pallets contribute to slowly propagating a fire in a storage array of 55 gallon drums [7]. The test report also identified limitations of the burn demonstration that could lead to a higher fire propagation rate at SWMF. The Board's staff review team observed that Department of Energy (DOE) Standard 5506-2007 recommends the use of non-combustible pallets for storing TRU waste, particularly for facilities lacking preferred fire controls, such as fire suppression and confinement ventilation systems, as is the case for SWMF.

Further, in evaluating potential fires involving the combustible pallets, Section 3.2.3 of the *SWMF Fire Hazards Analysis* states that "the propagating fire spread can be contained by responding fire department personnel before exposure to surrounding Pads. See Section 3.4.2 for analysis on fire department emergency response" [8]. Section 3.4.2, however, does not address the absence of a means to notify the fire department of a fire when the facility is not staffed.

This suggests that during these times, a fire involving the combustible pallets could expose surrounding pads and involve additional waste, which the DSA does not currently analyze.

High Curie Containers Outside of Overpacks—The Fire Event C-1-5c scoping scenario (See Section 4.2.2.1.1 of the *Consolidated Hazards Analysis*) is used to ensure that the High Container Storage Array MAR limit is not vulnerable to a single container small fuel pool fire [2]. This scoping scenario was evaluated to verify that there are not any missing fire controls; however, the analysis is highly dependent on assumptions and inputs that have large uncertainties. At the time of the review, there were approximately 20 drums (approximately 6,700 PEC total) in High Container Storage Arrays[1] that were not in overpacks. Because of the high MAR content, these drums are a significant contributor to the dose consequences of a fire accident at the facility. The Board's staff review team observed that the SWMF personnel are considering overpacking these drums, which would prevent lid ejection during severe fire accidents and help reduce the potential radiological consequences. The Board's staff review team believes overpacking is a prudent measure to reduce the potential for a significant fire-driven radiological release, particularly given the uncertainties in the scoping scenario of a single container small fuel pool fire (Fire Event C-1-5c).

Additional Observations. The Board's staff review team made additional observations during its review of the SWMF DSA. The intention for noting the following items in this issue report is to provide further information regarding the SMWF safety basis.

Waste Form Distribution Assumptions—The SWMF DSA relies on historical data for legacy TRU waste received from other DOE sites to derive the TRU waste form distribution (i.e., 34 percent combustible) [3]. Dose calculations in the accident analysis are sensitive to the waste form distribution, and particularly to the fraction of waste considered combustible.

In the analysis of historical data to derive the debris waste form distribution, Savannah River Nuclear Solutions (SRNS) omits unknown or miscellaneous legacy containers, which constituted approximately 30 percent of the legacy PEC inventory. The Board's staff review team also observed that there is not a control to protect the assumption of the TRU debris waste form distribution, such as a periodic review of waste received at SWMF to determine compliance with the waste form assumptions. Instead, SWMF relies on an annual forecasting review of waste streams that will be entering SWMF in the upcoming years to provide confidence that the assumption remains bounding.

SRNS's position is that there is sufficient data to bound the assumption because historically higher PEC drums have been noncombustible and 99 percent of the TRU waste at SWMF is legacy material. Also, looking forward to future campaigns, SRNS expects new drums with higher PEC content to be noncombustible. While the Board's staff review team does not disagree with this position, the absence of a formal SWMF control to protect waste form (e.g., as part of the inventory control program) presents a vulnerability to protecting established MAR limits should routine methods, such as waste forecasting, not identify a future waste form change for review against the safety basis.

[1] High Container Storage Arrays are groupings of high-curie-content containers that are treated separately in the DSA due to their higher potential consequences.

Co-located Worker χ/Q—In April 2015, DOE's Office of Environment, Health, Safety, and Security issued OE-3:2015-02, *Atmospheric Dispersion Parameter (χ/Q) for Calculation of Co-located Worker Dose*. The OE-3 document concluded that the default χ/Q adopted by the DOE complex-wide, and used by the SWMF, for determining co-located worker dose may not be conservative for open air releases or releases from small buildings [9]. The document provides recommendations for determining an appropriate χ/Q in these situations.

The Board's staff review team concluded that the OE-3 document may be applicable to several accident scenarios at SWMF, including (1) large fires involving TRU waste that would consume the fabric weather enclosure over the TRU pads, and (2) vehicle transportation accidents that involve the transport of TRU waste between SWMF buildings.

MACCS2 calculations performed for SRS in *MACCS2 Calculations Supporting Stack Release and Plume Heat Factors for Unit Dose TED Factors (U)* indicate that outdoor releases can result in χ/Q values that are significantly greater than the default χ/Q reported in DOE-STD-1189-2008 (before accounting for plume buoyancy) [10]. Given that SWMF vehicle event T2 (Table 43-A of S-CLC-E-00259) reports a co-located worker dose of 88.1 rem, only a 14 percent increase in χ/Q is needed to exceed 100 rem [5]. DOE's Savannah River Office (DOE-SR) and SRNS personnel have neither evaluated nor planned to evaluate the impacts of the OE-3 document specifically on the SWMF control set. DOE-SR and SRNS maintain that the default co-located worker χ/Q value is adequate.

Conclusion. The Board's staff review team concluded that SWMF cannot adequately protect the assumption of a two-hour fire department response. There are no automatic fire detection systems throughout most of the facility, and it is only staffed Monday through Thursday during normal work hours, nominally from 0500 to 1700. Therefore, it is possible for a fire to burn undetected and exceed the two-hour response time assumption. Facilitated by the use of combustible pallets and the presence of high-curie containers outside of overpacks, a fire event that exceeds two hours has the capability to affect more MAR than is currently assumed and analyzed in the SWMF accident analysis. This could result in a higher dose consequence than what is documented in the safety basis.

References

[1] Savannah River Nuclear Solutions LLC, *Savannah River Site Solid Waste Management Facility Documented Safety Analysis*, WSRC-SA-22, Rev. 26, Aiken, SC, July 2016.

[2] Savannah River Nuclear Solutions LLC, *Consolidated Hazards Analysis for Solid Waste Management Facility (U)*, WSRC-TR-2006-00263, Rev. 29, Aiken, SC, July 2017.

[3] D.B. Burns, *Solid Waste Management Facility (SWMF) Inputs and Assumptions (U)*, S-CLC-E-00207, Rev. 15, Aiken, SC, December 2014.

[4] Savannah River Nuclear Solutions LLC, *Conduct of Engineering and Technical Support Procedure Manual*, Manual E7, Procedure 2.25, November 2012.

[5] P.E. Wisdom, *Master Calculation for Solid Waste Management Facility (SWMF) Dispersion Modeling Update [Mitigated Accident Analysis]*, S-CLC-E-00259, Rev. 1, Aiken, SC, June 2015.

[6] Department of Energy, *Daily Occurrence Report July 25, 2017*, EM-SR—SRNS-CPWM-2017-0003, July 25, 2017.

[7] J.M. Harris, *Fire Propagation Demonstration of High Density Polyethylene Pallets Final Report*, F-TRT-E-00001, Aiken, SC, February 2007.

[8] B.A. Boucher, *Fire Hazards Analysis for E-Area Solid Waste Management Facilities (U)*, F-FHA-E-00002, Rev. 11, Aiken, SC, June 2014.

[9] Department of Energy, *Atmospheric Dispersion Parameter (χ/Q) for Calculation of Co-located Worker Dose*, OE-3:2015-02, April 2015.

[10] E.P. Hope, *MACCS2 Calculations Supporting Stack Release and Plume Heat Factors for Unit Dose TED Factors (U)*, S-ESR-G-00044, Rev. 1, Aiken, SC, May 2015.

AFFIRMATION OF BOARD VOTING RECORD

SUBJECT: Fire Detection and Response Time at SWMF

Doc Control#2018-100-014

The Board, with Board Member(s) Bruce Hamilton, Jessie H. Roberson, Daniel J. Santos, Joyce L. Connery *approving,* Board Member(s) none *disapproving,* Board Member(s) none *abstaining,* and Board Member(s) none *not participating,* has voted to approve the above document on April 3, 2018.

The votes were recorded as:

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIPATING*	COMMENT	DATE
Bruce Hamilton	☒	☐	☐	☐	☐	04/02/18
Jessie H. Roberson	☒	☐	☐	☐	☐	04/03/18
Daniel J. Santos	☒	☐	☐	☐	☐	04/02/18
Joyce L. Connery	☒	☐	☐	☐	☐	04/02/18

*Reason for Not Participating:

This Record contains a summary of voting on this matter together with the individual vote sheets, views and comments of the Board Members.

Executive Secretary to the Board

Attachments:
1. Voting Summary
2. Board Member Vote Sheets

cc: Board Members
OGC
OGM Records Officer
OTD

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: **Bruce Hamilton**

SUBJECT: **Fire Detection and Response Time at SWMF**

Doc Control#2018-100-014

Approved__X__ **Disapproved_____** **Abstain_____**

Recusal – Not Participating_____

COMMENTS: **Below____** **Attached____** **None__X__**

Bruce Hamilton

2 APRIL 2018

Date

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: **Jessie Roberson**

SUBJECT: **Fire Detection and Response Time at SWMF**

Doc Control#2018-100-014

Approved X **Disapproved**_____ **Abstain**_____

Recusal – Not Participating_____

COMMENTS: **Below**____ **Attached**____ **None** X

Jessie Roberson

April 3, 2018

Date

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: **Daniel J. Santos**

SUBJECT: **Fire Detection and Response Time at SWMF**

Doc Control#2018-100-014

Approved X **Disapproved**____ **Abstain**____

Recusal – Not Participating____

COMMENTS: **Below**___ **Attached**___ **None** X

Daniel J. Santos

4/2/18

Date

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

NOTATIONAL VOTE RESPONSE SHEET

FROM: **Joyce Connery**

SUBJECT: **Fire Detection and Response Time at SWMF**

Doc Control#2018-100-014

Approved ✓ **Disapproved**_____ **Abstain**_____

Recusal – Not Participating_____

COMMENTS: **Below**____ **Attached**____ **None** ✓

Joyce D Connery

Joyce Connery

April 2, 2018

Date