Peter S. Winokur, Chairman
Jessie H. Roberson, Vice Chairman
Sean Sullivan

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

October 23, 2014

Mr. Mark Whitney
Acting Assistant Secretary for
Environmental Management
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Whitney:

The design of the Waste Treatment and Immobilization Plant (WTP) continues to progress without an adequate control strategy to address the volcanic ashfall hazard at the Hanford Site. The most recent hazard assessment by the United States Geological Survey, *Estimate of Tephra Accumulation Probabilities for the U.S. Department of Energy's Hanford Site, Washington*, and all related calculations predict a significant increase in ashfall parameters over previous estimates. The current design and safety basis do not include the most recent assessment, contrary to DOE Order 420.1B, *Facility Safety*. Additionally, DOE withdrew its direction to the contractor in March 2014 to evaluate the impacts of this assessment on the project. The lack of an ashfall control strategy based on the latest hazard assessment, concurrent with design activities, may lead to the need for significant new designs, design revisions, or retrofits to already-constructed systems. Further details are contained in the enclosed report.

Pursuant to 42 U.S.C. § 2286b(d), the Defense Nuclear Facilities Safety Board requests a written response within 90 days of the issuance of this letter documenting the Department of Energy's intent and plan to incorporate the updated ashfall hazard assessment into the WTP design and safety basis.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Dr. Monica Regalbuto
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

August 12, 2014

MEMORANDUM FOR: S. A. Stokes, Technical Director

COPIES: Board Members

FROM: E. Gibson

SUBJECT: Volcanic Ashfall at the Waste Treatment and Immobilization Plant

Staff Issue Summary. Members of the Defense Nuclear Facilities Safety Board's (Board) staff reviewed the strategy outlined by the Department of Energy (DOE)-Office of River Protection (ORP) to address the volcanic ashfall hazard in the design of the Waste Treatment and Immobilization Plant (WTP). In 2011, the United States Geological Survey (USGS), as requested by DOE-ORP, provided a new analysis for a volcanic ashfall event at the Hanford Site [1]. As this was a significant change in natural phenomena hazard (NPH) assessment methodology and site-specific information, DOE Order 420.1B, *Facility Safety*, required the site NPH assessment to be updated. In January 2013, Bechtel National, Incorporated (BNI) identified NPH mitigation deficiencies in the existing WTP structural, ventilation, and emergency power designs due to the updated assessment [2]. However, in March 2014, DOE-ORP requested BNI stop work on the ashfall control strategy and continue to solve open technical issues with the 1996 ashfall analysis in the safety basis [3].

BNI developed a Safety Design Strategy (SDS) as part of DOE-ORP's effort to realign the design and safety basis and to resume engineering, procurement, and construction activities for the High-Level Waste (HLW) facility. The approved SDS does not contain the updated ashfall hazard assessment. DOE-ORP explained to the Board's staff team during a teleconference on June 12, 2014, that they would request that BNI first develop a control strategy for the 1996 ashfall analysis, then BNI will evaluate the impacts of incorporating the new ashfall assessment into the WTP design and safety basis. However, this means the WTP design will continue to advance for months and, potentially, years before the new ashfall loads are adopted. The Board's staff team believes that if DOE-ORP continues with this strategy it should document its intent and plan to incorporate the new analysis into the WTP design and safety basis.

Description of the Volcanic Ashfall Hazard. Some of the notable NPHs in the Pacific Northwest are the volcanos of the Cascade Range, five of which are within or close to 200 kilometers of the Hanford site [1]. While the site is removed from the proximity of volcanic hazards such as lava flows, landslides, and avalanches, the potential for ash fallout is a significant concern. During volcanic eruptions, rock and lava fragments are ejected and form air

plumes. Large particles drop out first, but small ash particles can travel great distances. As these ash particles fall, they have the potential to clog and abrade engines and mechanical components, short out electrical connections, reduce visibility, and increase loads on structures.

The current WTP General Information Preliminary Documented Safety Analysis (PDSA) [4] relies on two sources for the characterization of the volcanic ashfall hazard at the Hanford site (referred to as the baseline analysis for the remainder of this report). The ash structural loads were developed in a 1996 report, WHC-SD-GN-ER-30038, *Volcano Ashfall Loads for the Hanford Site* [5]. The report implemented a probabilistic approach to determine the expected ash thickness at the site and then calculated the structural load based on ash density. Also, the PDSA references ash concentrations, accumulation rates, and event duration from the 1982 Supplemental Safety Evaluation Report No. 3 for the Washington Nuclear Power Plant 2, now known as the Columbia Generating Station.

At the time these reports were developed, there was little guidance or experience to draw upon to estimate ash loads, concentrations, and duration of events. For NPHs, new data, methodologies, and interpretations are continually developed over time. DOE Order 420.1B, *Facility Safety*, requires an evaluation of site-specific NPH assessments every 10 years to determine if they require updating. The baseline analysis no longer includes the most complete dataset and hazard characterization.

In 2011, the USGS, as requested by DOE-ORP, estimated the probability associated with ash accumulation thickness at the Hanford site. For NPH design, the hazard exceedance probability is driven by the Performance Category (PC) requirements of DOE Standard 1020-94, Chg. 1, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, which is included in the WTP Code of Record. PCs are specified for the design and evaluation of structures, systems, and components (SSCs) based on potential consequences of failure. According to DOE Standard 1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, this ranges from PC-0 where there is no importance to safety or mission, to PC-4 where failure during an NPH event could result in off-site release consequences greater than or equal to the unmitigated release from a large Category A reactor severe accident. Each PC has a performance goal defined as the annual probability of exceedance of acceptable behavior limits. In the WTP design, the Low Activity Waste (LAW) facility is designated PC-2 and the HLW and Pretreatment Facility (PTF) are designated PC-3.

The USGS study estimates ash thickness values similar to the baseline analysis, as seen in Table 1. However, USGS also recommended the use of a compacted density in determining the structural loads because the thickness estimates were from the analysis of deposits that were mostly compacted by the time they were studied and do not represent freshly fallen ash [6]. DOE-ORP applied an uncompacted density in the baseline analysis. By incorporating the compacted density, the structural load almost doubles. The Pacific Northwest National Laboratory (PNNL) adopted this new data to recalculate the duration and concentration of the airborne ash [6] [7]. The USGS and PNNL studies will be referred to as the new analysis in this report. The maximum airborne ash concentration increased considerably over the values originally estimated in the baseline study. One of the most significant changes was identification

of the potential for resuspension of the ash particles. Wind or other sources can resuspend newly fallen ash, causing it to remain airborne. In conclusion, as shown in Table 1, the new analysis predicts structural loads that are significantly larger than the baseline study, airborne concentrations of ash that are higher than the baseline study, and an event duration that has increased from 20 hours to 60 days for a PC-3 event.

Table 1: Comparison of Baseline and New Ashfall Values

Volcanic NPH Property	Baseline Analysis [5] [8]	New Analysis [6] [7]
Ash Thickness	PC-1—N/A PC-2—3.1 cm PC-3—7.8 cm	PC-1—1.4 cm PC-2—5 cm PC-3—10 cm
Ash Density	780 kg/m^3	1125 kg/m^3
Ash Structural Load	PC-1—15 kg/m^2 PC-2—24 kg/m^2 PC-3—61 kg/m^2	PC-1—16 kg/m^2 PC-2—58 kg/m^2 PC-3—112 kg/m^2
Ashfall Duration	20 hr	Initial Ashfall Event—12 hr Ashfall Resuspension Duration PC-1—30 days PC-2—50 days PC-3—60 days
Maximum Airborne Ash Concentration	PDSA—220 mg/m^3	PC-1—370 mg/m^3 PC-2—1325 mg/m^3 PC-3—2650 mg/m^3

WTP Design Impacts. In 2012, DOE-ORP requested that BNI evaluate the impacts of incorporating the new analysis [9]. On January 11, 2013, BNI responded that there would be significant impacts to implementing the new ashfall estimates [2]. Excerpts from this letter include:

> *Structural Impacts*—The change will require a revision to existing seismic analysis of Seismic Category I, II, and III[1] structures due to increased mass roof steel members for support of increased ashfall load and revision to the design calculations for the steel roof member sizes for all facilities to determine overall impacts. The increase in ashfall loading approximately doubles the current design load used for these structures. It is expected that the current design of some areas of the roof structure will be overstressed and require redesign and modification. Additionally, there will be significant modifications to the existing structures to accommodate any ash filtration equipment which would be required. [2]
>
> and,

[1] Seismic Category I and II are equivalent to PC-3 while Seismic Category III is equivalent to PC-2. Additional design details are provided in 24590-WTP-SRD-ESH-01-001-02, Rev 7, *Safety Requirements Document Volume II* [12].

Ventilation Impacts—The increased suspended ash concentrations will make currently accepted controls ineffective, and will require extensive redesign of equipment and/or processes for all facilities. Further consideration to design philosophy, approach and control features is required. [2]

BNI's letter further states that changes to the current design approach to accommodate the increased ash loading could impact the ventilation makeup air that requires filtration. It states that this could require an annex or new building, larger HLW facility footprint, new structural loading on facility roofs, additional compressed air, or administrative controls. BNI concluded the letter by stating that:

> Since this change affects the roof structures of LAW, the Analytical Laboratory (LAB), HLW and PTF such that other impacts cannot be fully defined until controls are selected, a potential impact is that facility design, procurement, and construction activities would be suspended until the design has substantially progressed and the unaffected portions of the design, procurement, construction can be released. During this period, the affected facilities including LAW, LAB, HLW, and PTF would be placed on hold until the criteria are reconciled and the design is aligned. [2]

Proposed Nuclear Safety Controls. On September 25, 2013, BNI's Nuclear Safety Engineering organization (then known as Environmental & Nuclear Safety) proposed a preliminary control strategy to address the new analysis [10]. This preliminary strategy was issued to make the control concepts available to support the development of the SDS documents for HLW. The preliminary control strategy identified several administrative and engineering controls to address the potential ashfall hazards quoted below:

- Building roof or structural damage
- Power line breakage and damage to steel towers and wooden poles due to ashfall loading
- Arcing/shorting/current leakage via settled ash on electrical equipment
- Loss of normal electrical power
- Reduced cooling efficiency of heat exchanger and condensing units
- Accelerated erosion, pitting, and scouring of metallic apparatus, particularly moving parts
- Plugged air intake filters
- Clogged gutters, drains, and sewer systems
- Immobilized vehicular and air traffic
- Increased frequency of lightning
- Disrupted lines of communication
- Reduced visibility
- Acute respiratory problems, eye problems, and skin irritation
- Distracted workers, high error rates, and conflicted priorities

- Overwhelmed community services (e.g., water)

The administrative controls described in this preliminary control strategy place the WTP facilities in a safe condition by reducing toxic and radioactive off-gas production from the operating melters, minimizing building exhaust flow, minimizing building heat loads, and placing emergency clear air supply systems into service. The engineered controls include four new buildings dedicated to the emergency clear air supply that will contain filtration systems for the (1) emergency turbine generators, (2) chiller/compressor building, (3) PTF confinement ventilation makeup air, and (4) HLW confinement ventilation makeup air.

DOE-ORP Response. The Board's staff team observed that draft versions of the HLW SDS from November 14, 2013, through March 5, 2014, included the design criteria from the new ashfall analysis. However, on March 4, 2014, DOE-ORP rescinded its 2012 request for BNI's impact analysis of the incorporation of the new analysis into the WTP design [3]. DOE-ORP requested that BNI focus on the resolution of underlying technical issues to support the baseline design, scope, cost, and schedule for the ashfall criteria. The approved HLW SDS does not consider the new ashfall analysis [11].

DOE-ORP discussed this further with the Board's staff team during a teleconference on June 12, 2014. DOE-ORP personnel explained that they would like BNI to first resolve open technical issues that include the necessary controls for safe hydrogen gas release, the air requirement to support pulse jet mixing, and the subsequent realignment of the design and safety basis. After the resolution of these technical issues, DOE-ORP intends to direct BNI to finalize its previous control strategy with the ashfall loads from the baseline analysis and then to evaluate the impact of incorporating the new ashfall analysis into the design and safety basis. During a teleconference on August 28, 2014, DOE-ORP commented that they believe that this strategy is low risk because they put holds on all design and construction work for the PTF and a minimal amount of design work is being performed for the HLW. However, the Board's staff team remains concerned that the lack of an updated ashfall control strategy based on the latest hazard assessment, concurrent with design activities, may lead to the need for significant new designs, design revisions, or retrofits to already-constructed systems.

Conclusion. The Board's staff team is concerned that not incorporating the new ashfall analysis into the design and safety basis early may result in unresolved safety issues at a later stage in design and construction. As described in this report and stated by BNI in its initial evaluation, the incorporation of the new analysis will have significant impacts on the structural, ventilation, and emergency power designs. By continuing design activities without incorporating the latest assessment of the hazard, the project is not meeting the requirement of DOE Order 420.1B, *Facility Safety*, as listed in the WTP Code of Record, to design and construct facility SSCs to withstand natural phenomena hazards and ensure protection of the public. DOE-ORP has indicated it will evaluate the impacts of incorporating the new analysis after finalizing the initial control strategy for the baseline analysis. However, this means the WTP design will continue to advance for months and, potentially, years before the new ashfall loads are adopted. The Board's staff team believes that if DOE-ORP continues with this strategy it should document its intent and plan to incorporate the new analysis into the WTP design and safety basis.

Cited References

[1] Hoblitt, R. P. and W. E. Scott, *Open-File Report 2011-1064 Estimate of Tephra Accumulation Probabilities for the U.S. Department of Energy's Hanford Site, Washington*, United States Geological Survey, 2011.

[2] Sawyer, S. L., Letter to R. L. Dawson, Contract No. DE-AC27-01RV14136 Estimated Impact to the WTP Design from the Incorporation of Revision 2 of HNF-SD-GN-ER-501 National Phenomena Hazards, Hanford Site, Washington, CCN 254129, Bechtel National, Inc., January 11, 2013.

[3] Dawson, R. L., Letter to L.W. Baker, BNI, Contract No. DE-AC27-01RV14136 Request for Design and Cost Estimate for the Baseline Natural Phenomena Hazards of Ashfall, Hanford Site, 14-WTP-0026, Department of Energy-Office of River Protection, March 4, 2014.

[4] Bechtel National, Inc., *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information,* 24590-WTP-PSAR-ESH-01-002-01, Rev. 5a, Department of Energy, October 2013.

[5] Salmon, M., *Volcano Ashfall Loads for the Hanford Site for the U.S. Department of Energy, Richland Operations Office, Richland, Washington*, WHC-SD-GN-ER30038, Rev. 0, EQE International, 1996.

[6] Pacific Northwest National Laboratory, *Volcano Ashfall Loads for the Hanford Site*, WHC-SD-GN-ER-30038, Rev. 2, July 2012.

[7] Pacific Northwest National Laboratory, *Natural Phenomena Hazards, Hanford Site, Washington*, HNF-SD-GN-ER-501, Rev. 2, July 2012.

[8] Bechtel National, Inc., *White Paper: An Evaluation of WTP Ashfall Design Requirements and Recommended Mitigation Strategy*, 24590-WTP-PRPT-ENG-10-016, Rev. 1, January 1, 2010.

[9] Dawson, R. L., Letter to S. L. Sawyer, BNI, Contract No. DE-AC27-01RV14136 Notice of Intent to Modify the Contract—U.S. Department of Energy (DOE) Document HNF-SD-GN-ER-501, Natural Phenomena Hazards, Hanford Site, Washington, 12-WTP-0268, Rev. 2, August 28, 2012.

[10] Bechtel National, Inc., *Proposed Control Strategy—Volcanic Ashfall*, 24590-WTP-RPT-ENS-13-012, Rev. A, Department of Energy-Office of River Protection, September 25, 2013.

[11] Bechtel National, Inc., *Safety Design Strategy for the High-Level Waste Facility*, 24590-HLW-PL-ENS-13-0001, Rev. 0, Department of Energy-Office of River Protection, June 23, 2014.

[12] Bechtel National, Inc., *Safety Requirements Document, Volume II*, 24590-WTP-SRD-ESH-01-001-02, Rev. 7, Department of Energy-Office of River Protection, September 9, 2013.