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**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



May 8, 2015

Mr. David M. Klaus
Acting Under Secretary for
Management and Performance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Mr. Klaus:

The Defense Nuclear Facilities Safety Board (Board) issues letters at major project milestones to assist the Department of Energy (DOE) in evaluating the readiness of a project to move forward. This letter describes open safety issues that require DOE senior management attention to achieve resolution and produce a defensible safety basis for the High-Level Waste (HLW) Facility at the Waste Treatment and Immobilization Plant (WTP) at Hanford.

On August 19, 2014, after a nearly two-year effort to resolve safety issues and realign the design with the safety basis, the DOE Office of River Protection (DOE-ORP) granted the WTP contractor a conditional authorization to proceed with all engineering work necessary to finalize the design of the HLW Facility, and limited procurement and construction. In its authorization letter, DOE-ORP stated that the HLW issues have been substantially resolved. The Board advises DOE senior management that a considerable amount of work remains to resolve all open safety issues for the HLW Facility. These issues are summarized in the paragraph below and detailed in the enclosure.

The Board recently identified safety issues associated with volcanic ashfall hazards; unanalyzed melter accidents; seismic categorization of systems, structures, and components; and the control strategy for hydrogen explosion hazards. Also, several safety issues previously identified by the Board are unresolved. These issues are pulse jet mixing; pulse jet mixer controls; hydrogen in piping and ancillary vessels; the methodology for analysis of spray leaks; facility interaction hazards; erosion and corrosion of piping, vessels, and components; design and construction of electrical distribution systems; and formation of sliding beds in process piping.

DOE plans to grant the WTP contractor full authorization to proceed with engineering, procurement, and construction work for the HLW Facility once the design and the safety basis are fully aligned. The Board plans to re-examine DOE's progress in resolving open safety issues and developing a defensible safety basis for the HLW Facility prior to DOE granting a full authorization to proceed to ensure adequate protection of the public and the workers.

Sincerely,



Jessie H. Roberson
Vice Chairman

Enclosure

c: Mr. Joe Olencz

ENCLOSURE

Status of the High-Level Waste Facility and Related Safety Issues

High-Level Waste (HLW) Facility Status. In 2012, the Department of Energy (DOE) restricted engineering, procurement, and construction work for the HLW Facility due to unresolved safety and programmatic issues, as well as misalignments of the design and safety basis. The DOE Office of River Protection (DOE-ORP) developed a two-phase decision process for authorizing Bechtel National, Incorporated (BNI) to proceed with engineering, procurement, and construction work at the HLW Facility. The first decision is a conditional authorization to proceed with limited production engineering and construction. The second decision is a full authorization to proceed, which will be granted following full alignment between the design and safety basis. In October 2013, DOE-ORP identified activities that BNI must perform to support a conditional authorization to proceed. One of the prerequisites was for BNI to develop and submit a Safety Design Strategy (SDS) for the HLW Facility. On August 1, 2014, the DOE-ORP manager and the Federal Project Director for the Waste Treatment and Immobilization Plant (WTP) approved the SDS with concurrence from the DOE Chief of Nuclear Safety and the Associate Deputy Assistant Secretary for Safety, Security, and Quality Programs for Environmental Management.

The SDS “provides the basis for updating, and ultimately revising, the preliminary documented safety analysis (PDSA) for the [HLW] Facility to ensure the final design is compliant with 10 CFR [Code of Federal Regulations] 830, Part B, *Nuclear Safety Management*. This SDS is a re-alignment to guide future hazard analyses, design activities, and technical issue resolutions, culminating in a revised PDSA to be submitted for approval” [1]. An SDS is a concept from DOE Standard 1189, *Integration of Safety into the Design Process*, and is typically developed early in the project life to guide design and safety basis development. However, this SDS is a unique, tailored application of the concept to a partially constructed facility with several outstanding safety issues and a previously approved PDSA. Additionally, DOE Standard 1189 is not required by the WTP contract. The SDS contains the preferred nuclear safety controls for the facility. The content and nuclear safety control strategy outlined in the SDS will have direct implications on the safety basis. Therefore, a deficient SDS may lead to incomplete reconstitution of the PDSA and a safety basis that does not meet the requirements of 10 CFR 830.

Another prerequisite specified by DOE-ORP for a conditional authorization to proceed with engineering, procurement, and construction work was for BNI to resolve open technical issues and recommend design changes. On August 19, 2014, DOE-ORP authorized BNI to resume all engineering work necessary to finalize the design of the HLW Facility and limited procurement and construction. In the authorization letter, DOE-ORP stated that “BNI substantially resolved the HLW technical issues as documented in BNI design assessments addressing: pulse jet vessel mixing, erosion-corrosion risk, HLW equipment redundancy, in-service inspection, pipeline plugging, and HLW vessel and component structural design” [2].

The Defense Nuclear Facilities Safety Board (Board) closely followed the WTP project team’s efforts to reach a conditional authorization to proceed. During the review of the SDS, the

Board identified three safety issues associated with (i) melter accidents; (ii) seismic classification of systems, structures, and components (SSCs); and (iii) the control strategy for hydrogen explosion hazards. Additionally, the Board identified WTP project-wide safety issues associated with the volcanic ashfall hazard that affect the HLW Facility. Previously identified Board safety issues associated with the HLW Facility remain unresolved and a considerable amount of work remains for the WTP project team to resolve open safety issues.

Recently Communicated Safety Issues. The Board identified the following safety issues during its review of the HLW Facility SDS and other oversight activities:

Volcanic Ashfall—In an October 23, 2014, letter to DOE, the Board communicated its concern that the WTP design continues to progress without an adequate control strategy to address the volcanic ashfall hazard at the Hanford site. Also, the current WTP design and safety bases do not include the most recent ashfall assessment. The incorporation of the new assessment will have significant impacts on the structural, ventilation, and emergency power design requirements. 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*, to design and construct facility SSCs to withstand natural phenomena hazards and ensure protection of the public. On February 11, 2015, DOE provided a response that describes a phased approach to address the ashfall hazard. DOE is revising the estimate of ashfall consequences and evaluating hazards analysis alternatives and additional operational controls.

Unanalyzed Melter Accidents—In a December 5, 2014, letter to DOE, the Board communicated its concern that implementation of the nuclear safety control strategy for the melter and associated support systems in the SDS could produce a design that is insufficient to ensure adequate protection of the public and the workers. The Board identified several melter accident scenarios that were not analyzed in the SDS. As a result, the SDS does not identify nuclear safety controls for these accidents. An incomplete SDS can lead to a safety basis that does not meet the requirements of 10 CFR 830. In a March 9, 2015, response, DOE stated their intent to perform comprehensive hazard analyses.

Hydrogen Control Strategy—In a January 21, 2015, letter to DOE, the Board communicated its concern that the SDS does not define a nuclear safety control strategy for hydrogen explosion hazards following the loss of mixing in HLW Facility process vessels containing non-Newtonian waste. This hazard, if not properly addressed, may result in releases of radioactive materials. The lack of a viable hydrogen control strategy for the HLW Facility can lead to a safety basis that is insufficient to ensure adequate protection of the public and the workers. The Board also expressed concerns that the WTP project team plans to rely on evaluations for resolving similar issues in the Pretreatment (PT) Facility to support and inform the development of a hydrogen control strategy for the HLW Facility. Due to significant differences in the design of the mixing systems and waste properties at these two facilities, evaluations for the PT Facility may not apply to the HLW Facility.

Seismic Classification of SSCs—In a February 2 , 2015, letter to DOE, the Board communicated its concern that the nuclear safety control strategy for a seismic design basis accident does not ensure the confinement ventilation system known as “C5V” will be able to

effectively perform its credited safety class functions. The SDS proposes downgrading the seismic classification of several key components. This downgrade can result in penetrations through the C5V confinement boundary that compromise safety functions protecting the workers by maintaining cascade airflow from areas of lower to higher contamination, and the public by filtering releases prior to discharge to the environment. As a result, the preferred nuclear safety control strategy described in the SDS does not meet DOE requirements for protecting the public and workers.

Open Safety Issues. The following is a listing of the remainder of the Board's unresolved safety issues associated with the HLW Facility.

Pulse Jet Mixed Vessels—In a January 28, 2014, letter to the Secretary of Energy, the Board closed Recommendation 2010-2, *Pulse Jet Mixing at the Waste Treatment and Immobilization Plant*, and expressed concern that the underlying safety-related pulse jet mixing issues remain unresolved. Inadequate mixing can lead to the accumulation of solids in process vessels, resulting in generation and accumulation of hydrogen, and potentially leading to explosions. To address this issue for the HLW Facility, the WTP project team performed a mixing assessment for the HLW Facility process vessels containing pulse jet mixers, i.e., radioactive liquid waste disposal (RLD) vessels. The project determined that the majority of the un-dissolved solids in RLD vessels would come from off-specification batches received from the melter feed preparation vessels. The project proposed changes to the HLW Facility flowsheet to eliminate the off-specification feed streams from being routed to these vessels and, thus, to resolve the mixing issues. However, waste spills from the melter feed preparations vessels collected in sumps and containing the un-dissolved solids are also routed to RLD vessels. Therefore, additional work remains for the WTP project team to resolve pulse jet mixing issues for the HLW Facility.

Pulse Jet Mixer Control—The pulse jet mixer control issue was first identified in a January 6, 2010, Board letter and reiterated in the Board's Recommendation 2010-2 closure letter. It remains an unresolved safety issue that applies to the HLW Facility. If not properly designed and constructed, the pulse jet mixer control system may cause frequent overblows, i.e., discharge of air from the pulse jet mixer that may lead to vessel damage and releases of radioactive materials. DOE is testing prototypic pulse jet mixers to confirm the control system design and ensure the control system can perform its safety functions. Also, the WTP project team is conducting structural evaluations of HLW Facility process vessels containing pulse jet mixers to assess their performance under overblow loads.

Hydrogen in Pipes and Ancillary Vessels (HPAV)—Flammable gases generated by the wastes processed at WTP, including the HLW Facility, will accumulate in process piping whenever flow is interrupted and in regions that do not experience flow, such as piping dead legs. The WTP project team refers to this hazard as HPAV. This hazard, if not properly addressed, may result in explosions and releases of radioactive materials within the facility. The WTP project team initiated work on structural analyses to support resolution of HPAV issues at the HLW Facility.

Inadequacies in the Spray Leak Methodology—In an April 5, 2011, letter to DOE, the Board identified safety issues related to DOE's model for estimating radiological consequences to the public from spray leak accidents in the PT and HLW Facilities. Inadequacies in the spray leak methodology may lead to improper identification of SSCs important to safety for these facilities. Therefore, the HLW Facility design may not be adequate to protect the public and the workers. DOE previously completed a two-phase spray leak testing program at Pacific Northwest National Laboratory and is currently incorporating the test results into accident analyses for WTP.

Facility Interaction Hazards—In a September 13, 2011, letter to DOE, the Board communicated its concern that the design and safety-related controls for potential releases of large quantities of gaseous chemicals, including ammonia, at the WTP Balance of Facilities did not adequately protect workers and facilities. The Board reiterated this concern in a September 24, 2014, letter to DOE. In its response, DOE committed to perform the hazard analyses to identify controls needed to protect the workers and facilities.

Erosion and Corrosion of Piping, Vessels, and Components—In a January 20, 2012, letter to DOE, the Board communicated its concern that the design information for WTP does not provide confidence that wear allowances are adequate to ensure that piping, vessels, and components located in HLW Facility black cells and hard-to-reach areas are capable of confining radioactive waste over the 40-year design life of the facility. The WTP project team finalized localized corrosion design limits for WTP vessels and piping and is continuing to perform erosion-corrosion testing to address the Board's concerns.

Design and Construction of the Electrical Distribution System—In an April 13, 2012, letter to DOE, the Board identified several issues related to the operability and safety of the electrical distribution system for WTP. Inadequacies in the design and construction of the electrical distribution system would lead to the inability of safety SSCs to perform their functions of protecting the public and the workers. In its response, DOE committed to address these issues, but it will take several years to complete.

Formation of Sliding Beds in Process Piping—In an August 8, 2012, letter to DOE, the Board communicated its concern that the design of the WTP slurry pipeline system is susceptible to formation of sliding beds of solids that can increase both wear from erosion and the likelihood of pipeline plugging. Also, prolonged operation of a centrifugal pump with a plugged process line could cause the pump to fail catastrophically, resulting in the loss of primary confinement of radioactive waste and damage to adjacent SSCs. DOE plans to address this issue through systematic evaluation of hazards, reassessing the pipeline design strategy, performing additional erosion testing, and establishing appropriate Waste Acceptance Criteria.

Project Self-Identified Safety Issue. In a report dated September 11, 2014, the WTP project team self-identified significant issues with the design of the HLW Facility confinement ventilation and off-gas treatment systems. The HLW Facility safety basis credits the confinement ventilation and off-gas treatment systems with confinement and filtration of radioactive aerosols before the air is released to the atmosphere. As designed, these HLW Facility safety systems may not be able to perform their intended functions or ensure adequate

protection of the public and the workers. The WTP project team is developing a path forward for resolving these issues.

Conclusions. The WTP project team is performing work to finalize the design of the HLW Facility and update the PDSA, which are prerequisites for a full authorization to proceed with engineering, procurement, and construction work. The resolution of all open safety issues is a necessary step for the project to reach a defensible PDSA for the HLW Facility. The Board will continue to review and monitor the WTP project team's activities associated with obtaining a full authorization to proceed. The Board will continue to evaluate the WTP project team's progress in resolving open safety issues and developing a defensible PDSA for the HLW Facility to ensure adequate protection of the public and the workers.

Cited References

- 1 Bechtel National, Incorporated, *Safety Design Strategy for the High-Level Waste Facility*, 24590-HLW-PL-ENS-13-0001, Rev 0, June 23, 2014.
- 2 Hamel, W.F., Assistant Manager, Federal Project Director, Waste Treatment and Immobilization Plant, the Department of Energy Office of River Protection, Letter to M. McCullough, Project Director, Bechtel National, Incorporated concerning Contract No. DE-AC27-01RV14136 - Authorization to Proceed With High-Level Waste Facility Production Engineering, and Conditional Procurement and Construction, Richland, WA, August 19, 2014.