DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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July 15, 2008

The Honorable Thomas P. D'Agostino
Administrator
National Nuclear Security Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0701

Dear Mr. D'Agostino:

The staff of the Defense Nuclear Facilities Safety Board (Board) recently performed a review of the Preliminary Documented Safety Analysis (PDSA) for the Waste Solidification Building (WSB) to be constructed at the Savannah River Site. The Board's staff identified several issues that warrant your attention. These issues have been communicated to personnel from the National Nuclear Security Administration site office and the design contractor. The contractor has already begun to address some of these issues through revisions to the PDSA. Remaining significant issues include the following:

- The design criterion used to analyze hydrogen explosion scenarios in unvented pipes and vessels appears to be consistent with that used to evaluate the operational safety of the Defense Waste Processing Facility—an existing facility. The Board believes that the design of a new facility should be based on a more stringent criterion that preserves the confinement integrity of the primary boundary during a potential accident, similar to the Department of Energy's (DOE) expectations for the new Waste Treatment Plant at the Hanford Site.

- DOE Standard 1189, *Integration of Safety into the Design Process*, has not yet been applied to the WSB. Its application may have an impact on the identification and classification of safety-related systems.

The enclosed report details the issues identified by the Board's staff. Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests a briefing on the resolution of these issues prior to approval of the Critical Decision 2/3 milestone.

Sincerely,

A. J. Eggenberger
Chairman

c: Mr. R. Kevin Hall
Mr. Mark B. Whitaker, Jr.
Mr. Robert J. McMorland

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

June 5, 2008

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: F. Bamdad and A. Gerlach

SUBJECT: Safety Basis Review of the Waste Solidification Building

This report documents a review of the safety basis for the Waste Solidification Building (WSB), to be constructed at the Savannah River Site (SRS). This review was conducted by members of the staff of the Defense Nuclear Facilities Safety Board (Board) D. Andersen, F. Bamdad, M. Duncan, A. Gerlach, R. Kasdorf, D. Minnema, and M. Sautman. The staff held discussions with personnel from the design contractor (Washington Savannah River Company) and the National Nuclear Security Administration (NNSA) site office on April 23–24, 2008.

Background. WSB is being designed at SRS to process liquid waste from the Mixed-oxide Fuel Fabrication Facility (MFFF) and the Pit Disassembly and Conversion Facility (PDCF). WSB will be divided into two main areas to process the low-activity waste stream from MFFF and PDCF and the high-activity waste (HAW) stream from MFFF. Both waste streams will be concentrated through evaporation, neutralized, and solidified into concrete.

Because of the activity and quantity of the waste to be processed, WSB has been classified as a Hazard Category 2 nuclear facility. A combined Critical Decision 2/3 (approved preliminary and final design) is planned for late September or early October 2008.

Discussion. The contractor has prepared a Preliminary Documented Safety Analysis (PDSA) for this project that has undergone several changes during the past few months. The following comments are based on the staff's review of the March 2008 revision of this document, supplemented by the presentations made during discussions at the site.

Hazards Analysis—The project has used the site's Consolidated Hazards Analysis process to identify and evaluate hazards. As a result, chemical hazards that do not exceed the threshold quantities of 29 Code of Federal Regulations (CFR) 1910.119, *Occupational Safety and Health*, or 40 CFR 68, *Chemical Accident Prevention Provisions*, are assumed to pose an acceptable risk to the public and are not considered for further analysis. This assumption is inconsistent with the Department of Energy's (DOE) expectations for identification of safety-related controls as described in DOE Standard 3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis [DSA]*. This standard

requires safety-significant controls to be identified if an unmitigated release would result in significant chemical or toxicological consequences to workers. Additionally, guidance in DOE Standard 1189, *Integration of Safety into the Design Process*, specifies quantitative criteria for determining the need to identify such controls. It is likewise not clear that the project's hazards analysis would meet the expectations of this standard.

The Consolidated Hazards Analysis (CHA) for the Waste Solification Building is listed as a reference in Chapter 3, "Hazard and Accident Analysis," of the PDSA. Events from the CHA with the potential to have significant unmitigated consequences for the public or workers are then summarized in the PDSA for identification of safety-related controls. The controls needed for lower-consequence hazards (i.e., those controls not required to be safety-significant) are not carried forward from the reference into the PDSA itself. The Nuclear Safety Management rule (10 CFR 830, *Nuclear Safety Management*) requires contractors to perform work in accordance with the safety basis, which documents the hazard controls, to ensure adequate protection of workers, the public, and the environment. It is not clear that the references in the PDSA would be included as an explicit part of the safety basis as defined by the rule. This issue could also create future difficulties in performing or determining the results of Unreviewed Safety Question evaluations if the safety basis is limited to the DSA and Technical Safety Requirements (TSRs), but not their references.

Accident Analysis—The PDSA identifies several operational and external events as design basis accidents for which further quantification of their unmitigated consequences is required to determine whether safety-class controls are needed. These events include fires, explosions (hydrogen deflagration or detonation in process systems, vessels, and transfer piping), loss of confinement, external hazards, and natural phenomena hazards. The structural walls of the building, including those enclosing the HAW operations, are designated as safety-significant and designed to withstand a site-specific design basis earthquake (DBE); this seismic motion is based on the Nuclear Regulatory Commission's Regulatory Guide 1.60 and bounds the site's Performance Category-3 seismic motion. The HAW process vessels and piping are designated as safety-significant and designed to confine the materials during a DBE event. The Process Vessel Ventilation System (PVVS) and all its support systems are also identified as safety-significant for the function of confinement and designed to discharge hydrogen generated during normal operations and postseismic events. In addition, the HAW area ventilation system and the fire suppression system are designated as safety-significant, but are not required to operate after the DBE since the hazardous materials would be confined to the process vessels and piping.

There are no safety-class controls associated with this project as the contractor believes that the unmitigated consequences of up to 8 rem are sufficiently below the DOE evaluation guideline of 25 rem. The Board's staff made the following observations:

- The contractor believes that, based on the waste material received from MFFF, the possibility of having a red oil explosion is precluded, and this event is beyond the design basis for the facility. The Board's staff believes there needs to be a TSR-level control on the composition of the waste material to ensure that such an event is excluded from the facility's design basis. Additionally, technical bases have not been

provided to support the declaration that if certain criteria are met, the received waste would not be capable of creating conditions suitable for a red oil explosion.

- The hydrogen explosion analysis supporting the PDSA makes a key assumption related to the volume of the gas (10,000 liters of a stochiometric hydrogen–air mixture) without providing adequate technical justification. For example, it is not clear why 20,000 liters (the capacity of the evaporator head tank) was not chosen. Application of this assumption to the unmitigated dose analysis results in a site boundary dose of about 4.1 rem to the public. This parameter has not been technically justified to validate that safety-class controls are unnecessary.

- The possibility exists that hydrogen generated by radiolysis will accumulate in the pipes and vessels that are not vented. The current design approach for these pipes and vessels is "not to fragment" should a hydrogen detonation occur. This criterion was developed for evaluation of a similar event that could occur at the Defense Waste Processing Facility after its startup. Although this methodology appears to be appropriate for an existing facility, it is not considered appropriate for the design of a new facility.

  The criterion used by the project for fragmentation compares the stresses due to the postreaction pressure with the ultimate stress in the pipe. The pipe schedule is then selected to provide an ultimate stress that exceeds or equals the stresses due to the postreaction pressure. This approach could lead to loss of confinement should a hydrogen detonation occur. The Board's staff believes that stress induced by the peak hydrogen detonation pressure ought to be compared with the pipe's yield stress to maintain the confinement integrity of the pipes.

Identification of Controls—The following observations are based on the information provided in Chapter 4, "Description of the Safety Systems," and Chapter 5, "Derivation of TSRs," provided in the draft PDSA (the final TSRs have not been prepared):

- Identification and classification of controls for WSB are based on certain assumptions regarding the americium 241 (Am-241) contents of the waste material to be received from MFFF. The contractor currently relies on MFFF to verify such assumptions before the waste is transferred to WSB, and may only verify the waste contents periodically to ensure that the waste acceptance criteria are met. These assumptions have not been given a TSR-level control to ensure that they are not exceeded, leading to the need for additional controls. WSB operations staff do not have a process for ensuring that sampling and characterization of every transfer from MFFF have been performed to ensure that the waste acceptance criteria are met before the waste is accepted.

- Several specific administrative controls (SACs) appear to be embedded in the safety management programs. For example, plans are for the air flow into the gloveboxes and enclosures that provide a safety-significant function for the protection of workers

to be included in the Radiation Protection Program instead of being stand-alone SACs in the TSR document. The latter approach would be consistent with DOE Standard 1186, *Specific Administrative Controls*.

- It is not clear how the functional and performance criteria identified in Chapter 4 of the PDSA are translated into design parameters for the safety-related systems. In Chapter 4, for example, the process pipes, valves, and vessels are required to withstand the peak pressure from a detonation in the charge vessel. It is not clear how this functional requirement is transferred into the design of the charge vessel. The System Design Description refers to the Facility Design Description for such parameters; neither one contains the appropriate design information. The contractor stated that the parameters would be in the Safety Requirements Specification, which was recently revised but has not yet been provided for review. Similarly, the PVVS is required to prevent a hydrogen explosion by maintaining the hydrogen concentration below 25 percent of the lower flammability limit. It is not clear how this functional requirement is translated into the design flow rate of the system.

- The boundaries of the safety-related controls and their support systems are not clearly defined in the appropriate section of the PDSA. This omission is important as it could lead to improper classification of the support systems. For example, several of the support systems for the HAW PVVS are required to be safety-significant and qualified to function after a DBE event. In Chapter 4 of the PDSA, the PVVS structural support is not identified as safety-significant, and the backup diesel generator is not identified as being seismically qualified. Similarly, the chiller and demister support systems for the PVVS are not designated as safety-significant because their function is not credited in the accident analysis; however, their confinement pressure boundary must be identified as a requirement since they are to be seismically qualified. Although the contractor representatives expressed their belief that these systems are described adequately in Chapter 2 of the PDSA, "Facility Description," the functional and performance requirements of the safety systems, the system boundaries, and design expectations need to be defined clearly in Chapter 4 of the PDSA in accordance with DOE Standard 3009-94.

- The project has not applied DOE Standard 1189 to the design of this facility. The Board's staff was informed that application of this standard will be assessed at a later date, and a path forward for resolution of the gaps will be proposed. At the time of the review, project personnel did not believe that there would be any significant impact on the design, but the staff believed this evaluation ought to be performed as soon as possible and the results incorporated before Critical Decision 2/3 as the design could be affected. The following are examples of areas in which the application of DOE Standard 1189 could have significant impacts on the design:

  - The project used 50th percentile meteorological conditions for estimating the unmitigated consequences to collocated workers at 100 meters from the facility. DOE Standard 1189 specifies parameters for such calculations that could lead to

an increase in the calculated doses by a factor of about 5. Consequently, additional safety-significant controls may be required for accidents that previously had consequences of about 20 to 100 rem. Examples include fires and spills of the HAW and a fire at the transuranic waste storage pad.

Following the review by the Board's staff, the contractor performed a new dose consequence analysis using DOE Standard 1189 methodology and identified eight new events. However, the existing safety-significant controls are stated to be adequate to address the new events, and will be credited with that function in a revision to the PDSA.

- The chemical hazards, as discussed earlier, are analyzed in accordance with the site's procedure. DOE Standard 1189 provides a methodology for analysis of chemical hazards that includes quantitative thresholds for identification and classification of controls that differ from those used in the site's procedure.

- DOE Standard 1189 states that safety-class controls should be considered if the unmitigated consequences to the public exceed 5 rem.

Recommendation 2004-2, *Active Confinement Systems.* The project recently completed its evaluation of the active confinement ventilation system according to DOE's requirements for implementation of the Board's Recommendation 2004-2 and submitted its report for consideration by the Independent Review Panel. This report and the majority of the NNSA evaluation reports due under the implementation plan for Recommendation 2004-2 are significantly overdue. The ventilation system for the HAW area comprises two systems: the PVVS and the room area ventilation system. PVVS (including the discharge stack), as discussed earlier, is designated as safety-significant and designed to the facility's DBE requirements. This system is equipped with a chiller and a demister to prevent excess moisture generated in the vessels from reaching the high-efficiency particulate air (HEPA) filters; however, these pieces of equipment are not safety-related since their function is not credited for postaccident operations. Project personnel believe that in case of a fire, the safety-significant fire suppression system would limit the size of the fire such that no boiling of the waste would occur inside the vessels, and thus the function of the PVVS HEPA filters would not be jeopardized. As a result, neither system is equipped with a deluge system for protection of its HEPA filters.

The room area ventilation system is classified as safety-significant, but not designed to the facility's DBE requirements. The rationale for the lack of seismic qualification of this system is that the hazardous material is confined to the seismically qualified PVVS, and thus no significant source term would be released (other than residual retention on the HEPA filters).