DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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December 22, 2010

The Honorable Inés R. Triay
Assistant Secretary for Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Dr. Triay:

The Defense Nuclear Facilities Safety Board (Board) has closely followed the conceptual design activities and safety basis development for Phase 1 of the Sludge Treatment Project (STP), also known as the Engineered Container Retrieval and Transfer System (ECRTS), at the Hanford Site. The Board notes that on June 17, 2010, the Department of Energy Richland Operations Office (DOE-RL) approved the Critical Decision (CD)-1 milestone for the ECRTS in accordance with DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets*. In the enclosed report, the Board notes several issues regarding the design and safety basis for the project:

- *Site boundary definition*—The ECRTS portion of the STP is located in the K West Basin at Hanford's 100 K Area. To determine the appropriate safety classification of structures, systems, and components (SSCs), project analysts evaluated the potential dose consequence to the maximally exposed offsite individual at the Wahluke Slope north of the 100 K Area. The Board believes that public access to the Columbia River, which is significantly closer to the 100 K Area than the Wahluke Slope, must be considered in determining the safety classification for SSCs. DOE-RL is currently studying options to resolve this issue by either upgrading the safety classification of several SSCs to safety-class or keeping the safety-significant classification of the SSCs and controlling public access to the river in the event of an accident.

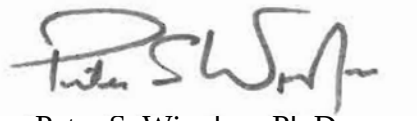
- *Design information*—The design documentation for the active ventilation system for the Modified K West Basin Annex does not include sufficient information with which to identify the safety-significant system boundaries and flow control devices needed to verify that the system will be able to perform its safety function of venting hydrogen.

- *Tailoring of requirements*—The STP tailoring strategy does not adequately integrate safety into the preliminary design. The strategy combines CD-2 and CD-3 but does not require either a Preliminary Safety Design Report or a Preliminary Safety Validation Report, both of which should be due at CD-2. Instead, project personnel plan to submit a Preliminary Documented Safety Analysis for the combined CD-2/3. To ensure that safety is adequately incorporated and verified early in the design process, the Board believes the project should develop the safety documentation and perform the safety reviews normally required at CD-2. Such safety reviews should not be delayed when combining CD-2 and CD-3.

- *Spray leak methodology*—In reviewing the safety analysis for the Waste Treatment and Immobilization Plant (WTP), the Board's staff identified several issues associated with the methodology used to evaluate spray leak accidents. These issues could impact the methodology used by the contractor to assess spray leak accidents in the STP conceptual design. The Board encourages personnel from both projects to share information and will continue to evaluate the STP and WTP spray leak accident methodologies as they are developed.

The enclosure to this letter summarizes the Board's understanding of the status and safety posture of the ECRTS project and provides further detail on the above issues. The Board will continue to follow these issues as the STP design effort matures. The interaction between the Board's staff and STP project personnel has been productive, and we look forward to continuing this dialogue as the project moves forward.

Sincerely,



Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Mr. Matthew S. McCormick
Mrs. Mari-Jo Campagnone

Enclosure
Summary of Sludge Treatment Project and Related Issues

Background. The mission of the Sludge Treatment Project (STP) is to remove radioactive sludge from 105-K West (KW) Basin; process the sludge into a stable, nondispersible form suitable for long-term disposal; and package the sludge in approved containers suitable for transportation to a national repository. The Department of Energy Richland Operations Office (DOE-RL) will carry out this mission in two phases. Phase 1, also referred to as the Engineered Container Retrieval and Transfer System (ECRTS), will involve retrieving the sludge from KW Basin; placing it into sludge transport and storage containers (STSCs); and transporting the sludge-filled STSCs to the Central Plateau where they will be emplaced in the cells at T-Plant for interim storage. Phase 2 will involve treating and packaging the sludge for long-term disposal at a yet-to-be-determined time and location. Currently, CH2M Hill Plateau Remediation Company (CHPRC) is exploring various alternatives for treating the sludge. DOE-RL approved the Critical Decision (CD)-1 milestone for STP Phase 1 on June 17, 2010.

Safety Basis. The material-at-risk in the ECRTS is approximately 30 m^3 of radioactive sludge, which is a mixture of fuel degradation products (including metallic uranium, uranium oxide, and fission and activation products), small fuel fragments, iron and aluminum oxide, concrete grit, sand, and debris. The KW Basin is categorized as a Hazard Category (HC)-2 nuclear facility. For the ECRTS, CHPRC has determined that each STSC will contain an HC-2 quantity of radioactive material.

Project analysts issued the latest Conceptual Safety Design Report (CSDR) on February 22, 2010. Significant hazards identified include deflagrations in process equipment, release of radioactive sludge slurry as an aerosol, and release of radioactive sludge caused by a seismic event and ensuing fire. Engineered and administrative controls will prevent and mitigate consequences to workers from these and other events identified in the safety basis. The safety strategy for the ECRTS relies on the following:

- Preventing spray releases by providing safety-significant primary containment and protecting the primary containment from failure due to overpressurization by use of a rupture disk designed to return fluids back into the basin

- Preventing hydrogen deflagrations in the STSCs during sludge retrieval activities by maintaining the hydrogen concentration below 25 percent of the lower flammability limit through the use of active ventilation

- Preventing hydrogen deflagrations in the transfer line service box by preventing slurry leaks within the box

- Preventing hydrogen deflagrations in the STSC and Sludge Transport System (STS) cask upon completion of sludge retrieval activities by using an argon gas purge system to reduce the oxidant concentration

- Preventing slurry line rupture/spray releases and hydrogen deflagrations by preventing fire-induced structural damage to the Modified KW Basin Annex and by preventing fire-induced failure of the ventilation exhaust system ductwork

- Preventing slurry line rupture/spray releases by verifying that the transfer line heat trace system and facility environmental controls are functional when external temperature falls below a to-be-determined value and mitigating these hazards by using secondary containment and leak detection if a spray leak occurred

To prevent and mitigate these and all other potential accidents, the STP team did not identify any safety-class controls but did identify several safety-significant controls:

- Slurry transfer lines
- Slurry transfer line rupture disk
- Ion exchange module water check valves
- Slurry transfer line secondary containment
- Slurry transfer line leak detection systems
- STSC active ventilation system
- Transfer line service box active ventilation system
- Argon gas purge system
- STS cask pressure boundary
- Sludge quantity instrumentation
- STSC
- STS cask
- STS cask shading (to limit temperature rise)
- Modified KW Basin Annex structure
- Ventilation system exhaust ducting

Technology Maturity. To support the conceptual design for the ECRTS, CHPRC conducted an extensive testing and development program at the Maintenance and Storage Facility, located near the Fast Flux Test Facility. This testing and development program included component and system testing with the purpose of advancing the readiness of the various technology elements. In October 2009, DOE-RL conducted a technology readiness assessment (TRA) of the ECRTS conceptual design. The TRA identified the critical technology elements and determined that each was at the acceptable maturity level for conceptual design. In its report, the TRA team observed that improved characterization data and simulant development efforts are critical to project success and recommended that the STP team continue the planned testing programs (including the full-scale, prototypical tests), continue the program for process improvements, and proceed with Phase 2 process development as soon as possible. Following the TRA, CHPRC developed a Technology Maturation Plan to raise the critical technology elements to a technology readiness level of at least 6 and to address the issues identified in the TRA report. The Defense Nuclear Facilities Safety Board (Board) supports the efforts of DOE-

RL and CHPRC to incorporate a testing and development program throughout preliminary and final design of the ECRTS as well as the process development and conceptual evaluation for Phase 2.

Issues. The Board's staff reviewed several key aspects of the design and safety basis of the ECRTS. The staff identified the issues detailed below, which the Board believes must be addressed as the project progresses through preliminary design.

Site boundary definition—Project analysts evaluated the potential dose consequence to the maximally exposed offsite individual at the Wahluke Slope north of the 100 K Area to determine the appropriate safety classification of structures, systems, and components (SSCs). The Board believes that public access to the Columbia River, which is significantly closer to the 100 K Area than the Wahluke Slope, must be considered in determining the safety classification for SSCs. DOE-RL is evaluating two alternatives to resolve this issue. For the first alternative, DOE-RL had tasked the integrated project team to study various options for controlling public access to the river in the event of an accident at the 100 K Area. DOE-RL has acknowledged that the options being considered would require a change in the procedures for emergency preparedness and an emergency drill that would exercise this control before ECRTS operations could commence. For the second alternative, DOE-RL is evaluating potential changes to the conceptual design that would upgrade the safety classification of several SSCs to safety-class. For defense-in-depth, DOE-RL would also implement the emergency preparedness actions noted above. The Board supports this more robust control.

Design information—DOE-RL has identified the active ventilation systems for the STSCs and the transfer line service box as safety-significant controls to prevent the accumulation of hydrogen in excess of 25 percent of the lower flammability limit. The ventilation systems also provide ventilation for other confined spaces and the facility in general. To verify the ventilation systems' active safety function, the conceptual design is expected to identify flow control devices to ensure that sufficient flow will be drawn through the safety-related portions of the systems. The design also needs to identify the active and passive safety components, along with the system boundaries, to ensure that a failure in a nonsafety portion of the systems will not compromise the flow control strategy. The Board's staff evaluated the systems and found that no flow control devices or safety boundaries were identified on the conceptual design drawings.

DOE-RL conducted a Technical Independent Project Review (TIPR) of the conceptual design for the ECRTS in May 2010 as required by DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets.* However, the TIPR did not identify the design issues regarding the active ventilation systems. The Order states that one purpose of the TIPR is "to determine that the safety documentation is sufficiently conservative and bounding to be relied upon for the next phase of the project." The TIPR team focused their review on only the safety basis so as to avoid duplicating DOE-RL's technical review of the adequacy of the CD-1 design submittal, which was completed by the federal integrated project team. The safety documentation referred to by DOE Order 413.3A encompasses more than the safety basis, including as well the documentation that reflects incorporation of safety into the design. The approach of relying on DOE-RL's technical review of the conceptual design documentation did

not constitute a complete, independent review of the safety documentation as required by DOE Order 413.3A. The Board's staff believes that this approach precluded the TIPR team from identifying issues concerning the incorporation of safety into the design.

Tailoring of requirements—DOE-RL approved CD-1, including a baseline schedule in which project managers plan to combine CD-2 and CD-3. According to the Project Execution Plan (PEP), the combination of CD-2 and CD-3 is part of a "tailoring strategy" whereby project managers do not plan to require a Preliminary Safety Design Report (PSDR), a Preliminary Safety Validation Report, or the formal external independent review that would normally occur prior to CD-2. The PEP cites DOE Guide 413.3-8, *Environmental Management (EM) Cleanup Projects*, as the reference for this tailoring strategy.

The ECRTS is considered to be a major modification. DOE Standard 1189, *Integration of Safety into the Design Process*, states "Where a major modification is found to exist, an SDS [Safety Design Strategy] must be developed that addresses (1) the need for a CSDR or PSDR (as well as the required PDSA [Preliminary Documented Safety Analysis]) to support project phases." The STP schedule identifies that there will be a preliminary design phase, which includes a preliminary design review in accordance with DOE Order 413.3A. The Order states that this design review should include a focus on safety and security systems.

The SDS and Risk Management Plan for the STP do not address the programmatic risks posed by failing to develop a PSDR or combining CD-2 and CD-3. As a result, it is unclear whether the risks of eliminating a key safety-in-design deliverable and the risks associated with combining critical decisions have been identified and mitigated by project personnel.

Spray leak methodology—In reviewing the safety analysis for the Waste Treatment and Immobilization Plant (WTP), the Board's staff identified several issues associated with the methodology used to evaluate spray leak accidents. These issues also could impact the methodology used by the contractor to assess spray leak accidents in the STP conceptual design. Specifically, the staff questions the droplet size distribution correlations and the effect of evaporation on the droplets, either of which can impact the dose consequence resulting from a spray leak accident. The Board will continue to evaluate the STP and WTP spray leak accident methodologies as they are developed.

Observations. The Board's staff raised issues in several other safety-related areas and made the observations detailed below. The staff discussed these observations with STP personnel, who are taking actions to address the observations.

Instrumented systems—The CSDR identifies instrumented systems as part of the safety-significant SSC control set. However, the Code of Record (HNF-44226 Revision 0) for the ECRTS does not include International Society of Automation (ISA)-84.00.01-2004, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector*, as the standard to which safety-significant instrumented systems will be designed, procured, operated, and maintained. It is the understanding of the Board's staff that the design included in the CSDR is being modified

to eliminate the need for safety instrumented systems, but the revised design has not been completed or made available for the staff to review.

Fire hazards analysis—The Fire Hazards Analysis fails to analyze the potential for a fire to impact directly the hose-in-hose transfer system or the ventilation equipment and ventilation electrical system in the Modified KW Basin Annex. As a result, the Fire Hazards Analysis contains no analysis of the need for the fire sprinkler system to be safety-significant rather than general-service. The Board's staff is aware that DOE-RL and CHPRC have reached an understanding that the fire sprinkler system in the Modified KW Basin Annex will be designated as a safety-significant control. The Board's staff will review the safety classification of the fire sprinkler system in the preliminary design as it becomes available.

Safety-related ventilation systems—The CSDR states that the active ventilation systems for the STSC and the transfer line service box require electrical power to perform their safety functions. However, the CSDR does not identify a method for preventing hydrogen deflagrations in the event that power is lost. Instead, the CSDR states that a preferred method will be selected during preliminary design and indicates that implementation of this method will not have a large cost or schedule impact. This approach represents a lack of key safety decision-making in the SDS for active ventilation systems (as well as for the fire protection systems). The Board's staff understands that CHPRC has identified a standby diesel generator as the means of providing electrical power to the active ventilation systems in the event that power is lost. The staff is aware that DOE-RL and CHPRC have reached an understanding that the standby diesel generator will be designated as a safety-significant control.

The CSDR designates only the STSC and transfer line service box portions of the active ventilation system for the Modified KW Basin Annex as safety-significant controls. These portions of the active ventilation system are credited for their safety function to prevent the accumulation of flammable hydrogen concentrations during sludge retrieval activities. Since the CSDR was issued, DOE-RL and CHPRC decided that the whole active ventilation system for the Modified KW Basin Annex will be credited as a safety-significant control, specifically for its safety function to provide confinement. The Board's staff will review the safety classification and design of the new diesel generator and the active ventilation system for the Modified KW Basin Annex when they become available.