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DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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September 7, 2005

Mr. James A. Rispoli
Assistant Secretary for
Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Rispoli:

The Defense Nuclear Facilities Safety Board (Board) is aware that the Office of River Protection (ORP) has embarked on the design and construction of a pilot plant at the Hanford Site to demonstrate bulk vitrification of low-activity waste, a method that may be used to supplement the Waste Treatment Plant. The Board understands the limited operational life of this pilot plant and its potential benefits. However, the Board is also interested in ensuring that this facility is built with appropriate features to prevent escape of radioactive materials and to protect the workers.

The enclosed report presents observations of the Board's staff resulting from a review of the Demonstration Bulk Vitrification Project and is provided for your information and use as appropriate. The report notes potential weaknesses in such areas as the confinement of materials and worker protection that need to be considered in finalizing the design of the facility. The Board is aware of and is encouraged by the fact that ORP and its contractor have already taken steps to evaluate some of the issues raised in this report.

Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests, at a time consistent with the maturity of the design for the Demonstration Bulk Vitrification Project, a briefing on the resolution of the issues identified in the enclosed report. The Board expects this briefing to occur no later than January 2006. In addition, the Board requests, within 60 days of receipt of this letter, a briefing on ORP's technical and programmatic oversight of this project.

Sincerely,

A. J. Eggenberger
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. Roy J. Schepens

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

August 9, 2005

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: J. W. Troan

SUBJECT: Demonstration Bulk Vitrification Project, Hanford Tank Farms

The purpose of this report is to document reviews of the Demonstration Bulk Vitrification Project conducted by the staff of the Defense Nuclear Facilities Safety Board (Board); these reviews included site visits during May 24–26 and July 12–14, 2005. Members of the Board's staff M. Feldman, A. Matteucci, J. Shackelford, J. Troan, and R. Zavadoski participated in the reviews. The staff met with personnel from the Department of Energy (DOE) Office of River Protection (ORP), CH2M Hill Hanford Group, Inc. (CHG), and the demonstration bulk vitrification system subcontractor, AMEC, to discuss the design, preliminary safety analyses, and controls for the project.

Background. The project consists of a full-scale facility for research, development, and demonstration of the bulk vitrification process. The facility will be used to vitrify waste from single-shell tank S-109 to demonstrate the effectiveness of the process as means of supplementing the low-activity waste capacity of the Waste Treatment Plant (WTP). Supplementing the WTP is considered necessary to meet the milestones of the Tri-Party Agreement for completing retrieval of waste from Hanford single-shell tanks by 2018 and treatment of tank waste by 2028.

The design and construction of the demonstration bulk vitrification facility are expected to be completed by early 2006. The first campaign using radioactive waste is expected to start in mid-2006. In December 2004, the Washington State Department of Ecology issued a permit to ORP and CHG to operate the demonstration bulk vitrification facility. The permit remains in effect for a maximum of 400 "operating" days or 3 years, whichever comes first. Closure activities will follow operations, and the facility is then expected to be decontaminated and decommissioned.

Several aspects of the facility design, operation, and testing are not fully developed. Many elements of the design are new and unproven and will require testing. Because of the status of the project, many issues and questions identified by the Board's staff remain unresolved, and much work must be completed before operations begin. The following observations highlight some issues noted by the staff.

Design. The current design has a number of major vulnerabilities with respect to overall confinement of radioactive and hazardous materials. Contrary to DOE's design requirements to use successive physical barriers for protection against the release of radioactivity,[1] the current design uses only one barrier to confine material in portions of the plant. The project's confinement strategy also relies on a mix of active and passive safety-significant systems, non-safety-related design features, and administrative controls.

Safety-significant confinement boundaries include double-walled (hose-in-hose transfer line) piping, double-walled tanks, and piping designed to the requirements of American Society of Mechanical Engineers B31.3, *Process Piping*. Non-safety-related design features include the In-Container Vitrification™ container, which includes connections to the off-gas treatment system and dried waste transfer system. Because these design features are not classified as safety-significant, they may lack reliability and availability commensurate with their safety functions.

The confinement strategy also relies on the implementation of a specific administrative control to ensure the closure of three non-safety-related cone valves (from the clean soil impingement tanks). These three valves are collocated with the safety-significant dryer outlet cone valves on top of the vitrification container and form a portion of the overall confinement boundary.

As a result of these vulnerabilities, the potential exists for the failure of a single non-safety-related barrier that could lead to the unfiltered release of radioactive or toxic materials and unacceptable consequences to workers. For example, failure of the integrity of the non-safety related vitrification container could result in an unfiltered and untreated release of radioactive and toxic material.

Guidance and requirements establish that structures, systems, and components serving a safety-significant confinement function be classified as safety-significant, that successive physical barriers be used to protect against the release of radioactivity, and that the number and arrangement of confinement barriers and their required characteristics be determined on a case-by-case basis. This approach leads to a minimum of two physical barriers for the protection against the release of radioactivity, with at least one barrier designated as safety-significant. The Board's staff observed that in some portions of the demonstration bulk vitrification facility the confinement barrier is not designated safety-significant and successive physical barriers are not used. The justification for the demonstration bulk vitrification facility's confinement strategy is not adequate. The staff needs additional information to better understand the reason for not designating some physical barriers as safety-significant and not using successive physical barriers. This justification ought to include more complete hazard assessments, engineering evaluations, alternatives that were considered, and compensatory measures.

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[1] In accordance with DOE Order 420.1A, *Facility Safety*.

Since the facility's design predates the Board's Recommendation 2004-2, *Active Confinement Systems*, the overall confinement strategy does not incorporate considerations set forth therein regarding an active confinement system. As a result, the proposed design does not align well with the expectations and guidance being developed in the Implementation Plan for Recommendation 2004-2.

Safety Analyses. The staff observed weaknesses in the analysis of anticipated events and in source term assumptions. As noted earlier, since the design is not complete, many issues and questions identified by the staff remain unresolved.

For example, an anticipated system upset condition, such as the loss of power during vitrification, was initially viewed by the contractor as an abnormal event that would result in a focused decision at the time of occurrence as to whether to recover by restarting the melt. The Board's staff believes that, given the expected nature of this occurrence, further analysis of the restarting of the process and the hazardous conditions that could result is warranted. Confirming the behavior of the postulated upset and the recovery procedures for this and other abnormal operating scenarios may be appropriate as part of the project's test program prior to the introduction of radioactive material.

Experience has shown that certain fission products from vitrified waste will volatalize, migrate, and collect in various portions of the off-gas treatment system. The possibility of undesirable accumulation of radioactive materials in this system has not been adequately considered in the current design. As a result, some of the hazards associated with operations, upsets, and maintenance may not be appropriately anticipated. As part of the project's test program, it may be advisable to evaluate actual performance characteristics relative to the carryover and hold-up of fission products in the off-gas treatment system.

Safety of Facility Workers. The contractor's approach to identifying safety-significant controls to protect facility workers does not appear to be consistent with the expectations contained in DOE directives. ORP and the contractor have drawn a distinction between facility workers and collocated workers such that in general, scenarios with significant consequences to collocated workers have safety-significant controls, while scenarios with significant consequences only to facility workers rely on safety management programs. In the Preliminary Documented Safety Analysis, no safety-related structures, systems, and components are identified as exclusively protecting the facility workers. However, several non-safety-related engineered features are included in the demonstration bulk vitrification system design to reduce the hazards to these workers (e.g., shield walls, enclosures, ammonia sensor/alarm). While hazards to facility workers are typically addressed through safety management programs, the Board's staff believes it would be advisable to consider the use of safety-significant controls to address exposure of facility workers to significant radiological and chemical hazards.

For example, ammonia is identified in the Preliminary Documented Safety Analysis as a hazardous material that is stored and used at the demonstration bulk vitrification facility. Approximately 9,000 lb of ammonia will be delivered and stored in a tank for use in the off-gas

treatment system. The Preliminary Document Safety Analysis states that nonradiological hazards, such as chemical hazards, are addressed by safety management programs (e.g., industrial safety and industrial hygiene programs), and lists non-safety-related engineered features that mitigate the ammonia hazard (e.g., vehicle barriers, sensor and alarm, and a standard for building and testing the pressure vessel). The Board's staff is concerned that ammonia poses a significant hazard to workers, and that the ammonia hazard is not being appropriately recognized and controlled. The staff believes it would be advisable to protect workers from this hazard through safety-significant structures, systems, and components and Technical Safety Requirements, such as Limiting Conditions of Operation and Specific Administrative Controls.