# DEFENSE NUCLEAR FACILITIES SAFETY BOARD

## Staff Issue Report

**MEMORANDUM FOR:** J. K. Fortenberry

**COPIES:** Board Members

**FROM:** C. Shuffler

**SUBJECT:** Radioactive Liquid Waste Treatment Facility Project, Los Alamos National Laboratory

This report documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the Radioactive Liquid Waste Treatment Facility (RLWTF) project at Los Alamos National Laboratory (LANL). Staff members D. Eyler, J. Plaue, C. Shuffler, S. Stokes, B. Broderick, and C. Keilers were onsite the week of December 10, 2007, to review project management, the design process and requirements, and the preliminary safety basis.

**Background.** The RLWTF project will replace the existing waste treatment facility at LANL, which processes transuranic (TRU) and low-level radioactive liquid wastes. The existing facility began operations in 1963, and despite ongoing life extension efforts, requires replacement to support future laboratory missions reliably.

*Facility Description*—The new RLWTF will be located adjacent to the existing facility in Technical Area (TA)-50. This proposed Hazard Category 2 facility will include a treatment building, a central utility building, and a covered drum storage area. The treatment building will house TRU wastewater influent storage tanks, low-level and TRU wastewater processing equipment, chemical additive systems, and other support systems. Drummed waste will be transferred to TA-54 for disposition.

RLWTF will receive TRU wastewater via existing, dedicated acid and caustic transfer lines from the Plutonium Facility. Millions of liters of low-level wastewater will be transferred annually through the existing Radioactive Liquid Waste Collection System; however, the strategy for its storage prior to processing is uncertain. A separate project, Cerro Grande Rehabilitation Waste Management Risk Mitigation (WMRM), was initiated in part to increase low-level wastewater influent storage capacity. To complete this project, a pump house and influent storage facility were designed and partially constructed at TA-50, but the project was suspended in spring 2007 because of unexpected cost increases and insufficient funds. The design basis for the RLWTF project assumes WMRM will provide low-level wastewater influent storage and pretreatment; given the problems associated with WMRM, however, RLWTF project personnel are reevaluating this strategy. A decision regarding the use of WMRM or expansion of the scope of the RLWTF project to include low-level wastewater influent storage is expected shortly.

*Status*—The RLWTF project received Critical Decision (CD)-1 approval in June 2006. Because of the uncertainty with WMRM and design and safety basis deficiencies identified by the RLWTF project, the planned November 2007 submission of the CD-2 package was delayed. Design work is currently on hold pending the National Nuclear Security Administration's (NNSA) approval of a baseline change proposal that would allow an "enhanced preliminary design" phase to resolve these deficiencies by summer 2008.

**Project Management.** The design authority for the RLWTF project is the site contractor, Los Alamos National Security, LLC (LANS). The architect-engineer for the preliminary design is DMJM Holmes and Narver. OMICRON Safety & Risk Technologies, Inc. developed the preliminary documented safety analysis. The final design will be bid under a separate contract.

The federal Integrated Project Team (IPT) is staffed by personnel from the Los Alamos Site Office, the NNSA Service Center, and NNSA Headquarters. Although the appropriate project management and technical disciplines are represented, the team does not appear to be well integrated or providing effective oversight to ensure the early integration of safety into the design process. For example, interviews of IPT members conducted by the Board's staff revealed that the team's involvement is typically limited to isolated document reviews at critical milestones, instead of more comprehensive and routine involvement in the design process. The IPT does not meet on a regular basis, and few team members are able to commit significant time to the project. For example, the federal project director and his deputy are the only team members who support the project with greater than half of their time. The federal project director stated that he has limited capability to provide important oversight of the project during design (e.g., IPT coverage of contractor design reviews) because team members have other work commitments.

**Weaknesses in the Design Process.** The Board's staff identified weaknesses in the design process involving material selection, development of seismic design requirements, consideration of the Board's Recommendation 2004-2, *Active Confinement Systems*, and configuration management.

*Technical Bases for Material Selection*—The material selected for process tanks and piping, which serve as the primary confinement boundaries for radioactive wastes and hazardous chemicals, is reinforced thermoset plastic (RTP). Several critical design aspects of the use of RTP have not been fully considered, including the following:

- The Department of Energy (DOE) Standard, DOE-STD-1066, *Fire Protection Design Criteria*, states that combustible materials should not be used for process system confinement barriers. The RTP material specified for safety-significant process vessels and piping is Derakane, which may be combustible depending on the resin selected.

- The impact of a facility fire on the confinement function of RTP components has not been evaluated. This information needs to be incorporated into the performance criteria for the safety-significant fire suppression system, which is credited to prevent dispersal of radioactive material and hazardous chemicals during a facility fire.

- The use of RTP materials in a radiation environment during the 30-year design life of the equipment has not been evaluated. A paucity of data exists regarding this material's behavior when exposed to radiation.

- No formal review has been performed to compare the guidance in DOE Guide 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety* with the design standard adopted by the architect-engineer for safety-significant RTP equipment—American Society of Mechanical Engineers (ASME) Standard RTP-1, *Reinforced Thermoset Plastic Corrosion Resistant Equipment*. The contractor should technically justify the use of the ASME standard.

*Seismic Design Requirements*—Several structures, systems, and components (SSCs), including process equipment, the fire suppression system, and the treatment building structure, are credited to perform safety-significant functions during and after a seismic event. These SSCs are designed to Performance Category (PC)-2 design criteria in accordance with guidance in DOE-STD-1021, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*. However, DOE Guide 420.1-2, *Guide for Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Non-Nuclear Facilities*, contains guidance which states that when safety analyses determine that local confinement of high-hazard materials is required for worker safety, a PC-3 designation may be appropriate. Given the need to ensure controls can reliably perform their safety function in all credited operating environments, the staff emphasized that PC-2 design criteria may not be adequate to ensure functionality during and after a seismic event. The Board previously identified this concern in an August 27, 2004, letter to DOE requesting that the DOE directives be revised to clarify the necessary design criteria to ensure hazardous material confinement. DOE is addressing this problem through development of DOE-STD-1189, *Integration of Safety into the Design Process*, which should provide clarification on acceptable seismic design criteria for the project. The staff encouraged project personnel to define desired end states for safety-related SSCs following a seismic event and to provide acceptable design criteria commensurate with the required level of performance. Design criteria required to achieve these end states may exceed the PC-2 specifications used in the current design.

In addition, the water supply supporting the fire suppression system is not safety-related or seismically designed. Project personnel previously identified this weakness and are evaluating potential solutions, such as providing a dedicated safety-significant and seismically qualified water supply system for the facility.

*Active Confinement Ventilation System*—The facility design includes an active confinement ventilation system, but it is not credited as safety-related in the draft Preliminary Documented Safety Analysis (PDSA). NNSA has proposed excluding RLWTF from further evaluation under DOE's Implementation Plan for Board Recommendation 2004-2 using the categorical exclusion criterion provided for existing buried or in-ground waste tanks and waste transfer line sections. The staff believes that this exclusion criterion does not apply to RLWTF. The design of the active confinement ventilation system for this facility should meet DOE expectations and performance criteria provided in *Ventilation System Evaluation Guidance for Safety-Related and Non-Safety-Related Systems*, which was provided by DOE as part of its Implementation Plan for Recommendation 2004-2. The staff intends to devote additional time to review the adequacy of the confinement system.

*Configuration Management*—The staff noted weaknesses regarding the configuration management of project design requirements. Requirements are scattered among a variety of design documents, making the tracking and design verification processes onerous for the design authority. The LANS project manager acknowledged this deficiency and committed to developing a computerized tracking database for all major project requirements, including safety requirements, prior to the CD-2 milestone.

**Safety Basis Development.** The staff reviewed the process and products relating to the development of the safety basis and observed several significant weaknesses with the hazards analysis technique, evaluation of worker consequences, and management of key safety basis assumptions.

*Hazards Analysis Technique*—The LANL hazards and accident analysis procedure describes several acceptable techniques for analyzing hazards. Selection of a technique is based on the type and complexity of the process or activity being analyzed, along with the facility's life-cycle stage. OMICRON adopted a combination of the what-if and checklist techniques for the RLWTF hazards analysis, as commonly applied at other LANL facilities. Given the processes employed at RLWTF and the maturity of the preliminary design, the staff believes that a more robust and systematic technique may be appropriate to better integrate safety basis and design development processes. Two candidate techniques are hazards and operability analysis (HAZOP) and the failure modes and effects analysis.[1] The staff identified several hazards not captured in the RLWTF hazards analysis that would likely have been identified by the HAZOP technique. Two examples are (1) incomplete precipitation, resulting in the transfer of soluble TRU constituents beyond the current safety-significant TRU waste system boundary (i.e., into the low-level portion of the facility), and (2) incorrect addition of chemical reagents, resulting in thermal and pressurization hazards. Given the widespread use of the what-if/checklist methods at LANL, NNSA may wish to consider whether other techniques would better support the integration of safety into the design process.

[1] These techniques are described in the American Institute of Chemical Engineers' *Guidelines for Hazard Evaluation Procedures, Second Edition with Worked Examples*.

*Evaluation of Worker Consequences*—The draft preliminary safety basis for RLWTF does not quantitatively evaluate radiological doses to collocated workers for use in the functional classification of controls. Although qualitative evaluation has historically supported safety basis development at LANL, quantitative evaluation is becoming standard practice across the complex. In 2006, DOE issued formal guidance directing Environmental Management projects to calculate doses to collocated workers to support classification of controls in the early stages of design. Furthermore, this practice will become a requirement as part of Appendix A of DOE-STD-1189. The Board's staff anticipates approval of DOE-STD-1189 before the RLWTF design is complete. While the federal project director committed to addressing the tenets of DOE-STD-1189 once approved, the staff believes this approach may drive significant and costly project changes too late in the design process. A quantitative evaluation of radiological doses to collocated workers should be adopted to support development of the safety basis and the preliminary design.

*Inadequate Management of Safety Basis Assumptions*—The staff noted deficiencies with the management of key assumptions in the draft preliminary safety basis. Specifically, many assumptions are unprotected[2], are supported by weak technical bases, or drive design requirements that are not captured in preliminary design documents outside of the draft PDSA. Several examples are provided in the attachment to this report. The staff believes development of an assumptions tracking database would be prudent to ensure that critical safety basis assumptions are protected and defended, and that design requirements are clearly identified and carried forward into preliminary design documents. The LANS project manager committed to developing this database during the staff's review.

[2]Assumptions that are not guaranteed by appropriate engineered and/or administrative controls.

**Attachment**

## Examples of Deficiencies in Management of Safety Basis Assumptions

### Unprotected Assumptions

- The hazards analysis screens a hydrogen deflagration from consideration based in part on an unprotected assumption that waste will not accumulate and remain untreated for significant periods of time (> 5 months).

- The Chloride Extraction for Actinide Recovery (CLEAR) system, which can reduce the radioactive material content of the caustic transuranic influent stream by 93 percent, is assumed to operate 75 percent of the time in the derivation of material-at-risk received from the Plutonium Facility. However, CLEAR is not currently operating and requires additional physical modifications, safety basis work, and procedure development that face funding challenges. Given these uncertainties, the Defense Nuclear Facilities Safety Board's staff believes it prudent to provide a safety strategy at this stage of the design process that does not rely on the CLEAR system. During the staff's review, the Los Alamos National Security, LLC project manager expressed a strong interest in removing dependence on the CLEAR system from the draft Preliminary Documented Safety Analysis (PDSA).

### Assumptions Supported by Weak Technical Bases

- Criticality hazards are not analyzed based on the assumption that a criticality safety evaluation will demonstrate that no credible criticality accidents exist. A criticality safety evaluation has not yet been performed to support the overall safety analysis and design. Los Alamos Site Office noted this particular deficiency in its recent review of the draft PDSA.

- The draft PDSA assumes that the chemical consequences of a fire are bounded by a spill at ambient temperatures because the increased chemical evaporation rates accompanying a fire are offset by increased dispersion. While the staff agrees that the two effects are offsetting, an evaluation has not been performed to compare the significance of each competing effect quantitatively.

- The transuranic sludge-thickening tank is assumed to have a maximum radiological inventory of half its volume. This assumption is based solely on operating experience at the existing RLWTF. Additional evaluation needs to be performed to confirm that this value is bounding.

**Capturing Assumptions in the Design**

- A calculation in the draft PDSA postulates a natural gas leak and a deflagration at the central utility building that drives a required minimum separation distance between the central utility building and the nearby treatment building. Critical assumptions in this calculation, such as the natural gas supply line pressure and pipe diameter, are not captured as design requirements outside of the safety basis.

- The maximum chemical spill volume evaluated in the hazards analysis during transfer operations between the facility and a supply truck is assumed to be equal to the volume of a standard chemical storage container from the vendor. This unprotected assumption does not drive a requirement to limit the container volume the facility can accept.