DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

December 7, 2010

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 Defense Nuclear Facilities Safety Board (Board) and its staff have closely followed National Nuclear Security Administration (NNSA) efforts to develop a Documented Safety Analysis (DSA) to support post-2010 operations at Los Alamos National Laboratory's Chemistry and Metallurgy Research (CMR) facility. The recently approved DSA is a critical component of NNSA's safety rationale for continuing operations in this aging facility. The Board is pleased with the laboratory's commitment to reduce the hazards at CMR in the next annual revision to the DSA. This reduction will ensure that the Department of Energy's Evaluation Guideline of 25 rem Total Effective Dose Equivalent will not be exceeded for bounding postulated accident scenarios.

The Board's staff reviewed the draft DSA in April 2009 and the final safety basis in August 2010. Notwithstanding the laboratory's commitment to reduce the potential offsite consequences below the Evaluation Guideline, the Board believes the concerns identified in these reviews warrant consideration by NNSA to ensure operations at CMR, while being mindful of the seismic fragility of this aging facility. Enclosed for your information is the staff's report highlighting outstanding issues from these reviews. The Board and its staff will continue tracking final implementation of the DSA and any corrective actions identified to address the issues discussed in the enclosed report.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Mr. Kevin W. Smith
Mrs. Mari-Jo Campagnone

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

September 1, 2010

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: C. Shuffler

SUBJECT: Chemistry and Metallurgy Research Facility Documented Safety Analysis

This report documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the Documented Safety Analysis (DSA) for the Chemistry and Metallurgy Research (CMR) facility at Los Alamos National Laboratory (LANL). This review was performed during the week of August 2, 2010, by staff members B. Broderick, T. Davis, J. Pasko, and C. Shuffler with CMR staff from Los Alamos National Security, LLC (LANS) and personnel from the Los Alamos Site Office (LASO).

Background. The current CMR safety basis is the 1998 Basis for Interim Operation, which will expire at the end of 2010. A DSA prepared in accordance with Title 10, Part 830, of the Code of Federal Regulations is required to support CMR operations until at least 2022, when LANS estimates the CMR Replacement project will be completed. The Board highlighted significant safety issues related to the future use of CMR in letters to the National Nuclear Security Administration (NNSA) dated October 23, 2007, and May 16, 2008. In this correspondence, the Board requested that NNSA develop a safety rationale for continuing CMR operations after 2010. NNSA's response identified the development of a rule-compliant DSA as a key component of this safety rationale.

The Board's staff conducted an initial review of the draft CMR DSA in April 2009 and communicated several concerns to LANS and LASO. LASO formally approved a final revision of the DSA in June 2010. This latest safety basis resolves some, but not all, of the staff's initial concerns. The most recent staff review identified additional issues with the DSA. This report documents the outstanding issues from both staff reviews.

Evaluation Guideline. The bounding accident in the CMR DSA is a seismically induced fire. The unmitigated and mitigated dose consequences to the maximally exposed offsite individual are both 36.3 rem Committed Effective Dose Equivalent (CEDE) because the seismically fragile CMR building structure is assumed to fail. Since no effective engineered controls exist to mitigate the consequences of this bounding event, reducing the public dose below the Evaluation Guideline of 25 rem CEDE can be achieved only by reducing or protecting the quantity of material-at-risk (MAR) allowed in the facility. Subsequent to the staff's most recent August review, LANS management communicated an intent to administratively restrict the quantity of MAR allowed in the facility to levels that would not exceed the Evaluation Guideline in the bounding accident and to formalize this restriction in the next annual update to the DSA.

Material-at-Risk. The Technical Safety Requirements (TSRs) impose a total MAR limit for CMR and additional MAR restrictions on individual wings, the yard, the main vault, the waste assay area, the hot cells, and Confinement Vessel Disposition activities. LANS derived these limits from historical facility inventories. The hazard analysis assumes that localized process accidents involve the maximum TSR-allowed MAR for an area in the facility. For example, the DSA postulates fires, explosions, and spills in individual process enclosures (i.e., gloveboxes and hoods) and laboratory rooms involving the TSR-controlled wing MAR limits (e.g., the equivalent of 3.8 kilograms of plutonium-239 in wings 5 and 7). This practice is generally conservative for nuclear facility safety analyses because it provides a bounding basis for the identification of safety-related controls.

During the staff's review, LANS representatives explained that typical process enclosures contain gram quantities of MAR. Further, they could not imagine a scenario in which the TSR-allowed MAR limit for a wing could accumulate in a localized area. The CMR DSA could therefore realize significant risk reduction for the facility workers by imposing additional administrative or procedural MAR limits for localized processes (e.g., process enclosures, laboratory rooms) to supplement the existing, less restrictive limits.

Hazard and Accident Analyses. The staff identified several issues related to the hazard and accident analyses:

- It is unclear how the hazards associated with MAR activities in the locked rooms are evaluated in the DSA. For example, the hazard analysis postulates various accidents involving MAR outside of glovebox and hood enclosures. These scenarios would appear to apply to MAR operations in the locked rooms. However, key credited controls for these events (exhaust ventilation, fire suppression) are not available in the locked rooms.

- For fire accidents postulated in wings 5, 7, and 9 that lead to wing structural collapse, the accident analysis inappropriately bounds these scenarios with a spreading roof fire between two wings. The individual wing fires have unmitigated consequences qualitatively determined to exceed 5 rem CEDE. The CMR DSA includes an explicit assumption that doses in excess of 5 rem CEDE challenge the Evaluation Guideline. The safety-class controls identified for the spreading roof fire scenario are not applicable, however, to the wing fire events. The DSA should therefore evaluate whether safety-class controls are needed to prevent or mitigate the wing fire events with structural collapse.

- DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, allows for the screening of man-made external events, such as natural gas explosions, based on frequency arguments. The CMR DSA, however, screened the natural gas explosion scenario without clearly articulating the quantitative analytical basis as prescribed by the DOE standard. Further, the DSA initially concluded that the accident is credible with an unmitigated offsite dose consequence that challenges the Evaluation Guideline. The staff encouraged LANS to refine and clearly document in the DSA the technical basis for screening the natural gas explosion event. The staff also encouraged LANS to consider other credible pathways for natural gas to enter the facility (e.g., underground conduit).

- The wildland fire design basis accident impacts the MAR in only one CMR wing. The accident analysis acknowledges that a wildland fire could impact multiple wings, but concludes without basis that the consequences are bounded by other fire scenarios evaluated in the DSA. Including the MAR from multiple wings in the wildland fire accident calculation would yield an unmitigated consequence that challenges the Evaluation Guideline, thus warranting consideration of safety-class controls. It has not been shown that the controls identified for other fire scenarios in the DSA bound the potential control set applicable to a wildland fire.

The staff also observed that the DSA adopts a unique accident progression methodology that is inconsistent with expectations in DOE Standard 3009 for accident analysis and controls selection. For example, several spreading fire scenarios between wings are carried forward from the hazard analysis as design basis accidents. The unmitigated consequences of these scenarios challenge the Evaluation Guideline. LANS did not consider crediting candidate controls within the wings (e.g., fire suppression) because their failure is an assumed prerequisite in the accident progression (i.e., a spreading fire between wings is assumed to occur only if the wing fire suppression systems fail). Assuming failure of controls is consistent with unmitigated analysis expectations in DOE Standard 3009, screening controls from consideration for protection of the workers and the public is not. In this example, the DSA identifies safety-class fire barriers to limit fire impacts to one wing, reducing the offsite dose to just below 5 rem CEDE. Crediting local and available controls such as the fire suppression system for this event would likely have reduced offsite consequences below this value.

Safety Management Programs. The DSA places inordinate reliance on safety management programs (SMPs) to perform credited safety functions better reserved for specific administrative controls (SACs) and safety-related structures, systems, and components (SSCs). For example, in the hazard evaluation tables, the DSA postulates numerous accidents yielding unmitigated consequences that warrant consideration of safety-significant controls, but only SMPs are credited. Key examples include large chemical explosions, full wing fires, wildland fires, and source material irradiation.

Structures, Systems, and Components. The staff identified issues related to the ability of safety SSCs to provide adequate worker protection, the functional classification of SSCs supporting safety SSCs, configuration management of safety SSCs, and CMR's capability to promptly detect and address a loss of ventilation.

- Exhaust ventilation is credited to mitigate the radiological impacts from chemical explosions in process hoods and laboratory rooms. The DSA acknowledges that "...enclosures and exhaust ventilation systems may provide minimal consequence reduction from explosions...." It is therefore unclear how facility workers are adequately protected from such events.

- The exhaust ventilation system is credited as safety-significant to prevent flammable gas explosions inside and outside process enclosures by providing adequate dilution airflow. The DSA does not establish clear ventilation system performance requirements tied to this safety function (e.g., minimum dilution flow rates) or clear performance criteria to ensure that such requirements are met. The staff notes that LASO shares this concern and identified resolution of this issue as a condition of approval in the Safety Evaluation Report (SER).

- The header pressure performance criteria protecting the exhaust ventilation system's credited confinement function is based on historical CMR operational data, not a clear technical basis. A defensible technical basis is particularly important to protect the safety function in laboratory rooms, where calibrated gauges or other indicators are not available to confirm ventilation system operability.

- Rigorous configuration management is not currently maintained for the safety-class spinal partitions. More specifically, no drawings or other documentation define the baseline configuration deemed acceptable for preventing fire spread between wings as analyzed in the fire hazard analysis (FHA). The staff emphasized the importance of establishing a rigorous baseline configuration prior to DSA implementation and ensuring that this configuration is consistent with the analysis in the FHA.

- The electrical distribution system, which supports the safety-significant exhaust ventilation system, is not classified as safety-significant. The staff notes that LASO shares this concern, and is requiring LANS to evaluate this system for designation as safety-significant through a condition of approval in the SER.

The staff questioned CMR's ability to detect promptly ventilation system failure, a particularly important function given the system's age and lack of local alarms to notify facility workers. The key indicator of ventilation system performance is header pressure. While CMR operators perform daily TSR pressure surveillances at local calibrated differential pressure gauges, continuous header pressure indication is available in the control room through the Facility Monitoring System (FMS). The FMS indication is alarmed to notify operations personnel if pressure drops below the TSR-required value. The staff observed that the control room pressure indicators are highly inaccurate, rendering the information useless to operations staff. For example, one indicator was reading approximately 40 percent lower pressure than the TSR-recorded surveillance. Further, this pressure indicator has alarmed continuously for years, although header pressure verified locally indicates more than adequate performance to meet TSR requirements. CMR staff expressed their intent to replace these instruments with more reliable components this fall.

The staff identified another weakness in the monitoring system for the ventilation system. If the ventilation system fails when the operations center is not manned, an automatic dialing system notifies an on-call operator so that appropriate actions can be taken. This same system provides the operations supervisor with a redundant notification capability during normal operations (i.e., in addition to the inaccurate FMS alarms previously discussed). However, the photohelic pressure control gauges that initiate the automatic dialing system are not calibrated, nor is their functionality tested regularly through CMR's maintenance program.

Specific Administrative Controls. The staff identified two issues related to the SACs in the DSA.

- The double containment SAC is credited as safety-significant to reduce the likelihood of MAR being released during a spill event by requiring double containment of radioactive material outside of enclosures (e.g., metal or plastic containers, plastic bags). The DSA assigns no quantitative protection to this control. Given the significant worker hazard, the staff believes either greater specificity in the SAC or an alternate control is warranted to protect containment integrity. For example, plastic bags may be appropriate for small samples moved by hand within a laboratory, but would not be appropriate for large material quantities transferred within wing 9 by a forklift. Greater specificity in the SAC or an alternate control would ensure containment reliability commensurate with the hazards.

- A flammable gas SAC is credited as safety-class to prevent explosions by ensuring that flammable gas sources cannot yield a flammable mixture if released within the volume of the storage location (e.g., a laboratory room). Sources stored in flammable gas storage cabinets, however, are excluded from SAC coverage. The cabinets provide no unique safety function for preventing or mitigating the flammable gas release hazards postulated in the DSA (e.g., leaking valve stems). The basis for this exclusion is therefore not clear.

Technical Safety Requirements. The staff highlighted issues associated with the timeliness of TSR actions to correct or mitigate the degradation of a safety control:

- The TSR MAR surveillance frequency is monthly, relaxed from a weekly requirement in the current CMR Basis for Interim Operation. Between TSR surveillances, a single individual will track MAR against TSR limits using hand calculations and manual worksheets. Because MAR control is a critical assumption in the safety basis, the staff believes restoring a higher TSR surveillance frequency is warranted.

- The TSRs allow seven days to place MAR in a safe configuration following failure of a process enclosure to meet TSR operability requirements. More prompt action (e.g., immediate) appears justified to mitigate the increased risk.

- The TSRs allow indefinite storage of MAR in CMR wings and process enclosures that fail to meet ventilation operability requirements, provided CMR locally terminates normal operations and places the MAR in a safe configuration. A safe configuration is qualitatively defined in the TSRs as a state that minimizes risk. Because this state cannot eliminate the risk, it is not clear why the TSRs do not specify further actions (e.g., deinventory the affected areas) if operability cannot be restored within a reasonable time period.

- TSR actions in response to low ventilation header pressure do not address the potential degradation of the credited safety function for the ventilation system outside process enclosures (e.g., in laboratory rooms). The TSR actions consider only operability requirements for hoods and gloveboxes.