Mello Aff#1, Par 18, Ref 2: http://www.hss.energy.gov/deprep/2009/FB09S04B.pdf

CHEMISTRY AND METALLURGY RESEARCH REPLACEMENT FACILITY PROJECT LOS ALAMOS NATIONAL LABORATORY

CERTIFICATION REVIEW

REPORT TO CONGRESSIONAL DEFENSE COMMITTEES

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

SEPTEMBER 2009

The update of the PSHA ground motions also revealed that the approach used to derive vertical-to-horizontal ratios had produced overly conservative estimates for these ratios. The 2007 PSHA assumed that the dominant earthquake that controlled the PSHA was a single magnitude 7.0 earthquake at a close-in distance. The update refined the estimate for the dominant earthquake, determining that a range in magnitude of 6.0 to 7.0 was more appropriate at close distances. The ground motion studies resulted in reducing design basis earthquake ground motions by about 25 to 40 percent. The Board reviewed this work and found it acceptable.

The seismic hazard at LANL is complex. LANL has completed numerous studies during the past two decades to better understand the seismic hazard, including studies to understand the rate of movement on the PFS. Given this complex seismic environment, the Board encourages LANL to continue long-term seismic hazard studies aimed at reducing significant uncertainties. These uncertainties include the rate of movement on the PFS and the subsurface stiffness properties, both of which have a significant impact on estimates of ground motion. LANL is developing a long-term seismic hazard program plan; the Board will review this plan as it becomes available.

2.1.2.3 CMRR Seismic and Structural Design

The Board reviewed the Nuclear Facility structural and seismic design. This review focused on evaluating the Nuclear Facility structural configuration and behavior to ensure that the current structural design can resist seismic design ground motions. This evaluation addressed structural issues that could result in the need for significant and costly redesign efforts if not addressed early in the design process.

The Board issued a letter to NNSA on May 30, 2008, documenting structural and seismic design issues. In that letter, the Board pointed out that the open structural layout of the laboratory portion of the facility represented a design challenge. At that time, the ongoing seismic analysis revealed excessive vertical in-structure accelerations for the laboratory roof. These large in-structure accelerations could have been prohibitive from a facility and equipment design perspective. To address this issue, LANL performed a parametric study of the facility that resulted in a structural reconfiguration of the building. LANL recommended several structural changes that would vertically stiffen the roof level above the laboratory level.

Given these changes, the Board focused on the CMRR Project's structural design criteria and plans for completing the structure's seismic design. While the structure had been stiffened several structural design challenges remained. For example, at the mezzanine level of the structure, there are large openings in the floor to allow routing of ventilation equipment and ductwork. The Board's review revealed that there was insufficient confidence that the structural behavior of the Nuclear Facility had been adequately assessed. This could lead to unacceptable structural damage during a design basis earthquake. This led to the identification of the Board's Finding *CMRR Seismic Design.*

The Board met with CMRR Project personnel to discuss the structural behavior and the approach to seismic and structural design. At this meeting, project personnel proposed

modifications to the seismic analysis approach. One of these modifications involved a new approach to defining seismic design ground motions at the foundation of the Nuclear Facility, at a depth of about 75 feet below the ground surface.

The Board continued to express concern about the dynamic behavior of the updated structural configuration of the Nuclear Facility. This configuration is complex. The laboratory level is open, representing a relatively flexible portion of the structure between the stiffer basement and roof. There are few walls in the laboratory level; the CMRR Project instead is employing large columns to support an open laboratory concept for operational flexibility. Walls were added to the structure above the laboratory in an effort to reduce the large vertical in-structure motions. The interaction between these walls and the columns below requires detailed study.

Given these structural complexities, the Board concluded that CMRR Project personnel did not have a sufficient understanding of the building's dynamic response. Project personnel agreed to take actions to develop a better understanding of the structural behavior of the Nuclear Facility. They performed an assessment of building response that resulted in several recommendations related to the Nuclear Facility structural configuration and analysis. These recommendations included extending the mezzanine floor between the laboratory and vault, modifying the roof to remove a structural discontinuity, and accounting for additional structural walls in the dynamic analysis. Project personnel also agreed to add several seismic chords and collector beams to ensure improved structural behavior. These changes will ensure that a suitable load path exists where large discontinuities are encountered in structural slabs and shear walls.

CMRR Project personnel also discussed the need to modify the soil layer immediately below the Nuclear Facility foundation to prevent adverse response of the foundation, such as collapse of the soil under bearing and building sliding. The plan is to either replace or modify this soil layer to improve foundation conditions. While it has not been formally demonstrated that remediating this soil layer will improve the facility's seismic response, the Board agrees that stiffening this layer should improve the seismic response of the Nuclear Facility structure and address project concerns about building sliding. However, a detailed assessment of the revised foundation approach needs to be completed before approval to proceed into final design. This assessment should quantify the impact on foundation-level seismic design ground motions and describe how the seismic analysis model will account for the locally modified soil layer under the structure.

The CMRR Project team's approach to seismic analysis and the general approach to structural and seismic modeling were reviewed. The Board determined that the project lacked an integrated approach to structural modeling. As a result, the structural design process may not be properly validated. Because of computational constraints, project personnel proposed using design and analytical approximations. Providing assurance that such an approach is acceptable is essential, but is complicated by such issues as remediation of the soil layer below the foundation. To address these issues, a detailed structural model with a minimum number of approximations was needed. This model could then be used to validate both the general analysis and design approaches.

CMRR Project personnel agreed with these concerns and revised the structural design process to include the development of a detailed structural model. A design process check is planned to ensure that the approach used is adequate and will meet the structural loads that result from a design basis earthquake. The Board agrees that this is an acceptable path forward. CMRR Project personnel also plan to update the seismic soil-structure interaction analysis. It will be necessary to ensure that the structural model(s) has adequate refinement and inputs to properly capture the dynamic behavior of the Nuclear Facility. A detailed assessment of the remediation of the Nuclear Facility foundation soil will also be necessary to ensure that the soil-structure interaction approach properly models the effects on the seismic design ground motions.

It will be advisable for the project to continue using LANL structural personnel, supported by a peer review panel, to provide detailed oversight of the structural seismic analysis and design. As the Nuclear Facility design proceeds the Board will review the CMRR Project team's detailed assessment of the impact of the revised Nuclear Facility foundation approach.

2.1.3 Finding: *Seismic Design of Active Confinement Ventilation System and Support Systems*

The CMRR Project should not proceed to final design until there is high confidence that the necessary portions of the active confinement ventilation system can be seismically qualified. As discussed in Section 2.1.2.2, the structural response of the Nuclear Facility to vertical design basis ground motions led project personnel to be concerned that the vertical accelerations were at or above the upper limit at which some equipment could be seismically qualified, and to state that the seismic design for some of the safety-related systems might have to be downgraded as a result. The Board did not agree with downgrading the seismic design of any safety-related equipment and determined that inadequate technical justification had been provided to fully understand the equipment seismic qualification issue. Downgrading the seismic design of the active confinement ventilation system would jeopardize the ability of the system to function following a design basis earthquake, resulting in significantly larger releases of radioactive material.

The Board suggested that the CMRR Project team reconfirm its commitment to seismically designing the active confinement ventilation system to PC-3 seismic design requirements. The Board also suggested near-term studies to assess the potential conservatism of PC-3 design basis earthquake ground motions given recently published ground motion attenuation models, and suggested that the CMRR Project team perform a peer review of the approach to seismically qualifying safety-related equipment.

In response to this Finding, the CMRR Project team committed to seismically designing the systems and components of the active confinement ventilation system to PC-3 seismic design requirements. An update to the seismic design ground motions for the CMRR facility was also completed (see Section 2.1.2.2). The Board determined that the resulting reductions in PC-3 horizontal and vertical seismic design ground motions are technically supportable. These reductions alleviate the need to downgrade any safety-related equipment.