

# DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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August 26, 2009

Gerald L. Talbot, Jr.  
Assistant Deputy Administrator for  
Nuclear Safety and Operations  
National Nuclear Security Administration  
1000 Independence Avenue, SW  
Washington, DC 20585-0701

Dear Mr. Talbot:

Pursuant to the certification mandate provided in Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, the Defense Nuclear Facilities Safety Board's (Board) staff responsible for certification activities has reviewed design data for the Chemistry and Metallurgy Research Replacement (CMRR) Project provided to date by the National Nuclear Security Administration (NNSA). The Board's staff is focusing its review on topics previously raised regarding the nuclear safety strategy for CMRR, the Preliminary Documented Safety Analysis, and design of safety-class and safety-significant systems. Those topics were provided electronically to NNSA on November 20, 2008. The staff has documented specific technical issues on a Findings Form. For purposes of the certification review, the staff considers a Finding a design topic related to an issue raised by the staff regarding the CMRR design that has not been adequately resolved and that could preclude certification by the Board.

Finding 1, Site Characterization and Seismic Design—CMRR Seismic Design Issues, was transmitted to your office on January 16, 2009. NNSA provided an initial response to Finding 1 on March 3, 2009, and a final response on August 14, 2009. The Board's staff has evaluated the NNSA final response and has determined that Finding 1 can be considered closed. Enclosed is the completed Finding Form that includes the Board's Final Resolution to Finding 1. Should you have any questions regarding this matter, please contact me at (202) 694-7128.

Sincerely,

Roy E. Kasdorf  
Nuclear Facility Design and  
Infrastructure Group Lead

Enclosure

c: Mr. Mike Thompson  
Mr. James McConnell  
Mr. Patrick Rhoads  
Mr. Herman LeDoux  
Mr. Mark B. Whitaker, Jr.

## Board Findings

Chemistry and Metallurgy Research Replacement Facility: Congressional Certification Review

**Topic:** Site Characterization and Seismic Design

**Finding Title:** CMRR Seismic Design Issues

**Finding:** The CMRR project should not proceed into final design until there is high confidence that the CMRR structural capacity is adequate for the PC-3 seismic design ground motions and that there are no significant unresolved design challenges. Structural stiffening recommendations were documented in January 2008 and used to revise the CMRR structural configuration. The general arrangement drawings (9/29/2008 revisions) and the structural drawings (12/01/08 revisions) indicate additional structural changes. The structural behavior must be understood from both a response and design perspective; examples of structural design challenges follow:

- (1) The Mezzanine floor has extensive openings, which makes it difficult to adequately transfer forces to walls, especially in the out-of-plane direction of the Wall along Column Line 9 (between the Basement and Laboratory levels). A detailed understanding of lateral load transfer from the Mezzanine floor to the adjoining levels is needed to ensure that design problems will not occur.
- (2) It is not clear how the connections between the laboratory columns and the interstitial walls can be designed for seismic forces.

Developing appropriate structural models for both the Fixed Base and Soil-Structure Interaction (SSI) analyses is important to understanding the seismic behavior of the CMRR facility. It is not clear to what level of rigor design control has been implemented between the three design entities (LANL, Sargent & Lundy, and Simpson, Gumpertz, & Heger). The SSI analysis must demonstrate:

- (1) That the soil model appropriately models the ground motions and results in realistic ground motions at the foundation level and free field away from the structure.
- (2) That the time history relative displacement motions in both NS and EW directions at each level of the CMRR structure (Roof, Interstitial, Laboratory, Mezzanine, and Basement) do not indicate complex structural behavior. The SSI analysis should include the appropriate number of column line intersection nodes to assess this behavior.
- (3) How the results (forces and relative displacements) from the 3-D SSI analysis will be transferred to the 2-D structural design model.

In summary, given the recent changes to the CMRR structural configuration, sufficient design information must be provided to have high confidence that a final design solution will be feasible without significant structural changes during final design.

**Basis for Finding:** DOE O 420.1B (IV) (1) Facility SSCs must be designed, constructed, and operated to withstand NPH, and (2) The design and construction of new facilities and SSCs must address (a) potential damage to and failure of SSCs resulting from both direct and indirect NPH events, and (b) common cause/effect and interactions resulting from failures of other SSCs.

**Suggested Resolution or Path Forward:** NNSA should provide the following information:

- (1) Structural drawings that clearly identify all load carrying structural elements and their dimensions without ambiguity, particularly slab thicknesses;
- (2) A detailed lateral load transfer model for the Mezzanine floor that includes all walls up to the Laboratory floor and down to the basement floor. This model should address potential large relative displacements that could develop from higher dynamic modes;
- (3) Examples of 2-D strip models for design of NS and EW slab strips interior to the structure. These strips should include appropriate foundation calculations based on CMRR geotechnical data. Documentation of these examples should include discussion of what loads and relative displacements would be applied;
- (4) A discussion of how the out-of-plane and in-plane forces/displacements would be used in the design of the Wall along CL 9. Show preliminary design calculations for this wall;
- (5) A discussion of how lateral loads on the slab between CL 11 and 12 at the Mezzanine floor level are transferred. Show preliminary design calculations for this slab;
- (6) Provide preliminary design details for the NS walls in the Interstitial level, the columns in the Laboratory level, and their connections;
- (7) Provide a discussion of how the SSI soil model appropriately models the ground motions given the sloping site conditions with the South face of the building embedded less than the other sides. Demonstrate that the ground motions are realistic at the foundation level and at the free field away from the structure.
- (8) Provide a discussion of how forces/displacements from the 3D SSI analysis will be transferred to and designed for in the CMRR 2-D structural design.
- (9) Provide a discussion of how the SSI model will address in-structure relative displacement concerns.
- (10) Develop and execute a Fixed Base model of the latest CMRR structural configuration to ensure that overall static and dynamic behavior is understood.

**NNSA Response:** An initial NNSA response was provided on March 3, 2009, and a final response was provided on August 14, 2009. The final NNSA response attaches a letter from the Los Alamos Site Office providing supplemental responses from the CMRR Project to each of the Board's issues identified in the path forward. Technical information provided by the CMRR Project was forwarded electronically to the Board separately.

**DNFSB Final Resolution:** The CMRR project used the current structural model to perform an assessment of the building response. The purpose of this study was to determine if the structure would have acceptable seismic performance. This effort resulted in a CMRR Structural Behavior Report. Based on the observed building dynamic behavior, the CMRR project is adjusting their structural and seismic design plans accordingly.

The CMRR project discussed the need for modifying the soil layer immediately below the CMRR foundation to prevent adverse soil response (such as collapse under bearing and building sliding). The general concept is to either replace or modify this layer to improve foundations conditions. At the present time, it has not been demonstrated that remediating this soil layer will improve facility seismic response. A detailed assessment of the revised foundation approach needs to be completed prior to final design approval. The detailed assessment should describe how the seismic analysis model will properly reflect the physical condition of the locally modified soil layer under the structure.

The CMRR project revised their Structural Design Criteria and Structural Design Plan. Revisions to these documents have addressed several concerns raised by both the Board's staff and the CMRR project peer reviewers. These documents better describe the approach to CMRR design and seismic analysis. The CMRR project revised their Seismic Analysis Plan. The Seismic Analysis Plan outlines the approach to seismic analysis and discusses the general approach to structural and seismic modeling. The Seismic Analysis Plan is intended to provide the basis for a seismic analysis to capture global dynamic response of the CMRR structure.

The Board's staff met with CMRR Project personnel to discuss the structural behavior and modeling. Project personnel agreed with the Board's concerns and took steps to develop an improved understanding of the complex structural behavior of CMRR. The Board's staff has determined that the CMRR Project has developed an acceptable understanding of the structural behavior of CMRR by revising the structural design process to include the development of a detailed structural model. The Board's staff also agrees that stiffening the soil layer immediately below the CMRR foundation should improve the seismic response of the CMRR structure.

Finding #1 is considered closed.

DNFSB: <u>Roy G. Kasdorf</u> <u>8/25/09</u> Roy Kasdorf Date	NNSA: <u>NNSA Response Signed by Gerald L. Talbot, Jr.</u> <u>NA-17</u> Date: August 14, 2009
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