Department of Energy
National Nuclear Security Administration
Washington, DC 20585

March 11, 2009

Mr. Roy Kasdorf
Nuclear Facility Design and
Infrastructure Group Lead
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW., Suite 700
Washington, D.C. 20004-2901

Dear Mr. Kasdorf:

This letter is in response to your January 16, 2009, letters to me which contained the Finding Forms documenting the Defense Nuclear Facilities Safety Board's issues on the following two topics:

1. Safety Significant Active Ventilation System
2. Seismic Characterization and Seismic Design

As you requested, we have completed these forms and have attached them to this letter with the applicable supporting documentation.

We look forward to continuing to work with you during your review of the design of the Chemistry and Metallurgy Research Replacement Facility (CMRR) design needed to support the Board's CMRR Certification to Congress as specified in Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009.

If you have any questions, please contact me or have your staff contact Patrick Rhoads (202) 586-7859.

Sincerely,

James McConnell for

Gerald L. Talbot Jr.
Assistant Deputy Administrator
for Nuclear Safety and Operations

Attachments

Board Findings Chemistry and Metallurgy Research Replacement Facility: Congressional Certification Review
Topic: Safety-Significant Active Ventilation System
Finding Title: Seismic Design of Active Confinement Ventilation System and Support Systems
Finding: The CMRR project should not proceed into final design until there is high confidence that the PC-3 portions of the active confinement ventilation system can be seismically qualified. The CMRR Nuclear Safety Design Strategy (CMRR-AP-0307, Rev. 1) states that it may not be economically feasible to seismically design and qualify some components of the active confinement ventilation system or its support system to PC-3 seismic design requirements. The structural response of CMRR to vertical design basis ground motions (see most recent SSI calculation) has led to the concern by the project that vertical accelerations are at or above the upper limit of those for which rotating equipment can be economically seismically qualified. It is not acceptable to downgrade PC-3 seismic design requirements for the active confinement ventilation system.
Basis for Finding: DOE O 420.1B Chapter I (3)(b)(7) Safety SSCs must be designed, commensurate with the importance of the safety functions performed, to perform their safety function when call upon; and Chapter IV (3)(a)(1)(a) Facility SSCs must be designed, constructed and operated to withstand NPH and ensure confinement of hazardous materials.
Suggested Resolution or Path Forward: NNSA should reconfirm its commitment to seismically design the active confinement ventilation system to PC-3 seismic design requirements. This reconfirmation should include: (1) Near-term studies to assess the potential conservatism in PC-3 vertical design basis ground motions, and revise PC-3 vertical design basis ground motions as appropriate. (2) An assessment of equipment seismic qualification related to both the safety-class fire suppression system and the safety-significant active ventilation system, and associated support systems. The assessment should document the approach to seismically qualify safety-related equipment to PC-3 design basis ground motions including the potential use of seismic isolation for this equipment.

NNSA Response:

NNSA agrees that the risk associated with active confinement ventilation system must be understood and we must have confidence that equipment associated with this system can be seismically qualified during design. Designer and vendor interactions are necessary to confirm qualification of identified safety components can be achieved. It is our commitment that such dialog will occur and be documented, and the plan to do so communicated with DNFSB staff. NNSA commitment for an active confinement ventilation system at PC-3 is reconfirmed in the most recent approved version of the *Nuclear Safety Design Strategy, Rev 2 dated January 28, 2009.* Action confinement ventilation is credited as a Safety Significant PC-3 seismic SSC in the current draft PDSA. NNSA has completed review of the current draft PDSA and has documented in the draft PSVR acceptance of a Safety Significant PC-3 active confinement ventilation system.

(1) The LANL seismic team has undertaken several studies to reduce input vertical motion and has recommended that the project wait until the report is issued in March 2009, prior to initiating the next SSI iteration. [Ref LANL memo D5-09-048, *Impact of Recent Ground Motion Studies on CMRR Design Basis Earthquake Ground Motion* (3-02-2009).] At this time, a study of time histories is being developed to address the higher damping which occurs due to the soil-structure interaction. In-process results were presented by CMRR Project Team at the Feb 17, 18, 2009 DNFSB Meetings in Orange County, CA (at the SGH Offices). Recently, the CMRR Project Team has prepared a summary of the recommended approach to developing ground motions for use in CMRR NF SSI Analyses which includes two sections: Development of PSHA Consistent Response Spectra for Input to the SSI Analyses; and Development of Time History Records for Use in SSI Analyses. [Ref LANL memo D5-09-047, *Recommended Approach to Developing Ground Motions for Use in CMR-R SSI Analyses* (3-02-2009).] Also, LANL will provide Strain-Compatible Soil Properties for Use in Soil Structure Interaction Analyses; based on the March Report as well as a validation of W. Silva's procedure / methodology and results [Ref: LANL memo D5-09-012, *Strain Compatible Soil Properties Consistent with the CMR-R PSHA for Use in Soil Structure Interaction Analyses* (2-25-2009).] Also, Viewgraphs related to the above topics were presented at the Feb 17, 18 DNFSB Meetings in Orange County, CA (at the SGH Offices). [Ref Viewgraphs: *Development of FIRS for SSI Analyses; Status of Recent PSHA Studies (URS Work); A Second Look at ASCE 43 Time-History Fitting Criteria.*]

(2) For the primary and support equipment required for the reduced-flow active confinement ventilation systems, equipment vendors that serve the commercial nuclear industry were contacted in the Preliminary Design phase to assess the availability of equipment that would meet CMRR Nuclear Facility seismic-qualification requirements.

Discussion with typical HVAC fan, HVAC filter plenum, electrical distribution, diesel generator and control equipment vendors confirmed that equipment supplied for the international commercial nuclear market in Taiwan and Japan were qualified to higher levels than typically seen in the US. Certain equipment designs are sufficiently robust to withstand higher seismic motions. However in some cases, the use of seismic isolation approaches may be part of an equipment vendor's strategy to meet specific seismic response spectra.

Early procurement plans are also included in the project work plans and schedule to purchase long-lead and safety-related equipment during the continuing Interim Design activities this calendar year. This strategy is intended to address both long engineering and manufacturing lead times for this equipment as well as allow sufficient time for seismic test development, execution, and evaluation including the potential use of seismic isolation strategies.

CMRR Project Team has prepared a Safety-Related Equipment Seismic Qualification Plan which includes: a flowchart of the CMRR Seismic Qualification process, a summary table of Seismic Qualification of Major PC-3 Active Components; and a table of CMRR Preliminary Seismic Accelerations (by floor level, location in NF building, and % damping). [Ref: *Safety Related Equipment Seismic Qualification Plan* (3-02-2009) CMRR-PLAN-ENG-2806_R0.doc]

DNFSB: ____________ ____________ Roy Kasdorf Date	NNSA: James McConnell 3/11/2009 James McConnell, Acting NA-17 Date

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 Mar 3, 2009

NNSA Response:

NNSA agrees that the structural response of the CMRR Nuclear Facility must be understood for PC-3 seismic design ground motions. NNSA also agrees that the Soil Structure Interaction analysis is fundamental to understanding the seismic behavior of the Nuclear Facility. Since the issuance of this finding, a number of detailed conversations between the CMRR Project and DNFSB staff have been held to review new analysis, understand associated documented information, and to further define the approach to further understand these behaviors. Below are NNSA's detailed responses to actions requested by DNSFB to resolve and/or find a path forward for the identified issue.

(1) The S-Series drawings have been forwarded to the DNFSB in mid-Dec 2008. Walls that are 2-ft thick or more are shaded to indicate that they are to be considered part of the lateral load resisting system. Slab thicknesses are indicated. [Ref S-Series drawings are: S-1100 *CMRR NF Basement Foundation Rev E* 12/01/2008; S-1200 *CMRR NF Basement Mezzanine Rev E* 12/01/2008 ; S-1300 *CMRR NF Laboratory Level Floor Rev E* 12/01/2008; S-1400 *CMRR NF Interstitial Level Floor Rev E* 12/01/2008; S-1500 *CMRR NF Main Roof Plan Rev E* 12/01/2008; S-1600 *CMRR NF Aux Bldg Penthouse Floor and Roof Plan Rev E* 12/01/2008; S-3001 *CMRR NF Longitudinal Bldg Sections Rev E* 12/01/2008; S-3101 *CMRR NF Transverse Bldg Sections Rev E* 12/01/2008; Ref S&L Transmittal *12271-2008-DT-0128 Interim Phase Seismic Analysis Report 12-8-08.*]

(2) A SAP2000 3-D model has been developed for the Security Category 1 Building and the Auxiliary Building to study the lateral load transfer at the mezzanine level. 1-g static load cases have been run for the North-South, East-West and Vertical directions. [Ref Reports: *Security Category I Building Mezzanine-Level Load-Path Study of the Chemistry and Metallurgy Research Replacement Building (CMRR) (for 1-g Static Loading) (2-27-2009)* 100320-RPT-001, Rev A - Cat I Mezzanine; and *Auxiliary Building Mezzanine-Level Load-Path Study of the Chemistry and Metallurgy Research Replacement Building (CMRR) for 1-g Static Loading (2-27-2009)* 100320-RPT-002, Rev A - Aux Mezzanine.]

(3) The CMRR Project design team does not intend to use any vertical 2-D strip models through the structure. The design team will design floor slabs and the basemat foundation for vertical loading using the SAFE slab design program. Floor diaphragms will be evaluated for the in-plane shear demand computed from SASSI analysis. Columns will be designed for axial loads resulting from vertical loads, as well as lateral story displacements (taken from SASSI) due to earthquake loading. [Also Ref Reports listed in items 2 above, and 4 through 6 below.]

(4) A SAP2000 model was created of the shear wall along column line 9. Dead, live and earthquake loads for a 1-g acceleration were applied and 5 different load combinations were evaluated that would result in maximum in-plane shear and axial forces. The study, *9-Line Shear Wall Study for the CMRR (for 1-g Static Loading)*, Rev A, (2-27-2009) (100320-RPT-004, Rev A - Shear Wall) provides an example of how shear walls will be evaluated.

(5) For the slab between CL 11 and 12 at the Mezzanine floor level, the lateral load path is demonstrated using a SAP2000 3-D model from CL 9 to 13 and A to R and an applied 1-g static load. [Ref Report: *Auxiliary Building Mezzanine-Level Load-Path Study of the Chemistry and Metallurgy Research Replacement Building (CMRR) (for 1-g Static Loading) (2-27-2009)* 100320-RPT-002, Rev A - Aux Mezzanine]

NNSA Response (cont'd):

(6) The connections between the columns and interstitial walls were evaluated under a 1-g static load using a SAP2000 3-D FEM to illustrate the lateral force resisting elements in the CMRR NF. The design of the columns uses the software PCA Column V 3.6.1 and is based on the dead, live, and preliminary earthquake loads. [Ref Report: *Roof Girder Load Path Evaluation for the Chemistry and Metallurgy Research Replacement Building (CMRR)NF (for 1-g Static Loading) (2-27-2009)* 100320-RPT-003, Rev A - Roof Girder]

(7) This topic is addressed in the Seismic Analysis Plan (as written by SGH). This updated plan has incorporated responses to all of the submitted comments dated October 9, 2008. The new plan will also has updated appendices on the backfill modeling sensitivity study, the mesh refinement sensitivity study, and the slab stiffness study. In the backfill study, a beam and column model for the structure is being used instead of the area element model to avoid unrealistic Poisson's ratio effects. In the mesh study, some cases are being added for increasing the slab modulus of elasticity to account for the stiffening effect of large column and wall supports. These studies are part of Rev C of the Seismic Analysis Plan (as appendices). [Ref: *Seismic Analysis Plan for CMRR NF, Rev C,* Jan 2009.]

(8) Story displacements are very small. There will be only very minor secondary moments at the ends of columns. The CMRR will be designed using a 3-D FEM model (as opposed to the originally proposed 2-D structural design). The *Seismic Design Plan*, Rev.0A (2/06/2009) provides details of how SASSI output will be used in the seismic design (see Table 2, Sect. 5A.4). Section 5A.4.1 (of *Seismic Design Plan*) also provides specific details of how the SASSI analysis results will be used to develop horizontal seismic forces (in Sect. 5A.4.1.1); vertical seismic forces (in Sect. 5A.4.1.2); and out-of plane inertial forces (in Sect. 5A.4.1.3) for shear walls. Section 5A.4.2 (of *Seismic Design Plan*) provides details of how SASSI output will be used to calculate the slab design forces that are to be applied.

(9) The displacements are negligible, due to the stiffness of the elements involved. In the 3-D model, the design team is using "very-soft" springs that are parallel and adjacent to each of the columns. The "very-soft" springs extend the full length of each column. Each soft spring is about 10^{-4} times the stiffness of the adjacent column. From these "very-soft" springs, the relative displacements can be obtained. [Ref: Feb 17, 18 Viewgraphs *Relative Column Displacements from SSI Analysis,* also listed in item 10 below.]

(10) The design team is currently working on this topic; and presented the in-process results at the Feb 17, 18 DNFSB Meetings in Orange County, CA (at the SGH Offices). The CMRR Project design team will begin the SSI Analyses at the end of March 2009; and the process will SSI Report will be complete at the end of July 2009. [Ref Viewgraphs from Feb 17, 18: *Slab Stiffness Study; Relative Column Displacements from SSI Analysis; Backfill Modeling Sensitivity Study; CMRR NF SSI Analysis; Floor Loading for CMRR NF; CMRR NF Structural Design; Structural Model of CMRR Bldg.]*

DNFSB Final Resolution:

DNFSB: ________ Roy Kasdorf ________ Date	NNSA: James McConnell, Acting NA-17 3/11/2009 Date