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

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September 4, 2009

To the Congressional Defense Committees:

The Defense Nuclear Facilities Safety Board (Board) is pleased to submit to Congress its certification report on the design of the Chemistry and Metallurgy Research Replacement (CMRR) Project, Los Alamos National Laboratory, Los Alamos, New Mexico. This report was mandated by Congress in Section 3112 of the Duncan Hunter Defense Authorization Act for Fiscal Year 2009, Public Law 110-417. Section 3112 directs the Board to submit a certification to the congressional defense committees that concerns raised by the Board regarding design of CMRR safety-class systems (including ventilation systems) and seismic issues have been resolved.

Section 3112 also requires that the National Nuclear Security Administration (NNSA) perform a parallel CMRR certification review to certify that the Board's concerns have been resolved. The CMRR Project is presently at the end of the preliminary design stage. The Board anticipates that NNSA will continue to develop the CMRR Documented Safety Analysis and the design of safety-related structures, systems, and components as the project prepares for and proceeds to final design.

The Board has worked with NNSA throughout the CMRR certification review process to identify the Board's concerns and the actions necessary to resolve them. As part of this process NNSA has revised or agreed to revise the CMRR preliminary design, design requirements, and design processes to address these concerns as more fully described in the enclosed certification report. NNSA has also committed to implement detailed designs during final design consistent with the specific design requirements agreed to as part of this certification process.

The Board's certification relies upon the future full implementation of these final design commitments by NNSA. The Board will continue to review the design progression for implementation by NNSA consistent with these commitments. The Board will reopen issues if commitments, as described in the certification report, are not properly met during final design.

Relying upon NNSA's full implementation of commitments made by NNSA concerning safety-related processes, structures, systems, and components, as described in the enclosed certification report, with regard to: (1) preliminary design including design requirements and design processes, and (2) final design including development of design requirements into final design elements, the Board certifies that its concerns regarding the design of the CMRR have been resolved.

Respectfully submitted,

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Enclosure

PREFACE

This report is provided in response to the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 (Public Law 110-417), Section 3112:

SEC. 3112. LIMITATION ON FUNDING FOR PROJECT 04-D-125 CHEMISTRY AND METALLURGY RESEARCH REPLACEMENT FACILITY PROJECT, LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO.

Of the amounts appropriated pursuant to an authorization of appropriations in this Act or otherwise made available for fiscal year 2009 for Project 04-D-125 Chemistry and Metallurgy Research Replacement (in this section referred to as "CMRR") facility project, Los Alamos National Laboratory, Los Alamos, New Mexico, not more than $50,200,000 may be made available until—

(1) the Administrator for Nuclear Security and the Defense Nuclear Facilities Safety Board have each submitted a certification to the congressional defense committees stating that the concerns raised by the Defense Nuclear Facilities Safety Board regarding the design of CMRR safety class systems (including ventilation systems) and seismic issues have been resolved; and

(2) a period of 15 days has elapsed after both certifications under paragraph (1) have been submitted.

EXECUTIVE SUMMARY

Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 directs the Defense Nuclear Facilities Safety Board (Board) to submit a certification concerning the Chemistry and Metallurgy Research Replacement (CMRR) Project at Los Alamos National Laboratory (LANL) in New Mexico. The legislation requires the Board to certify that concerns raised by the Board regarding the design of CMRR have been resolved by the National Nuclear Security Administration (NNSA). This report summarizes the Board's certification efforts. Section 3112 also requires that NNSA perform a parallel CMRR certification review to certify that the Board's concerns have been resolved. The Board has worked with NNSA throughout the CMRR certification review process to keep NNSA apprised of the Board's concerns and the actions necessary to resolve them.

Relying upon NNSA's full implementation of commitments made by NNSA concerning safety-related processes, structures, systems, and components, as described in this certification report, with regard to: (1) preliminary design including design requirements and design processes, and (2) final design including development of design requirements into final design elements, the Board certifies that its concerns regarding the design of the CMRR have been resolved.

BACKGROUND

The CMRR Project at LANL is being planned to relocate and consolidate analytical chemistry, materials characterization, and actinide research and development support capabilities currently housed at the Chemistry and Metallurgy Research Facility (built in 1952). The CMRR Project consists of two primary elements: (1) the Radiological Laboratory/Utility/Office Building and (2) the Nuclear Facility. The Nuclear Facility will be a Hazard Category 2 facility and poses the greatest hazard because of its substantial inventory of radioactive and other hazardous materials. That facility was the focus of the Board's concerns and accordingly the certification review.

The CMRR Project has completed preliminary design of the Nuclear Facility. The Board's certification review focused on design materials available as of the end of December 2008, as well as additional materials provided by NNSA through August 2009 to address the CMRR certification review topics. NNSA's decision to authorize the start of the CMRR final design phase is planned to occur in fiscal year 2010.

SCOPE AND APPROACH OF CMRR CERTIFICATION REVIEW

The Board's certification review focused on seven topics the Board deemed significant to the CMRR design:

1. Site Characterization and Seismic Design
2. Preliminary Documented Safety Analysis and Safety Strategy
3. Safety-Class Fire Suppression System
4. Safety-Significant Active Ventilation System
5. Safety-Class Container Design

6. Safety-Significant Electrical Distribution System
7. Design Control Process

As these topics were reviewed, the Board identified concerns with NNSA's resolution of the topics as either Findings or Comments. Findings, transmitted formally to NNSA during the review process, represented those issues that needed to be resolved prior to CMRR certification, while Comments represented those issues that can be addressed during final design. The CMRR certification review resulted in the following Findings with regard to safety-related processes, structures, systems, and components:

- *CMRR Seismic Design* (ensuring an adequate structural design)

- *Seismic Design of Active Confinement Ventilation System and Support Systems* (ensuring that safety-systems are properly seismically qualified)

- *Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria* (ensuring that a complete set of safety-related controls and functional requirements are identified)

- *Documenting and Maintaining Preliminary Documented Safety Analysis*[1] *Safety-Related Functions and Requirements* (ensuring that the design control process formally integrates the safety envelope into the design)

- *System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately* (ensuring consistency between the safety analysis and system design)

CMRR CERTIFICATION REVIEW TOPICS

Site Characterization and Seismic Design

The Nuclear Facility structure and much of the facility equipment are designated as safety-related, requiring appropriate seismic design. LANL personnel are proceeding with the Nuclear Facility design based on initial estimates of the seismic design ground motions. A technically defensible seismic design will ensure that safety-related structures, systems, and components can perform their intended safety functions when subjected to design basis earthquake ground motions. The Board submitted two Findings related to this topic.

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[1] The Preliminary Documented Safety Analysis is documentation developed during preliminary design that provides a reasonable basis for the preliminary conclusion that the nuclear facility can be operated safely through the consideration of factors such as nuclear safety design criteria and a safety analysis that derives aspects of design that are necessary to satisfy the nuclear safety design criteria [10 CFR 830 *Nuclear Safety Management*].

Finding: ***CMRR Seismic Design***

The CMRR Project should not proceed to final design until there is high confidence that the structural capacity of the Nuclear Facility is adequate for the design basis earthquake ground motions and that no significant unresolved design challenges exist. The Board determined that the CMRR Project team had not adequately assessed the complex structural behavior of this facility. The Board did not have confidence that a final design solution would be feasible without significant structural changes during final design. This increased the likelihood of structural damage in the event of a design basis earthquake occurring, that could lead to unacceptable releases of radioactive material.

The Board met with CMRR Project personnel to discuss the structural behavior of the Nuclear Facility and related structural modeling. Project personnel agreed with the Board's concerns and took steps to develop an improved understanding of the complex structural behavior of the Nuclear Facility. Project personnel performed an assessment of building response that resulted in several project recommendations related to the structural configuration, load path, and structural analysis. These changes include extending the mezzanine floor between the laboratory and vault, modifying the roof, and accounting for additional structural walls in the analysis. In addition, project personnel discussed the need to modify or replace the soil layer immediately below the foundation to prevent adverse soil response during the design basis earthquake (such as collapse under the buildings weight and slope instability leading to building sliding).

The Board has determined that the CMRR Project team has now developed an acceptable understanding of the structural behavior of the Nuclear Facility that includes revising the structural design process to include the development of a more detailed structural model. The Board also agrees that the project proposal to stiffen the soil layer immediately below the foundation of the Nuclear Facility should improve the seismic response of the structure and lower seismic loads on safety-related equipment. The Board has closed this Finding.

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

The CMRR Project should not proceed to final design until there is high confidence that the necessary safety-related portions of the active confinement ventilation system can be seismically qualified. The structural response of the Nuclear Facility to the vertical design basis ground motion 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 appropriate seismic design requirements. The Board also suggested near-term studies to assess the potential conservatism of design basis earthquake ground motions given recently published ground motion attenuation models. The CMRR Project team responded satisfactorily to both of these suggestions. NNSA reconfirmed its commitment to seismically designing the active confinement ventilation system to appropriate seismic design requirements. The ground motion studies resulted in reducing design basis earthquake ground motions by about 25 to 40 percent.

Having determined that inadequate technical justification had been provided to fully understand the equipment seismic qualification issue, the Board suggested that the CMRR Project team perform a peer review of the approach used to seismically qualify safety-related equipment. CMRR Project personnel had an independent evaluation of seismic equipment qualification performed. This independent evaluation revealed a high degree of confidence that safety-related equipment for the Nuclear Facility can be seismically qualified. The Board has reviewed this independent evaluation and agrees with the conclusion that the uncertainty in seismic equipment qualification has been adequately addressed by prior nuclear design experience. The Board has closed this Finding.

As the Nuclear Facility final design proceeds, the Board will review the CMRR Project team's detailed assessment of the impact of the revised foundation approach, the structural model and analysis, the updated soil-structure interaction analysis, and the qualification plan for safety-related equipment.

Preliminary Documented Safety Analysis and Safety Strategy

The CMRR Preliminary Documented Safety Analysis (PDSA) and safety strategy need to be based on: (1) a hazard analysis[2] that examines the complete spectrum of potential events; (2) an accident analysis[3] that results in proper selection of those structures, systems, and components which are safety-related; (3) adequate definition of safety functions which must be performed and functional requirements which must be met for these safety-related structures, systems, and components; and (4) design requirements so that these safety-related structures, systems, and components will perform as required.

The PDSA relies on certain functional requirements for the identified safety-related controls, supported by performance criteria that will need to be incorporated into the design of

[2] A hazard analysis results in a determination of material, system, process, and plant characteristics that can produce undesirable consequences, followed by the assessment of hazardous situations associated with a process or activity. The hazards analysis examines the complete spectrum of potential accidents that could expose members of the public, collocated workers, facility workers, and the environment to hazardous materials [DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis*].

[3] An accident analysis is a follow-on effort to the hazard analysis and requires documentation of the basis for assignment to a given likelihood of occurrence range in hazard analysis and performance of a formally documented consequence analysis. Consequences are compared with an Evaluation Guideline to identify safety-class structures, systems, and components [DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis*].

the controls during final design. The PDSA did not incorporate those functional requirements thoroughly and completely. As a result, some of the credited functions in the hazard analysis tables did not correlate with the corresponding functional requirements for the safety-related controls. The Board identified numerous instances of inadequate identification of functional requirements that the safety-related control set must meet. If not corrected this would reduce the likelihood that safety-related structures, systems, and components would perform adequately in protecting the public and workers. This led to the following Finding.

Finding: ***Inadequate Identification of Safety-Related Controls, Functional Requirements and Performance Criteria***

The CMRR Project should not proceed to final design until the PDSA identifies all safety-related controls and corresponding functional requirements for these controls. The Board suggested that the CMRR Project team submit a process plan for addressing the PDSA deficiencies and prepare a document that would comprehensively describe all safety-class[4] and safety-significant[5] controls and their support systems that envelope the events identified in the PDSA. This document would identify the functional requirements for all those safety-related structures, systems, and components, along with their seismic design performance categorization, to ensure that they can be given appropriate credit in the hazard or accident analysis.

CMRR Project personnel developed a plan for addressing the deficiencies identified by the Board. This plan would systematically and comprehensively identify the credited controls in the hazard analysis, including the functional requirements for those controls. The Board reviewed this approach and found it acceptable.

Subsequently, project personnel performed the activities to which they had committed and completed their review of all the potential hazards. Project personnel identified the controls that were credited for protection of the public and workers, correlated each control with its safety functions, identified the functional requirements for each control consistent with its credited safety functions, and documented the results. New safety-related controls were also identified for several events of concern to the Board. Consequently, a complete set of safety-class and safety-significant controls was identified that will prevent or mitigate all the hazards identified in the hazard evaluation. The Board found this set of safety-related controls to be comprehensive and the identified functional requirements to be adequate for final design of those safety-related controls. The Board has closed this Finding.

As the CMRR design proceeds, the Board will review the updated PDSA for the CMRR Project to verify that these commitments are carried through to the final design.

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[4] Safety-class is a designation assigned to those structures, systems, and components whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public [10 CFR 830, *Nuclear Safety Management*].

[5] Safety-significant is a designation assigned to those structures, systems, and components which are not designated as safety-class, but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety [10 CFR 830, *Nuclear Safety Management*].

Safety-Class Fire Suppression System

The fire suppression system has been designated as safety-class. This will be the first fire suppression system built as safety-class at a new facility in the Department of Energy (DOE) complex. The safety-class fire suppression system needs to remain operable and perform its intended safety functions following design basis accidents in order to protect the public. The establishment of appropriate design requirements relates directly to the credited safety function of the safety-class fire suppression system.

The Board's review revealed that the specified attributes of the safety-class design of the automatic sprinkler systems and the Preliminary Fire Hazards Analysis are appropriate at this preliminary stage of design. Appropriate design standards have been referenced and are adequately applied in the design documents.

The Board concludes that the preliminary design of the safety-class fire suppression system incorporates sound engineering principles and appropriate design standards. The Board will monitor the development of the safety-class fire suppression system to verify the implementation of the specified attributes and standards into the final design. The final design of the safety-class fire suppression system must demonstrate that this system will remain operable and perform its intended safety functions during normal and abnormal environmental and design basis events in order to protect the public and workers.

Safety-Significant Active Ventilation System

The safety-significant active ventilation system needs to remain operable and perform its intended safety functions following design basis accidents, including earthquakes. The establishment of appropriate design requirements relates directly to the credited safety function of the safety-significant active ventilation system. The Board reviewed the preliminary design of the safety-significant active ventilation system to verify that the safety controls in the PDSA were appropriately identified and to ensure that the system's safety functions and functional requirements were reflected in the design.

Early in preliminary design, CMRR Project personnel took the position that the active ventilation system did not need to remain operable following a design basis earthquake. The project was relying on passive confinement to mitigate a release of radioactive material due to a design basis earthquake. The Board did not agree that this reliance on passive confinement after a design basis earthquake was adequate to protect collocated workers. Subsequently, project personnel committed to designing the safety-significant active ventilation system so as to ensure its operability following a design basis earthquake. The project's safety strategy was developed to be consistent with this approach.

The Board's review of the incorporation of the PDSA requirements into the design revealed that while many of the PDSA requirements were reflected in the system design descriptions, they were not always appropriately designated as safety-related. CMRR Project personnel have agreed to revise the system design descriptions to be consistent with the PDSA requirements. The Board's review of the system design descriptions for the ventilation system and facility design criteria revealed that the appropriate DOE directives and consensus standards had been incorporated into the design requirements. The Board concludes that the preliminary design for the safety-significant active ventilation system is sufficiently mature to proceed to final design. As the CMRR design proceeds, the Board will review the final design of the safety-significant ventilation system.

Safety-Class Container Design

The current safety strategy for the Nuclear Facility relies on container design to prevent the release of large fractions of the material-at-risk. Containers that will be used in the Long-Term Storage Vault have been designated as safety-class; other containers used for protecting in-process material-at-risk have been designated as safety-significant. Definitive design requirements and performance expectations for both types of containers had not been established. In the Long-Term Storage Vault, thermal design requirements[6] had not been established. CMRR Project personnel analyzed the vault environment assuming a loss of cooling to quantify the maximum temperature to which the safety-class containers would be exposed. The Board's review revealed that the thermal environment of the vault was not adequately defined. It was unclear whether additional safety-class controls to mitigate the consequences of a loss-of-cooling accident were needed.

The Board reviewed subsequent preliminary design calculations performed by the CMRR Project team to address the thermal environment of the Long-Term Storage Vault. These calculations demonstrated that containers designed to DOE Standard 3013-2004, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials,* would adequately resist the thermal conditions of the vault. This provides assurance that CMRR has containers that will not fail during a loss-of-cooling event.

The CMRR Project team will formally revise its vault heat transfer calculations to incorporate the results of the preliminary calculations. The Board will review the revised calculations as they become available. The Board concludes that there is now sufficient understanding of the thermal environment of the Long-Term Storage Vault to support not having safety-related forced cooling. Project personnel agreed to add functional requirements for the vault's containers to specify compliance with an approved DOE standard for long-term storage of special nuclear materials (similar to DOE Standard 3013-2004). The Board will continue to review the final design of the Long-Term Storage Vault and safety-related container design to verify implementation of the stated requirements and design approaches.

Safety-Significant Electrical Distribution System

The safety-significant electrical distribution system supports the safety-significant active ventilation system and must remain operable and perform its intended safety functions following design basis accidents. The establishment of appropriate design requirements relates directly to the reliable performance of the credited safety function of the safety-significant electrical distribution system.

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[6] Stored radioactive materials generate heat due to radioactive decay, which must be removed. If the heat is not properly dealt with, it can cause safety issues under both normal and accident conditions.

The Board's review of the electrical distribution system revealed that it will meet all relevant codes and standards after some preliminary design modifications that the CMRR Project team has agreed to make. Preliminary design documents incorporate sound engineering principles and appropriate design standards to ensure that the system will remain operable and perform its intended safety function. The final design of the electrical distribution system should demonstrate that this system will remain operable and perform its intended safety function during normal and abnormal environmental and design basis events. The Board will continue to review the final design of the electrical distribution system to verify implementation of the stated requirements.

Design Control Process

Following the Board's certification of CMRR, it will be important that the integration of safety into the design (designation of safety systems, safety functions, and functional requirements and incorporation of these requirements into the system's design) be appropriately maintained throughout the remainder of the design process. Any changes in the established safety strategy will need to be justified and approved at the appropriate project levels. The safety strategy will be maintained through implementation of a design control process.

The Board's review revealed that the design control process did not establish appropriate change control of the PDSA safety envelope—specifically, change control of safety-related structures, systems, and components and their safety functions and functional requirements. The CMRR Project team had not developed a requirements approach that formally integrated the safety envelope established by the PDSA into the system design descriptions. The Board submitted two Findings related to this topic.

Finding: ***Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements***

The CMRR Project should not proceed to final design without a design control process that formally integrates the safety envelope into the design. The Board suggested that the CMRR Project team commit to revising the Systems Engineering Management Plan, Configuration Management Plan, and system design descriptions to explicitly incorporate requirements from the PDSA.

CMRR Project personnel committed to developing a design control process that formally establishes change control for safety-related structures, systems, and components and their safety functions and functional requirements. They committed to revising the Systems Engineering Management Plan, Configuration Management Plan, and system design descriptions to explicitly incorporate the requirements in the PDSA. Project personnel agreed that the safety functions and functional requirements should be explicitly listed in the appropriate system design descriptions, and provided a detailed schedule for the completion of these activities.

The Board reviewed procedures and plans written to specify a formal design control process related to establishing a technical baseline and controlling changes to that baseline. The procedures and plans being put in place will adequately establish a design control process for

CMRR. The Board will verify that the actions committed to are implemented. The Board has closed this Finding.

Finding: ***System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately***

The CMRR Project should not proceed to final design until there is explicit flowdown of requirements from the PDSA to system design descriptions. The system design description is the central coordinating link among the engineering design documents, the PDSA, and implementing procedures. During design, the system design description serves as the vehicle for collecting and conveying the system requirements and their bases. The CMRR Project's system design descriptions need to be revised to incorporate the safety functions and functional requirements in the PDSA. The Board suggested that project personnel submit a plan for revising the system design descriptions to ensure consistency with the PDSA, including a schedule for such revisions. This action should ensure that the system design descriptions serve their function of aiding the complete and efficient incorporation of the PDSA requirements into the final design. Revisions to the system design descriptions should be complete prior to final design.

The CMRR Project team has taken steps to ensure that requirements established in the PDSA are properly linked to the system design descriptions. Project personnel have committed to revising the system design descriptions before the project proceeds to final design. The Board will review the revised system design descriptions as they become available. The Board has closed this Finding.

As the CMRR design proceeds, the Board will review the CMRR Project's revised Systems Engineering Management Plan, Configuration Management Plan, and updated system design descriptions.

EVALUATION OF NNSA'S TECHNICAL INDEPENDENT PROJECT REVIEW

NNSA conducted a Technical Independent Project Review (T-IPR) of the CMRR Nuclear Facility from January 27 through February 4, 2009. The Board has evaluated the adequacy of NNSA's T-IPR for CMRR. In general, the CMRR T-IPR did not identify new nuclear safety issues. While the CMRR T-IPR was technically adequate, the Board identified the following areas requiring improvement:

- The Review Plan for the CMRR T-IPR was improved over earlier T-IPR's in terms of the Criteria and Review Approach Documents (CRADs). However, inconsistencies among the CRADs (topic to topic) still remain and should be addressed in future T-IPRs.
- The Final Report of the CMRR T-IPR treats review items inconsistently; a number of review items not identified as significant concerns should have been identified as such. While the Corrective Action Plan addresses all review items in the Final Report, these items may not be explicitly checked by NNSA's Office of Project Management and Systems Support before the final design proceeds.

- NNSA's Independent Project Review Policy needs to be strengthened to explicitly require the use of review plans for all nuclear facility T-IPRs. The policy should state that review plans must include the identification and use of CRADs tailored to the specific project design stage being reviewed.

- The execution of NNSA's T-IPRs could be improved by the development of a consistent approach to the use of CRADs. This consistency should be documented in appropriate NNSA procedures.

- NNSA needs to improve the way in which T-IPR review items are defined and documented to ensure that all significant concerns are properly identified during future reviews.

Once NNSA addresses these areas requiring improvement they will reduce the number of newly-identified safety issues that surface and must be corrected during final design and construction. The Board will review NNSA's actions to improve its T-IPRs.

EVALUATION OF NNSA'S PRELIMINARY DOCUMENTED SAFETY ANALYSIS REVIEW AND PRELIMINARY SAFETY VALIDATION REPORT

The Los Alamos Site Office (LASO) completed a technical review of the CMRR PDSA. A review of LASO's PDSA comments demonstrates that LASO performed a detailed and comprehensive review of the CMRR PDSA. LASO's Preliminary Safety Validation Report provides NNSA approval of the CMRR PDSA and includes nine conditions of approval that must be resolved before NNSA authorizes proceeding to final design. Several of the conditions of approval are consistent with the Board's Findings. LASO's review comments on earlier versions of the draft PDSA identified similar issues, indicating that NNSA's approach to ensuring that comments on a draft PDSA are adequately resolved on a timely basis needs to be improved. NNSA and LASO must take steps to ensure that issues raised do not remain open, particularly any review issues that can impact the design of safety-related systems.

CMRR CERTIFICATION CONCLUSIONS

Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 directs the Board to submit a certification concerning the CMRR Facility at LANL in New Mexico. The legislation requires the Board to certify that concerns raised by the Board regarding the design of CMRR have been resolved by NNSA.

The Board developed a systematic approach to completing the CMRR certification review. The Board identified seven topics for the certification review, which were the five open concerns identified by the Board in its quarterly report to Congress plus two additional areas the Board considered important to the CMRR design process. As the CMRR certification topics were reviewed, the Board identified concerns with NNSA's resolution of the topics. Those concerns that needed to be resolved prior to CMRR certification were classified as Findings and formally transmitted to NNSA. For each Finding, the Board identified the specific concerns and the technical basis for the concerns and suggested a path forward.

NNSA provided a response to each Finding. The Board reviewed each response and met with NNSA to reach agreement on how each Finding would be resolved. Based on NNSA's responses and commitments, each of the Findings was closed. As part of this process NNSA has revised or agreed to revise the CMRR preliminary design, design requirements, and design processes to address these concerns as more fully described in this certification report. NNSA has also committed to implement detailed designs during final design consistent with the specific design requirements agreed to as part of this certification process.

The Board's certification relies upon the future full implementation of these final design commitments by NNSA. The Board will continue to review the design progression for implementation by NNSA consistent with these commitments. The Board will reopen issues if commitments, as described in this certification report, are not properly met during final design.

Relying upon NNSA's full implementation of commitments made by NNSA concerning safety-related processes, structures, systems, and components, as described in this certification report, with regard to: (1) preliminary design including design requirements and design processes, and (2) final design including development of design requirements into final design elements, the Board certifies that its concerns regarding the design of the CMRR have been resolved.

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1. INTRODUCTION

1.1 CONGRESSIONAL CMRR CERTIFICATION REQUIREMENT

Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 directs the Defense Nuclear Facilities Safety Board (Board) to submit a certification concerning the Chemistry and Metallurgy Research Replacement (CMRR) Facility at Los Alamos National Laboratory (LANL) in New Mexico. The legislation requires the Board to certify that concerns raised by the Board regarding the design of CMRR have been resolved by the National Nuclear Security Administration (NNSA). This report summarizes the Board's certification efforts. Section 3112 also requires that NNSA perform a parallel CMRR certification review to certify that the Board's concerns have been resolved. The Board has worked with NNSA throughout the CMRR certification review process to keep NNSA apprised of the Board's concerns and the actions necessary to resolve them.

1.2 BACKGROUND

The CMRR Project at LANL is being planned to relocate and consolidate analytical chemistry, materials characterization, and actinide research and development support capabilities currently housed at the Chemistry and Metallurgy Research Facility (built in 1952). The CMRR Project consists of two primary elements: (1) the Radiological Laboratory/Utility/Office Building and (2) the Nuclear Facility. The Nuclear Facility will be a Hazard Category 2 facility and poses the greatest hazard because of its substantial inventory of radioactive and other hazardous materials. That facility was the focus of the Board's concerns and accordingly the certification review.

The Nuclear Facility portion of the CMRR Project has completed preliminary design. The Board's certification review focused on design materials available as of the end of December 2008, as well as additional materials provided by NNSA to address the CMRR certification review topics. NNSA's decision to authorize the start of the CMRR final design phase is planned to occur in fiscal year 2010.

1.3 SCOPE OF CMRR CERTIFICATION REVIEW

In determining the scope of its CMRR certification review, the Board considered the current project design phase—the end of preliminary design. At the time Section 3112 was promulgated, the Board had identified five significant topics for the CMRR Project, documented in the Board's Quarterly Reports to Congress on the Status of Significant Unresolved Issues with the Department of Energy's (DOE) Design and Construction Projects. The five significant topics were:

1. Site Characterization and Seismic Design
2. Preliminary Documented Safety Analysis and Safety Strategy
3. Safety-Class Fire Suppression System
4. Safety-Significant Active Ventilation System
5. Safety-Class Container Design

In November 2008, following the introduction of Section 3112, the Board determined that two additional topics should be addressed as part of the CMRR certification review because of their significance to the CMRR design:

6. Safety-Significant Electrical Distribution System
7. Design Control Process

The Board's CMRR certification review addressed each of these seven topics. Based on the review, the Board determined what additional action by NNSA was needed to ensure that each topic would be adequately addressed and resolved.

1.4 CMRR DESIGN IMPLICATIONS

As noted, the CMRR Project is presently at the end of preliminary design. For the purposes of its CMRR certification review, the Board verified that NNSA had taken appropriate steps to review the Preliminary Documented Safety Analysis (PDSA)[1] and the design of the CMRR Facility. NNSA's review of the design was documented as part of a Technical Independent Project Review (T-IPR). Decisions made during the preliminary design phase provide the basis for the approach to final design and, ultimately, construction.

It is essential that NNSA (both the site office and Headquarters) be fully engaged with the CMRR Project so its views and advice regarding nuclear safety and design can be considered in a timely fashion as the design evolves. Without such a systematic approach, the identification of viable engineering solutions to nuclear safety design requirements cannot be accomplished with high confidence.

In assessing the CMRR design, it is critical that the CMRR safety strategy, as supported by the PDSA, establish a conservative control set of safety-related structures, systems, and components. Continuous integration of the PDSA and the design is essential to provide assurance that the safety design basis will be demonstrated to be acceptable once the design has been completed.

1.5 CMRR CERTIFICATION REVIEW APPROACH

The Board developed a systematic approach to completing its CMRR certification review. The Board established closure criteria for each of the above seven topics with three overarching emphases: (1) review the PDSA with attention to the adequacy of the hazard and accident analyses and selection of safety systems, including the specification and adequacy of safety functions, system descriptions, and functional requirements; (2) review the flowdown of requirements from the PDSA to the system design, including consistency between the system design descriptions and the PDSA; and (3) review the system design, including calculations,

[1] The Preliminary Documented Safety Analysis is documentation developed during preliminary design that provides a reasonable basis for the preliminary conclusion that the nuclear facility can be operated safely through the consideration of factors such as nuclear safety design criteria and a safety analysis that derives aspects of design that are necessary to satisfy the nuclear safety design criteria [10 CFR 830, *Nuclear Safety Management*].

specifications, drawings, piping and instrumentation diagrams, one-line diagrams, interface control documents, and engineering studies.

As these topics were reviewed, the Board identified issues with NNSA's resolution of the topic area as either Findings or Comments. Findings represented those issues that needed to be resolved prior to CMRR certification, while comments represented those issues that can be addressed during final design. Each CMRR Finding was formally transmitted to NNSA during the review process on a Findings Form; comments were provided to NNSA informally.

On each Findings Form, the Board identified the specific concerns, the technical basis for the concerns, and a suggested resolution and path forward. NNSA provided a response to each Finding. Each Finding is discussed in detail in Section 2 of this report. Appendix A provides a chronology of the Findings Form transmittals and the final Findings Forms sent from the Board to NNSA.

Section 2 of this report summarizes the Board's evaluation of each CMRR certification topic, and discusses each Finding in detail. Section 3 summarizes the Board's evaluation of NNSA's CMRR T-IPR and provides suggestions for improving NNSA's T-IPR process. Section 4 summarizes the Board's evaluation of NNSA's PDSA review and preparation of a Safety Validation Report. Section 5 presents the conclusions of the Board's CMRR certification review.

Appendix B of this report provides a listing of the Board's future CMRR review activities.

2. CMRR CERTIFICATION REVIEW TOPICS

2.1 SITE CHARACTERIZATION AND SEISMIC DESIGN

2.1.1 Topic Description

The Nuclear Facility structure and much of the facility equipment are designated as safety-class[2] or safety-significant[3], requiring appropriate seismic design. LANL personnel are proceeding with the Nuclear Facility design based on initial estimates of the seismic design ground motions. A technically defensible seismic design will ensure that safety-related structures, systems, and components can perform their intended safety functions when subjected to the design basis earthquake ground motions.

In addressing site characterization and seismic design, the Board's certification review focused on the following:

- Mapping of the CMRR excavation must demonstrate that there are no active seismic faults present and that fault displacement is not a design consideration.
- The CMRR seismic design must be based on appropriate horizontal and vertical design basis ground motions.
- The CMRR seismic design must demonstrate that the building structure has been properly modeled, capturing the dynamic behavior of the building and soil-structure interaction effects; that the structural design is adequate to resist seismic forces; and that the in-structure response spectra have been properly calculated such that safety-related equipment can be appropriately designed.

2.1.2 Topic Evaluation

2.1.2.1 Mapping of the CMRR Excavation

The Board reviewed the geologic mapping at the excavation of the Nuclear Facility site. The purpose of this geologic mapping is to evaluate the potential for tectonic or seismic surface rupture at the site. Evidence of nontectonic features, such as those that might be associated with movement or offsets related to depositional processes, should be distinguished from the more hazardous tectonic or seismic rupture features.

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[2] Safety-class is a designation assigned to those structures, systems, and components whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public [10 CFR 830, *Nuclear Safety Management*].

[3] Safety-significant is a designation assigned to those structures, systems, and components which are not designated as safety-class, but whose preventive or mitigative function is a major contributor to defense-in-depth and/or worker safety [10 CFR 830, *Nuclear Safety Management*].

LANL's western boundary is at the western boundary of the Rio Grande Rift and is defined by the Pajarito Fault System (PFS). This fault system is significant for assessing and understanding the seismic hazard at LANL. Geologic mapping and evaluation of tectonic or seismic surface rupture at the Nuclear Facility site are important given the proximity (~ 4,000 feet) to the PFS, an active tectonic and seismogenic fault capable of generating a magnitude 6.5 to 7.0 earthquake. Detailed geologic mapping demonstrates that strands or splays of the PFS traverse Technical Area 3, west of the Nuclear Facility site.

The term "fault" is used here in the common geologic sense, as a descriptive term for geologic deformation with no implications regarding the origin of that deformation. The term refers to a geologic structure that displaces geologic unit (layer) contacts, often called "fault offsets." Faults that are of tectonic and seismic origin are referred to as "seismogenic faults." Seismogenic faults have implications for seismic design, as these faults could cause permanent surface rupture that could rupture a building's foundation, resulting in unacceptable facility damage.

The Nuclear Facility site excavation provided a unique opportunity to inspect geologic features in three dimensions. LANL personnel performed a detailed study of the geology and geologic structure exposed on the walls of a large pit excavated at the Nuclear Facility site. This detailed study was used to understand the origins and timing of the development of the geologic structure found at the site.

The Board's staff and outside expert each visited the Nuclear Facility site excavation to review the field evidence collected and the results of the detailed geologic mapping. The geologic mapping included the inspection and mapping of 32,000 square feet of exposed excavation walls, supplemented by sample collection and laboratory analysis. Both permanent and temporary walls were mapped over 1,300 feet of exposure for heights ranging from 15 to 30 feet. The geologic mapping identified more than 2,000 fractures. Orientation data were collected on 1,204 fractures, 23 of which were identified as faults, meaning that geologic materials on two sides of a fracture were observed to be offset.

Mapping of faults (fractures with offsets) within the excavation revealed an orientation that is inconsistent with the orientation of the PFS, indicating that fault orientation was controlled by the local topography and the volcanic depositional process. Maximum offset across mapped fractures was less than 2 feet, compared with a maximum offset in the Bandelier Tuff of up to 500 feet for the main Pajarito fault.

The pattern that emerges from the geologic mapping indicates that the geologic structure developed during cooling of the Bandelier Tuff. LANL personnel concluded that faults found within the excavation were created during cooling and compaction of the tuff, and are related to settling of the blocks of the cooling tuff. Based on its review of the results of the geologic mapping and its field visit to the Nuclear Facility excavation, the Board agrees with this conclusion. The fractures and offsets are not associated with tectonic and seismic movements that pose a potential for surface offsets that could impact the Nuclear Facility.

2.1.2.2 CMRR Seismic Design Ground Motions

The design basis earthquake has been established at Performance Category[4] 3 (PC-3), consistent with the project determination that the Nuclear Facility structure and much of the facility equipment are designated as safety-class or safety-significant.

The Board's review of the Nuclear Facility safety strategy revealed that CMRR Project personnel were concerned about the magnitude of the in-structure seismic design motions within the Nuclear Facility. This concern pertained to the project's ability to seismically qualify safety-related systems and components that perform an active safety function. The structural response to vertical design basis ground motions raised concern as to whether vertical accelerations are at or above the upper limit at which rotating equipment can be seismically qualified. CMRR Project personnel stated that the seismic design for some of the safety-related systems might be downgraded if those systems could not be seismically qualified economically. The Board determined that inadequate technical justification had been provided to fully understand this issue. This determination led to the identification of the Board's Finding *Seismic Design of Active Confinement Ventilation System and Support Systems.*

The Board reviewed the project's update of seismic design ground motions, including studies undertaken to determine whether those ground motions were overly conservative. The current CMRR seismic design ground motions are based on a probabilistic seismic hazard analysis (PSHA) completed in 2007. This PSHA directly estimated horizontal seismic ground motions, with equal weight given to empirical and site-specific ground motion attenuation models. For the CMRR site, the PSHA considered the site-specific shear wave velocity profile of geologic units and the impact of topography (CMRR is located on a mesa). Vertical seismic ground motions were indirectly estimated by developing ratios of vertical-to-horizontal motions and applying these ratios to the horizontal motions.

The PSHA ground motions associated with a return period of 2,500 years were used to derive the PC-3 seismic design ground motions. The peak spectral acceleration for the vertical seismic motions has been the focus of considerable attention because the ongoing seismic structural analysis indicates that the vertical motions are amplified by the Nuclear Facility structure, creating in-structure vertical motions that may be excessive.

Since the 2007 LANL PSHA was published, new sets of empirical ground motion attenuation models have become available as part of the Pacific Earthquake Engineering Research Center's Next Generation Attenuation (NGA) Models for the Western United States Project. The NGA models have been accepted by the seismic hazard community and have been used by the United States Geological Survey as part of the National Seismic Hazard Map. The 2007 LANL PSHA was to have used the NGA models, but they were not published in time.

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[4] Performance categories are a classification system used to ensure that specified performance goals are met during natural phenomena events such as earthquakes [DOE Standard 1021, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*]. Performance Category 3 is used when the accident consequences to the public or collocated worker are large enough to warrant increased seismic design.

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.

CMRR Project personnel had an independent evaluation of seismic equipment qualification performed. The engineering firm that completed this evaluation has significant experience with seismic equipment qualification for nuclear facilities, including those in highly seismic regions such as California. This independent evaluation revealed a high degree of confidence that safety-related equipment for the Nuclear Facility can be seismically qualified.

The Board has reviewed this independent evaluation and agrees with the conclusion that the uncertainty in seismic equipment qualification has been adequately addressed by prior nuclear design experience. As the CMRR Project proceeds into final design, the development of detailed seismic qualification plans for safety-related equipment will be necessary. The Board has closed this Finding.

2.1.4 Finding: *CMRR Seismic Design*

The CMRR Project should not proceed to final design until there is high confidence that the structural capacity of the Nuclear Facility is adequate for the design basis earthquake ground motions and that no significant unresolved design challenges exist. The Board determined that the CMRR Project team had not adequately assessed the complex structural behavior of this facility. The Board did not have confidence that a final design solution would be feasible without significant structural changes during final design. This increased the likelihood of structural damage in the event of a design basis earthquake occurring, that could lead to unacceptable releases of radioactive material.

The Board met with CMRR Project personnel to discuss the structural behavior of the Nuclear Facility and related structural modeling. Project personnel agreed with the Board's concerns and took steps to develop an improved understanding of the complex structural behavior of the Nuclear Facility. In addition, the CMRR Project personnel discussed the need to modify or replace the soil layer immediately below the foundation of the Nuclear Facility to prevent adverse soil response during the design basis earthquake (such as collapse under the buildings weight and slope instability leading to building sliding).

The Board has determined that the CMRR Project team has now developed an acceptable understanding of the structural behavior of the Nuclear Facility. The Board agrees that the project proposal to stiffen the soil layer immediately below the foundation of the Nuclear Facility should improve the seismic response of the structure and lower seismic loads on safety-related equipment. This judgment is considered sufficient for CMRR certification purposes, but a detailed assessment of the revised foundation approach needs to be completed before approval to proceed with final design. This assessment will need to 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 lacked an integrated approach to structural modeling. The structural design process was revised to include the development of a more detailed structural model. A design process check is planned to ensure that the design approach is adequate. The Board agrees that this is an acceptable path forward. To execute the revised structural design process, the CMRR Project team will need to describe how the design process check will be performed and develop acceptance criteria for the analysis models. As the Nuclear Facility design proceeds the Board will review the CMRR Project team's structural model and analysis, and updated soil-structure interaction analysis. The Board has closed this Finding.

2.2 PRELIMINARY DOCUMENTED SAFETY ANALYSIS AND SAFETY STRATEGY

2.2.1 Topic Description

The CMRR PDSA and safety strategy need to be based on: (1) a hazard analysis[5] that examines the complete spectrum of potential events; (2) an accident analysis[6] that results in proper selection of those structures, systems, and components which are safety-related; (3) adequate definition of safety functions which must be performed and functional requirements which must be met for these safety-related structures, systems, and components; and (4) design requirements so that these safety-related structures, systems, and components will perform as required.

In addressing the adequacy of the CMRR PDSA and safety strategy, the certification review focused on the following:

- A hazard analysis must examine the complete spectrum of potential events.

- An accident analysis must result in adequate selection of (1) safety-class controls with acceptable mitigated consequences and (2) safety-significant controls for protection of facility and collocated workers.

- Safety functions, functional requirements, system descriptions, and system evaluation must be adequately defined.

- Design requirements must be established for safety-related structures, systems, and components.

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[5] A hazard analysis results in a determination of material, system, process, and plant characteristics that can produce undesirable consequences, followed by the assessment of hazardous situations associated with a process or activity. The hazards analysis examines the complete spectrum of potential accidents that could expose members of the public, collocated workers, facility workers, and the environment to hazardous materials [DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis*].

[6] An accident analysis is a follow-on effort to the hazard analysis and requires documentation of the basis for assignment to a given likelihood of occurrence range in hazard analysis and performance of a formally documented consequence analysis. Consequences are compared with an Evaluation Guideline to identify safety-class structures, systems, and components [DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis*].

2.2.2 Topic Evaluation

The Board reviewed the PDSA and its supporting documents. The project team used the What-if methodology to identify the operational hazards at the facility. Although this methodology is not as comprehensive as a Process Hazard Analysis (PrHA), it is adequate for this stage of design, appropriately identifying the hazards for consideration of the necessary controls. Project personnel committed to completing a PrHA and including its results in the next revision of the PDSA.

All hazards that were identified through application of the What-if methodology were tabulated, along with the credited controls (safety-class or safety-significant) identified for protection of the public or workers. For the majority of the hazards, an adequate set of safety-related or defense-in-depth controls was provided. However, the Board identified several instances in which the controls would not have been effective or were not adequately described in the body of the PDSA. Without adequate controls, workers may not be protected.

The PDSA relies on certain functional requirements for the identified safety-related controls, supported by performance criteria that will need to be incorporated into the design of the controls. The PDSA did not incorporate those functional requirements thoroughly and completely. As a result, some of the credited functions in the hazard analysis did not correlate with the corresponding functional requirements for the safety-related controls. The Board identified numerous instances of inadequate identification of functional requirements for the safety-related control set. If not corrected this would reduce the likelihood that safety-related structures, systems, and components would perform adequately in protecting the public and workers.

The determination that the PDSA may not contain an adequate set of safety-related controls and that the set of functional requirements is incomplete resulted in the Board's Finding *Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria*. To resolve this Finding, the Board suggested that CMRR Project personnel take steps to ensure that a complete set of safety-related controls is defined, with corresponding safety functions and functional requirements.

A limited set of operational accidents, external events, and natural phenomena hazards was identified in the PDSA as design basis accidents with potential offsite consequences. These accidents were analyzed quantitatively to determine the unmitigated consequences and identify safety-class controls. However, the PDSA did not provide quantitative evaluation of the unmitigated consequences to collocated workers to support the identification of safety-significant controls. Project personnel committed to performing the required dose calculations for inclusion in the next revision of the PDSA. The Board reviewed the current version of the PDSA, the results of the PrHA, and the updated assessment of safety-related controls to ensure that the set of safety-class and safety-significant controls is adequate to protect the public and workers. Future dose calculations for collocated workers are not expected to identify facility-level safety-significant structures, systems, and components that would have a major impact on the facility's future design. The Board will review future work to confirm this.

The major accidents that are quantitatively analyzed in the PDSA include fires; spills; criticality events; and seismic events, including seismically induced fires. The primary safety-related features of the facility are the safety-class structural design, safety-class fire suppression system, and safety-significant active confinement ventilation system. Early in preliminary design, CMRR Project personnel took the position that the safety-significant active confinement ventilation system would not need to remain operable following a design basis seismic event. The Board did not agree with this position because of the significant consequences to collocated workers. Subsequently, CMRR Project personnel committed to designing this system to ensure its operability following a design basis earthquake. Given this change, all safety-related structures, systems, and components that are required to perform their functions after a design basis earthquake have been identified.

The Board identified deficiencies in the performance criteria for the safety-class containers used in the accident analysis of a spill due to an elevator drop. The performance criteria identified for these containers to withstand this specific event did not appear to mitigate the consequences of or prevent the event. CMRR Project personnel committed to reducing the amount of material that can be transported in the elevator at any one time to reduce the consequences of this event and eliminate the need for a safety-class control. The amount of material will be controlled through a Specific Administrative Control[7] in the Technical Safety Requirements[8] portion of the next revision of the PDSA. The Board will review the next revision of the PDSA as it becomes available.

The draft PDSA did not provide for active removal of the decay heat generated by the materials stored in the Long-Term Storage Vault after a design basis earthquake. The Board was concerned that the technical analysis provided by the CMRR Project team was insufficient to support the design. A lack of heat removal capability could lead to overpressurization of the stored containers and potential rupture that could disperse hazardous materials to the outside. Extensive follow-up analyses indicated that the passive heat removal capability of the Long-Term Storage Vault would limit the temperature rise of the containers to acceptably low values for a period of at least 100 days following a design basis earthquake. Consequently, the CMRR Project personnel committed to allowing for provision of a portable and redundant cooling system and to implementing a Technical Safety Requirement for the system, to be installed within 30 days of a total loss of the main heat removal system.

[7] Specific Administrative Controls are identified in the documented safety analysis as a control needed to prevent or mitigate an accident scenario, that have a safety function that would be safety-significant or safety-class if the function were provided by a structure, system, or component [DOE Standard 3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analysis*].

[8] Technical Safety Requirements mean the limits, controls, and related actions that establish the specific parameters and requisite actions for safe operation of a nuclear facility, and include, as appropriate for the work and the hazards identified in the documented safety analysis for the facility: safety limits, operating limits, surveillance requirements, administrative and management controls, and use and application provisions, and design feature as well as a bases appendix [10 CFR 830 *Nuclear Safety Management*].

2.2.3 Finding: *Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria*

The CMRR Project should not proceed to final design until the PDSA identifies all safety-related controls and corresponding functional requirements for those controls. The Board suggested that the CMRR Project team submit a process plan for addressing the PDSA deficiencies and prepare a document that would comprehensively describe all safety-class and safety-significant controls and their support systems that envelope the events identified in the PDSA. This document would identify the functional requirements for all safety-related structures, systems, and components, along with their seismic design performance categorization, to ensure that they can be given appropriate credit in the hazard or accident analysis.

CMRR Project personnel developed a plan for addressing the deficiencies identified by the Board. This plan would systematically and comprehensively identify the credited controls in the hazard analysis, including the functional requirements for those controls. The Board reviewed this approach and found it acceptable.

The CMRR Project team completed the PrHA, which will be documented in the next revision of the PDSA. CMRR Project personnel performed the activities to which they had committed and completed their review of all the hazard evaluation tables provided in the PDSA, including the PrHA; identified the controls that were credited for protection of the public and workers; correlated each control with its safety functions; identified the functional requirements for each control consistent with the credited safety functions; and documented the results in a new set of tables. New safety-related controls were also identified for several events of concern to the Board. Consequently, a complete set of safety-class and safety-significant controls was identified that will prevent or mitigate all the hazards identified in the hazard evaluation. The Board found this set of safety-related controls to be comprehensive and the identified functional requirements to be adequate for final design of those safety-related controls. The Board has closed this Finding.

As the CMRR design proceeds, the Board will review the updated PDSA for the CMRR Project to verify that these commitments are carried through to the final design.

2.3 SAFETY-CLASS FIRE SUPPRESSION SYSTEM

2.3.1 Topic Description

The fire suppression system has been designated as safety-class. This will be the first fire suppression system built as safety-class at a new facility in the DOE complex. The safety-class fire suppression system needs to remain operable and perform its intended safety functions following design basis accidents in order to protect the public. The establishment of appropriate design requirements relates directly to the credited safety function of the safety-class fire suppression system.

In addressing the safety-class fire suppression system, the certification review focused on the following:

- A comprehensive set of design requirements, along with a system design implementing those requirements, must be established.
- The PDSA must adequately identify the system's safety functions, functional requirements, design parameters, and design requirements.
- The Preliminary Fire Hazard Analysis (PFHA) must be technically adequate.
- The design documents, including system design descriptions, must contain the PDSA requirements and incorporate sound engineering principles and appropriate design standards to ensure that the system will remain operable and perform its intended function.

2.3.2 Topic Evaluation

The Board reviewed the CMRR Project's PFHA, supporting documentation and drawings, and the PDSA. The attributes of the safety-class design of the automatic sprinkler systems are appropriate at this preliminary design stage. The preliminary designs meet or exceed the draft interim guidance DOE is currently preparing in response to the Board's Recommendation 2008-1, *Safety Classification of Fire Protection Systems*. Additional equipment details and an enhanced system design description for the fire protection system are anticipated during final design.

The PFHA is appropriate for the current preliminary stage of project design. Appropriate design standards have been referenced and are adequately applied in the design documents. Preliminary hydraulic calculations supporting the sizing of the fire water tanks, the fire pumps, and the larger distribution piping are technically defensible.

The PFHA identifies a set of safety-related fire protection structures, systems, and components, as well as defense-in-depth safety controls. These systems will provide the preventive and mitigative functions necessary to limit exposure of the public and collocated workers to radioactive and other hazardous materials.

The PFHA evaluates the ongoing design of several fire protection features, including the Material Transfer System Tunnel, which passes through rated fire walls; the glovebox heat detectors; the dry chemical fire suppression system for atmospheric gloveboxes; alternative fire suppression systems for atmospheric gloveboxes and hoods; smoke control and exhaust systems; and the safety-class fire sprinkler system. These evaluations are all technically defensible for this stage of design.

The final design of all safety-related fire protection design features will be evaluated by a panel of fire protection subject matter experts, including the design engineers, project consultants, and site contractors. The currently defined panel has appropriate expertise and resources. The Board will continue to follow the peer review and evaluations of design details as they are developed.

The Board identified a number of inconsistencies between the PFHA and the PDSA: some controls identified in the PFHA as safety-related were not addressed in the PDSA; events analyzed in one document as credible were dismissed in the other; and the PDSA relied on questionable, unsubstantiated computer fire models, while the PFHA used a more deterministic approach. NNSA acknowledged these inconsistencies and stated that their resolution will be documented in the next revisions of the PFHA and PDSA. This response is acceptable.

The Board concludes that the preliminary design of the safety-class fire suppression system incorporates sound engineering principles and appropriate design standards. The PFHA is adequate for this stage of the design effort. The Board will monitor the development of the safety-class fire suppression system to verify the implementation of the specified attributes and standards into the final design. The final design of the safety-class fire suppression system must demonstrate that this system will remain operable and perform its intended safety functions during normal and abnormal environmental and design basis events in order to protect the public, and workers.

2.4 SAFETY-SIGNIFICANT ACTIVE VENTILATION SYSTEM

2.4.1 Topic Description

The safety-significant active ventilation system needs to remain operable and perform its intended safety functions following design basis accidents, including earthquakes. The establishment of appropriate design requirements relates directly to the credited safety function of the safety-significant active ventilation system.

In addressing the safety-significant active ventilation system, the certification review focused on the following:

- A comprehensive set of design requirements for the safety-significant ventilation system, along with a system design implementing those requirements, must be established.

- The PDSA must adequately identify the system's safety functions, functional requirements, design parameters, and design requirements.

- The design documents, including system design descriptions, must contain the PDSA requirements and incorporate sound engineering principles to ensure that the system will remain operable and perform its intended function.

2.4.2 Topic Evaluation

The Board reviewed the safety-significant active ventilation system to verify that the safety controls in the PDSA were appropriately identified and to ensure that the system's safety functions and functional requirements were reflected in the design.

Early in preliminary design, CMRR Project personnel took the position that the active ventilation system did not need to remain operable following a design basis earthquake. The project was relying on passive confinement to mitigate a release of radioactive material due to a design basis earthquake. The Board did not agree that this reliance on passive confinement after a design basis earthquake was adequate to protect collocated workers. Subsequently, CMRR Project personnel committed to designing the safety-significant active ventilation system so as to ensure its operability following a design basis earthquake. The project's safety strategy was developed to be consistent with this approach.

The Board's review of the CMRR safety strategy revealed that CMRR Project personnel were concerned about the magnitude of the in-structure seismic design ground motions within the CMRR Nuclear Facility. This concern pertained to the project's ability to seismically qualify safety-related systems and components that perform an active safety function. As discussed in Sections 2.1.2.2 and 2.1.4, the structural response of the Nuclear Facility to vertical design basis ground motions led to the concern that vertical accelerations are at or above the upper limit of those for which rotating equipment can be economically seismically qualified.

The Board's review of the PDSA revealed that the ventilation system provides both passive and active safety-significant functions. The passive function is to maintain the facility contamination boundary with qualified duct work, high efficiency particulate air (HEPA) filters, and bubble tight dampers on the air intake plenums. The active safety function is to maintain pressure differentials between ventilation zones and ensure that air is exhausted from the facility through credited HEPA filters during normal operations and following design basis accidents. The majority of the safety functions and functional requirements were adequately developed.

The Board's review of the incorporation of the PDSA requirements into the design included a review of the system design descriptions, process flow diagrams, process and instrumentation diagrams and the preliminary system balance and sizing calculations. While many of the PDSA requirements were reflected in the system design descriptions, they were not always appropriately designated as safety-related. CMRR Project personnel have agreed to revise the system design descriptions to be consistent with the PDSA requirements.

The Board reviewed the process flow diagrams and process and instrumentation diagrams for the Nuclear Facility's ventilation systems with a safety function. The system boundaries for the Security Category 1 portion of the Nuclear Facility adequately identified the safety boundaries of the systems. The piping drawings will need to be updated to clearly define those portions of the system that are safety-related. The Board's review of the system design descriptions for the ventilation system and facility design criteria revealed that the appropriate DOE directives and consensus standards had been incorporated into the design requirements.

The Board reviewed flow balance and pressure drop calculations for the Nuclear Facility's ventilation systems. The models adequately evaluate flow balance and pressure drop for the facility in both normal operation and reduced-flow modes. The Board concludes that the preliminary design for the safety-significant active ventilation system is sufficiently mature to proceed to final design.

2.5 SAFETY-CLASS CONTAINER DESIGN

2.5.1 Topic Description

The current safety strategy for the Nuclear Facility relies on container design to prevent the release of large fractions of the material-at-risk. Containers that will be used in the Long-Term Storage Vault have been designated as safety-class; other containers used for protecting material-at-risk have been designated as safety-significant. These safety-class containers need to remain operable and perform their intended safety functions following design basis accidents. Definitive design requirements and expectations for both types of containers had not been established. In the Long-Term Storage Vault, thermal design requirements for a given geometry and specifications for spacing constraints have not been established.

In addressing the safety-class containers, the certification review focused on the following:

- The PDSA must appropriately specify containers as hazard controls following design basis accidents.
- The PDSA safety functions and functional requirements for safety-class containers must be adequately defined. The functional requirements must be bounded by the environmental limitations established in DOE standards.

2.5.2 Topic Evaluation

The Board reviewed the CMRR Project's functional requirements for the safety-class Long-Term Storage Vault containers as described in the CMRR PDSA. The PDSA specified a functional requirement that the containers must prevent the release of material given a loss-of-cooling accident. CMRR Project personnel analyzed the vault environment assuming a loss of cooling to quantify the maximum temperature to which the safety-class containers would be exposed. The Board's review revealed that the thermal environment of the vault was not adequately defined. It was unclear whether additional safety-class controls to mitigate the consequences of a loss-of-cooling accident were needed. It was possible that safety-related cooling of the Long-Term Storage Vault would be necessary—a significant design change.

The Board identified concerns regarding the validity of the heat transfer model used to assess the thermal environment of the vault. The primary concern was related to the approach used for determining the maximum temperatures of the containers in a single storage cell. The model was developed in a two-dimensional coordinate system with the origin at one side of the cell. The actual physical situation should be represented by a three-dimensional cylindrical coordinate system with the axis of symmetry located at the centerline of the can. To account for the heat generation from a three-dimensional source in a two-dimensional coordinate system model, CMRR Project personnel scaled the heat generation rate of the two-dimensional model by matching concrete temperatures to those from a full three-dimensional model. No technical justification for this scaling was provided.

To address the Board's concerns, the CMRR Project team took the following actions to update the assessment of the thermal environment of the vault given a loss of cooling:

1. Performed a storage container temperature evaluation to determine the maximum surface temperatures of the storage containers during a loss-of-cooling event.

2. Performed a concrete structure temperature evaluation to determine an effective maximum temperature for the concrete structure during a loss-of-cooling event and evaluate the acceptability of that temperature with regard to concrete strength.

3. Performed a vault room bulk airspace temperature evaluation to determine the maximum bulk temperature experienced by equipment or components in the vault rooms above the storage matrix.

The Board reviewed subsequent preliminary design calculations performed to address the thermal environment of the Long-Term Storage Vault. These calculations demonstrated that containers designed to DOE Standard 3013-2004, *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials,* would adequately resist the thermal conditions of the vault. This provides assurance that CMRR has containers that will not fail during a loss-of-cooling event. The calculations also show that typical equipment and components can be designed for the ambient temperature of the vault.

The CMRR Project team will formally revise its vault heat transfer calculations to incorporate these results of the preliminary calculations. The Board will review the revised calculations as they become available. The CMRR Project has yet to develop a system design description for the Long-Term Storage Vault containers. Project personnel agreed to add the functional requirements for the vault's containers to specify compliance with an approved DOE standard for long-term storage of special nuclear materials (similar to DOE Standard 3013-2004). The ambient conditions of the vault will need to be specified as functional requirements consistent with the thermal conditions.

The Board concludes that there is now sufficient understanding of the thermal environment of the Long-Term Storage Vault to support not having safety-related forced cooling. The Board will continue to review the final design of the Long-Term Storage Vault and safety-related container design to verify implementation of the stated requirements and design approaches.

2.6 SAFETY-SIGNIFICANT ELECTRICAL DISTRIBUTION SYSTEM

2.6.1 Topic Description

The safety-significant electrical distribution system (EDS) supports the safety-significant active ventilation system and must remain operable and perform its intended safety functions following design basis accidents. The establishment of appropriate design requirements relates directly to the reliable performance of the credited safety function of the safety-significant EDS.

In addressing the safety-significant EDS, the certification review focused on the following:

- A comprehensive set of design requirements for the safety-significant EDS, along with a system design implementing those requirements, must be established.
- The PDSA must adequately identify the system's safety functions, functional requirements, design parameters, and design requirements.
- The design documents, including system design descriptions, must contain the PDSA requirements and incorporate sound engineering principles to ensure that the system will remain operable and perform its intended function.

2.6.2 Topic Evaluation

The safety-significant EDS provides a source of backup power upon loss of normal power for critical systems and components such as the active confinement ventilation system. The safety-significant EDS include diesel generators to provide backup power for these critical systems and components. The Board reviewed the latest one-line drawings for the EDS and concluded that the sizing for the safety-significant diesel generators is adequate for transient conditions, such as starting all the required loads using a load sequencer. The Board noted that these diesel generators will be seismically qualified and designed.

The EDS is currently configured so that the safety-significant switchgear can provide backup power to non-safety switchgear. Supplying power to non-safety loads from the safety-significant switchgear is not desirable because doing so can degrade the reliability of the safety-significant EDS. CMRR Project personnel agreed to delete the connection between the safety-significant and non-safety switchgears.

The safety-significant uninterruptible power supply (UPS) system provides reliable, conditioned, and limited-capacity uninterrupted alternating-current electrical power. The UPS system powers the sensitive electronic equipment, control equipment, egress lighting, communications, and other devices that would need power during a loss of offsite power. The UPS also provides uninterruptible power to the fire detection system, the facility management system, the public address system, the criticality alarm system, and other specified critical safety systems or components. The CMRR Project will seismically qualify and support the UPS.

The Board's review of the safety-significant EDS revealed that it will meet all relevant codes and standards after design modifications that the CMRR Project team has agreed to make (related to deleting the connection between the safety-related and non-safety switchgears) have been made. Preliminary design documents incorporate sound engineering principles and appropriate design standards to ensure that the system will remain operable and perform its intended safety function.

The final design of the safety-significant EDS should demonstrate that this system will remain operable and perform its intended safety function during normal and abnormal environmental and design basis events. The Board will continue to review the final design of the EDS to verify implementation of the stated requirements.

2.7 DESIGN CONTROL PROCESS

2.7.1 Topic Description

Following the Board's certification of CMRR, it will be important that the integration of safety into the design (designation of safety systems, safety functions, and functional requirements and incorporation of these requirements into the system's design) be appropriately maintained throughout the remainder of the design process. Any changes in the established safety strategy will need to be justified and approved at the appropriate project levels. The safety strategy will be maintained through implementation of a design control process.

In addressing the design control process, the certification review focused on the following:

- The CMRR Project must establish and maintain an integrated design from a safety standpoint.
- Project plans and mechanisms to control changes must be established.
- The PDSA and system design descriptions must be consistent.

2.7.2 Topic Evaluation

The Board's CMRR certification review focused on two aspects of the design control process (including change control): (1) whether project procedures and mechanisms properly establish design control, and (2) whether there is evidence that project design control procedures and mechanisms have properly linked requirements from the PDSA to the system design descriptions.

The safety strategy established in the PDSA depends on maintaining control of safety functions, functional requirements, and design criteria through a design control process. The Board reviewed the CMRR Program Requirements Document (PRD), System Engineering Management Plan (SEMP), and Configuration Management Plan (CMP) to determine whether this control has been adequately established.

The CMRR PRD requires that the project develop a SEMP. The SEMP needs to establish a hierarchy of technical documents that demonstrates how requirements flow down and explain how requirements are allocated to structures, systems, and components. The Board's review of the SEMP indicated that the systems engineering process did not include information from the PDSA. As a result, the flowdown of information from the PDSA to the system design descriptions risked being faulty. This in turn could have resulted in incomplete or inadequate design of safety-related systems, or worse, lack of required safety-related systems.

The Board reviewed the CMP for CMRR to understand the project's approach to design control. The CMRR Project team uses a database to establish relationships among functions, requirements, and systems. The CMP indicates that requirements from the PDSA need to be incorporated explicitly into the CMRR database. Based on the Board's review, the design control process did not establish appropriate change control of the PDSA safety envelope—specifically, change control of safety-related structures, systems, and components and their safety functions and functional requirements.

The Board's review revealed that the CMRR Project team had not developed a requirements approach that formally integrated the safety envelope established by the PDSA into the system design descriptions. The SEMP was out of date and did not fulfill the requirements in the PRD. This led to the Board's Finding *Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements*. Resolution of this Finding required that the project recognize deficiencies in the SEMP and CMP, and take steps to establish appropriate procedures and mechanisms to establish and maintain design control.

The Board reviewed the PDSA and several system design descriptions to determine whether safety functions and functional requirements were properly linked between the two sets of documents. This review revealed that:

- The safety functions and functional requirements in the system design descriptions are not consistent with the corresponding information in the PDSA and do not include references back to the PDSA.
- In some cases, functional requirements in the PDSA are identified as safety functions in the system design descriptions.
- Some key functional requirements and performance criteria in the PDSA were not included in the system design descriptions.

The Board's review revealed that the CMRR Project team had not developed a requirements approach that formally integrated the safety envelope established by the PDSA into the system design descriptions. This led to the Board's Finding *System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately*.

2.7.3 Finding: *Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements*

The CMRR Project should not proceed to final design without a design control process that formally integrates the safety envelope into the design. The Board suggested that the CMRR Project team commit to revising the SEMP, CMP, and system design descriptions to explicitly incorporate requirements from the PDSA.

CMRR Project personnel committed to developing a design control process that formally establishes change control for safety-related structures, systems, and components and their safety functions and functional requirements. They committed to revising the SEMP, CMP, and system design descriptions to explicitly incorporate the requirements in the PDSA, agreed that the safety functions and functional requirements should be explicitly listed in the appropriate system design descriptions, and provided a detailed schedule for the completion of these activities. The Board has reviewed this schedule and found it acceptable.

The Board reviewed procedures and plans written to specify a formal design control process related to establishing a technical baseline and controlling changes to that baseline. The procedures and plans being put in place will adequately establish a design control process for CMRR. The Board will verify that the actions committed to are implemented. The Board has closed this Finding.

2.7.4 Finding: *System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately*

The CMRR Project should not proceed to final design until there is explicit flowdown of requirements from the PDSA to system design descriptions. The system design description is the central coordinating link among the engineering design documents, the safety basis (PDSA), and implementing procedures. During design, the system design description serves as the vehicle for collecting and conveying the system requirements and their bases. The CMRR Project system design descriptions need to be revised to incorporate the safety functions and functional requirements in the PDSA. The Board suggested that CMRR Project personnel submit a plan for revising the system design descriptions to ensure consistency with the PDSA, including a schedule for such revisions. This action should ensure that the system design descriptions serve their function of aiding the complete and efficient incorporation of the PDSA requirements into the final design. Revisions to the system design descriptions should be complete prior to final design.

The CMRR Project team has taken steps to ensure that requirements established in the PDSA are properly linked to the system design descriptions. CMRR Project personnel have committed to revising the system design descriptions before the project proceeds to final design. The Board will review the revised system design descriptions as they become available. The Board has closed this Finding.

As the CMRR design proceeds, the Board will review the CMRR Project's revised SEMP, CMP, and updated system design descriptions.

3. EVALUATION OF NNSA'S TECHNICAL INDEPENDENT PROJECT REVIEW

NNSA conducted a T-IPR of the CMRR Nuclear Facility from January 27 through February 4, 2009. The review was conducted by NNSA's Office of Project Management and Systems Support. As documented in the Board's Quarterly Reports to Congress on the Status of Significant Unresolved Issues with DOE's Design and Construction Projects, the Board has evaluated the adequacy of NNSA's T-IPR for CMRR.

NNSA's T-IPR for CMRR was conducted following the direction of NNSA Policy Letter BOP-50.003, *Establishment of a NNSA Independent Project Review Policy.* A CMRR T-IPR Review Plan was prepared. It included 18 Criteria and Review Approach Documents (CRADs) establishing the review objective and criteria for each of the review topics. The CMRR CRADs represent a significant improvement over past nuclear facility T-IPRs. This improvement was the direct result of the involvement of NNSA's Chief of Defense Nuclear Safety. In general, the CMRR T-IPR did not identify new nuclear safety review issues. The CMRR T-IPR did document several significant concerns:

- Incomplete seismic structural design
- Incomplete seismic qualification of mechanical equipment
- Inadequate container safety functions, functional requirements, and performance criteria
- Incomplete resolution of the Los Alamos Site Office's (LASO's) comments on the PDSA
- Inadequate implementation of the configuration management program
- An ineffective risk and opportunity management system

The Board's staff attended the CMRR T-IPR closeout briefing, which summarized these significant concerns.

NNSA's T-IPR review process requires that significant concerns be addressed in Corrective Actions Plans; thus it was important that significant concerns be properly identified. Based on a review of the Final Report of the CMRR T-IPR, a number of review items not identified as significant concerns should have been identified as such. For example, the inconsistency between the PDSA and the system design descriptions was identified as an observation, and inadequacy in integrating safety into the design as part of the SEMP was identified as a significant opportunity. This weakness was alleviated in part by the project's establishment of corrective actions for all significant concerns, opportunities, recommendations, and observations.

While the CMRR T-IPR was technically adequate, the Board identified the following areas for improvement:

- The review plan for the CMRR T-IPR was improved over earlier TIPR's in terms of the CRADs. However, inconsistencies among the CRADs (topic to topic) still remain and should be addressed in future T-IPRs.
- The Final Report of the CMRR T-IPR treats review items inconsistently; a number of review items not identified as significant concerns should have been identified as such. While the Corrective Action Plan addresses all review items in the final report, these items may not be explicitly checked by NNSA's Office of Project Management and Systems Support before the final design proceeds.
- NNSA's Independent Project Review Policy needs to be strengthened to explicitly require the use of review plans for all nuclear facility T-IPRs. The policy should state that review plans must include the identification and use of CRADs tailored to the specific project design stage being reviewed.
- The execution of NNSA's T-IPRs could be improved by the development of a consistent approach to the use of CRADs. This consistency should be documented in appropriate NNSA procedures.
- NNSA needs to improve the way in which T-IPR review items are defined and documented to ensure that all significant concerns are properly identified during future reviews.

The Board believes that NNSA's addressing these areas for improvement will reduce the number of newly-identified safety issues that surface and must be corrected during final design and construction. The Board will review NNSA's actions to improve its T-IPRs.

4. EVALUATION OF NNSA'S PRELIMINARY DOCUMENTED SAFETY ANALYSIS REVIEW AND PRELIMINARY SAFETY VALIDATION REPORT

LASO completed a technical review of the CMRR PDSA. The Board followed the review process from the development of the review plan, to the generation of several rounds of review comments, to the development of the Preliminary Safety Validation Report (PSVR). The Board's staff attended a number of CMRR monthly meetings addressing the development of the CMRR PDSA. A review of LASO's PDSA comments demonstrates that LASO performed a detailed and comprehensive review of the CMRR PDSA. LASO's PSVR provides NNSA approval of the CMRR PDSA with Conditions of Approval (COAs). The PSVR requires that these COAs be resolved and corrected to the satisfaction of NNSA before the CMRR Project enters the final design phase.

LASO's PSVR includes nine COAs that must be resolved before NNSA authorizes proceeding to final design. Several of the COAs are consistent with the Board's Findings. LASO's review comments on earlier versions of the draft PDSA identified similar issues, indicating that NNSA's approach to ensuring that comments on a draft PDSA are adequately resolved needs to be improved. NNSA and LASO must take steps to ensure that issues raised do not remain open, particularly any review issues that can impact the design of safety-related systems.

5. CMRR CERTIFICATION REVIEW CONCLUSIONS

Section 3112 of the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, directs the Board to submit a certification concerning the CMRR Facility at LANL in New Mexico. The legislation requires the Board to certify that concerns raised by the Board regarding the design of CMRR have been resolved by NNSA.

In determining the scope of the CMRR certification review, the Board considered the current project design phase—the end of preliminary design. The Board identified seven topic areas for the certification review, which were the five open Board concerns identified in its quarterly reports to Congress plus two additional areas the Board considered important for the CMRR design process. The seven topic areas were:

1. Site Characterization and Seismic Design
2. Preliminary Documented Safety Analysis and Safety Strategy
3. Safety-Class Fire Suppression System
4. Safety-Significant Active Ventilation System
5. Safety-Class Container Design
6. Safety-Significant Electrical Distribution System
7. Design Control Process

The Board developed a systematic approach to completing the CMRR certification review. As the CMRR certification topics were reviewed, the Board identified concerns with NNSA's resolution of the topics. Those concerns that needed to be resolved prior to CMRR certification were classified as Findings and were transmitted to NNSA. The Board identified the specific concerns and the technical basis for the concerns and suggested resolution and path forward. The CMRR certification review resulted in the following Findings.

- *CMRR Seismic Design*

- *Seismic Design of Active Confinement Ventilation System and Support Systems*

- *Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria*

- *Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements*

- *System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately*

NNSA provided a response to each Finding. The Board reviewed each response and met with NNSA to reach agreement on how each Finding would be resolved. Each of the seven topics and associated Findings are discussed in detail in Section 2 of this report. Appendix A provides a chronology of the Findings Form transmittals and the final Findings Form sent from the Board to NNSA. Based on NNSA's responses and commitments, each of the Findings was closed. As part of this process NNSA has revised or agreed to revise the CMRR preliminary design, design requirements, and design processes to address these concerns as more fully described in this certification report. NNSA has also committed to implement detailed designs during final design consistent with the specific design requirements agreed to as part of this certification process.

The Board's certification relies upon the future full implementation of these final design commitments by NNSA. The Board will continue to review the design progression for implementation by NNSA consistent with these commitments. The Board will reopen issues if commitments, as described in this certification report, are not properly met during final design.

Relying upon NNSA's full implementation of commitments made by NNSA concerning safety-related processes, structures, systems, and components, as described in this certification report, with regard to: (1) preliminary design including design requirements and design processes, and (2) final design including development of design requirements into final design elements, the Board certifies that its concerns regarding the design of the CMRR have been resolved.

APPENDIX A – DNFSB Findings and NNSA Response

Listed below is a chronology of the correspondences between the Board and NNSA related to each of the CMRR Findings. This is followed by a copy of the final letter from the Board's staff closing each Finding along with the final Findings Form.

Finding – Site Characterization and Seismic Design: CMRR Seismic Design Issues

Transmitted from DNFSB to NNSA – January 16, 2009
Initial Response from NNSA to DNFSB – March 3, 2009
Final Response from NNSA to DNFSB – August 14, 2009
DNFSB Closure to NNSA – August 26, 2009

Finding – Safety-Significant Active Ventilation System: Seismic Design of Active Confinement Ventilation System and Support Systems

Transmitted from DNFSB to NNSA – January 16, 2009
Initial Response from NNSA to DNFSB – March 3, 2009
Final Response from NNSA to DNFSB – August 14, 2009
DNFSB Closure to NNSA – August 26, 2009

Finding – Design Control: Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements

Transmitted from DNFSB to NNSA – March 4, 2009
Response from NNSA to DNFSB – April 21, 2009
DNFSB Closure to NNSA – July 10, 2009

Finding – *Preliminary Documented Safety Analysis and Safety Strategy: Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria*

Transmitted from DNFSB to NNSA – March 16, 2009
Initial Response from NNSA to DNFSB – April 21, 2009
Final Response from NNSA to DNFSB – August 14, 2009
DNFSB Closure to NNSA – August 26, 2009

Finding – *Design Control: System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately*

Transmitted from DNFSB to NNSA – March 30, 2009
Response from NNSA to DNFSB – April 21, 2009
DNFSB Closure to NNSA – July 10, 2009

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
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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

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

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
(202) 694-7000

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 the 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 2, Safety-Significant Active Ventilation System—Seismic Design of Active Confinement Ventilation System and Support Systems, was transmitted to your office on January 16, 2009. NNSA provided an initial response to Finding 2 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 2 can be considered closed. Enclosed is the completed Findings Form that includes the Board's Final Resolution to Finding 2. Should you have any questions regarding this matter, please contact me at (202) 694-7128.

Sincerely,

Roy E. Kasdorf

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: 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 called 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: 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 supplement responses from the CMRR Project to each of the 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 committed to seismically design 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 completed. The update of PSHA motions determined that PC-3 design response spectra now has a peak horizontal ground acceleration of 0.43g, with a peak horizontal spectral acceleration of 0.84g, and a peak vertical ground acceleration of 0.47, with a peak vertical spectral acceleration of 1.33g. The Board's staff determined that reductions in PC-3 horizontal and vertical seismic design ground motions are technically supportable.

The CMRR Project performed an independent evaluation of seismic equipment qualification. The engineering firm that completed this evaluation has significant experience in nuclear facility seismic equipment qualification, including high seismic regions such as California. The independent evaluation concluded that there is a high degree of confidence that safety-related equipment for the CMRR facility can be seismically qualified. The Board's staff has reviewed the independent evaluation of seismic equipment qualification and agrees with the conclusion that the uncertainty in seismic equipment qualification has been adequately addressed. As the CMRR project proceeds into final design, development of detailed seismic qualification plans for safety-related equipment should be prepared.

Finding #2 is considered closed.

DNFSB: Roy E. Kasdorf 8/25/09 Roy Kasdorf Date	NNSA: NNSA response signed by Gerald L. Talbot, Jr., NA-17 Date: August 14, 2009

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
(202) 694-7000

July 10, 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's) 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 the 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 # 3, Design Control - Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements, was transmitted to your office on March 4, 2009. NNSA provided a response to this Finding on April 21, 2009. The Board's staff has evaluated that response and has determined that Finding # 3 can be considered closed. Enclosed is the completed Findings Form that includes the Board's Final Resolution to Finding # 3. Should you have any questions regarding this matter, please contact me at (202) 694-7128.

Sincerely,

Roy E. Kasdorf

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: Design Control
Finding Title: Documenting and Maintaining Preliminary Documented Safety Analysis Safety-Related Functions and Requirements
Finding: The overall approach to establishing and maintaining functional and operational requirements can be found in the following CMRR documents: (1) CMRR Program Requirements Document (PRD) (CMRR-PLAN-PM-0101, Rev. 0) January 2009, (2) CMRR Functional and Operational Requirements (F&OR) (CMRR-PLAN-ENG-2801, Rev. 0) January 2009, (3) CMRR Systems Engineering Management Plan (SEMP) (CMRR-PLAN-1905, Rev. 0) September 2007, (4) CMRR Configuration Management Plan (CMP) (CMRR-PLAN-ENG-0301, Rev. 0) December 2008, and (5) CMRR Facility Design Description (FDD) (CMRR-FDD-001, Rev. 0B) January 2009. Review of these documents indicates that requirements generated through the safety basis development process are not adequately and explicitly integrated into the overall approach to Design Control. The Preliminary Documented Safety Analysis (PDSA) is the fundamental document that identifies safety-class (SC) and safety-significant (SS) structures, systems, and components (SSCs). Once identified, the PDSA establishes an appropriate set of safety functions (see PDSA Table 3-37), and for each safety function a set of functional requirements and performance criteria are established (see PDSA Chapter 4). The safety envelope for CMRR depends on maintaining control of these functions, requirements, and criteria. Review of the PRD, F&OR, SEMP, CMP, and FDD indicates that this control has not been established. The PRD requires that CMRR develop a SEMP, and that the SEMP (1) establishes the hierarchy of technical documents and demonstrates how requirements are flowed down, (2) explains how requirements are allocated down to SSCs, and (3) that commits to crosswalk the safety case for SSCs with the design features. As noted above, the PDSA establishes the safety case. Review of the SEMP indicates that the systems engineering process does not include information generated from the PDSA. The SEMP describes an approach that can be labeled "a classic project management approach" (top-down derivation of functions and requirements), silent on the overall roll and preeminence of requirements generated from the PDSA. The CMRR F&OR is consistent with the PRD, largely silent on requirements generated from the PDSA. The F&OR does include a requirement (R.0.7.m) that "Prior to Title I design of the CMRR, facility design features pertaining to meeting safety, security, and quality assurance criteria shall be identified and tracked as part of the project's technical baseline." It is not clear that the project has met this functional requirement. The CMRR CMP establishes the overall approach to design control, using the CORE database to establish relationships between functions, requirements, and systems. The CMP indicates that requirements from the PDSA should be explicitly incorporated in the CORE database. However, review of the CMRR FDD suggests that key safety terms such as "safety functions" and "functional requirements" may not be consistent with how this terminology is intended in the PDSA. Review of the FDD design requirements indicates that the basis for these requirements is "code/standard" driven; the link and integration from the PDSA is missing. Given this, integration between the PDSA and System Design Descriptions (SDDs) is questioned.

The CMRR CMP also establishes the overall approach to change control. It is not clear how the change control process establishes appropriate change control of the PDSA safety envelope, specifically change control of SC and SS SSCs, and their safety functions and functional requirements. The change control process should include the appropriate level of control for critical safety-related decisions (note that the Safety Validation Report is how NNSA formally accepts the safety envelope).

Ultimately, SDDs have been developed for each CMRR structure and system. The content of SDDs is described in DOE-STD-3024; the intent of this standard is that SDDs should contain requirements that are derived from the PDSA. This requires that terminology (safety functions and functional requirements) between the PDSA and SDD be consistent to ensure that the safety envelope is properly translated into design requirements, and properly maintained throughout design and operation.

In conclusion, the CMRR project has not developed a requirements approach that formally integrates the safety envelope established by the PDSA. The SEMP is out-of-date and does not fulfill the requirements from the PRD. The CMRR FDD introduces terminology that results in inconsistency with the PDSA. As a result, there is lack of confidence that the FDD and SDDs will properly capture requirements from the PDSA.

Basis for Finding: (1) 10 CFR Part 830.122 (f) (2) Incorporate applicable requirements and design bases in design work and design changes.

(2) DOE Order 413.3A (5)(a) Requirements set forth in this Order are established to ensure adherence to the following principles: (2) Sound disciplined up-from planning, (4) Well-defined and managed performance baseline, and (5) Effective project management systems.

(3) DOE Order 413.3A (5)(i)(3) Change control ensure that project changes are identified, evaluated, coordinated, controlled, reviewed, approved/disapproved, and documented in a manner that best serves the project.

(4) DOE Standard 3024 The SDD is the central coordinating link among the engineering design documents, the facility authorization basis, and implementing procedures. The SDD should contain requirements that are derived from the associated safety analysis.

Suggested Resolution or Path Forward: The CMRR project needs to commit to revising the SEMP, CMP, and SDDs to explicitly incorporate requirements from the PDSA. The PDSA safety functions and functional requirements should be explicitly listed in the applicable SDDs. The CMRR project needs to develop a change control process that formally establishes an appropriate level of change control on SSC safety functions and functional requirements to maintain the safety envelope. Schedules for these revisions should be developed as part of the NNSA response.

NNSA Response: The NNSA is committed to revising the SEMP, CMP, and SDDs to explicitly incorporate the requirements from the PDSA. We agree that the safety functions and functional requirements should be explicitly listed in the appropriate SDDs. A detailed schedule for the completion of these activities (along with the remainder of the work to address the NNSA COAs contained in the PSVR (RO)) is in the attached document. The update of the plans and implementing procedures is included within COA-6.

To address the long term consistency of the safety function and functional requirements within the PDSA and the SDDs, these elements

will be included in the CORE database and reports for all of the documentation generated from CORE. This includes the PDSA and the SDDs. This is not intended to take the ownership of these descriptions from the safety basis team, but to place them into a common place for configuration control. The details of the schedule to accomplish this explicit conformance are included in the COA-6 portion of the schedule.
DNFSB Final Resolution: The CMRR project committed to revising the SEMP and CMP to explicitly incorporate the requirements from the PDSA. This commitment should ensure that PDSA safety functions, functional requirements, and performance criteria are properly integrated into the SDDs. The CMRR project provided a detailed schedule for the completion of these activities. The Board's staff has reviewed this schedule and found it acceptable. The CMRR project committed to develop a formal change control process. The Board's staff reviewed several CMRR procedures and plans written to establish a formal change control process related to establishing a technical baseline and controlling technical changes to that baseline. The processes being put in place adequately establish a change control process. The CMRR commitment to revising the SEMP and CMP, and establishing changes control procedures and plans results in Finding #3 being closed.

DNFSB: Roy E. Kasdorf 7/10/2009 Roy Kasdorf Date	NNSA: NNSA Response Signed by James McConnell, Acting NA-17 Date: April 21, 2009

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
(202) 694-7000

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 4, PDSA and Safety Strategy—Inadequate Identification of Safety-Related Controls, Functional Requirements, and Performance Criteria, was transmitted to your office on March 16, 2009. NNSA provided an initial response to Finding 4 on April 21, 2009, and a final response on August 14, 2009. The Board's staff has evaluated the NNSA response and has determined that Finding 4 can be considered closed. Enclosed is the completed Finding Form that includes the Board's Final Resolution to Finding 4. Should you have any questions regarding this matter, please contact me at (202) 694-7128.

Sincerely,

Roy E. Kasdorf

Roy E. Kasdorf
Nuclear Facility Design and
Infrastructure Group Lead

Enclosure

c: Mr. Mike Thompson
Mr. James McConnell

Board Findings

Chemistry and Metallurgy Research Replacement Facility: Congressional Certification Review

Topic: PDSA and Safety Strategy

Finding Title: Inadequate Identification of Safety-related Controls, Functional Requirements, and Performance Criteria

Finding:

The Hazard Analysis (HA) section of the Preliminary Documented Safety Analysis (PDSA) is to identify the spectrum of hazards potentially posed by the operations, and identify an adequate set of controls to protect the public and the workers. This HA has been documented in Appendix 3B of the PDSA. It appears to be relatively comprehensive for this stage of the PDSA (the project has made a commitment to perform a process HA for the next revision of the PDSA). Appendix 3B highlights (in blue) the "safety-related" controls that are needed to protect the public or the workers from significant consequences.

Section 3.4 of the PDSA quantitatively evaluates the unmitigated consequences of major accidents from the HA, and identifies the "safety-class" (SC) controls for events potentially exceeding 5 rem Total Effective Dose Equivalent (TEDE) at the site boundary. The quantitative analysis should also evaluate the unmitigated consequences to the Collocated Workers (CLW) at 100 meters for comparison with the DOE criterion. This evaluation is not presented in this PDSA (the project has committed to provide that information in the next revision to the PDSA). Chapter 4 of the PDSA collectively lists all the safety-related controls (i.e., safety-significant (SS) structure, systems, and components (SSC) from Appendix 3B and safety-class SSCs from Section 3.4), and identifies functional requirements (FR) and performance criteria to ensure that the controls meet their intended functions.

The following deficiencies have been identified (the Attachment to this Finding provides examples for demonstration purposes only, and by no means is expected to be an all inclusive list: Note attachment provided on March 16, 2009):

(1) The set of safety-class and safety-significant controls identified in the PDSA have not been demonstrated that they will ensure adequate protection of the public and the workers.

(2) The functional requirements and performance criteria identified for safety-related controls in Chapter 4 of the PDSA do not support the credit given to them in the Chapter 3 analysis.

Basis for Finding:

10 CFR 830, 202(b): "(4) Prepare a documented safety analysis for the facility; and (5) Establish the hazard controls upon which the contractor will rely to ensure adequate protection of workers, the public, and the environment."

10 CFR 830, 204(b)(4): "Derive the hazard controls necessary to ensure adequate protection..., demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards."

10 CFR 830, G.3: "Safety structures, systems, and component require formal definition of minimum acceptable performance in the documented safety analysis...by first defining a safety function...then placing functional requirements."

DOE O 420.1B, 3.a.(1): "(a) Safety analyses must be used to establish the identity and function of safety class and safety significant SSCs, and (b) the significance to safety of functions performed by safety class and safety significant SSCs."

Suggested Resolution or Path Forward:

- **Pre-certification:** The project must (1) submit a process plan for addressing the PDSA deficiencies, and (2) prepare a document that briefly, but thoroughly and comprehensively, describes all safety-class and safety-significant controls and their support systems that envelope the identified events in the PDSA, including its Appendix 3B. This document should also identify the functional requirements for all those SSCs, along with their performance categorization, to ensure appropriate credit can be given to them in the hazard or accident analysis. This document should be placed in a configuration control system as this document will be part of the Board's certification.

  The process plan should include commitment to:

  - Revise Chapter 2 to describe safety-related SSCs and their support systems as portrayed in the SDDs and credited in the PDSA.
  - Revise Chapter 3 to include the process HA and CLW dose calculations, identify any new controls from these analyses, and implement/incorporate Board specific comments.
  - Revise Chapter 4 to capture all SS and SC controls from Chapter 3 and Appendix 3B including their support SSCs, and clearly identify the FR for all those SSCs along with their performance categorization to demonstrate the credit given to them in the hazard and accident analyses.
- **Post-certification:** Within 6 months of the certification, the PDSA must be revised to (1) address the identified deficiencies, (2) implement the results of the Process hazards analysis, (3) evaluate unmitigated dose consequences to the collocated workers, (4) Incorporate the above list, as well as any new safety-related SSCs from the process HA and the CLW dose calculations, and their corresponding performance criteria and system evaluations, and (5) notification of any deviation from the above document of safety SSCs.

NNSA Response: An initial NNSA response was provided on April 21, 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: CMRR Project personnel developed a plan for addressing the deficiencies identified by the Board. The plan would systematically and comprehensively identify the credited controls in the hazard analysis, including the functional requirements for those controls, in a table that will be used to prepare the next revision of the PDSA. The Board reviewed this approach and found it acceptable.

Subsequently, project personnel performed the activities committed to and completed its review of all the potential hazards. Project personnel identified the controls that were credited for protection of the public and workers; correlated the controls with its safety functions; identified the functional requirements for those controls consistent with its credited safety functions; and documented the results in a new set of tables for review by the Board. New safety-related controls were also identified for several events of concern to the Board.

The Board's staff reviewed the new set of tables and provided detailed comments on July 7, 24, and 30, 2009. The project addressed each of these comments by email, committing to modify the tables as needed. The Board's staff comment on the operations center was not addressed, pending discussion with NNSA and LANL management. The Board's staff agrees that resolution of this comment can be deferred to after CMRR Certification; but the personnel in the Operations Center must be adequately appropriately protected from hazards including hazards from adjacent facilities.

Given the above, the Board's staff concludes that a complete set of safety-class and safety-significant controls was identified that will prevent or mitigate all the hazards identified in the hazard evaluation. The Board's staff found this set of safety-related controls to be comprehensive and the identified functional requirements to be adequate for final design of those safety-related controls.

These actions result in Finding 4 being closed.

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

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
(202) 694-7000

July 10, 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's) 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 the 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 #5, Design Control - System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately, was transmitted to your office on March 30, 2009. NNSA provided a response to this Finding on April 21, 2009. The Board's staff has evaluated that response and has determined that Finding # 5 can be considered closed. Enclosed is the completed Findings Form that includes the Board's Final Resolution to Finding #5. 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: Design Control

Finding Title: System Design Descriptions Do Not Incorporate Preliminary Documented Safety Analysis Requirements Adequately

Finding: The Board CMRR certification review is evaluating the adequacy of the flow down of requirements from the Preliminary Documented Safety Analysis (PDSA) to the System Design Descriptions (SDDs). This includes SDD consistency with the PDSA and with DOE-STD-3024-98, *Content of System Design Descriptions*. The Board previously identified a Finding related to how the CMRR project documents and maintains design control of PDSA safety-related functions and requirements.

As stated in the introduction to DOE-STD-3024, "The SDD is a central coordinating link among the engineering design documents, the facility authorization basis, and implementing procedures." "Accordingly, the development of the SDD must be coordinated with the engineering design process and with the safety analysis development." It is critical that there is traceability between safety functions, functional requirements, performance criteria, and design requirements to ensure that the design of all safety-related structures, systems, and components is adequate. Two key attributes of the SDDs have been given in the Basis for Finding.

Review of several SDDs indicate that:

- The SDD safety functions and functional requirements are not consistent with the corresponding information in PDSA and do not have references back to the PDSA.
- In some cases PDSA functional requirements are identified as safety functions in the SDDs.
- In some cases, safety functions are identified in the SDDs that are not identified in the PDSA.
- The PDSA functional requirements and performance criteria are not always included in the SDD.
- The SDD safety requirements are not consistently and explicitly correlated back to the PDSA functional requirements and performance criteria. The requirements are not sorted by importance with PDSA related requirements interspersed with requirements from other sources.
- The bases for the requirements are incomplete, with the PDSA bases behind the requirements not discussed, instead only order or standard bases related to the requirement are given. As a result the importance of the requirements cannot be determined without referencing back to the PDSA contrary to the purpose of the SDDs per DOE-STD-3024.

Attached to this Finding are several examples that document the inconsistencies discussed above. These examples are not intended to be complete, but indicate that systemic PDSA/SDD integration issues exist.

This finding is based on a review of the following SDDs: Nuclear Facility Laboratory Enclosure System (017, Rev 0A), Fire Protection System (019, Rev 0B), Uninterruptible Power Supply System (021, Rev 0B), Engine Generator System (022, Rev 0B), Security Category I Building HVAC System (029, Rev 0B), Security Category I Building (036, Rev 0B), Security Category I Vault Building (037, Rev0B), Instrument Air and Compressed Air System (045, Rev 0H), Facility Management System (048, Rev 0B), Fuel Oil System (059, Rev 0A), Electrical Power

System (062, Rev 0B), Electrical Distribution System (063, Rev 0B).

Basis for Finding: DOE-STD 3024-98, *Content of System Design Descriptions.* Section 2.1, "Statements of safety functions in the SDD shall be consistent with the corresponding information in the facility authorization basis and specific references to the authorization basis documents shall be provided." Section 3 "The safety requirements statements shall be consistent with, and be explicitly correlated back to, the corresponding statements of functional requirements and performance criteria in the facility FSAR, TSRs/OSRs, and other authorization basis documents."

Suggested Resolution or Path Forward:

- **Pre-Certification:** The project must submit a plan for revising the SDDs to ensure consistency with the PDSA, including a schedule for SDD revisions. SDD revisions should be complete prior to award of the Final Design contract.
- **Post-Certification:** Revise the System Design Descriptions to identify PDSA safety functions, functional requirements, and performance criteria in accordance with DOE-STD-3024 to ensure the SDDs serve their function in aiding the complete and efficient incorporation of the PDSA requirements into the final design.

NNSA Response: The response is similar to that submitted for finding #3. The NNSA agrees that the safety functions and functional requirements should be explicitly listed in the appropriate SDDs. A detailed schedule for the completion of these activities (along with the remainder of the work to address the NNSA COAs contained in the PSVR (RO)) is in the attached document.

To address the long term consistency of the safety function and functional requirements within the PDSA and the SDDs, these elements will be included in the CORE database and reports for all of the documentation generated from CORE. This includes the PDSA and the SDDs. This is not intended to take the ownership of these descriptions from the safety basis team, but to place them into a common place for configuration control. The details of the schedule to accomplish this explicit conformance are included in the COA-6 portion of the schedule.

The approach also will address the commitments under the response to Finding #4.

DNFSB Final Resolution: The CMRR Project has taken steps to ensure that requirements established in the PDSA are properly linked in SDDs. The CMRR Project has committed to revising SDDs prior to the project proceeding into Final Design. The Board's staff will review the revised SDDs as they become available.

The CMRR commitment to revising SDDs to be consistent with the PDSA resulted in Finding #5 being closed.

DNFSB: Roy E. Kasdorf (signature) 7/10/09 Roy Kasdorf Date	NNSA: NNSA Response Signed by James McConnell, Acting NA-17 Date: April 21, 2009

APPENDIX B – Future DNFSB CMRR Review Activities

As CMRR design proceeds, the Board will continue to review the development of the safety basis and design products such as calculations, drawings, specifications, and system design descriptions. Based on the current CMRR schedule, the following review activities represent the near-term focus of the Board's review.

1. LANL Long-term Seismic Hazard Program Plan.
2. CMRR Project detailed assessment of impact of revised foundation approach including the ground motions and how seismic analysis models will account for this modified layer.
3. CMRR Project detailed three dimensional structural model for structural analysis and design.
4. CMRR Project seismic design process check.
5. CMRR Project updated soil-structure interaction analysis.
6. CMRR Project Seismic Qualification Plan for Safety-Related Equipment.
7. CMRR Project updated Preliminary Documented Safety Analysis.
8. CMRR Project final design of the safety-class fire suppression system.
9. CMRR Project final design of the safety-significant active ventilation system.
10. CMRR Project determination that cascading differential pressures between ventilation zones, including the vault, is maintained under reduced flow conditions.
11. CMRR Project revised vault heat transfer calculations.
12. CMRR Project final design of the safety-significant electrical distribution system.
13. CMRR Project revised Systems Engineering Management Plan.
14. CMRR Project revised Configuration Management Plan.
15. CMRR Project updated system design descriptions for safety-related systems.
16. NNSA actions to improve Technical-Independent Project Reviews.

GLOSSARY OF ACRONYMS

Board	Defense Nuclear Facilities Safety Board
CMRR	Chemistry and Metallurgy Research Replacement Project
CMP	Configuration Management Plan
COA	Condition of Approval
CRAD	Criteria and Review Approach Document
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
EDS	Electrical Distribution System
HEPA	High Efficiency Particulate Air
LANL	Los Alamos National Laboratory
LASO	Los Alamos Site Office
NGA	Next Generation Attenuation Models
NNSA	National Nuclear Security Administration
PC	Performance Category
PDSA	Preliminary Documented Safety Analysis
PFHA	Preliminary Fire Hazard Analysis
PFS	Pajarito Fault System
PRD	Program Requirements Document
PrHA	Process Hazard Analysis
PSHA	Probabilistic Seismic Hazard Analysis
PSVR	Preliminary Safety Validation Report
SEMP	Systems Engineering Management Plan
T-IPR	Technical Independent Project Review
UPS	Uninterruptible Power Supply