DEFENSE NUCLEAR FACILITIES SAFETY BOARD

November 4, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: J. Blackman

SUBJECT: Los Alamos National Laboratory (LANL) - Review of Chemistry and Metallurgy Research (CMR) Facility Hot Cell Upgrades and the Fire Resistant Pit (FRP) Test Program

1. **Purpose:** This trip report documents a Defense Nuclear Facilities Safety Board (DNFSB) technical staff and outside experts' review of hot cell upgrades being installed in Wing 9 of the CMR at LANL. These upgrades are being performed to support the FRP Test Program. This review was performed by staff members J. Blackman, A. Hadjian, A. Jordan, C. Keilers and R. Zavadoski and by outside experts W. Hall, J. Stevenson and N. Vaidya on August 24-25, 1994.

2. **Summary:** The DNFSB staff believes that both the process by which the CMR Wing 9 Seismic Upgrade Project has been implemented and the technical execution are not technically satisfactory. Fundamentally, the project has not been conceived and implemented based on a thorough understanding of the potential hazards posed by the FRP experiment or other future CMR missions. It is uncertain that the project will achieve its stated objective, containing hazardous materials in the hot cells, unless these and other planned building structural and ventilation upgrades are designed and installed in a technically adequate manner.

3. **Background:** CMR is a large, 550,000 square foot facility, primarily used for analytical chemistry, chemistry research, and actinide metallurgy. Most of CMR was built in 1952. The Department of Energy (DOE) and LANL have recognized that CMR needed to be either upgraded or replaced; current plans are to upgrade the facility to extend its life.

   In 1993, LANL contracted with Merrick & Company (Merrick) to design structural and ventilation system upgrades that will ensure hazardous material confinement within the building envelope following a design-basis event. EQE International (EQE) is assisting Merrick in this effort. Ventilation system upgrades, including a new standby electrical system, are also planned as part of a multiphase upgrade program. The Wing 9 Seismic Upgrade Project, however, is being funded and implemented separately from the CMR Upgrade Project.

4. **Discussion:** LANL briefed the DNFSB staff on the planned fire resistant pit experiments and conducted a tour of Wing 9. Merrick and EQE then described the hot cell seismic upgrades to be installed in support of the experiments and the other building seismic upgrades now in conceptual design.

The DNFSB staff believes that while the hot cell upgrades being installed will improve the seismic resistance of Wing 9, the upgrades as currently conceived are not adequate to satisfactorily mitigate potential hazards posed by the FRP experiment. Modifications to the safety-related structures, systems and components (SSC), necessary to minimize and mitigate the consequences of an accident, such as the ventilation system, need to be evaluated before the FRP experiments can begin. Detailed comments are provided below:

a. Design Process:

1. According to DOE Order 5480.23, a "Safety Analysis means a documented process: (1) to provide systematic identification of hazards within a given DOE operation; (2) to describe and analyze the adequacy of measures taken to eliminate, control, or mitigate identified hazards; and (3) to analyze and evaluate potential accidents and their associated risks." It is clear that the "graded safety analysis report" that LANL has subcontracted was not being used as DOE Order 5480.23 requires.

   LANL is still reviewing a draft "graded" safety analysis report (SAR) on the experiments and does not plan to complete the review and submit it to DOE before December 1994. However, the hot cell seismic upgrades have already been developed, and designed, and are being installed before the hazards, potential accident consequences, and possible accident mitigation systems involved with the FRP experiments are established. For example, it is unclear whether the seismic performance goals chosen are appropriate or how they could be chosen before first identifying the hazards and consequences.

   The DNFSB staff has not had an opportunity to review the graded SAR. However, based on the potential consequences of an unmitigated radionuclide release during an accident, consideration of the use of more stringent seismic performance goals than those currently selected may be prudent. Such goals would consider the full range of future mission hazards and the anticipated extension of the CMR service life, possibly another 20 years. At the very least, the hazards need to be understood to validate the current choice of performance goals.

2. Based on discussions with LANL regarding responsibilities and accountability, it is unclear who at LANL is responsible and accountable for assuring that the hot cell seismic upgrades will perform their stated functions. Other than budgetary responsibility, LANL management responsibility for these upgrades is diffuse.

3. The design review process used by LANL to review the hot cell seismic upgrade design was weak and ineffective. Based on DNFSB staff review and discussions with LANL during the presentations concerning the technical substance of a design review, the DNFSB staff observed that the comments generated by LANL personnel were essentially non-technical in nature. They did not focus on whether or not the facility

upgrade was adequate to prevent initiation of collapse mechanisms, as well as minimize and mitigate the FRP hazards and consequences. In particular, the comments of the LANL seismic reviewer merely requested that the comments previously prepared by the DOE reviewer be resolved. This suggests that LANL has not provided technical oversight of its contractors.

4. Technical inconsistencies exist between what is actually being done in the CMR building upgrade design[1] and what is described in program documents[2], and also between key program documents themselves. Furthermore, the quality assurance requirements imposed on Merrick and EQE for these upgrades are not adequately specified in program documents. Reference to DOE Order 5700.6C, Quality Assurance is not sufficient to specify implementing requirements for a quality assurance program.

5. The furnace that will be used to heat the pit has been procured and has been installed in a mockup. When questioned as to what codes and standards were used in the design and fabrication of the furnace, LANL could not immediately identify any. It was merely suggested that the codes and standards that the manufacturer normally used might be sufficient.

b. Structural Upgrade Evaluation: The stated function of the hot cell seismic upgrades is to contain the material within the hot cells after a design basis event. However, numerous technical issues discussed below suggest that this design objective may not be achieved due to potential deficiencies in the evaluation. Detailed concerns are as follows:

1. The upgrades currently being installed will only remedy deficiencies of the hot cell support structure. Other identified structural deficiencies in Wing 9 will not be remedied until Phase II, which has not been funded, is complete. Therefore, the FRP experiments are planned to proceed without remediation of other known structural deficiencies. While representatives from the design contractor stated that the other structural deficiencies will not affect the integrity of the hot cell, the validity of this conclusion is not apparent, since the lateral resistance of the hot cell support system is dependent on the integrity of the adjoining structural components.

2. The seismic evaluation of Wing 9 was performed assuming that the structure is fixed at the foundation elevation. Soil-structure interaction analysis has not been included based on the assumption that its effect on the building is minimal. In attempting to

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[1] Merrick & Company and EQE Engineering Consultants, "Project Criteria and Procedures - CMR Facility Seismic/Wind Upgrade - Los Alamos National Laboratory," February 25, 1994.

[2] Merrick & Company and EQE Engineering Consultants, "Project Plan - CMR Facility Seismic/Wind Upgrade - Los Alamos National Laboratory," February 25, 1994.

validate this assumption, an approximate analysis was performed that only included horizontal motion effects--rocking and vertical motion were not included. Since horizontal and rocking modes are usually coupled, neglecting rocking is not demonstrably conservative.

Furthermore, since certain parameters of rocking and horizontal stiffnesses and damping values are functions of different powers of a characteristic dimension of the foundation, the assumption that the actual footing geometry is equivalent to one large foundation is erroneous. Characteristic parameters of rocking and translation stiffness and damping would be larger or smaller when considering the actual footing geometry.

3. Wing 9 of the CMR Building consists of two structures, Lot 1 and 2, separated by a three inch isolation joint that extends for the entire height of the building sections. The structures have been modeled as two separate entities, and potential interaction effects, such as pounding, have not been considered. Examination of the joint revealed that the filler material is a wood fiber that can be easily deformed with a pocket knife. However, it has been the experience of the DNFSB staff that at high strains, similar materials begin to exhibit high stiffness. If, during a seismic event, the lateral displacements of Lots 1 and 2 were to be sufficient to compress the joint filler material to high strain levels, significant interaction between Lots 1 and 2 might occur.

4. It is not apparent that the margins of safety reported during the presentation are valid. The hot cell seismic upgrades, as well as all of the CMR facility structural upgrades, are based on conformance with a combination of provisions from various codes and standards (i.e., using ACI-349 load combinations with ACI-318 or Uniform Building Code (UBC-91) capacities). If only one of the referenced codes were used to evaluate design margins, then the consistency of the results would be established. However, since this approach could not be followed, it is not obvious that the mix of various code provisions forms a consistent bases for margin evaluation. Therefore, the DNFSB staff believes that it is prudent for knowledgeable individuals, thoroughly familiar with the three codes used, evaluate the consistency of the code provisions used in this design upgrade to insure that valid margins of safety result.

c. <u>Safety System Upgrade Evaluation:</u>

1. The ventilation system that serves CMR, including the Wing 9 hot cells, is not designed for design accident conditions. For example, there is no emergency power for the ventilation systems, including those in Wing 9. The DNFSB staff believes that any systematic engineering approach to mitigate the FRP experiment and other mission hazards, must consider the necessary role played by the ventilation system in hazardous material confinement in design basis accident scenarios.

2. The structural evaluation of the building does not include the effect of possible severing of distribution systems that span from lot to lot, nor does it account for potential loss of safety systems, such as ventilation, that are needed to ensure hazardous material confinement. Since the building and essential safety systems may not withstand a severe earthquake[3], the hot cell upgrades may not be able to perform their intended function due to these neglected interaction effects.

5. **Future Planned Activities:** The DNFSB staff and its outside experts intend to review the graded SAR for the FRP experiments when it becomes available to determine if the seismic performance goals have been appropriately chosen. The staff will also closely follow progress of the CMR structural upgrade project.

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[3] Merrick & Company and EQE Engineering Consultants, "Project Plan - CMR Facility Seismic/Wind Upgrade - Los Alamos National Laboratory," February 25, 1994, pp 38.