

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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MEMORANDUM: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: A. H. Hadjian

SUBJECT: Ground Motion Issues at Los Alamos National Laboratory

1. **Purpose:** This report documents Defense Nuclear Facilities Safety Board (DNFSB) staff and outside experts evaluation of the July 18 and 19, 1994 final peer review meeting on the "Seismic Hazards Evaluation of Los Alamos National Laboratory" by Woodward-Clyde Federal Services (WCFS). The meeting was held at Los Alamos, New Mexico. DNFSB staff members A. Hadjian and A. Jordan, and outside experts Paul C. Rizzo and Peter J. Hutchinson, attended this meeting. Also attending the meeting, in addition to WCFS project staff with their consultants and the external peer review panel, were representatives of the Department of Energy (DOE), Los Alamos National Laboratory (LANL) and Sandia National Laboratory.
2. **Summary:** The LANL seismic hazard studies are planned to be completed by the end of September 1994. However, significant modifications made to the initial logic trees, the work that is needed to complete the report and the intense discussions during the peer review meeting of July 18 and 19, 1994, raise serious doubts whether the seismic hazard at LANL facilities could be adequately performed by the end of September. The main difficulties are: the logic trees have become extremely cumbersome; the seismogenic characteristics of the Pajarito fault are not well understood; fault rupture displacements need to be estimated close to or under critical facilities; and the effect of topography on ground motion at the top of the mesas requires a more appropriate treatment.
3. **Background:** The objective of the WCFS Seismic Hazard studies was to develop hazard curves for several of the Technical Areas at LANL using state-of-the-art assessment methodologies. It should be noted that there are no DOE Standards to develop hazard curves; and the profession is just beginning to sort out the several ground motion assessment methodologies. Following issuance of the Draft Final Report "Seismic Hazards Evaluation of the Los Alamos National Laboratory" Vols. I & II on June 1, 1993, two peer review panels held separate discussions on August 31 and September 1, 1993; and September 28 and 29, 1993, on seismic source and ground motion characterizations, respectively. Significant deficiencies and shortcomings in the WCFS report were highlighted during these meetings. Subsequently, WCFS was tasked to finalize its report by the end of September 1994. The primary purpose, therefore, of the July 18 and 19, 1994, peer review meeting was to discuss the latest modifications made to the logic trees before the final computer computations are made or the generation of the LANL seismic hazard curves.
4. **Discussion/Observations:** Compared to the earlier version, the latest logic trees are extremely complicated and hence cumbersome and confusing to work with. Moreover,

the weights assigned to the different branches do not reflect the best judgment of the analysts. Throughout the meeting, WCFS was looking to the review panel members to provide this information instead of presenting their preferences of the alternatives and defending those positions. For example, given the tectonic environment, assigning the same weights to nonintersecting and intersecting models of the Pajarito fault with the Rentage Canyon and Guaje Mountain faults indicates indecision. Additionally, WCFS was unable to document the slip rate, timing, and magnitude of the Pajarito fault, which would dominate the Design Basis Earthquake.

Even though another meeting with the peer review panel was scheduled to be held before the report is finalized, DNFSB staff and outside experts seriously doubt that the work that is needed to complete the report could be adequately performed by the end of September to characterize the seismic hazard at LANL facilities. These difficulties are primarily due to the lack of standards in this field and the fact that the state-of-the-art in ground motion assessment is in the developmental stage. Therefore, the following observations are based on the professional judgment of the DNFSB staff and the Board's outside experts. In addition to the logic tree complexity, the following technical issues need to be adequately resolved:

- a. No detailed Quaternary geologic map exists for the entire LANL site. Such a map would serve as the primary basis for identifying and characterizing potentially capable faults.
- b. The seismogenic characteristics of the Pajarito fault may have to be better understood in order that arguments regarding the level of conservatism that would otherwise be required in the design ground motions would be minimal.
- c. The mesas on which LANL facilities are located tend to amplify ground motions. The work done to-date on the estimation of the topographic effects on ground motion at the mesas is inadequate. Simple available solutions have been discarded in favor of untested new solutions.
- d. No work has been performed regarding the potential for fault rupture displacements under or near critical facilities, considering that both the Rendija Canyon and Guaje Mountain faults lie within the LANL boundaries. These surface ruptures could be very detrimental to the integrity of structures.
- e. To complete the seismic hazard evaluation at LANL, volcanism related issues, such as evidence of late Pleistocene to recent volcanism, need to be addressed.
- f. The present method of approximating the probabilities of *continuous* variables by probabilities of discrete variables, which are then used in the logic tree, is an issue that would impact adversely the accuracy of the results. The distributions of the continuous variables must first be determined consensually, then discretized in a manner which preserves information on the relevant tail of the distributions.
- g. A technical reconciliation between the probabilistic and deterministic ground

motion estimates is deemed desirable before the design/evaluation basis ground motion criteria for facilities is finalized.

- h. Design basis ground motion and site soil properties need to be uniformly correlated among the several facilities now being considered for potential structural upgrades.
5. **Future Staff Actions:** Significant changes were introduced in the parameters of the seismic hazard estimation model, which were not all endorsed at this meeting by the peer review panel and DOE. The staff and outside experts of DNFSB will review the final report, scheduled for the end of September 1994.