DEFENSE NUCLEAR FACILITIES SAFETY BOARD

August 22, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: C. H. Keilers

SUBJECT: Idaho National Engineering Laboratory - Structural and Seismic Review of CPP-666 Spent Fuel Storage Basins

1. **Purpose:** This report documents the status of on-going reviews by the Defense Nuclear Facilities Safety Board (DNFSB) staff and outside experts of structural/seismic evaluations for reracking the Chemical Processing Plant (CPP)-666 spent fuel storage basins at Idaho National Engineering Laboratory (INEL). The DNFSB staff will separately report the status of a concurrent series of structural reviews of the CPP-603 basins.

2. **Summary:** The DNFSB staff and outside experts consider that the proposed reracking of some CPP-666 pools to increase fuel loading *may* be found to be structurally acceptable; however, this is difficult to determine from the structural/seismic evaluations provided. Significant uncertainty exists in the evaluation conclusions because of some of the assumptions made and the methods applied and because of inadequate documentation. The Department of Energy (DOE) contractor is initiating efforts to improve the evaluations.

   Even if the current evaluations were conclusive, they are limited in scope. Since this facility will be used for decades for interim spent fuel storage, the DNFSB staff believes there will be a need for a comprehensive evaluation that addresses the structural adequacy of all CPP-666 safety-related structures, systems, and components. The DNFSB staff also believes that this evaluation would reasonably extend beyond the areas affected by reracking and would consider updated ground motion and other extreme loading events (both natural and man-made).

3. **Background:** CPP-666 was constructed in 1984 and is DOE's newest wet storage facility for spent fuel. It consists of stainless steel-lined concrete basins enclosed by a concrete shear wall superstructure with a cast-in-place roof supported by precast, prestressed girders. CPP-666 receives fuel from many sources, including naval reactors and CPP-603.

   Westinghouse Idaho Nuclear Co. (WINCO) contracted Advanced Engineering Consultants (AEC) to evaluate the structural adequacy of the CPP-666 spent fuel storage pools with proposed new fuel racks. The new racks are still being designed and could eventually permit quadrupling the amount of fuel stored in some pools. Since 1991, the DNFSB staff and outside experts have been reviewing progress on the AEC evaluations. The most recent review was

performed on June 6-7, 1994 by DNFSB staff members A. Hadjian and C. Keilers, and by outside experts J. Haltiwanger and J. Stevenson.

4. **Discussion:** DOE, WINCO, and AEC briefed the DNFSB staff and outside experts on the purpose of the analyses for the CPP-666 basins, as well as on the models, load combinations, geotechnical evaluations, and final analysis and evaluation results[1]. Also, a team from EQE International (EQE) provided a briefing on their independent review of AEC's evaluations[2].

   WINCO stated that the primary purposes of AEC's evaluations were to determine the facility's ability to accommodate additional fuel loading from reracking and to develop seismic inputs for the rack designer. The basins are being evaluated as "Performance Category 4" for natural phenomena hazards[3]. This is the highest performance category, which was selected to be consistent with the facility's original design basis. AEC did not evaluate parts of the facility assumed to be unaffected by reracking.

   EQE independently reviewed AEC's reports and performed appropriate analyses by alternate methods. EQE stated that their comments have since been resolved. EQE did not challenge fundamental assumptions and evaluation parameters in the reports, such as the ground motion in the site's Architectural Engineering Standard. EQE concluded that, given the evaluation basis, AEC's analyses were acceptable, that the new rack seismic inputs are conservative, and that the basin structure with full and loaded pools is adequate.

   Observations: The DNFSB staff and outside experts believe that the basins *may* be found to be adequate for increased fuel loading, but it is difficult to determine from the evaluation documents provided. As discussed below, significant uncertainty exists in the evaluation conclusions because of some of the assumptions made and the methods applied and because of inadequate documentation. WINCO and AEC have initiated efforts to improve the evaluations.

   Even if the current evaluations were conclusive, they are limited in scope. Since this facility will be used for decades for interim spent fuel storage, the DNFSB staff believes that there will be a need for a comprehensive evaluation that addresses the structural adequacy of all CPP-666 safety-related structures, systems, and components. The DNFSB staff also believes that this

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[1] Advanced Engineering Consultants, "Structural Capacity Evaluation of the ICPP-666 FAST Facility Fuel Storage Area, Volumes 1-3, April 1994.

[2] EQE International, "Independent Review of Seismic/Wind and Structural Analysis for the FSARR Project," April 1994.

[3] DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*, January 1993.

evaluation would reasonably extend beyond the areas affected by reracking, and would consider updated ground motion and other extreme loading events (both natural and man-made).

Some general deficiencies in the current evaluations and documentation, together with specific examples, are as follows:

a. The reports include few physical interpretations of the analytical results. For example, few structural deformation plots are provided. Such interpretations would facilitate reasonability checks. No explanation is given for why it takes 75 modes below 19 Hz to capture half the mass participation for a fixed base structure (EQE's explanation for this was unsatisfactory, and the question remains unanswered). Earthquake induced soil pressures from the computer code SASSI are used, but they were not compared to those of the applicable standard (ASCE 4-86) and were not validated as being adequate. The artificial seismic acceleration time histories generated were not compared to available records from the 1983 Borah Peak earthquake.

b. The sensitivity of parameter variations is not adequately explored in the reports. For example, the effect of using uncracked and cracked concrete material properties in different analyses is not examined. The consequence of assuming dry instead of saturated soil conditions in seismic analyses was not determined. The adequacy or effect of using SASSI predicted loads when most of the mass participation occurs at frequencies above the SASSI cutoff frequency was not confirmed. The sensitivity of assuming rack attachment to the basin floor, when actually the racks will be permitted to slide, was not evaluated.

c. The reports are not specific enough on some of the procedures and acceptance criteria used. For example, not all the live loads in the cited standard (ASCE 7-88) were actually used in the analyses. The analyses were also strictly linear elastic with no correction for ductility; this is conservative but inconsistent with the cited standard (UCRL-15910). Furthermore, the reports do not specify how the demand and capacity values cited were determined. Subsequently, AEC stated that they would document six representative examples of their demand and capacity calculations, which still have not been received by the DNFSB staff.

d. The effects of other accident or off-normal conditions were not fully evaluated. For example, extreme loading events other than earthquakes or high winds, such as realistic missile impact, aircraft crash, malevolent vehicle effects, or accidental explosion, were not evaluated. A lower bound design basis tornado may also be appropriate (i.e., a Fujita Class 2 with 159 mph winds).

   As another example, the seismic adequacy of having a flooded pool without fuel next to one loaded with fuel was evaluated implicitly but may warrant an explicit evaluation.

Explicit seismic evaluations of a dry basin next to a flooded and loaded basin indicated that a plastic hinge could develop in the separating wall (WINCO plans to procedurally control dry basin activities to avoid this). Explicitly confirming that similar behavior will not occur for a flooded basin without fuel next to one loaded with fuel would be desirable. For these analyses and the dry basin analyses, the maximum allowable strain criteria in the rebar and in the stainless steel basin liner may need to be revised to ensure the basins not only retain structural integrity but also remain leak-tight (e.g., consider ACI-359 criteria for joint rotations and liner strains).

5. **Future Planned Activities:** As information becomes available, the DNFSB staff and outside experts intend to review updated CPP-666 structural/seismic evaluations, capacity and demand computational examples, the new rack designs, and any subsequent comprehensive evaluations of safety-related structures, systems and components.