DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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October 21, 1994

Mr. Mark Whitaker, EH-6
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Whitaker:

Enclosed for your information and distribution are 24 Defense Nuclear Facilities Safety Board (DNFSB) staff reports. The reports have been placed in the DNFSB Public Reading Room.

Sincerely,

George W. Cunningham
Technical Director

Enclosures (24)

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

March 8, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: J. Blackman
A. Hadjian
C. Keilers

SUBJECT: Hanford K Basins Structural and Seismic Review

1. **Purpose:** This trip report documents a Defense Nuclear Facilities Safety Board (DNFSB) technical staff review of structural and seismic analyses, as well as material condition of the K-East and West basins at Hanford. This review was performed by J. Blackman, A. Hadjian, and C. Keilers on February 8-10, 1994.

2. **Summary:** Irradiated fuel in the K-West basin is stored in closed containers and is in unknown material condition. Irradiated fuel in the K-East basin is stored in open containers and has significantly corroded. In both basins, the fuel is stored under 16 feet of water. Each basin consists of a discharge chute area and three bays, all below grade with reinforced concrete walls and covered by a steel frame building. The chute is separated from an adjoining reactor building by an unreinforced expansion joint that is sealed by rubber water stops. The rubber water stops are now about forty years old and in unknown condition.

   In the event of a design basis earthquake, the basin and adjoining reactor building will move relative to one another. The DNFSB staff believes that the magnitude of this differential motion is difficult to accurately predict, thus raising the concern that the joint will open and rupture the seal, and thereby permit basin water to leak out and migrate to the Columbia River. Based on a DNFSB staff assessment of the existing structural analyses, a large differential movement in the chute area is suggested, leading to a possible rapid loss of basin water. If this were to occur, Westinghouse Hanford Company (WHC) would add make-up water from various sources. However, the process of adding water would result in additional sludge becoming suspended and being flushed out of the basin into the surrounding ground. As more water is added, basin leakage could continue to wash contamination through the soil toward the river. Furthermore, if the fuel were to become uncovered, the increased radiation levels and high contamination and airborne activity levels would present significant safety issues and complicate recovery operations.

3. **Background:** The K-West and K-East reactors and associated basins at Hanford were constructed in the early 1950's. The reactors operated until the early 1970's when both reactors were shutdown and all irradiated fuel was removed from the basins. The K-East and K-West basins were then modified to hold N Reactor fuel and returned to service in June 1975 and February 1981, respectively.

   The K-East and K-West basins are nearly identical. The key structural differences are:

   - K-West is epoxy-lined while K-East is lined only in the chute area;
   - K-West basin walls are tapered (27 inches thick at the base tapering to 18 inches at the top of the wall) while K-East basin walls have a uniform thickness (27 inches);
   - K-West roof has been upgraded while K-East roof is unmodified; and
   - K-West soil is more compact and apparently composed of more competent material than is K-East soil.

   Because the irradiated fuel in the K-East basin is stored in open canisters and is corroding, WHC is planning to encapsulate the fuel in sealed stainless steel containers, starting in June 1994. The encapsulation operations are to be done in the basin chute since this provides a convenient open area with low radiation levels in which to work.

4. **Discussion:** The DNFSB staff toured both K-East and K-West basins, reviewed reports documenting seismic analyses, and discussed the analyses in detail with DOE and WHC. Key DNFSB staff observations are:

   a. The basin chute area is locally separated from the reactor building by an unreinforced expansion joint. The joint is sealed by internal forty year old rubber water stops of unknown material condition. In the last decade, epoxy-based repairs have been made to the joint where it is exposed in order to prevent detectable basin leakage. The DNFSB staff is concerned with the seismic adequacy of the joint and the rubber seal.

   b. WHC has performed structural analyses to evaluate the adequacy of the reactor building, fuel basin, and adjacent structures to various natural hazard phenomena. The results of these analyses have also been used to compute the magnitude of the differential displacement between the reactor building and the basin chute area. Values of approximately 0.2 to 0.75 inches were reported. The DNFSB staff reviewed the models and technical approaches used to compute this differential displacement and believes that these values may be unrealistically low, based on inadequate modeling and material property assumptions. Follow-on WHC analyses predict leak rates from 200 to 2000 gallons per minute (gpm), depending on soil permeability, for a 0.75 inch joint displacement. For the maximum leak rate (2000 gpm), it is assumed that a cavity exist behind the joint.

c. WHC recognized the possibility of joint leakage at least two years ago and planned to fill the chute with concrete to resolve this concern. However, this has been postponed by the encapsulation operation, planned to start in the chute in June 1994. WHC now intends to resolve the joint concern after encapsulation is completed in FY 96. The DNFSB staff believes that reducing or eliminating the possibility of joint leakage ~~should proceed~~ in parallel with the encapsulation operation would be desirable.

d. The DNFSB staff considers that several assumptions made in the basin substructure seismic analyses increase uncertainty in the predicted joint motion and the overall seismic capacity of the basin. Examples are:

   1. The substructure model permits incompatible motions in the joint area by allowing the basin substructure and reactor foundation to pass through each other, ignoring any contact.

   2. Key analyses rely on a two dimensional model to capture three dimensional dynamic soil-structure interaction effects.

   3. The three dimensional analyses that were performed assume the chute area is filled with concrete, as previously planned but never accomplished. Analysis of the existing condition was not performed.

   4. The number of finite element degrees of freedom used in basin substructure 3D model may have been insufficient to realistically capture the basin behavior.

   5. Assumed soil properties may not have bounded worst case conditions, since high soil variations exist in the area, even between the K-West and K-East basin.

e. The basin roof and superstructure are interconnected to the reactor building by vertical columns. The DNFSB staff believes that these columns would be a weak structural link during an earthquake since the reactor building can move relative to the basin and thereby significantly increase the dynamic load on the columns. Furthermore, the WHC superstructure model did not include this effect since the basin and reactor building were not coupled.

f. The Make-up Water Service System is not a "safety class" system and therefore cannot be relied on to function following a design basis earthquake. The K Area has fire trucks that could pump water from the river to the basin; however, it is not clear to the DNFSB staff whether the flow rate capacity is sufficient to keep the basin filled or whether such capacity would even be available.

An existing service water system can add water to the basin from nearby underground storage basins - "the clearwells" - at the rate of 1500 gpm until the clearwells are drained. Service water can also be supplied from the N Area at about 150 gpm. The DNFSB staff believes that these systems may not function after an earthquake, since the safety class of both of these service water systems is lower than for the basin.

g. The K-East basin contains 10 million Curies of fission products and actinides, according to the DOE "Notice of Construction for the 105 KE Encapsulation Activity," dated March 1993. The K-West basin activity is probably comparable. For the K-East basin only, this includes 0.7 million Curies estimated to be in the sludge.

   If the K-East basin were to leak, The DNFSB staff is concerned that part of the sludge radioactivity could be mixed with the make-up water, flushed out of the basin into the ground, and eventually washed through the soil to the Columbia River, causing significant safety and environmental hazards. Furthermore, if the basin were to completely drain, the high radiation levels above the basin from 10 MCi will also present significant safety issues and complicate recovery operations.

5. **Future Staff Actions:** The DNFSB staff plans to perform a more in-depth structural review of the K basins and intends to closely follow DOE/WHC actions for resolving the seismic concerns at the basins.