DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004
(202) 208-6400

January 27, 1994

The Honorable Thomas P. Grumbly
Assistant Secretary for Environmental
Restoration and Waste Management
Department of Energy
Washington, D.C. 20585

Dear Mr. Grumbly:

Enclosed for your consideration and action, where appropriate, are a number of observations contained in a trip report concerning environmental and safety review aspects of the storage of spent fuel at the Hanford K-Basins. These observations were developed by members of the Defense Nuclear Facilities Safety Board (Board) staff, and were based on reviews of available documents and discussions with Department of Energy (DOE) staff and contractor personnel at Hanford on November 16-18, 1993. Subsequent to that review, in November 1993, the DOE Office of Environment, Safety, and Health issued the Spent Fuel Working Group Report on the inventory and storage of DOE's spent nuclear fuel. That report indicated that the K-East Basin was among those "with most significant vulnerabilities." The report also advised that "the encapsulation plan warranted management attention to ensure that dose to workers is minimized and that contingencies are reviewed."

Based on the observations in these two reports, and pursuant to 42 USC § 2286b(d), the Board requests that DOE provide a report describing the activities to be used to stabilize the degraded spent fuel stored in the K-East Basin at Hanford and a systematic engineering evaluation of these activities. This report should discuss: 1) the engineering alternatives, if any, that were considered in arriving at the planned encapsulating approach; 2) the criteria used in making the selection; 3) such additional systems engineering studies planned to assure that the actions required to address the fuel corrosion problem in K-East Basin will maintain both the exposure of personnel to ionizing radiation and radioactive material, and the release of radionuclides to the environment, as low as is reasonably achievable; and 4) anticipated radiation doses and dose commitment from the proposed operation.

The Board requests the report be submitted within 60 days of receiving this letter. If you need further information, please let me know.

Sincerely,

John T. Conway
Chairman

c: The Honorable Tara O'Toole, EH-1
The Honorable Victor H. Reis, DP-1
Ms. Jill Lytle, EM-30
Mr. Mark Whitaker, Acting EH-6

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

January 12, 1994

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: D. Burnfield

SUBJECT: Review of K-Basins at Hanford

1. **Purpose:** This memorandum documents the Defense Nuclear Facilities Safety Board (DNFSB) technical staff trip to the Hanford Site to review the K-Basins. The review was conducted during November 16-18, 1993 by F. Bamdad, D. Burnfield and M. Helfrich.

2. **Summary:** The following observations were noted during the tour of the K-East Basin and discussions with site personnel:

   a. A systematic, integrated engineering approach has not been used in the development of plans for the disposition of the spent fuel currently stored in the K-Basins.

   b. There appears to be a lack of involvement by DOE's Richland Operations Office (DOE-RL). DOE-RL relies on a contractor to provide leadership and oversight at these facilities.

   c. In addition, the DNFSB staff believes that the leak detection system in combination with the groundwater monitoring program is insufficient to adequately detect and track potential basin leaks. Based on the concentrations of radionuclides found in the monitoring wells adjacent to the basin, the DNFSB believes that the basins may be leaking radioactively contaminated water to the environment at an undetermined flow rate (<2000 liters per day).

   d. Expended ion exchange modules are buried as low level waste although they contain resins which are highly contaminated with transuranic elements. The modules are large concrete containers which have steel piping attached. The resin is not being stabilized by adding adsorbent, grout or other similar material.

Commercial burial grounds would require similar resins to be stabilized and buried in high integrity containers.

3. **Discussion:** Discussions between the Westinghouse Hanford Company (WHC) staff and the DNFSB staff resulted in the DNFSB staff making four significant observations as noted above. Additional discussion is contained in Attachment 1.

   a. Systems Engineering Approach: The WHC staff agreed that an integrated systems engineering approach had not been used to develop the plan of action for the disposition of the seriously corroded fuel stored in the K-Basins. The fuel in the K-East Basin is known to be seriously corroded while the fuel in the K-West Basin has not been evaluated for several years. A new WHC management team was recently assigned to these facilities. In discussions with the DNFSB staff, this team stated that an engineering review of basin operations has recently been performed, but did not reflect a true systems engineering analysis of the processes.

   In this area, it was noted that the safety analysis report, as modified to review the proposed fuel encapsulation, does not adequately address worker health and safety or the release of radionuclides to the environment during planned operations.

   b. DOE Technical Vigilance: There appears to be minimal DOE-RL attention to the K-Basin issues. For example, the K-Area does not currently have a full time DOE employee acting as the Facility Representative, although a Facility Representative was assigned in the past. The Facility Representative position has been effectively vacant for several months and has been assigned to a DOE contractor. In a recent review, the Office of Nuclear Safety (EH-10) indicated that neither DOE-RL nor WHC fully understood the potential problems associated with these facilities. A new hire has been selected to fill the Facility Representative role and will be on board soon; however, the technical training planned for this individual consists only of the standard training provided to the operators of the facility. No additional technical training, such as is provided to Facility Representatives at other facilities (e.g., Rocky Flats), is planned for this individual.

   A safety evaluation report was prepared by WHC to review potential problems with the re-encapsulation of the fuel. DOE-RL provided no technical review of this report.

   c. Basin Leakage: The DNFSB staff believes the basin may be leaking radionuclides to the environment and that such a leak would not necessarily be detected by the leak detection system or detected and tracked by the groundwater program at the 100-K area.

   The minimum leak detection sensitivity of the equipment at the basin is approximately 2000 liters per day. With the current isotopic concentrations present

in the basin water (large variances have been noted in the past) one might expect a potential release rate of approximately $2x10^4$ μCi/day of strontium-90, cesium-137, and tritium, and $2x10^2$ μCi/day of plutonium isotopes. In addition, other isotopes (such as antimony-125) are present in the basin water in smaller concentrations. (By comparison, the activity in the basin water at the ICPP 603 facility at Idaho National Engineering Laboratory is much less, with a total activity of approximately $6x10^5$ μCi.)

Seven groundwater monitoring wells have been installed around the K-East basin. Tritium, carbon-14, and antimony-125 are present in monitoring wells down-gradient of the facility. Tritium levels in two of the wells are in excess of the EPA drinking water standard. Although the carbon-14, and to a certain extent the tritium, may be attributed to other nearby sources, an alternative source for the antimony can not be identified.

Overall, the groundwater monitoring program has never been able to identify conclusively the sources of the contaminants found in the wells and therefore would not be able to detect and track releases from the basin. Additionally, it should be noted that tritium has been observed seeping into the Columbia River, although it is not evident that this tritium is coming from the basins and where is no clear indicator of its source.

d. Filtration Systems: The K-East Basin has two filtration systems; one system passes the basin water through a large sand filter and two ion exchange modules. Although these modules become loaded with high concentrations of transuranic materials, they are able to be buried as low level waste because the calculation for the concentration of transuranic wastes allows the weight of the concrete module containers to be included as a part of the waste matrix. The resin is not stabilized by the addition of adsorbents or grout. Commercial burial grounds (e.g., Barnwell) would require the resin to be stabilized and to be buried in high integrity containers. The DNFSB staff is concerned that the burial of these modules may not meet the standards required for similar material in commercial burial grounds.

4. Future Staff Action: The issues discussed in this report will continue to be followed by the DNFSB staff. The staff considers that future actions will be centered on monitoring the progress in resolving the basin issues.

Additional Supporting Discussion

1. **Tour of the facility:** Facility housekeeping has improved markedly since May 1993, although it is still considered less than satisfactory by WHC.

2. **Meetings with site personnel:** The meetings were divided into three general topic areas: monitoring and surveillance (including air emissions and liquid discharges and leaks), water chemistry of the basin, and safety analyses.

   a. Monitoring and surveillance. Discussions concerning this topic included the basis of the environmental protection program (including modeling) and its results.

      1. The K-East Basin has four roof exhausts, none of which has HEPA filters; composite samples are taken at each of the exhausts. Control of radioactive air emissions is effected through an administrative control on radioactive concentrations in the basin water. This method has been accepted by the State of Washington regulators as compliant with the requirements of 40 CFR Part 61, Subpart H, *National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities.*

      2. There have been at least two leaks from the K-East Basin; one in the late 1970's and one in February 1993. WHC states that the first leak appears to have been fixed as a result of facility action, while the second appears to have stopped on its own. However, leak detection equipment at the basin is only capable of detecting leaks greater than 2000 liters/day, and the facility, using an ultrasonic device, is only capable of locating leaks greater than 3800 liters/day. The state department of health requires Hanford to report leaks in excess of 25 gallons/hr (approximately 2000 liters/day).

      3. There are four groundwater monitoring wells located down-gradient from the K-East Basin; they were installed after the first major leak in 1979. Three additional wells have been installed recently; one monitoring well located up-gradient and two closer to Columbia River. These wells are about 90 feet deep. The water table in that area is 70 to 80 feet below the surface.

         Two of the down-gradient wells (K-27 and K-30), located about 50 feet from the K-East Basin, have shown constant elevated tritium levels of 50,000 to 1,500,000 pCi/liter (drinking water allowable limit is 20,000 pCi/l), which "appear to be the result of relatively low volume leakage." Well K-30, which has the highest levels, showed a gradual increase from 1984 to May 1993, and then declined to about 300,000 pCi/l. Another source for tritium in this well is K-Reactor condensate effluent discharged into a French drain near the basin, which would account for the C-14 levels

found in the well (the basin does not contain significant amounts of C-14); however, other well-water characteristics (particularly the ratio of tritium to C-14, which is higher than expected) indicate that the French drain is not the sole source of tritium in the well. Additionally, antimony (which is an indicator for basin water, as opposed to effluent discharged to the French drain) has been found in Well K-27; the concentration of antimony has been decreasing at the same rate as half-life decay.

b. Water chemistry. Discussions on this topic were focussed on the chemistry of the basin water (including corrosion) and the operation of the sand filter and ion exchange units.

1. The operating safety requirements (OSRs) for the K-East and K-West Basins only contain limits on releases to the environment; they do not specify active control of the radioactive water chemistry (i.e., mitigation as opposed to prevention).

2. A program was established to measure the rate of corrosion in the basin; however, each year the coupons were removed, tested, and replaced with new coupons. Results of these studies have shown that corrosion of new metal has decreased over the last ten years. However, this method of testing does not provide a good representation of how material that was previously in the basin is performing.

3. Knowledge of the water chemistry is based on the current basin conditions; there does not appear to be any understanding of the impact of encapsulation, which will dramatically increase the concentration of radioisotopes in the basin water and will therefore impact the operation of the water treatment units (sand filters, ion exchange columns and modules).

4. Waste generated as a result of the operation of the ion exchange columns has been classified as transuranic (TRU) waste, while waste generated from the operation of the ion exchange modules has been classified as low-level waste, a similar if not identical operation. This difference in classification appears to be based solely on the weight of the ion exchange module (a concrete monolith), which has been factored in to reduce the calculated curie per gram ratio below the level used to differentiate between low-level and TRU wastes. If this classification is challenged and reversed, then modules which have been stored as category 3 (retrievable) low-level waste will have to be retrieved and repackaged as TRU waste.

c. Safety analyses. In addition to introductory discussions on the status of the safety analysis report for the basins and unresolved safety questions (USQs) associated with basin operations, issues associated with the sequence of fuel movements and the design review of the encapsulation process were also discussed.

1. The approved Safety Analysis Report (SAR) for the Basins was written in 1975; a Safety Evaluation Report was written for the encapsulation process to supplement the SAR, and it concluded that the SAR bounds this process. The Basins have been categorized as a High Hazard Facility, however, the required implementation plan for DOE Order 5480.23, *Nuclear Safety Analysis Reports*, has not been approved. Current plans are to take the old spent fuel that is stored mostly in open bottom canisters, move it to a working table under water, dump the fuel on the table, scoop the relatively degraded fuel into new canisters, seal them and store the canisters back in the original open canister positions in the pool. There does not appear to be a program in place for dealing with the sludge in the pool (12 to 16 inches deep), or for long-term handling of the fuel. The decay heat from the fuel stored in the basin is only about 65 kW; and it appears that considerations should be given to dry storage of this severely degraded fuel and the cleanup of the potentially leaking pool. DOE-RL stated that encapsulation of the fuel is planned to reduce further fuel degradation and contamination of the water. However, DOE does not seem to have a plan for dealing with this issue on a long-term basis.

2. WHC stated that the sequence of fuel movements is being revised based on accountability and ALARA concerns. The major objective of the revisions is to better secure fuel and to minimize sludge generation, since sludge containment technology is not currently fully developed.

3. An independent review of the encapsulation process was recently commissioned by the WHC basin management and, although not yet issued formally, draft issues deal with the generation of TRU waste, technology for dealing with the sludge, and the method of removing fuel from the open containers (i.e., dumping the contents on the table). Recommendations will probably include redefinition of the objectives for encapsulation, expansion of ALARA considerations, and consideration of the impact of the change in water quality on the consequences of accidents or earthquakes.

4. There appear to be several issues related to criticality concerns in the K-East Basin. The old spent fuel from the Single Pass Reactor, which may have had higher enrichment than the fuel from the N-Reactor, is apparently also stored in K-East Basin with minimal additional administrative controls. The sludge in the pool appears not to have been characterized properly. WHC is currently in the process of identifying a technically justifiable method of sampling and testing the sludge for characterization of the fissile material contents. The original criticality analysis of the Basin was performed based on fuel assemblies being intact within the canisters. There are currently broken spent fuel pieces mixed with the sludge. The DNFSB staff requested the documents supporting the criticality analysis for internal review.