[DNFSB LETTERHEAD]

July 15, 1996

The Honorable Alvin L. Alm
Assistant Secretary for Environmental Management
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Alm:

Members of the Defense Nuclear Facilities Safety Board's (Board) staff visited the Los Alamos National Laboratory (LANL) on April 15-17, 1996, and reviewed LANL's support for Hanford Tank Waste Remediation System activities. The review identified deficiencies in the safety assessments for operations in Hanford's flammable gas watch list tanks, including the safety assessment for rotary mode sampling currently being reviewed by the Richland Operations Office. The Board's staff trip report is enclosed for your consideration in this review.

Sincerely,

John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. John Wagoner

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

May 17, 1996

MEMORANDUM: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Ralph Arcaro

SUBJECT: Trip Report - Review of Los Alamos National Laboratory Activities in Support of the Hanford Tank Waste Remediation System, April 15-17, 1996.

1. **Purpose:** This report documents a review performed by the Defense Nuclear Facilities Safety Board's (Board) staff members David Lowe, Rich Tontodonato, and Ralph Arcaro at the Los Alamos National Laboratory (LANL). The review covered LANL's support for the Hanford Tank Waste Remediation System (TWRS), namely, the historical model developed by LANL to estimate the contents of the Hanford High-Level Waste Tanks, and two safety assessments performed by LANL to support operations in flammable gas watch list tanks at Hanford.
2. **Summary:** The Board's staff made the following significant observations concerning LANL support of the Hanford TWRS:
    a. LANL's historical model for predicting waste tank contents is a credible effort with some immediate usefulness that should increase as the model is refined and validated
    b. The safety assessment for rotary-mode sampling flammable gas watch list tanks at Hanford predicts accident frequencies and consequences exceeding risk acceptance guidelines imposed by the Department of Energy's Richland Operations Office (DOE-RL). In an effort to meet the risk acceptance criteria, LANL has arbitrarily chosen to calculate the probability of accidents during a single 144-hour sampling event rather than during a year of sampling operations.
    c. Without active ventilation of flammable gas tanks, the probability and consequences of gas burns in the tanks during saltwell jet pumping also exceed the DOE-RL risk acceptance guidelines. This issue remains open.
3. **Background:**

    Characterization of the Hanford waste tanks is a high priority for the TWRS. Because records are often missing or incorrect, the contents of the Hanford waste tanks are not known with great certainty. LANL has embarked upon an effort to use essentially all historical information available, including waste generation and transfer records, to develop a model that can reasonably predict the contents of the waste tanks.

    The waste in some tanks is too hard to allow pushing a sampler into the waste. Sampling of these wastes must be done with a rotary drill-type sampler. Because the current authorization basis at Hanford does not address this additional ignition source in flammable gas watch list tanks, an additional safety assessment is required to allow rotary mode sampling in these tanks. Similarly, the interim stabilization of tanks can trigger flammable gas releases and can introduce ignition sources that are not

addressed in the current authorization basis. Therefore, an additional safety assessment is also required to allow saltwell pumping of flammable gas tanks.

4. **Discussion/Observations:**

   a. ***LANL Defined Wastes Model for Hanford High-Level Waste Tanks:***

      1. ***General***: LANL has developed estimated inventories for each of the 177 high-level waste tanks at Hanford, using primarily the historical records of site operations. LANL identified 48 waste types generated at Hanford over its operating history. The composition of each waste type was estimated using process knowledge, records of chemicals consumed and waste volume produced, and (rarely) assays of characteristic wastes. The emphasis was on chemical constituents; only six radionuclides (239Pu, 233U, 238U, 232Th, 137Cs, and 90Sr) were tracked. LANL then used historical records of transfers to, from, and among the waste tanks to estimate what waste types are currently contained in each tank.

         The LANL model tracked both solids and liquids for each tank. This was necessary because waste transfer mechanisms such as saltwell pumping and cascade lines transfer only the liquid phase, leaving essentially all of the solids behind. The compositions of the solid and liquid phases for each waste type were estimated using solubilities determined from available assays of waste supernatant.

      2. ***Organics***: At the time of this site visit, LANL had just completed revising the model to provide better estimates of the organic content of each tank. LANL believes that many tanks could contain organics, as process records show that organic concentrates were highly blended and widely distributed. LANL believes the two principal sources of organics in the waste tanks were PUREX solvent extraction operations (tributylphosphate (TBP) and normal paraffin hydrocarbons), and B Plant strontium extraction (ethylenediaminetetraacetic acid (EDTA), hydroxyethylethylenediaminetriacetic acid (HEDTA), sodium glycolate, and sodium citrate). LANL presented results showing a rough correlation between tanks predicted to be high in total organic carbon content and the current and proposed organic and flammable gas watch list tanks. LANL also concluded that some tanks have the potential for high organic concentrations on the waste surface. The Board's staff will review LANL's work in this area to determine whether actions beyond those already underway at Hanford are needed to ensure the safetY of such tanks.
      3. ***Known uncertainties***: There are several known sources of variability in the LANL model. Variability in the waste streams from the processing facilities, uncertainty in the composition of what was actually moved in tank-to-tank transfers, and inaccurate/missing information all contribute to uncertainty in the estimates. The model also does not generally predict the chemical species of waste constituents, information which can be essential for defining waste processing methods. Additionally, the model does not account for water loss from sludges over time or degradation of most

organic-q in the tanks. Comparisons to data from tank waste samples have shown that the historical model generally underestimates the concentration of some waste constituents and it misses some constituents of interest entirely for certain tanks. LANL is involved in these comparisons and is using this information to improve the source terms used in the model.

LANL also recognizes that estimates need to be developed for several other radionuclides. LANL plans to develop tank inventories of 237Np, 241Am, 99Tc, and 129I as a future enhancement to the model.

4. ***Key findings***: Several of LANL's results could have broad implications for Hanford's TWRS. Key findings are listed below:

    - Total sodium in the tanks is estimated to be about 40,000 metric tons, only about 60% of previous estimates. This difference is primarily due to the fact that LANL included discharges to cribs in their model, and found that about 20,000 metric tons of sodium went to cribs instead of tanks. Since sodium content is a limiting factor in waste loading for low-level waste vitrification, this could mean that a much smaller quantity of glass will be needed to immobilize the low-level fraction of the tank wastes.
    - LANL estimates that the tank wastes contain about 1800 metric tons of iron. Previous estimates were about 700 metric tons. This difference is primarily due to the fact that LANL included iron from process vessel corrosion in its inventory estimates. If this much iron is truly present, iron could become a limiting factor in waste loading for high-level waste vitrification.
    - The widespread nature of organics makes it possible that 90Sr may exist in complexed form in the liquid phase in numerous tanks. If this is the case, some form of strontium removal may be needed for the low-level waste stream.

b. ***Safety Assessment for Rotary-Mode Core Sampling Flammable gas Tanks***:

1. ***General***: LANL has developed a safety assessment to allow rotary-mode core sampling in Hanford's flammable gas watch list tanks. At the direction of DOE-RL, LANL performed a bounding, worst case analysis intended to show that the operations were safe for even the most conservative tank parameters.

    Uncertainties in several areas, particularly tank source term, dome collapse scenario, and gas release mechanisms, caused LANL to take a very conservative approach to ensure that ale operations were bounded. The safety assessment compares frequency of accidents and their respective calculated consequences to acceptable values in the risk acceptance guidelines imposed by DOE-RL. Several controls and design changes were identified to meet risk-acceptance guidelines. For example, a National Fire Protection Association certified exhauster will be required when sampling the flammable gas tanks. Additionally, automatic controls

that shut down the sampler on detection of flammable gases will be required. The safety assessment is being reviewed by an independent team at the Idaho National Engineering Laboratory.

2. ***Open Issues***:

    a. The assessment showed that failure of the automatic shutdown system in an area of dry high organic waste may result in an exothermic reaction. For this reason, the safety assessment will only allow sampling a subset of flammable gas watch list tanks.
    b. Testing is currently being performed by the Bureau of Mines to show that the drill bit will not generate sparks or heat sufficient to ignite trapped gas or the waste itself. The testing will also determine if a dropped drill string could ignite the waste or gas.
    c. The flammable gas monitors used in the detection and shutdown system are currently being designed. Verification that this design meets the requirements of the safety assessment is required prior to operation.

3. ***Comments***: Although a detailed review of the safety assessment has not yet been performed, the Board's staff made the following observations about the general approach to the safety assessment:

    a. The accident frequencies are calculated on a per-tank basis assuming a single 144-hour sampling event rather than a year of sampling operations. The risk acceptance guidelines provided by DOE-RL are to be used on a per-facility basis. LANL representatives stated that a per-tank basis was used because of the excessive conservatism introduced by the uncertainty and the bounding analysis approach. While the bounding analysis is indeed conservative, calculating accident frequency in this manner is inconsistent with the overall approach and arbitrarily reduces the conservatism without technical justification.
    b. The risk acceptance guidelines are applied on a per-accident basis. No attempt has been made to show that the total risk of operations in the tank farms is within risk acceptance guidelines.
    c. LANL used sampling data, historical records, and a Pacific Northwest National Laboratory (PNNL) statistical model to calculate the probability that each tank contained ignitable wastes. These probabilities were then combined with the frequency of control failures to estimate, for each tank, the likelihood that an organic-nitrate burn would occur during sampling. LANL concluded that only 21 of the single-shell tanks (SSTs) had accident probabilities less than 10-6. Only 5 of the 19 current flammable gas watch list SSTs are included in this number. Despite discussions with LANL personnel and subsequent review of the safety assessment, it is not clear how LANL calculated the probabilities that the tanks are energetic, particularly for tanks not sampled in the past.

The Board's staff does not agree with LANL's approach to this problem. In effect, LANL has concluded that despite controls on drilling parameters and cooling-gas flow rate, the only tanks which can be sampled are those which are almost certainly inert and present the least immediate safety concerns. The Board's staff believes that improved controls or more precise calculations of accident frequencies and consequences would be better approaches. Furthermore, while it is appropriate to use certain basic assumptions about the nature of the material being sampled, the ignitability of the waste is a key unknown. In the absence of data, a tank should be assumed to be ignitable. LANL is currently revising this portion of the safety assessment to allow sampling more tanks, but it appears that the same basic methodology will be used.

c. ***Safety Assessment for Saltwell Jet Pumping Flammable Gas Tanks***: The Safety Assessment for Saltwell Jet Pumping Operations was reported as complete and submitted to Westinghouse Hanford Company for review. However, several issues remain open.

    1. Several accidents would result in unacceptable on-site or off-site consequences. An exhauster qualified for operations in flammable atmosphere may be necessary to keep gas concentrations below flammable limits during pumping operations. LANL representatives believe these views are due to the conservatism in the source term and accident scenarios and do not accurately reflect true conditions. As such, there is not yet agreement on whether the exhausters will be installed. Although the safety assessment is indeed conservative, the analysis indicates that mitigative or preventive measures are required. Justification for not incorporating mitigative or preventive measures requires additional work to develop a more realistic source term or more realistic accident scenarios.
    2. As was the case in safety assessment of the rotary mode core sampling, the accident frequencies are calculated on a per tank basis rather than on a year of saltwell pumping.

5. **Future Staff Action:**

    a. The staff will continue to follow the refinement and validation of the *Defined Wastes Model for Hanford High-Level Waste Tanks* as part of its review of the implementation of Board Recommendation 93-5.
    b. The staff will perform a detailed review of the safety assessments affecting operations in flammable gas tanks in conjunction with its ongoing review of the Hanford tank farms authorization basis.