DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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

December 8, 1995

Mr. Mark Whitaker
Department of Energy
1000 Independence Avenue
Washington, DC 20585-0119

Dear Mr. Whitaker:

Enclosed for your information and distribution are six Defense Nuclear Facilities Safety Board staff reports. The reports have been placed in our Public Reading room.

Sincerely,

George W. Cunningham
Technical Director

Enclosures (6)

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

June 14, 1995

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: David T. Moyle

SUBJECT: Rocky Flats Solution Tanks Safety Review - Trip Report (May 23-25, 1995)

1. **Purpose:** This report documents a follow-up review of radiolytic hydrogen generation in Rocky Flats solution tanks. This review was conducted by Defense Nuclear Facilities Safety Board (Board) technical staff members D. Moyle and R. Zavadoski on May 23-25, 1995.

2. **Summary:** The current managing and operating contractor (EG&G) at the Rocky Flats Environmental Technology Site (RFETS) has declared a positive Unreviewed Safety Question (USQ) for hydrogen buildup in plutonium solution tanks in buildings 371 and 771. A tank vapor space sampling program in Building 771 has confirmed that explosive hydrogen concentrations exist in at least three tanks. EG&G plans to mitigate the hydrogen hazard by purging the tanks. However, the purging process has not been well thought out to ensure that the hydrogen is adequately swept out of the interconnected tanks and vent line system. Furthermore, it appears that potential hydrogen buildup is not being given an appropriate priority in Building 371, where sampling and mitigation plans have not been expedited. In light of the high hydrogen concentrations measured in Building 771 tanks, a comprehensive site-wide program Has not been implemented to investigate and mitigate hydrogen buildup in actinide solution tanks and process lines.

3. **Background:** Prior to 1989, when operations were terminated at RFETS, plutonium solutions were frequently transferred and processed. Since then, the solutions have remained stagnant and hydrogen buildup from radiolytic destruction of water has become a concern. The Los Alamos Technology Office (LATO) investigated this issue in 1993 and concluded that hydrogen would not build up in tank headspaces if ventilation was maintained on the tanks. EG&G verified that all vent line valves were in the open position and measured negligible hydrogen concentrations at the vent line outlets into their respective glove boxes. EG&G and LATO then concluded that there was no significant hydrogen buildup in tanks. However, they neglected to account for the fact that the tank vent line systems had no active ventilation and were dead-ended extensions of the glove box system. Thus, concentration gradients could develop in the vent lines such that outlet concentrations would not accurately reflect the tank headspace conditions.

The Board's staff conducted reviews on this issue in November 1994 and January 1995. In January 1995, EG&G drafted a negative Unreviewed Safety Question Determination. The Board's staff predicted hydrogen buildup approaching 67 volume percent in several tanks. EG&G later performed separate calculations that gave comparable results.

4. **Discussion:** Recent analyses have convinced EG&G of the potential for significant radiolytic hydrogen buildup in tank headspaces and vent lines even if vent lines are open. A positive USQ has been declared because the consequence of a hydrogen explosion in a tank have not been analazed. EG&G has begun a tank sampling program in Building 771. Mitigation plans, however, are not well thought out and EG&G has not extended its investigation of hydrogen buildup to other tanks across the site.

   a. Tank Sampling: As of May 23, 1995, EG&G had sampled nine tanks in Building 771 out of ten identified as potentially containing high hydrogen concentrations. Three of the tanks sampled, D550, D931, and D933, contained approximately 50, 50, and 40 volume percent hydrogen, respectively. These concentrations are well within the explosive range and 40-50 times higher than the hydrogen level allowed by Code 69 of the National Fire Protection Association (NFPA 69). Tank D452 contained two volume percent hydrogen, which also exceeds the NFPA 69 limit but is not flammable.

   The other five tanks sampled are operationally empty, but potentially contain a significant amount of residual solution below the sight glass level. Assuming large solution heels, calculations predicted high hydrogen concentrations in these tanks. Measured hydrogen concentrations, however, were much less than one volume percent, which may indicate that the tanks actually contain very little solution in the tank heel. These results, however, do not discount the possibility for other operationally empty tanks to contain significant residual solution and to generate significant amounts of hydrogen.

   Tank D1810 was not sampled initially because connecting the sampling apparatus would require opening a direct ignition path into the tank. Thus, EG&G stated that Tank D1810 would be purged first through a calibration line before attaching sampling equipment. Based on calculations, explosive hydrogen concentrations are expected in Tank D1810, and pre-sample purging is desirable as a safety precaution.

   Potential hydrogen buildup in Building 371 tanks is not being treated with the same sense of urgency as Building 771 tanks. The tanks have not been sampled, and no effort has been made to verify open vent lines on the four tanks of concern in that building. Three tank samples from Building 771 came out reasonably close to the predicted concentrations from a conservative model. This model has predicted explosive concentrations in Building 371 tanks as well, and indicates that sampling and mitigation of Building 371 tanks are also warranted.

b. Mitigation Approach: The high hydrogen tanks will be purged with inert argon gas and resampled to verify effective purging. Then, after some time, the tanks will be sampled to understand the hydrogen buildup rates. For the longer term, it has not been decided if a continuous or periodic purge will be implemented. EG&G recognizes the implications of evaporative solution loss during purging and will account for this in the final decision.

c. Common Vent Lines: During a tour of Building 771, the Board's staff noticed that tanks are often interconnected through a common vent line to a given glove box. Since all vent lines are open, hydrogen generated in one tank may diffuse into other tanks common to its vent system. The staff believes that tanks common to high hydrogen generators should be sampled to determine if there is significant diffusion into other tanks. Furthermore, tank purging must be carefully planned to assure that all hydrogen is swept out of the interconnected headspaces and vent system.

d. Screening of Tanks for Analysis: The staff believes that inadequate criteria have been used to screen the tanks that could potentially build up explosive hydrogen concentrations. Out of over 100 tanks in buildings 371 and 771, only 14 were determined to be a concern for hydrogen buildup. The tanks were screened based on their potential to generate a specified amount of hydrogen gas over five years, but not on the potential for hydrogen to build up to explosive concentrations. Therefore, tanks that have flammable concentrations of hydrogen and pose an explosive hazard may have been overlooked.

A comprehensive site-wide investigation could identify all actinide solution tanks that may contain explosive hydrogen concentrations. Uncertainty exists in solution levels and actinide concentrations; and vent lines may connect tanks that would normally not be considered a concern for hydrogen buildup to other tanks that contain high hydrogen concentrations. Therefore, strict analytical treatment of many of the tanks may not be adequate to conclude that they pose no hydrogen hazard. Extensive vapor space sampling may be needed to identify tanks with significant hydrogen buildup. In addition to tanks, there are several thousand liters of actinide solutions in process lines at Rocky Flats. Hydrogen is being generated in these lines and the implications of flammable gas buildup in lines may also warrant attention.