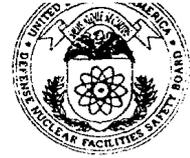


John T. Conway, Chairman  
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## DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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March 1, 1996

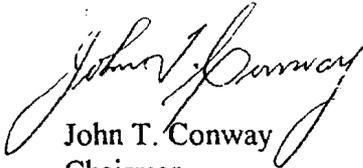
The Honorable Thomas P. Grumbly  
Assistant Secretary for Environmental Management  
Department of Energy  
Washington, DC 20585-0113

Dear Mr. Grumbly:

Members of the Defense Nuclear Facilities Safety Board's (Board) staff visited the Hanford Site on December 5-7, 1995, and focused on tank safety issues and the tank farms authorization basis. The Board's staff review identified several nonconservative areas in the current and proposed authorization basis. More significantly, the staff discovered that identified controls necessary to prevent flammable gas deflagration in the double contained receiver tanks have not been implemented. The Hanford contractor identified the need for these controls as early as 1993. The Board understands that efforts are in progress to upgrade the safety analysis and authorization basis of the tank farms; however, implementation of controls necessary for safety should not be delayed to accommodate formal changes to the authorization basis. The Board encourages your close oversight of the efforts at Hanford to improve the tank farms authorization basis.

The enclosed report is a synopsis of the observations made during the December 5-7, 1995, Board's staff review and is forwarded for your consideration. Mr. Ralph Arcaro or Mr. Richard Tontodonato of the Board's staff will be available to provide any additional information you may require.

Sincerely,

  
John T. Conway  
Chairman

c: Mr. Mark Whitaker

Enclosure

**DEFENSE NUCLEAR FACILITIES SAFETY BOARD**

January 12, 1996

**MEMORANDUM FOR:** G. W. Cunningham, Technical Director

**COPIES:** Board Members

**FROM:** Ralph Arcaro

**SUBJECT:** Trip Report - Review of Hanford Tank Farms Authorization Basis and Tank Waste Processing, December 5-7, 1995

1. **Purpose:** This trip report documents a visit by the Defense Nuclear Facilities Safety Board's (Board) staff members (David Lowe, Ralph Arcaro, Richard Tontodonato, and Cliff Moore) to the Hanford Site on December 5-7, 1995, to review the authorization basis for the high-level waste tank farms and tank waste processing issues.
2. **Summary:** Review of the tank farms authorization basis focused on efforts by the Department of Energy Richland Operations Office (DOE-RL) and Westinghouse Hanford Company (WHC) to identify and correct issues with the current authorization basis. Review of processing issues focused on tank safety issues, waste characterization, and plans to treat and immobilize the waste. The review team made the following significant observations:
  - a. The upgraded safety analysis intended to form the foundation for the effort to develop a compliant final safety analysis report is nonconservative in several areas. The conservatism of the source term is not proven, assumptions regarding effectiveness of administrative controls are not conservative, and some identified mitigative measures are not implemented although the need for them has been identified for several years.
  - b. WHC is using a systems engineering approach to reevaluate how to address the safety issues associated with the floating layer of organic solvents in tank 241-C-103. WHC intends to decide by the end of January 1996 whether to remove the organic layer, saltwell pump the tank with the organic layer in place, or pursue some other alternative.
  - c. WHC is working to validate its *Historical Tank Contents Estimate Report*. Data from the report are being further analyzed and compared to analytical data from tank samples to assess and improve the historical models.
  - d. WHC has been tasked to develop a contingency plan should privatization of tank waste treatment and immobilization fail. However, WHC has not completed testing to validate selection of the preferred pretreatment alternative, and reduced funding makes it unlikely that sufficient research and development can be accomplished to support these tasks.

3. **Background:** The current authorization basis for the Hanford Tank Farms is contained in the *Interim Safety Basis* and consists primarily of a collection of safety assessments and related controls. In an effort to rapidly improve the safety posture of the tank farms, WHC developed the *Accelerated Safety Analysis (ASA)*, which was intended to become the hazards and accident analysis of a compliant Final Safety Analysis Report (FSAR). External reviews by a DOE-RL-sponsored team from the Idaho National Engineering Laboratory (INEL) and a WHC-sponsored steering panel have identified many problems with the ASA. Furthermore, the ability of DOE-RL and WHC to manage the authorization basis has been criticized recently due to operations conducted outside the authorization basis.

The Tank Waste Remediation System (TWRS) is being designed to retrieve the waste from the Hanford high-level waste tanks, separate it into low- and high-level fractions, and immobilize the waste for ultimate disposal. In an effort to expedite cleanup of the tank farms, DOE-RL has chosen to bid out the pretreatment and immobilization functions of TWRS to commercial industry through a "privatization" effort.

#### 4. Discussion/Observations:

- a. Authorization Basis: The authorization basis for the tank farms is deficient both technically and administratively. Inadequate control and unclear responsibilities for the tank farm authorization basis have been identified problems. At the time of the staff visit, approval authority for changes to the authorization basis had been delegated to DOE-RL while DOE-Headquarters (DOE-HQ) maintained approval authority for the FSAR. DOE and WHC recognize that the authorization basis requires technical upgrade and have begun an effort to develop a compliant final safety analysis report by December 1996. DOE-RL personnel stated that while development of the FSAR continues, the Unreviewed Safety Question process will be used to identify near-term safety issues that require immediate change to the current authorization basis.
  1. Authorization Basis Management: A recent occurrence regarding criticality controls revealed poor management of the authorization basis at the tank farms. During this occurrence, WHC operated the tank farms outside the authorization basis for a period of nine months without DOE approval. An evaluation by DOE-RL following the occurrence concluded that the division of responsibility between DOE-HQ and DOE-RL regarding the approval authority of the tank farms authorization basis was not well understood. At the time of the visit, this situation was not improved. The DOE-RL manager responsible for tank farms operations and the authorization basis was not aware that authority to approve changes to the authorization basis had been delegated to DOE-RL, and assumed that DOE-HQ retained approval authority.

Part of the corrective action instituted by DOE-RL to ensure control of the authorization basis is an evaluation to ensure that controls are technically sound, adequate to ensure safety, and properly implemented. While such an evaluation is worthwhile, it should be noted that similar evaluations have occurred in the past and have not prevented occurrences related to the authorization basis. The Board's staff will closely follow this evaluation.

2. Flammable Gas Issues: The ASA analyzes the potential for flammable gas deflagrations in single- and double-shell tanks and double contained receiver tanks (DCRTs). The Board's staff review revealed that the safety posture relative to a flammable gas deflagration is not technically sound. The following key deficiencies were found:

- (a) The ASA concluded that the DCRTs could develop a flammable atmosphere within several days of receiving wastes, and that in-tank equipment could ignite the gases. However, the ASA assigned a frequency of "unlikely" to this accident, because no DCRT deflagrations have occurred at Hanford. Still, the ASA identified that controls are required to prevent this accident. The ASA recommended either actively ventilating the inner vessel within the DCRTs, ensuring that waste is not stored for more than 1.7 days, or limiting waste volume to 3 percent of the tank volume.

The Board's staff does not agree that operational history provides an adequate basis to conclude DCRT deflagrations are unlikely. More importantly, the Board's staff is extremely concerned that the DCRT controls recommended by the ASA have not been implemented, even though this document has been available since March 1995. Subsequent research by the Board's staff found that this problem was also identified in the Interim Safety Basis in 1993. WHC personnel stated that an effort to identify and implement essential controls identified in the ASA was expected to begin shortly.

- (b) The ASA relies on administrative work controls to show that ignition of flammable gases in single- and double-shell tanks is incredible.

Based on "engineering judgement", the ASA assumes that there is a  $10^{-4}$  probability of a failure of administrative controls which allows work to be inadvertently initiated on a tank containing a flammable atmosphere. The ASA also uses engineering judgement as the basis for assuming that controls intended to eliminate ignition sources have a failure probability of  $10^{-4}$ .

The ASA combines these probabilities to produce an overall accident probability of  $10^{-8}$ . The ASA concludes that this probability results in acceptable accident frequencies as long as intrusive activities in flammable gas watch list tanks are limited to 100 per year.

However, during 1995 at Hanford, work was performed on two organic watch list tanks without the required ignition controls, and a required vapor sample was not taken before work was begun on a flammable gas watch list tank. On another occasion in 1995, a vapor sample was taken from the wrong tank. These occurrences demonstrate that administrative controls are not sufficiently effective to reduce the accident frequency to the level assumed in the ASA.

- (c) The analysis in the ASA assumes that lightning mitigation will render lightning-initiated accidents incredible. No mitigation is in place, and WHC has not decided whether or not a lightning protection system will be installed.

- 3. Source Term Analysis: WHC now plans to reevaluate the ASA source term before using it in the FSAR. The report of the November 6-8, 1995, Board's staff visit to the Hanford Site identified several nonconservatisms in the ASA source term that warrant reconsideration for the FSAR.

In addition to the comments provided in the November 1995 report, the Board's staff has identified another important nonconservatism in WHC's analysis of the source term. WHC assumed that there was no  $^{244}\text{Cm}$  in the single-shell tanks, even though it is present in the double-shell tanks. Although there are valid analyses for four single-shell tanks reporting  $^{244}\text{Cm}$  in solids, WHC determined this was not a sufficient database for estimating a bounding concentration. The few analyses reporting  $^{244}\text{Cm}$  in single-shell tank liquids were determined to be unreliable.

WHC modeling predicts that  $^{244}\text{Cm}$  should be a significant contributor to accident doses, and WHC included it in the ASA's list of eleven radionuclides responsible for over 99 percent of the accident dose. Based on discussions with the Board's staff, WHC now intends to derive a bounding source term for  $^{244}\text{Cm}$  in single-shell tanks using available data for other transuranic isotopes.

- b. Floating organic layer in tank 241-C-103: WHC still has not decided how to resolve safety issues resulting from the layer of organic solvent floating atop the supernatant liquid in tank 241-C-103. Originally, WHC planned to skim off the organic liquids. In early 1995, WHC prepared analyses showing that hypothetical burns of the organic liquid are limited by the amount of oxygen available in the tank headspace. Once the oxygen is exhausted, the fire will self-extinguish. The resulting burn only consumes about 60 kilograms of organics.

WHC further concluded that the dose consequences of such a limited burn were acceptable. Based on this analysis, WHC recommended to DOE-RL that the organic layer not be separately removed. Instead, WHC planned to saltwell pump the tank, removing much of the organics, aqueous supernate, and drainable liquids together, and transferring the liquids to a double-shell tank.

DOE's Tanks Advisory Panel (TAP), and the Board's staff have raised several concerns with this approach. The principal concerns include safety issues resulting from organic infiltration into the tank's sludge and potential downstream processing problems resulting from moving the organic layer to a double-shell tank. In September 1995, DOE requested WHC to reconsider its recommendation.

WHC has initiated a systems engineering study on this topic. By the end of January 1996, WHC plans to complete an assessment of safety, cost, and schedule for various options for resolving the organic safety issue in tank 241-C-103. WHC also intends to determine whether other separable phase organics exist in the tank farms, and to evaluate whether their existence affects the recommended approach toward tank 241-C-103 (e.g., if other tanks also require skimming to remove organic liquids, the per-tank cost of reusable equipment is reduced).

- c. High-level waste tank characterization: Since flammable gas controls have been placed on all high-level waste tanks at Hanford, rotary mode core sampling has been prohibited. WHC is working toward qualifying equipment for rotary mode sampling in flammable gas tanks. WHC expects to have equipment modifications ready in January 1996, but more time will be required to complete authorization basis changes and obtain DOE-RL approval. In the meantime, WHC is using the rotary mode trucks in push mode to sample tanks believed to contain soft wastes.

WHC discussed progress in correlating analytical data from tank samples to historical models. WHC has found that tank wastes are systematically richer in iron, chromium, calcium, and silicon than predicted by models. WHC is working to find the sources of these materials. For example, it appears that corrosion of process equipment is the source of some of the excess iron and chromium.

Organics continue to be poorly predicted by historical models. The Los Alamos National Laboratory is attempting to develop a method to better predict the location of organic materials in the tank farms.

- d. Chemical Processing and Pretreatment: The baseline flowsheet for TWRS will separate the tank waste into low-level waste (LLW) and high-level waste (HLW) fractions prior to vitrification and final disposal. The separation options considered include simple sludge washing, enhanced sludge washing (ESW), and acid dissolution processing. Simple sludge washing was rejected due to the resulting large volume of HLW.

According to a trade study performed by WHC, acid dissolution processing achieves a 12 to 1 reduction in the HLW volume over ESW, but it presents a higher technical risk because of reliance on undemonstrated technologies.

Although ESW is simpler than acid dissolution, the ESW option is not without technical uncertainties. ESW has not been demonstrated on a pilot or large scale with Hanford tank waste. The small test sample size (5 grams) does not adequately address the heat and mass transfer, mixing, and settling characteristics of actual in-tank processing of several hundred thousand gallons of sludge. Furthermore, laboratory testing has been performed at 100°C while in-tank processing will realistically occur between 60-80°C. A full-scale sludge washing test in tank 241-AZ-101 is scheduled to begin in FY96. While this test will provide pertinent data on mixing and settling phenomena in a large tank, it does not involve the more critical step of caustic leaching. An in-tank test of sludge washing and caustic leaching could be done using tank 241-C-106 waste in FY97/98, but DOE has not committed to fund it. Another issue involving the ESW option is the degree of removal of <sup>90</sup>Sr and <sup>99</sup>Tc required to meet the Nuclear Regulatory Commission's Class C LLW restrictions. <sup>99</sup>Tc, in particular, has proven to be difficult to separate from the tank waste supernate and wash solutions.

WHC is required to develop and maintain a backup pretreatment option in the event that privatization cannot complete the TWRS mission. However, direct funding for pretreatment technology development in FY96 has been reduced to less than 25% of the FY95 funding level due to privatization and may not be adequate to support development of a contingency process. If privatization fails and the WHC contingency plan is not ready for detailed process engineering, retrieval and immobilization of the wastes will be delayed. Additionally, characterization efforts to date have been less than adequate to support feed envelope and pretreatment technology development for tank waste categories containing radiolytically-decomposed organics, "hard pan" layers, dried sludge, etc.

#### **5. Future Board's Staff Actions:**

- a. The Board's staff is currently working on a full review of the Hanford Tank Farms authorization basis. An interim report was completed in January 1996. The staff will continue to review the authorization basis as DOE-RL and WHC strive to upgrade their analysis and implement appropriate controls.
- b. Board's staff review of tank farms operations, especially those activities related to characterization of the tank wastes, will continue.
- c. The Board's staff will continue its review of design activities related to TWRS. The staff is currently reviewing the draft Request for Proposal for the privatized portion of TWRS.