95-0004205

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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

August 23, 1995

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

Dear Mr. Grumbly:

A Defense Nuclear Facilities Safety Board staff team visited the Hanford Site June 13-15, 1995, to review the operating life expectancy of the Hanford Tank 101-SY Mixer Pump. They noted that the Department of Energy plans to extend operations beyond the pump design life of 2.5 years to pump failure, or up to 10 years, without reevaluating the safety aspects of extended pump operations. A Failure Mode and Effects Analysis would be appropriate to identify the potential safety consequences of a pump failure during operations. The enclosed report is provided for your information.

Sincerely,

John T. Conway
Chairman

c: The Honorable Tara O'Toole
Mr. Mark Whitaker
Mr. John Wagoner

Enclosure

95/4205

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

July 14, 1995

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Lester Clemons

SUBJECT: Hanford Site - Evaluation of Estimated Life of Mixer Pump for Tank 101-SY

1. **Purpose:** This memorandum documents a trip to the Hanford Site to review the estimated life of a mixer pump that is exposed to the high radiation fields present in Tank 101-SY. The review was performed June 13-15, 1995, by Defense Nuclear Facilities Safety Board (Board) staff members L. Clemons and A. Gwal.

2. **Summary:** The Waste Mixer Pump for Hanford Tank 101-SY was designed and installed to mitigate episodic releases of hydrogen gas from the tank. The mixer pump Safety Assessment (SA) was based on the pump operating safely for 2.5 years in the high radiation fields in the tank. The Department of Energy (DOE) is planning to extend the pump operating life up to 10 years without reevaluating the safety aspects of the extended pump operations. DOE has developed various documents to justify this life extension; however, DOE has not performed a Failure Modes and Effects Analysis (FMEA) on the pump to determine the extent of any potential safety consequences of a pump failure during operations in the tank.

   Also, the Board's staff could not independently determine the life expectancy of the installed 480 volt silicon rubber power cables because of the uncertainty of cable type and unavailability of the vendor data. Based on existing industry data on the commercial grade silicon rubber cable, the staff believes that this cable may not survive for 10 years in the high radiation field of the tank. DOE has recently decided to perform a FMEA and to test the power cables of the type used in the existing mixer pump to determine their functional adequacy.

3. **Background:** The periodic release of hydrogen gas from the Hanford waste storage tank 101-SY created a safety hazard to workers, the public, and the environment. The concentration of hydrogen gas during a gas release event or "burp" frequently exceeded the lower flammable limit. The potential for an accidental fire or explosion existed, and in the event of an incident, radioactive materials could be released into the environment.

   The method for mitigating the safety hazard was to install a pump in the tank to mix the waste and release the gas at a controlled rate. A pump stored in a warehouse since 1987 was modified for use in the 101-SY application. In order to meet a tight schedule, off-the-shelf materials were used in the pump fabrication. Little effort was expended to acquire radiation resistant

organic based materials for cable insulation, oils, lubricants, gasket and sealant materials other than those supplied by the pump manufacturer. DOE originally intended to use the mixer pump for approximately 2-3 years until the waste in 101-SY tank could be diluted and transferred to new tanks. DOE's decision not to build the Multifunction Waste Tank Facility assumed that the life of the mixer pump could be extended to 8-10 years.

A radiation dose rate of 850 R/hr, determined from the analysis of a core sample of waste taken from the tank, was used in the Pump Safety Assessment Report. The accumulated exposures to the pump components may be approaching 1.5×10^7 rads (conservative estimate) since the pump was installed in the tank on July 3, 1993. The lifetime of some organic based materials that might be incorporated into the pump have not been adequately determined, and these materials could be approaching the end of their safe operating life.

4. **Discussion:** The staff's review process included an assessment of documents and drawings of the 101-SY mixer pump prior to the site visit. At the site a discussion with site personnel was held concerning pump fabrication methods, internal structural and operational components, wiring and schematic diagrams, and components exposed to the high radiation fields. A walk down of the replacement pump stored on a horizontal stand in the Maintenance and Service Facility (MASF) was also performed.

   a. Pump Service Life Extension: The criteria for pump replacement, as established by the Hanford Test Review Group, are to operate the pump beyond the original design life of 2.5 years, up to 10.0 years or until the pump fails. These criteria are being implemented without performing a FMEA.

      A FMEA is the process of identifying significant failures that might occur (irrespective of causes) and their consequences. This includes electrical and mechanical failures that could conceivably occur under specified service conditions and their effects. The failure modes of electrical and mechanical equipment are important because they identify the effects of the failure on the system. For example, the types of failures in a motor vary from flashover to electrical defects, to mechanical defects, with winding insulation and bearings sustaining the majority of the damage. Insulation breakdown, overheating, and mechanical seizing are the primary initiating causes with normal deterioration from age, loss of lubricant, and exposure to abnormal environmental conditions, such as high radiation levels. Similarly, cable insulation degradation because of the presence of high radiation level may lead to flashovers to ground. A FMEA will document the failure modes of all such components and evaluate the effects on the overall system.

      If a FMEA indicates a catastrophic failure resulting in fire or explosion, then the pump must be replaced prior to such failures. The staff believes a FMEA could be performed to establish the safety envelope to justify DOE's operating philosophy.

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b. Radiation Sensitive Materials: Pump materials with unknown radiation lifetimes exposed to the high radiation fields in the tank are as follows:

- 480 volt power cable silicon rubber insulation,
- Lubricating/coolant oil in the pump motor (Chevron Turbine Oil GST 68),
- Shaft bearing lubricating oil (Chevron Turbine Oil GST ISO 32), and
- Pressure sensor mineral oil.

The technical bases for establishing the pump's safe operating lifetime associated with these materials were not available for the staff to review during this trip. The Department of Energy Richland Field Office/Westinghouse Hanford Company (DOE-RL/WHC) stated that they will determine the types of materials used in the installed pump and will justify the capabilities of these materials to withstand radiation for the required amount of time.

DOE-RL/WHC have demonstrated that other pump materials, such as the pump motor stator winding insulation and instrument cable insulation, will withstand the radiation level of the tank for at least 10 years.

c. Radiation Dose: The organic based materials in the pump and motor would need to withstand an estimated accumulated exposure of 7.5×10^7 rads over a 10-year life based on an exposure rate of 850 R/hr. Shielding calculations are being performed by DOE-RL/WHC to determine any reduction in radiation levels inside the pump motor and cable housings from the shielding effect of structural materials in contact with tank waste. The results of the calculations were not available for the staff's review.

d. Replacement Pump: A second pump, designed and fabricated to replace the existing mixer pump in the tank, is stored in the MASF warehouse. It is designed essentially the same as the operating pump, starting from a pump previously purchased for other applications. It has been modified so that oil can be added to the pump motor housing; this is a design upgrade. The pump has been tested and is ready to be installed in the tank, when needed. Since the replacement pump was fabricated using materials similar to the operating mixer pump, the operating life is also suspect.

5. Future Staff Actions:

The Board's staff will continue to follow the 101-SY program on the issues discussed in this report.