96-0000433

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

November 20, 1995

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Lani Miyoshi

SUBJECT: Review of the Defense Waste Processing Facility (DWPF) at the Savannah River Site (SRS)

1. **Purpose:** This report documents the Defense Nuclear Facilities Safety Board (Board) staff review of DWPF at SRS. The review was conducted on October 24 - 27, 1995 by Joe Sanders, Cliff Moore, Joe Roarty, Roger Zavadoski, and Lani Miyoshi, and focused on process safety and hazard analyses, chemical and mechanical systems, and certain waste management activities.

2. **Summary:** The degree of defense-in-depth provided by upgrading certain mechanical systems, such as Zone 1 Exhaust, Melter Offgas, and Nitrogen Purge, to safety class was evaluated by the staff and found to be adequate. However, the review by the staff and outside experts of the seismic performance of these upgrades (i.e. whether these systems will operate successfully in the accident scenarios for which they are designed) has not been completed and will not be covered by this report. In addition, specific chemical processing concerns, including melter foaming and unplanned siphons between process vessels, were addressed and are approaching resolution. Existing safety significant systems allayed staff concerns over inadequate protection of the onsite worker, and acknowledgment of these safety significant activities will be included in Revision 13 of the DWPF Safety Analysis Report (SAR). The criticality safety program was also found to be adequate, but the controls required to ensure safety are not specifically included in the Technical Safety Requirements (TSRs) as consistent with DOE Orders 5480.22, "Technical Safety Requirements," and 5480.24, "Nuclear Criticality Safety." Additionally, concerns raised by a Board outside expert over the adequacy of systems for mitigation of a benzene explosion in the DWPF Salt Process Cell were found to be addressed by the existing SAR. Finally, the program for ensuring process vessel integrity was found to be well developed.

   However, two areas for which the staff has continuing concerns were identified during this review. First, emergency preparedness provisions for the new training facility located approximately 250 meters from DWPF, the Replacement Tritium Facility (RTF), and H Canyon/HB-Line do not appear adequate. The training facility accommodates 1000-1500 people on average, many of whom are not permanently located in the building. Although this is not a direct DWPF issue, given the nature and proximity of the aforementioned hazardous facilities to this new training facility, this deficiency needs to be addressed before DWPF begins radioactive operations. The Board staff will further investigate this issue.

   Secondly, specific plans and criteria for removing, decontaminating, shipping, and storing failed equipment in the Failed Equipment Storage Vault (FESV) have not been established. Because equipment removed from DWPF will most likely be contaminated with high level waste (HLW), a systems engineering approach needs to be utilized to ensure a safe transition of this equipment from failure to final disposal. Additionally, the FESV has not been functionally tested and is experiencing water infiltration problems from an unknown source.

3. **Background:** As noted in previous reviews by DOE and the Board, the original facility design did not provide adequate assurance of confinement of radioactive and chemical material under certain design basis accident scenarios. Neither the ventilation, purge, nor supporting backup electrical power systems were considered to be safety related. As a result of these critiques and further evaluations, backfit upgrades have been performed to provide greater defense-in-depth against applicable accident scenarios. These include safety class backup nitrogen purge systems in applicable process tanks, safety class upgrade of the Zone 1 Ventilation System, and modification of the effluent monitoring system to ensure post-accident functionality. While the safety protection provided by upgrades operating according to design under normal operations as well as certain accident scenarios was covered by this trip, the review by staff and outside experts of the ability of these upgraded systems, structures, and components to successfully perform their desired functions during the seismic events for which they are designed is ongoing.

The DWPF SAR, Revision 12, was issued May 1995 and an action plan for review of this revision was subsequently prepared by DOE-Savannah River (DOE-SR). The ensuing review identified 125 open issues and 101 revision issues for the DWPF SAR and its associated TSRs. The open issues are currently being resolved. DOE-SR will respond to the resolution of all open issues prior to issuing the Safety Evaluation Report (SER), which will serve as the basis for the DOE-SR approval of the DWPF SAR and its TSRs. The revision issues will be resolved before the first annual update of the SAR.

The Board staff has reviewed the DWPF safety authorization basis and supporting documents, including the DWPF SAR, TSRs, The report on the DOE review of the SRS DWPF SAR, and the Process Hazard Reviews (PHRs). The documents were reviewed not only for adequacy of analyses and completeness, but also for demonstrated commitment to design features necessary to ensure that DWPF processes can be conducted safely. These documents, along with previous staff visits, were the basis for the issues discussed in this visit. Comprehensive documentation of the overall review will be provided in the staff issue papers to be completed before the public hearing currently scheduled for January 9, 1996.

4. **Discussion:**

   a. Site Training Facility: Approximately 250 meters from the effluent discharge stack at DWPF is the new Site Training Facility, Building 766-H. The location of the training facility with respect to other SRS facilities is highlighted in the attached figure.
   The training facility provides a variety of training services, such as Radworker I and II, all phases of respiratory protection, various computer short courses, and hosts a large cafeteria. The average population of the facility is between 1000-1500 people during

operational hours, many of whom are transients due to the nature of the facility. Preliminary discussion with WSRC personnel did not reveal a substantial emergency preparedness program for the training facility. In view of the proximity of the building to potential effluent discharge locations during projected accident scenarios, specific considerations need to be given to the impact of various emergencies on the training facility and measures to be taken to reduce potential consequences. Again, information on this issue is preliminary and the Board staff has planned further investigation.

b. Management of Failed Process Equipment: Failed equipment not meeting the Waste Acceptance Criteria (WAC) for the E-Area vaults will be stored in the FESV, below-grade reinforced concrete structures adjacent to the DWPF. Failed equipment which can be stored in the FESVs include a failed melter, a melter catch pan filled with glass, thermowells, feed tubes, a melter feed tank, and the sludge receipt and adjustment tank (SRAT). A large steel box with a flange sealing system will house the failed equipment and be inserted into the vault. Two vaults have been constructed, and four more are scheduled for construction in FY98.

This review identified two main areas of concern with respect to the interim storage of failed equipment. First, the existing vaults have not been functionally tested, and certain technical issues must be resolved prior to operation. Foremost is a problem with water infiltration into the FESV. In 1992, two feet of water was discovered on the vault floors and was subsequently pumped out via the sump system. This same amount of water has been pumped out twice since then, most recently in August 1995. The source of this water has not been established. Additionally, testing and review of the facility will not be possible until fabrication and receipt of the failed equipment storage box and the railcar is ready for operation. A schedule has been established for the resolution of these problems and for the turnover, functional testing, and review of the FESV before the first projected failure of the melter (two years and five months after startup). However, as the DWPF process is not mature, premature equipment failure may require use of the FESV in an earlier time frame. The staff has not reviewed plans supporting the schedule and cannot make a determination whether the first FESV, storage box, and railcar will be ready to support DWPF operations in the anticipated time frame. The Board staff will continue to follow WSRC's performance on this matter.

Secondly, the SAR does not detail the specific operations and governing criteria for loading, decontaminating, transporting, and unloading the failed equipment to the FESV. This is a concern not only because these plans should be in place before the FESV is utilized, but also because the planning process lends insight into the possible hazard and operational problem scenarios that could arise in the process. Furthermore, if failed equipment to be stored in the vault may eventually be disposed as HLW, planning for placing failed equipment in the FESV should incorporate foresight regarding the removal and final disposition of this equipment from the FESV at some unspecified future date.

This issue is not a startup issue, but it is one that needs to be addressed in a timely matter, before the FESV is utilized. The staff has requested further documentation on this matter.

c. DWPF Criticality Safety: Kilogram quantities of fissile material will exist in DWPF. The presence of large quantities of neutron absorbers are relied upon to ensure subcriticality during normal and credible abnormal accident conditions. Actual ratios for iron and manganese relative to plutonium (Fe/Mn/Eq. Pu = 1321:55:1) as compared to safe weight ratios (Fe/Mn/Eq. Pu = 26.5:53:1) indicate significant margin exists in the processing of sludge and precipitate in DWPF.

The TSRs for DWPF omit any control or concern for criticality, other than to mention in a section entitled "Procedures, Programs and Manuals" that Nuclear Criticality Safety Evaluations and Nuclear Criticality Safety Analysis Summary Reports referenced in Chapter 8 of the DWPF SAR are the basis documents for nuclear criticality safety control. This approach to criticality control is not consistent with DOE Orders 5480.22, "Technical Safety Requirements", and 5480.24, "Nuclear Criticality Safety." Explicit statements to demonstrate the process for sampling batch quantities of sludge and precipitate, controlling additions of chemical agents that could potentially concentrate fissile materials, and identifying allowable variances in safe weight ratios for iron and manganese relative to plutonium would meet Order requirements. In addition, the order requirement for insuring double contingency protection needs to be explicitly addressed.

d. Mitigation of a Benzene Explosion in the DWPF Salt Processing Cell: DWPF utilizes a flowsheet which produces several explosion accident scenarios. In particular, a benzene explosion accident scenario in the Salt Process Cell (SPC) results in the most extensive offsite unmitigated dose consequences (36.5 REM) of any accident scenario involving the DWPF. One of the initiators for this scenario is an overflow of the Organic Evaporator (OE) due to uncontrolled water addition. Such an overflow results in a discharge of up to 814 gallons of hot benzene to the floor of the SPC. This could result in an explosion capable of breaching the canyon and dispersing both radioactive and toxic substances offsite. Prompted by a concern raised by a Board outside expert about the apparent lack of engineered mitigation for this initiator, the staff reviewed this issue extensively during this site visit.

According to the DWPF SAR, the primary control mitigating overflow of the OE is a TSR which restricts water additions. However, the staff review determined that DWPF process safety management provides additional defense-in-depth through the following engineered features:

- the released benzene is collected initially in the SPC sump. The sump and associated collection trenches are covered to minimize benzene vapor generation during an overflow;

- the sump level is monitored by a safety class level detection system which interlocks to shut off the SPC transfer and sample pumps on detection of a high liquid level in the sump;

- the process design provides no direct water input sources for the OE; and

- the safety class Zone 1 ventilation system provides dilution of the SPC airspace. Calculations are currently underway to determine if the Zone 1 ventilation system can maintain adequate dilution during an overflow coupled with sump system failure to ensure the benzene lower flammability limit is not reached. The staff will review these calculations when they are completed.

e. Process Vessel Integrity Program: The Structural Integrity Program (SIP) at DWPF is designed to maintain the integrity of the process vessels and related components. The program is mature and proactive, providing material testing, inspection points and frequencies, and vessel lifetime prediction. Incorporated in the program is an independent review committee that analyzes the inspection data and provides recommendations. Data from the inspections of pilot plant coupons and DWPF process vessels following cold chemical runs indicate excellent material performance with two minor exceptions. The cooling coils in the viscous frit slurry environments show erosion at the lower supports, and the melter head instrument ports show corrosion due to the presence of oxygen at high temperatures. Corrective actions for these concerns are currently in progress. Analysis of the information available to date suggests a process vessel lifetime of ten years and a cooling/steam coil lifetime of two to three years, depending on the service environment. Future activities for the SIP include development of eddy current or ultrasonic inspection techniques for in-service inspection of the process vessels.