DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

August 7, 2008

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: A. Gwal

SUBJECT: Review of Electrical Systems, Plutonium Finishing Plant and Tank Farms, at the Hanford Site

This report documents a review by the staff of the Defense Nuclear Facilities Safety Board (Board) of the electrical systems of the Plutonium Finishing Plant (PFP) and the Tank Farms at the Hanford Site. During June 3–5, 2008, staff members A. Gwal, S. Lewis, D. Eyler, E. Rozek, and R. Quirk (Site Representative) assessed the design and construction of these electrical systems with the participation of representatives of the Department of Energy (DOE) Richland Operations Office (DOE-RL) and its contractor for PFP, and DOE's Office of River Protection (ORP) and its contractor for the Tank Farms. The staff also reviewed documents received in July 2008 that related to electrical calculations and studies.

Plutonium Finishing Plant. Since the shutdown of the PFP complex in 1996, various deactivation and decommissioning activities have been performed. Originally, the buildings in the complex were to be demolished to slab-on-grade by September 2009. Funding constraints delayed this end state to 2016. The contractor evaluated the impact of this delay by conducting life extension studies for facility systems. The plant life extension (PLEX) program may include replacing or upgrading critical operational structures, systems, and components (SSCs). The contractor's evaluations included all critical SSCs except the electrical cables. Some of the electrical equipment is 25–60 years old.

Discussions held by the Board's staff with personnel from DOE-RL and the contractor focused mainly on the PLEX program. The staff also performed a walkdown of the facility to assess the condition of selected safety-related electrical equipment and cables. The following observations resulted from the discussions held and the walkdown of the facility.

Cable Condition Monitoring Program—In early 2007, PFP used various means to extend the life of the safety-related critical electrical equipment of the electrical distribution system. However, the insulated electrical cables were not evaluated as a critical SSC during the PLEX studies because PFP personnel believed the conductors normally do not fail unless they are disturbed. Safety-related cables at PFP vary in age and may be 20–60+ years old; they are approaching or have exceeded their intended service life. The Board's staff disagrees with the

contractor's position regarding the electrical cables. As cables age, their electrical characteristics may degrade to an unacceptable level, thereby decreasing the reliability of both the cables and the systems they support. Because these aged cables provide power for a number of facility safety systems, the staff believes it would be prudent to establish the remaining life of the cables and consider incorporating into the existing PLEX program the capability to monitor their condition. Monitoring the condition of the cables could improve the service life and reliability of electrical equipment by making it possible to detect damaged and deteriorating power, instrumentation, and control cables prior to equipment failure.

In a teleconference with PFP personnel on September 13, 2007, the Board's staff expressed concern that age-related degradation of the cables could lead to the failure of safety-significant systems. The staff suggested the use of industry practices to estimate the remaining life of the safety-related cables and the application of the Institute of Electrical and Electronics Engineers (IEEE) Standard-1205, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations*, for all of the electrical equipment. The staff also suggested that programs at the Savannah River Site (SRS) could provide a suitable model to follow. Following the September 2007 teleconference, PFP personnel contacted SRS and the Electric Power Research Institute to obtain details on their approaches to the assessment of aging electrical cables and obtained related documentation.

During the staff's recent review, PFP personnel stated they are evaluating the need for a program to monitor the condition of the electrical cables. If funded, the program would probably include testing to determine the remaining life of the cables. The Board's staff believes the approach taken thus far is appropriate.

Unprotected 480-Volt Switchgear—Safety-significant switchgear in Room 266 in Building 234-5Z is relied upon to provide power for safety-significant loads. The switchgear is designed with openings on the tops of the cabinets and vents on the front and back panels for heat dissipation. These openings are located under the sprinkler heads of the fire suppression system. Water spray resulting from an activation of the sprinkler system would likely penetrate the switchgear and could generate a short circuit that could damage the switchgear, create hazardous conditions, and leave safety-significant loads without power. PFP personnel agreed to evaluate this issue.

Additionally, the Board's staff observed that water could have leaked inside the 480-volt switchgear in Room 500 of Building 291Z. PFP personnel agreed to evaluate the switchgear for damage.

Hydrogen Explosion Hazard in the Battery Room—Batteries produce hydrogen gas during normal operation, and proper ventilation in the battery room is needed to ensure that hydrogen does not accumulate in quantities sufficient to create the potential for an explosion. American National Standards Institute C2, *National Electric Safety Code,* requires adequate ventilation in battery rooms to prevent hydrogen explosions. Battery Room 269 in Building 234-5Z has an exhaust duct to remove the hydrogen generated during normal operation. However, the opening of this duct is approximately 2 feet below the ceiling. This configuration

could allow the accumulation of hydrogen within this 2-foot space. This space also includes electrical cables that could serve as an ignition source. The Board's staff suggested that PFP personnel evaluate design modifications that would prevent hydrogen accumulation in the 2-foot space between the duct and the ceiling.

Additionally, the Board's staff noted an open-filament space heater above lead-acid batteries in the diesel generator room (Room 2721). An explosion could result if hydrogen of sufficient concentration produced by the lead-acid batteries were to come in contact with the open filament of the space heater. PFP personnel indicated they will evaluate this issue.

Routine Inspection—Because of aged electrical equipment, the Board's staff suggested the use of thermography devices for routine inspection of electrical switchgear, motor control centers, panel boards, and control panels. These devices can detect hot spots in electrical equipment and support the initiation of timely corrective action to prevent electrical failure, fire, and exposure of workers to possible arc-flash conditions. PFP personnel had considered using such devices but had not done so because of other priorities and funding constraints. They have agreed to reevaluate the use of these devices.

Tank Farms. The staff's review of electrical distribution systems at the Tank Farms was limited to those Tank Farms containing the 28 double-shell tanks (DSTs). Discussions between the staff and personnel from the Tank Farms focused mainly on the design of the electrical distribution systems, including the related calculations and studies. The staff also performed walkdowns of the AP, AY, and AZ Tank Farms to assess the condition of selected electrical equipment and cables. The following observations resulted from these discussions and walkdowns.

Electrical Calculations and Studies—The Board's staff reviewed load flow analyses, short-circuit calculations, and protective device coordination studies for all the DST Tank Farms. These calculations and studies, which were performed by the contractor in 2001, 2005, and 2007, identified many deficient design conditions. Examples of these deficient conditions include non-compliance with National Fire Protection Association (NFPA)-70, *National Electrical Code*, changes in cable size, improper modifications and settings of circuit breakers, an undersized transformer for the SY Tank Farm, and improper fuse changes. If not corrected, some of these deficiencies could create safety issues.

The contractor identified 78 design issues from the calculations and studies for the Tank Farms. According to Tank Farm personnel, 29 issues have been resolved, 39 require field work and verification, and 10 require engineering evaluation. Typically, design deficiencies identified by calculations are resolved soon after the calculations have been completed. However, several outstanding design deficiencies may date back to 2001. The Board's staff suggests that all of the design deficiencies be resolved as soon as possible.

Non-Safety Electrical System Supplying Power to Safety-Significant Loads—The primary ventilation systems for the DSTs are classified as safety-significant SSCs to prevent or mitigate accidents involving flammable gas. Electrical power is necessary to support the operation of the

exhaust fans for the primary ventilation systems, but the plant electrical distribution system supplying these fans is not classified as a safety-significant support SSC. The following DOE directives provide guidance related to the classification of support SSCs:

- DOE Guide 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, states: "Support SSCs to safety-significant SSCs that mitigate or prevent accidents with the potential for significant onsite consequences should be classified as safety-significant if their failures prevent a safety-significant SSC from performing its safety functions."

- A requirement in DOE Standard 3009-2004, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses* (DSA), is: "Identify SSCs whose failure would result in a safety-significant SSC losing the ability to perform its required safety function. These SSCs would also be considered safety-significant SSCs for the specific accident conditions or general rationale for which the safety-significant designation was made originally."

The DSA refers to a calculation that estimates the time required to reach 100 percent of the lower flammability limit (LFL) to be more than 38 days under zero ventilation conditions for the limiting tank. The DSA notes that if the primary ventilation system for a DST is not operating because of an interruption of electrical power, action shall be taken to restore electrical power (e.g., bypass routing or temporary generators) before flammable gas conditions in the tank reach a level of concern.

The Board's staff reviewed the electrical systems of all the DST Tank Farms and observed that the AY/AZ Tank Farms, which have the most limiting generation of flammable gas, have a diesel generator as a backup source for electrical power. The staff noted that this system could be upgraded to safety-significant status with little if any physical modification. However, none of the other DST Tank Farms have backup diesel generators, and they depend on alternative sources for electrical power in the event of a loss of normal electrical power. Although portable generators could be used, no formal procedure exists to ensure that the appropriate number of generators is always available to meet the requirements of all the Tank Farms during a total loss of electrical power for an extended period of time.

The Board's staff concurs with the decision not to require that power to the DST ventilation systems be classified as safety-significant because the time to reach LFL conditions is long. Waste retrieval and transfer activities can reduce this time, however. If the time to reach LFL conditions is significantly reduced by retrieval and transfer activities, the staff believes it would be prudent for ORP to reevaluate the functional classification of the electrical power supply and distribution systems.