DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

July 2, 2019

The Honorable James Richard Perry
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Perry:

The Defense Nuclear Facilities Safety Board reviewed the Hanford Site electrical infrastructure and systems supporting certain nuclear operations. The scope of this review included the site electrical distribution system, facility power systems, back-up power systems, and emergency lighting systems.

The Board observed that the Hanford Site has made progress on improving the site-wide electrical infrastructure over the past few years. There are projects planned that, when completed, should allow the operational flexibility necessary to manage the evolving Hanford mission. One issue of concern, however is that a significant portion of the T-Plant electrical distribution system is original to the facility and is well past its design life. Its age, combined with the lack of an alternate power supply, could impact the reliability of the safety significant confinement ventilation system. An alternate power feed, preventive maintenance program, and replacement of aging electrical support equipment would increase the reliability of the existing control set and help extend the operational life of the facility.

The enclosed report is provided for your information and use.

Yours truly,

Bruce Hamilton
Chairman

Enclosure

c: Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

March 13, 2019

Review of Hanford Site Electrical Infrastructure

Summary. Members of the Defense Nuclear Facilities Safety Board's (Board) technical staff traveled to the Hanford site on May 15–17, 2018, to review the electrical infrastructure and systems supporting nuclear operations at key facilities. The scope of this review included the site electrical distribution system (13.8/2.2 kV), facility power systems (480/120 V), back-up power systems, and emergency lighting systems. The staff review team performed walk-downs of selected electrical equipment to both assess its physical condition and to verify that specific design information matched the installed equipment. The review team also followed up on emergent information regarding the interrupting capacity of installed electrical breakers in late 2018-early 2019, but determined that the impact on this review was minimal. In addition to reviewing the design and condition of electrical equipment, the staff team reviewed the status of the site's electrical safety program.

Background. Two collocated Department of Energy (DOE) field offices, the Richland Operations Office (DOE-RL) and the Office of River Protection (ORP), are responsible for facilities at the Hanford site. CH2M HILL Plateau Remediation Company (CHPRC) manages the DOE-RL nuclear facilities. DOE-RL also is responsible for all site-wide infrastructure, and Mission Support Alliance (MSA) is the primary contractor for these systems. Washington River Protection Solutions (WRPS) manages the ORP nuclear facilities.

Given the size of the Hanford site and the number of its nuclear facilities, the staff review team tailored the scope of this review to focus on key systems and facilities. From DOE-RL, the team selected T-Plant and the Plutonium Uranium Extraction Plant (PUREX). The team also reviewed a cross-section of electrical distribution equipment across the site, including the A-8 and A-9 substations and primary distribution equipment supporting the 200 Area. From ORP, the team selected the double shell tank farms (with the exception of SY-farm), the 242-A Evaporator, and the 222-S Laboratory.

Discussion. The staff review team identified one primary area with significant potential to impact the safety and operability of a nuclear facility at the site. As a result, the review team has classified this as a Potential Safety Item. Two additional review observations are also provided in this section given their impact to multiple facilities across the site and the risk presented to facility workers and equipment.

Reliability of the T-Plant Electrical Distribution System—A significant portion of the electrical equipment supporting operations at T-Plant is original to the facility, which began operation in 1945, and is therefore well past its original design life. Even if properly maintained, the reliability of this equipment will degrade over time. As the facility does not have an alternate power source (e.g., back-up generation capability), the equipment age presents an increased risk to safe nuclear operations.

Table 3-17 of the documented safety analysis (DSA) for the Solid Waste Operations Complex [1] currently lists the T-Plant electrical distribution system as "Equipment Important to Safety" and states that its safety function is to support operation of the safety significant confinement ventilation system. This safety function currently is required only when the facility is in the ACTIVE mode. The table goes on to document the basis for this designation as the "facility does not have an alternate source of electrical power and as such the operational activities will be limited to those required to place the facility in a safe configuration, and place the affected areas of the facility in a STANDBY mode, upon loss of power." The system description adds to this discussion:

> *The power supply to the exhaust fan motors is not considered to be SS [safety significant] due to the availability of sources of electrical power to provide redundancy and also the potential consequences to the collocated worker and offsite exposed individual do not warrant expenditure of the resources to upgrade the available power to SS. U.S. Department of Energy, Richland Operations Office (RL) accepts the risk of having a SS ventilation system without having an associated SS electrical power supply.* [1]

Given the lack of an alternate power supply (e.g., back-up power) noted in Table 3-17, this justification appears incongruous, as in reality there is minimal function redundancy in the electrical distribution system. When compounded with the age of the primary electrical distribution equipment, the staff team concluded that the overall reliability of the safety significant ventilation system is significantly impacted. As DOE is now using the facility to store sludge waste from the 100-KW Basin, there is not a clear timeline for how long the existing safety significant control will be required to remain operational. Addressing the lack of an alternate power feed, increasing the frequency of scheduled preventive maintenance, and/or replacing aging electrical support equipment would both increase the reliability of the existing control set and help extend the operational life of the facility.

Qualification of Emergency Lighting—Facilities across the site generally provide emergency lighting (e.g., emergency lanterns and emergency exit signs) to assist safe egress upon loss of power in accordance with requirements in National Fire Protection Association (NFPA) 101, *Life Safety Code*. Through discussions with site personnel, the staff review team understands that emergency lighting generally is not designed to the Performance Category of the supported facility. Therefore, there is the potential that neither normal nor emergency lighting will be available during and after a design basis event (i.e., earthquake).

This vulnerability is inconsistent with both modern building codes and emergency management standards. The International Building Code and American Society of Civil Engineers Standard 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, establishes seismic performance expectations for all equipment commensurate with its life safety function. In addition, DOE Order 151.1D, *Comprehensive Emergency*

Management System [2], states that "Equipment must be maintained and tested, as applicable, to ensure equipment functions as designed for emergency response and implementation of protective actions[1] based upon the all hazards planning basis." Therefore, if equipment is to be relied on to support facility egress, it should be designed and tested to function in the same environment as the installed facility.

While the site contract currently does not require compliance with these standard revisions, this guidance remains good engineering practice. Logically, the emergency lighting system primarily is needed for events that both disrupt normal electrical power and require personnel to exit the facility quickly. Designing the emergency lighting to survive credible accident scenarios is therefore necessary to ensure that the system can perform its intended function in a meaningful way. Where not practical, compensatory measures to ensure an alternative means of egress should be provided.

*Maintenance of Electrical Cabling—*The Hanford site-wide electrical distribution system is designed to provide power to a diverse collection of nuclear and non-nuclear facilities spread over a large geographical area. Given the size and complexity of the system, reliability (or availability) is an essential statistic that MSA actively tracks and manages. The site-wide electrical distribution system is general service and is not explicitly credited in any facility safety basis. However, there is a fundamental assumption in safety basis development that utility systems are installed and maintained per relevant industry practices and are generally reliable.

The majority of the medium voltage power lines on the site are installed above ground on utility poles. As part of the maintenance program for the overhead electrical distribution system, MSA documents equipment condition on a periodic basis through the use of various monitoring techniques (e.g., thermography, insulation testing, visual inspections). These activities are managed through an electronic database to ensure compliance with the equipment maintenance requirements. MSA also has recently added a formal utility pole surveillance program to capture operational life data and identify deteriorating poles for replacement.

In addition to the above ground portions of the electrical distribution system, there are many key underground segments, such as transitions out of substations. While the underground segments are a small percentage of the overall electrical distribution network, underground cabling is a critical component that can affect overall system reliability. However, Hanford currently does not have a surveillance and maintenance program for underground electrical cabling.

The NFPA-70E Handbook [3] explains that commentary written along with the articles provides historical perspective "…into the reasons underlying the requirements, to provide a clear understanding of how those requirements are to be properly applied." Article 210.4 states that "insulation integrity shall be maintained, to support the voltage impressed," and the explanation section of the article goes on to explain that this means periodic maintenance and testing are necessary. When compounded with the age of installed electrical distribution system

[1] DOE Standard 151.1D [2] defines these as actions "taken to minimize the consequences of emergencies and to protect the health and safety of workers and the public." Facility egress is given as a specific example in the body of the standard.

cabling, the site's lack of surveillance and monitoring introduces a significant unknown related to the overall reliability of the site-wide electrical infrastructure. During discussions, MSA personnel acknowledged this vulnerability and discussed a general desire to replace aging underground cabling. However, MSA has not scheduled a project to perform this activity. While replacing old cabling on a preventive basis will improve the overall system condition, a monitoring and surveillance program (similar to that for utility poles) would provide a more robust long-term solution.

There are credited safety systems at the Hanford site (e.g., T-Plant confinement ventilation system) that rely on power from the electrical distribution system. The T-Plant confinement ventilation system is credited with reducing the consequences to workers from design basis spills and fires to an acceptable level. Consequently, unknowns related to the reliability of electrical power could translate into vulnerabilities regarding the ability of these systems to perform their credited safety functions, especially in cases where credited back-up power is not available. In addition, failure to maintain underground cabling is inconsistent with both NFPA guidelines and existing maintenance practices on other site medium voltage distribution equipment. Ideally, testing and monitoring activities should employ a repeatable, nondestructive method of trending and analysis that focuses on insulation health and tracking underground cable service life. With this data, MSA will be better able to identify deteriorating cable before it has a significant impact on the availability of the site-wide electrical distribution system.

Conclusion. Hanford has made significant progress on improving the site-wide electrical infrastructure over the past few years. There are projects planned that, when completed, should allow the operational flexibility necessary to manage the evolving Hanford mission. However, the staff review team did identify one Potential Safety Item that could impact the safe conduct of nuclear operations.

- Much of the T-Plant electrical distribution system is original to the facility and is well past its design life. A credited back-up power supply would increase the reliability of the existing control set and help extend the operational life of the facility.

The review team also noted two observations related to systems affecting multiple site facilities.

- Emergency lighting across the site generally is not seismically designed. As such, its availability to support facility egress after a design basis earthquake cannot be determined. This is inconsistent with modern building codes and DOE emergency management standards.

- There is currently no regular inspection or maintenance program for underground electrical distribution system cabling. This is inconsistent with both industry and other site distribution system maintenance practices and introduces a significant vulnerability to the overall reliability of the site-wide electrical distribution system.

Cited References

[1] CH2M HILL Plateau Remediation Company, *Solid Waste Operations Complex Master Documented Safety Analysis*, HNF-14741, Revision 12, October 2017.

[2] Department of Energy, *Comprehensive Emergency Management System*, DOE Order 151.1D, August 2016.

[3] National Fire Protection Agency, *Handbook for Electrical Safety in the Workplace*, NFPA-70E Handbook, 2015 Edition.