DEFENSE NUCLEAR FACILITIES SAFETY BOARD

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May 29, 2001

The Honorable Carolyn L. Huntoon
Acting Assistant Secretary for
Environmental Management
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Dr. Huntoon:

Enclosed for your consideration and action are observations made by the staff of the Defense Nuclear Facilities Safety Board (Board) concerning the electrical and instrumentation and control systems at the L-Area Experimental Facility (LEF) at the Savannah River Site. In the enclosed report, the staff notes that the Instrument Society of America standard for safety instrumented design, S84.01, *Application of Safety Instrumented Systems for the Process Industries*, has been considered for LEF safety systems, but may have been applied inappropriately. Furthermore, portions of the safety shutdown system do not appear to have been analyzed consistent with the safety function they are designed to perform.

The Board's staff also observed that certain electrical system calculations and coordination studies important to personnel safety have not yet been performed. The enclosed report summarizes the staff's observations regarding the LEF electrical system.

The Board would like to be kept abreast of the Department of Energy's actions in response to the enclosed report.

Sincerely,

John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Mr. Greg Rudy

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

April 24, 2001

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: C. Graham

SUBJECT: Electrical and Instrumentation and Control Systems, L-Area Experimental Facility, Savannah River Site

The staff of the Defense Nuclear Facilities Safety Board (Board) met with representatives of the Department of Energy (DOE) and its contractor at the Savannah River Site (SRS) on February 13–15, 2001, and conducted a follow-up review on March 22, 2001. The focus of these reviews was on evaluating the adequacy of the electrical and instrumentation and control (I&C) systems at the L-Area Experimental Facility (LEF), and in resolving issues regarding the I&C systems raised in a November 2000 staff review of the LEF. The February and March reviews were performed by A. Gwal, C. Graham, W. White, and site representative T. Davis.

Background. The LEF is designed to be a limited-use (i.e., 18-month campaign) research facility. It is a proof-of-concept experiment intended to demonstrate the capability to melt and dilute aluminum-based spent nuclear fuel. A manually controlled, off-the-shelf induction melter is used to melt the fuel. During its 18 months of operation, the LEF is expected to complete 6–10 fuel melts. The contractor plans to build a much larger facility if the LEF project is successful.

Safety-significant I&C components of the LEF system include redundant interlocks that shut down the furnace if limits are exceeded for temperature, temperature ramp, and moisture. Safety-significant instrumentation also includes alarms for high differential pressure across the high-efficiency particulate air filters and the furnace enclosure. Other safety-significant equipment includes an uninterruptible power supply (UPS), an exhaust fan, and several valves.

In an LEF design review conducted during November 1–3, 2000, the staff identified several issues related to I&C systems, conformance to industry standards, and human factors engineering. Many of these issues have since been resolved. The present report summarizes outstanding issues related to electrical and I&C systems.

Electrical System. The Board's staff has evaluated the design of the electrical distribution system for the LEF and identified the following issues:

Electrical Calculations—Comprehensive short-circuit, interrupting capacity, and coordination studies are essential for safety. These studies should be performed in accordance with Institute of Electrical and Electronics Engineers (IEEE) standards STD-141, *IEEE*

Recommended Practice for Electric Power Distribution for Industrial Plants, and STD-242, *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems*. The contractor has not yet completed these calculations. Therefore, the Board's staff could not verify the capability of the electrical equipment to perform its intended functions safely. During follow-up discussions LEF personnel informed the staff that these calculations will be performed. The staff will review the completed calculations when they are available.

Safety-Significant Uninterruptible Power Supply System—The UPS for the LEF will be seismically qualified by being tested in accordance with the requirements of IEEE-344-1987, *Recommended Practice for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations*. During the February 2001 review, LEF personnel stated their intention to use the seismically tested UPS for operation in the LEF. IEEE-344-1987, Section 7.1, provides guidance related to the use of seismically tested equipment. It states that equipment that has been shaker-table tested should, in general, not be installed in a plant unless it can be demonstrated that the accumulated stress cycles already experienced by the equipment will not degrade its ability to perform its safety function. Subsequent to the staff reviews, DOE informed the staff that a new UPS would be obtained for the LEF; accordingly, this issue is resolved.

Battery Ventilation—American National Standards Institute (ANSI) C2, *National Electric Safety Code*, requires adequate ventilation and loss-of-ventilation alarms for rooms with lead-acid batteries to ensure that hydrogen does not build up and result in an explosion. The staff visited the battery room in the L-Reactor area and is not convinced that it meets the intent of ANSI C2. The contractor will evaluate this situation and justify the adequacy of the battery room ventilation system to meet ANSI C2.

Lightning Protection—The Board's staff observed that the lightning protection system for the LEF does not meet the requirements of National Fire Protection Association (NFPA) Standard NFPA-780, *Lightning Protection Code*. The wall next to the control building has no lightning protection, and the few existing components of a lightning protection system installed in other L-Area buildings are not maintained. The staff believes a lightning protection system, compliant with NFPA-780, would be appropriate for the LEF. During follow-up discussions LEF personnel informed the staff that a lightning protection system will be designed and installed.

Instrumentation and Control Systems. The Board's staff evaluated the design of the I&C systems for the LEF and noted the following issues:

Design and Analysis of I&C Systems—Westinghouse Savannah River Company (WSRC) has incorporated Instrument Society of America (ISA) Standard S84.01, *Application of Safety Instrumented Systems for the Process Industries*, as a design requirement for safety-significant I&C systems. The Board's staff was pleased to note that SRS is the first DOE site to identify industry design standards for application to safety-significant I&C systems. However, the staff identified several issues regarding the methodology WSRC used to apply the standard.

- It does not appear that WSRC properly identified independent protection layers (IPLs) when performing layer-of-protection analysis to determine the safety integrity

level (SIL) required for a safety-significant instrument. IPLs are intended to protect against a specific hazard and should be independent of the unmitigated hazard event and other IPLs. The analysis incorrectly credited some systems with providing protection for events they were not designed to prevent. An IPL was incorrectly credited with protecting against an over-temperature condition, and project duration was considered as an IPL for both the over-temperature and steam hazards.

- WSRC focused primarily on the sections of ISA S84.01 that address the safety requirements specification (SIL determination) and reliability requirements of components to be used in the system. System design might be improved, however, if attention were given to ensuring that safety-significant I&C systems meet the deterministic criteria outlined in ISA S84.01 (Chapters 5–9) and the considerations of Annex B for the design, maintenance, and operation of safety systems.

Furnace Design—NFPA-86, Ovens and Furnaces, contains specific design guidelines for safety equipment related to furnaces. The staff discussed with contractor personnel the applicability of this standard to the LEF project and suggested that the contractor verify that the induction furnace conforms to NFPA-86, specifically to the design requirements of Chapter 5.

Furnace Shutdown Circuit—The staff is concerned about the operability and reliability of the furnace shutdown circuit. This circuit is a single point of failure, and its failure modes have not been analyzed. A part of the shutdown circuit uses a furnace control board that appears as a "black box" in the instrumentation diagrams. The contractor was unable to provide information about this control board, and the staff is concerned that its failure modes may not be well defined. The staff suggested that the contractor use a separate method for furnace power removal, independent of the furnace control board.

Functional Classification—Components relied upon for processing a shutdown following a safety-significant protective action should be designated as safety significant from sensor to final element. However, portions of the induction furnace circuitry discussed above have not been analyzed, nor have they been classified or procured as safety significant.