UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

September 6, 2013

NRC INFORMATION NOTICE 2013-17: SIGNIFICANT PLANT TRANSIENT INDUCED BY SAFETY-RELATED DIRECT CURRENT BUS MAINTENANCE AT POWER

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor early site permit, combined license, standard design certification, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operating experience involving the loss of one train of a direct current (DC) distribution system at power in a nuclear power plant. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Palisades Nuclear Plant

Palisades Nuclear Plant was operating in Mode 1 at approximately 98 percent power on September 25, 2011. An electrician was performing maintenance on the energized left train 125-volt DC distribution Panel D11-2 (reference figure on next page). While in the process of removing a breaker bus connector in safety-related Panel D11-2, without proper insulation of adjacent bus connectors, a maintenance technician inadvertently lost control of the energized positive copper bus connector, which swung down and contacted the negative copper bus connector. This resulted in an electrical fault in the panel and upstream shunt trip Breaker 72-01 (between the DC bus and the battery) opened on over-current, disconnecting the battery from the DC bus. By design, the fuse to Panel D11-2 was expected to isolate Panel D11-2 from the entire DC bus upon a fault in Panel D11-2. However, the shunt trip breaker was incorrectly installed in 1981 with thermal and instantaneous over-current protection features (latent design issue) and the over-current breaker trip device was at a current setting lower than the fuse current rating. Therefore, the shunt trip breaker opened quicker than the fuse could isolate the fault in Panel D11-2 and the entire left train 125-volt DC bus was lost (reference figure below).

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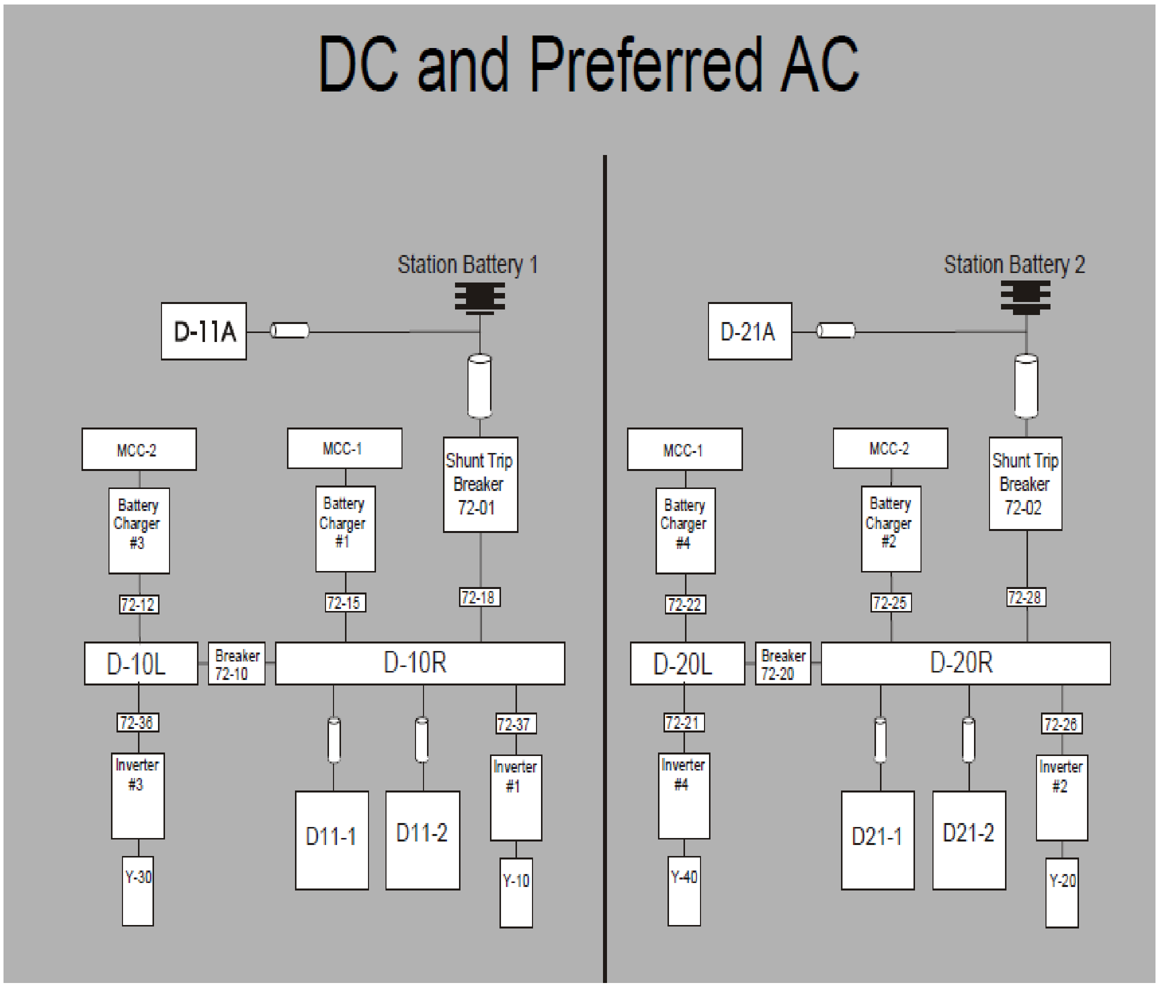
The electrical transient resulted in the failure of the in-service left train battery charger and associated left train inverters. This led to the loss of two preferred 120-volt alternating current (AC) power sources (busses Y-10 and Y-30) that supply power for the left train of annunciation and instrumentation in the control room. The failure resulted in the operators having only the right train of equipment available for annunciation and instrumentation in the control room.



Left Train **Right Train**

The loss of the left train 125-volt DC bus and two preferred AC power sources resulted in an instantaneous reactor and turbine trip caused by a reactor protection system actuation. These trips were coincident with the automatic actuation of the following systems and components: a safety injection actuation signal (automatically started right train emergency core cooling systems); main steam isolation signal (closed main steam isolation valves and main feedwater regulating valves); containment high radiation signal (switched control room heating, ventilation, and air conditioning system to emergency mode); containment isolation signal (closed left channel containment isolation valves); auxiliary feedwater (AFW) actuation signal (started one motor driven AFW pump and the turbine driven AFW pump with full flow); and a containment high pressure alarm (no actuation signal). The protection circuitry actuated as a result of the loss of the left train of DC power and was not required to mitigate a degraded or abnormal condition of the reactor. Also, at this time, the following major equipment was affected by the loss of the left train 125-volt DC system: the primary coolant pumps ‘A’ and ‘C’ coasted down; nonsafety-related AC busses 1A and 1F did not fast transfer; and the atmospheric steam dump valve master controller lost power, which made them unavailable to provide a steaming path to reduce primary side temperature and pressure. Secondary side steam pressure was controlled by the secondary side code safety valves for the first hour of the event.

During the transient, the operators encountered additional complications that included the following: an increasing primary coolant system (PCS) leak rate that was later determined to be from the actuation of a chemical and volume control system relief valve that relieved to the quench tank; an increasing PCS level in the pressurizer that could have reached a solid condition; an increasing steam generator ‘A’ level, which reached approximately 95 percent; and the actuation of suction and discharge pressure relief valves for the charging pumps, which displaced volume control tank water into the charging pump cubicles located in the auxiliary building.

The operators immediately responded to the event by using the emergency operating procedures. However, the licensee’s functional recovery and associated off-normal procedures were only written to address the loss of a DC train coincident with the loss of only one preferred AC power source. In this case two preferred AC power sources were lost, thus complicating the operators’ response. Operators were able to implement the existing procedures, while maintenance personnel troubleshot, diagnosed and corrected the loss of the 125-volt DC system. This action took approximately 50 minutes. Once power was restored to the preferred AC busses, secondary-side steam pressure was controlled through the use of the atmospheric steam dump valves. The operators then safely brought the plant to cold shutdown and the licensee began an event investigation. On September 26, 2011, the NRC dispatched a special inspection team to independently review the licensee’s actions and to determine the causes of the event.

Additional information appears in the following NRC inspection reports:

“Palisades Nuclear Plant – NRC Special Inspection Team (SIT) Report 05000255/2011014 Preliminary Yellow Finding,” dated November 29, 2011, in the NRC’s Agencywide Documents Access and Management System (ADAMS) under Accession No. ML113330802.

“Final Significance Determination of Yellow and White Findings with Assessment Followup and Notice of Violation, NRC Inspection Report Nos. 05000255/2011019 and 05000255/2011020, Palisades Nuclear Plant,” dated February 14, 2012, under ADAMS Accession No. ML120450037.

BACKGROUND

The DC power system provides power for Class 1E equipment such as breaker control, the plant instrumentation and control, monitoring, lighting (main control room and remote shutdown area) and other functions. The battery supplies the load without interruption should the battery charger or associated preferred AC source fail.

Criterion 21, “Protection System Reliability and Testability,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 states, “The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed.”

DISCUSSION

Reliability of the Class 1E DC power system is important in a nuclear power generating station. The DC power system is designed so that no single failure of an electrical panel, battery, or a battery charger will result in a condition that will prevent the safe shutdown of the plant. Addressees are encouraged to review their design, installed equipment, processes, and procedures to ensure that a similar latent design issue would not degrade the performance of their DC electrical system.

While the cause of the event at the Palisades Nuclear Plant revealed a latent design deficiency with DC protective devices, licensee current performance issues directly initiated and contributed to the event. The work performed could have been completed safely and without incident had licensee personnel followed and implemented existing procedures, as required.

Several operating experience lessons learned for emergent safety-related work on plant equipment were identified as a result of this plant transient. The following are applicable to all NRC licensees:

- In-field, engaged management oversight that reinforces worker behaviors and approved procedures is critical when working safely on risk significant, safety-related equipment.

- Ensure operations procedures exist for the response to all design basis events and licensed operators are trained on those scenarios as part of initial or continuing training.

- All employees are essential and responsible for ensuring work control processes and procedures are followed for all aspects of a maintenance evolution including work order planning, pre-job brief level determination, operational risk assessment of the work to be performed, conducting pre-job briefs and in-field changes to work orders or procedures.

- Noncovered nuclear workers (i.e., not covered under 10 CFR Part 26, “Fitness for Duty Programs”), including department-level managers and above, are required to follow applicable work hour guidance for noncovered workers as prescribed in licensee procedures.

- Before performing maintenance activities, an effective operational risk assessment typically includes worse-case scenarios, the importance of the work, and specified measures for working safely on risk significant equipment.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or to the appropriate NRC project manager.

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under NRC Library/Document Collections.

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