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

November 17, 2010

NRC INFORMATION NOTICE 2010-25: INADEQUATE ELECTRICAL CONNECTIONS

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor issued 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.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees about operating experience involving loose electrical connections. The NRC expects recipients to review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. The suggestions that appear in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

The Office of Nuclear Reactor Regulation reviewed operating experience related to inadequate electrical connections and found that the following issues often caused connection problems:

- lack of work order documentation indicating that connections had been loosened or removed
- failure to follow vendor- or industry-recommended torque requirements
- inadequate quality control verification of connection torque and resistance measurement
- incomplete or inappropriate maintenance practices
- improper washer installation
- lack of resistance verification to verify adequate torque
- inadequate tightening of connection after the removal of test leads
- failure to crimp and inspect the tightness of a lug connection
- marginal electrical connection during installation

- loose fuse holder retaining clips
- thermal cycling of electrical connections over time
- electrical connectors that are not fully seated
- worn or high-resistance electrical connector pins and sockets

The events described below are examples of recent electrical connection problems.

Columbia Generating Station

On August 5, 2009, an electrical fault occurred on a 6.9-kilovolt (kV) nonsegregated bus at Columbia Generating Station while the plant was operating at 100-percent power. The fault caused a main generator differential lockout, which resulted in a main turbine trip and the subsequent actuation of the automatic reactor protection system. The nonsegregated bus experienced a catastrophic failure, and the associated fire generated enough smoke in the turbine building to require the declaration of a notification of an unusual event. Although the extent of damage to the bus made it impossible for plant personnel to substantiate a direct cause, the licensee postulated that the most probable cause was the failure of a link assembly that allowed a short circuit between phase conductors. The failure of the link was attributed to thermal cycling that caused the bolted connections on the central flexible link to loosen. The licensee omitted steps in its preventive maintenance procedure for torque verification and high-potential testing without evaluating the scope and implications of these omissions. The licensee could have prevented the bus failure by performing these steps. (See Licensee Evaluation Report (LER) 397/2009-004-00, "6.9 kV Non-Segregated Electrical Bus Failure," issued 2009, Agencywide Documents Access and Management System (ADAMS) Accession No. ML092870468.)

Waterford Steam Electric Station, Unit 3

In May 2008, workers at Waterford Steam Electric Station (Waterford), Unit 3, replaced a cell in a safety related battery bank. The licensee failed to ensure that the scope of work was adequate. Specifically, the electricians did not (1) torque all of the affected intercell connections as recommended by the vendor, (2) obtain the required quality control inspector verification for every connection torque, (3) ensure that all the resistance measurements for the electrical connections were performed, and (4) ensure that the quality control verification for resistance checks met technical specification (TS) limits. These errors resulted in an undetected loose electrical connection that rendered the Train B battery inoperable. On September 3, 2008, Waterford operations declared the station battery 3B-S inoperable because of low voltage and entered TS 3.8.2.1. Licensee personnel discovered loose bolts on an intercell connector between two battery cells and immediately corrected the condition by tightening and verifying intercell resistance. The licensee declared the battery operable on the same day. (See LER 382/2008-004-01, "Loose Intercell Connecting Bolts on 125 vdc Station Battery (Revised)," issued 2010, ADAMS Accession No. ML101800330.)

San Onofre Nuclear Generating Station, Unit 2

On March 25, 2008, plant personnel at San Onofre Nuclear Generating Station, Unit 2, were performing TS Surveillance Requirement 3.8.4.1 of a Class 1E battery while the unit was operating at 100-percent power and discovered that its voltage was below the required value. Subsequently, the licensee observed signs of a loose connection on the breaker that provides charging current for the battery in its normal configuration. The licensee declared the battery inoperable, as required by TS Surveillance Requirement 3.8.4, Action A. The licensee torqued the loose connection bolts and completed the required TS surveillance requirements with satisfactory results. The licensee concluded in its root cause evaluation that it had most likely not fully torqued the connection bolts on March 17, 2004, when it last replaced the breaker. The bolts were not torqued because of an incomplete work plan and the lack of an effective second check of the critical steps. (See LER 361/2008-006-00, "Loose Connection Bolting Results in Inoperable Battery and TS Violation," issued 2008, ADAMS Accession No. ML082660036.)

Dresden Nuclear Power Station, Unit 3

On October 29, 2008, with Unit 3 at approximately 85 percent power, licensee personnel at Dresden Nuclear Power Station identified that the open indication light for the normally open primary containment isolation valve was flickering. Troubleshooting on November 1, 2008, led to the discovery of an intermittent high-resistance electrical connection for control power to the valve. The intermittent electrical connection caused the indicator light to flicker, and the intermittent connection would have prevented valve closure from the control room. The licensee declared valve 3-3702 inoperable and took actions in accordance with the requirements of TS 3.6.1.3. The licensee restored the valve to operable status on the same day. The most probable cause of the high resistance connection was a marginal electrical connection during original installation and equipment vibration over time causing the intermittent connection. Additionally, the cause of not entering TS 3.6.1.3 on October 29, 2008, was a lack of proper procedural guidance that led operations personnel to assume the problem was simply a faulty light socket. (See LER 249/2008-002-00, "Unit 3 Primary Containment Isolation Valve Declared Inoperable," issued 2008, ADAMS Accession No. ML090060879.)

BACKGROUND

Related Generic Communications

- IN 2008-18, "Loss of a Safety-Related Motor Control Center Caused by a Bus Fault," dated December 1, 2008
- IN 89-64, "Electrical Bus Bar Failures," dated September 7, 1989
- IN 88-11, "Potential Loss of Motor Control Center and/or Switchboard Function Due to Faulty Tie Bolts," dated April 7, 1988

Related Operating Experience Smart Samples

- FY 2009-01, "Inspection of Electrical Connections for Motor Control Center, Circuit Breakers, and Interfaces," issued 2009

DISCUSSION

Inadequate electrical connections can lead to unanticipated plant transients and the failure or unavailability of safety related equipment. They can also affect equipment important to safety or can potentially challenge safety related equipment. A recent review of operating experience has determined that the following items are important to ensuring the integrity of electrical connections:

- Torque verification
- Visual inspections
- Periodic thermography measurements
- Resistance measurements
- Adherence to vendor recommendations
- Use of proper lubricants for switch contact surfaces
- Identification of single point connection vulnerabilities

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

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

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