

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

July 23, 2012

NRC INFORMATION NOTICE 2012-11: AGE-RELATED CAPACITOR DEGRADATION

**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 or applicants for an early site permit, standard design certification, standard design approval, manufacturing license, or combined license issued 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 problems involving age-related degradation of capacitors. 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**

Surry Power Station Unit 1

On June 8, 2010, an automatic reactor trip occurred from full power because of an inadvertent electrical contact made during maintenance activities. The plant conditions encountered and system responses as a result of the trip were generally as expected, except as noted below.

Approximately 1 hour following the event, failure of a resistor/capacitor (RC) suppressor in a nuclear instrument (NI) cabinet resulted in a small control room fire, which was extinguished by the use of manual carbon dioxide fire extinguishers. Approximately 3 hours later, another RC suppressor failed in a second NI cabinet, causing a control power fuse to blow and the source range NIs to become deenergized. The source-range NIs were restored in about 5 minutes. (No power failures or blown fuses resulted from the RC suppressor failures in the first NI cabinet.)

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The most probable cause of the RC suppressor failures was age-related hardening and cracking of the RC suppressor's epoxy insulation, which allowed degradation of the RC suppressor capacitor. These RC suppressors were original plant equipment and had not been replaced. The capacitor degradation allowed the RC suppressor circuit to draw excessive current and overheat. The excessive heat caused the epoxy in the RC suppressor to ignite. The older (date codes from 1969 to 1971) suppressors contained epoxy which is not flame retardant. Subsequent to this event, the licensee opted to install newer RC suppressors which use a flame retardant epoxy.

Additional information is available in NRC Special Inspection Report 05000280/2010006, dated September 10, 2010, and can be found on the NRC's public website in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML102560333.

#### Edwin I. Hatch Unit 2

Between March 2005 and February 2009, three loss-of-offsite-power/loss-of-coolant-accident (LOSP/LOCA) loading timers associated with redundant plant service water pumps for the two Unit 2 and swing emergency diesel generators experienced failures. After the failure in February 2009, the licensee established a root cause team which determined the failures were caused by age-related degradation of electrolytic capacitors.

Specifically, the power supplies for the LOSP/LOCA circuitry were exhibiting excessive voltage ripple on their outputs. The root cause team attributed this to degradation of electrolytic capacitors in the power supply circuits, which tend to exhibit increased noise toward the end of life. These capacitors had been installed for 20 years, which was beyond their vendor-recommended service life of 10 years.

Additional information is available in NRC Inspection Report 05000366/2009005, dated February 12, 2010, and can be found on the NRC's public Web site in ADAMS under Accession No. ML100430494.

#### Additional Examples of Age-Related Degradation of Capacitors and Other Components

Additional examples of problems involving age-related degradation of capacitors can be found on the NRC's public Web site in ADAMS under Accession No. ML12033A044.

NRC IN 2012-06, "Ineffective Use of Vendor Technical Recommendations" provides additional insight on components that are left in service beyond the vendor-recommended service life. IN 2012-06 can be found on the NRC's public Web site in ADAMS under Accession No. ML112300706.

### **DISCUSSION**

Criterion XVI, Corrective Action, of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" to 10 CFR Part 50 requires licensees to assure that conditions adverse to quality are promptly identified and corrected and corrective actions are taken to preclude repetition.

Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operation)" (ADAMS Accession No. ML003739995), Section 9.b, states "preventive maintenance schedules should be developed to specify lubrication schedules, inspections of equipment, replacement of such items as filters and strainers, and inspection or replacement of parts that have a specific lifetime such as wear rings."

RC suppressors contain a capacitor and a resistor connected in series. Both components are normally completely encased in a molded epoxy package with an electrical lead from one end of the resistor and one end of the capacitor extending out. In a non-degraded condition, the epoxy electrically insulates the RC suppressor's capacitor, resistor, and their conductive surfaces in an encapsulated environment devoid of oxygen, moisture, and other air contaminants.

Aging adversely affects the capacitors in RC suppressors by causing the epoxy insulation to harden and crack over time. This degrades the capacitor, allowing a high flow of current and excessive heating. The excessive heat can then ignite the epoxy in the RC suppressor. Although newer RC suppressors use a fire retardant epoxy, capacitor overheating can still cause failure.

Capacitors also may exhibit tendencies to leak, drift, or make electronic noise, as a result of varying environmental conditions (e.g., shifts in temperature, humidity levels, or both). Extreme temperature conditions can be problematic for capacitors that contain aluminum electrolytes. At lower temperatures, capacitance falls off rapidly. At higher temperatures, the electrolyte may be lost through evaporation, thereby accelerating leakage. This may result in premature circuit damage or malfunction.

Capacitors are energy storage devices that are widely used in electronic and electrical power circuits. Operating experience has shown that capacitors have finite lifetimes. Placing these capacitors in a periodic preventative maintenance program that accounts for both time in storage and time in service can address the adverse effects of aging capacitors in equipment circuitry and prevent equipment failures.

## CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or to the appropriate Office of Nuclear Reactor Regulation 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.

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\*via e-mail

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