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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

XXXXXX, 2005

NRC GENERIC LETTER 2005-XX: INACCESSIBLE OR UNDERGROUND CABLES THAT DISABLE ACCIDENT MITIGATION SYSTEMS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, 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 generic letter to:

(1) Alert the licensees on the potential susceptibility of certain cables to affect the operability of multiple accident-mitigation systems.

(2) Request that addressees provide information regarding the monitoring of the inaccessible or underground electrical cables in light of the information provided in this letter. Adequate monitoring will ensure that cables will not fail abruptly and cause plant transients or disable accident mitigation systems when they are needed.

Pursuant to 10 CFR 50.54(f), addressees are required to submit a written response to this generic letter.

BACKGROUND

Cable failures have a variety of causes: manufacturing defects, damage caused by shipping and installation, and exposure to electrical transients or abnormal environmental conditions during operation. Most of these defects worsen gradually over time as insulation degradation leads to cable failure.

Electrical cables in nuclear power plants are usually located in dry environments. However, some cables are exposed to moisture from condensation and wetting in inaccessible locations such as buried conduits, cable trenches, cable troughs, duct banks, underground vaults and direct buried installations. Cables in these environments can fail due to various failure

mechanisms such as water treeing (physical degradation), electrical treeing or other mechanisms of insulation degradation over varying voltage levels that decrease the dielectric strength of the conductor insulation.

Information Notice (IN) 2002-12 described medium-voltage cable failures at Oyster Creek and Davis-Besse and several other plants which experienced long-term flooding problems in manholes and duct banks in which safety related cables were submerged. In response to the concern identified in IN 2002-12, several plants began manhole restoration projects to replace faulty dewatering equipment and cable supports and made other modifications. Several other plants have reported water removal problems but have not yet reported any program for the early detection of potential failures.

The rugged design of the electrical cables may prevent early failures even when they have been immersed in water for extended periods. When the staff observed that some of the cables qualified for 40 years through the equipment qualification program were also failing at several nuclear stations, a detailed review was conducted. Even though there are only about a dozen cables susceptible for moisture-induced damage in a nuclear station, the staff identified 23 Licensee Event Reports (LERs) and morning reports since 1988 on failures of buried medium-voltage cables from insulation failure. These reported events are believed to be only a very small fraction of the failures since not all cable failures are reportable. In most of the reported cases, the failed cables were in service for 10 years or more and none of these cables were identified as designed or qualified for long-term wetting or submergence.

APPLICABLE REGULATORY REQUIREMENTS

NRC regulations in Title 10 of the Code of Federal Regulations (CFR) Part 50, Appendix A, General Design Criterion (GDC) 4 states that, “Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation[.]”

10 CFR, Part 50, Appendix A, GDC 17 states that, “Provisions shall be included to minimize the probability of losing electric power from any of the remaining [power] supplies, ... loss of power from the transmission network, or the loss of power from the onsite electric power supplies.”

10 CFR, Part 50, Appendix A, GDC 18 states that, “Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important ... features, such as wiring, insulation, ... the operability of the systems as a whole and, ... the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.”

10 CFR 50.65 (a)(1) states that, “Each holder of a license to operate a nuclear power plant ... shall monitor the performance or condition of structures, systems, or components, ... in a manner sufficient to provide reasonable assurance that such structures, systems, and components, ... are capable of fulfilling their intended functions.”

10 CFR, Part 50, Appendix B, Criterion XI, requires, “A test program shall be established to assure that all testing required to demonstrate that ... components will perform satisfactorily in service is identified and performed[.]”

These design criteria require that cables which are routed underground be capable of performing their function when subjected to anticipated environmental conditions such as moisture or flooding. Further, the design should minimize the probability of power interruption when transferring power between sources. The cable failures that could disable risk-significant equipment are expected to have monitoring programs to demonstrate that the cables can perform their safety function when called on. However, the recent industry cable failure data indicates a trend in unanticipated failures of underground/inaccessible cables that are important to safety.

DISCUSSION

Although nuclear plant systems are designed against single failures, undetected degradation of cables due to pre-existing manufacturing defects or wetted environments of buried or inaccessible cables could result in multiple equipment failures. The following are examples of risk-significant cable failures:

- The failure of power cables that connect the offsite power to the safety bus could result in an inability to recover offsite power far beyond the coping time considered for station blackout conditions. The incipient failures of these cables can go undetected because these cables generally remain de-energized when the plant is generating power.

- The failure of the power cables from an emergency diesel generator (EDG) to the respective safety bus (where the EDGs are located in separate buildings) would prevent recovery of standby power from the respective EDG and result in the unavailability of a full train of accident mitigation systems during a loss-of-offsite-power event (LOOP).

- The failure of the power cables to an emergency service water (ESW) or component cooling water pump can disable one train of emergency core cooling systems for long-term service unless the headers can be cross-connected and the redundant pump(s) can be lined up to supply sufficient cooling for both trains. If the EDGs are cooled from ESW or service water, the cable failure could disable the EDG and lose one train of standby power.

At the Davis-Besse nuclear station, an underground cable insulation failure resulted in the trip of the 13.8kV circulating water pump breaker and loss of power to two other 4kV substations. The cable showed signs of insulation degradation caused by moisture intrusion (Inspection Report No: 05000346/2004017, ADAMS Accession No: ML050310426, issued on January 30, 2005). Generally, cable failure results in fault currents several orders of magnitude over the normal current. Until isolated by a breaker, the fault current or transient voltages travel on the immediate power systems, trip breakers that operate near their trip setpoint and fail other degraded insulation systems.

As cables that are not qualified for wet environments are exposed to wet environments, they will continue to degrade with an increasing possibility that more than one cable will fail on demand from a cable fault or a switching transient. While a single failure may be manageable, multiple failures of this kind would pose undue challenges for the plant operators.

Certain plants have reported failures in other safety systems such as auxiliary feedwater and containment spray systems with AC and DC power and control cables routed underground or along other inaccessible paths. Those degraded cables that are normally energized may fail to reveal their degraded condition, and the potential failure of the associated safety systems might only be revealed during a demand for the mitigation capability.

Certain licensees have attempted to periodically drain the accumulated water from the cable surroundings to avoid cable failures. In areas where the water table is relatively close to the cable, the water refills the cavity soon after the draining. In other cases, the water accumulates seasonally during snow fall or rain, filling the conduit or raceways, and cables may dry out whenever the humidity drops. In both cases, periodic draining may decrease the rate of insulation degradation but it does not prevent cable failures.

Potential cable failures can be detected through state-of-the-art techniques for measuring and trending the condition of cable insulation. The cables that are susceptible to moisture-induced failures may vary from plant to plant, and they are generally routed in underground conduits, concrete duct banks, cable trenches, cable troughs, underground vaults or direct buried installations. Selective use of testing techniques, such as the partial discharge test, time domain reflectometry, dissipation factor testing, very low frequency AC testing, and broadband impedance spectroscopy, have helped licensees assess the condition of cable insulation with reasonable confidence, such that cables can be replaced in a planned way during refueling outages. The Oconee Nuclear Station relied on the partial discharge test to monitor the condition of the emergency power supply cable insulation and replaced the cable during a scheduled outage (Inspection Report 50-269/99-12, 50-270/99-12, ADAMS Accession No: ML0036767490 issued on September 21, 1999).

A diagnostic cable test program provides reasonable confidence that the cable will perform its intended function. The frequency of the test should be commensurate with the observed cable test results. To avoid unplanned outages and unanticipated failures, certain licensees have adopted a baseline frequency of 5 years for new cables or more frequent testing when insulation degradation is observed.

REQUESTED INFORMATION

Within 90 days of the date of this generic letter, addressees are requested to provide the following information to the NRC:

(1) Provide a history of inaccessible or underground cable failures, that are within the scope of 10 CFR 50.65 (the Maintenance Rule), for all voltage levels indicating the type, voltage class, years of service and the root causes for the failure.

(2) Provide a description and frequency of all inspection, testing and monitoring programs, including surveillance programs, to detect degradation of inaccessible or underground cables used to support EDGs, offsite power, emergency service water, service water, component cooling water and other systems that are within the scope of 10 CFR 50.65 (the Maintenance Rule).

(3) If a program as described in (2) is not in place, explain why you believe such a program is not necessary.

The required written response should be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, 11555 Rockville Pike, Rockville, Maryland 20852, under oath or affirmation under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f). In addition, a copy of the response should be sent to the appropriate regional administrator.

REQUIRED RESPONSE

In accordance with 10 CFR 50.54(f), addressees are required to submit written responses to this generic letter. There are two options:

(b) Addressees may choose to submit written responses providing the information requested above within the requested time period.

(c) Addressees who cannot meet the requested completion date or who choose an alternate course of action are required to notify the NRC of these circumstances in writing as soon as possible but no later than 60 days from the date of this generic letter. The response must address any alternative course of action proposed, and the basis for the acceptability of the proposed alternative course of action.

REASONS FOR REQUESTED INFORMATION

This generic letter requests addressees to submit information. The requested information will enable the NRC staff to determine whether applicable requirements (10 CFR Part 50, Appendix A, General Design Criteria 4, 17 and 18; 10 CFR 50.65, and 10 CFR Part 50, Appendix B, Criterion XI) are being met in regard to the operational readiness of the power system and accident mitigation systems and whether additional action is necessary on those topics. The staff considers 40 hours of information collection burden to be reasonable in light of the benefit gained to identify and correct unanticipated failures of accident mitigation systems.

BACKFIT DISCUSSION

Under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), this generic letter transmits an information request for the purpose of verifying compliance with applicable existing requirements. Specifically, the requested information will enable the NRC staff to determine whether applicable requirements (plant Technical Specification in conjunction with 10 CFR Part 50, Appendix A, General Design Criteria 4, 17

and 18; 10 CFR 50.65, and 10 CFR Part 50, Appendix B Criterion XI) are being met in regard to the operation readiness of the power system. No backfit is either intended or approved in the context of issuance of this generic letter. Therefore, the staff has not performed a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment on this generic letter was published in the *Federal Register* on (xx Frxxxxx) on {date}. Comments were received from {indicate no of commentors by type}. The staff considered all comments that were received. The staff's evaluation of the comments is publicly available through the NRC's ADAMS under Accession No. xxxxxxxxx.

PAPERWORK REDUCTION ACT STATEMENT

This generic letter contains information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq*.). These information collections were approved by the Office of Management and Budget, approval No: 3150-0011, which expires on February 28, 2007.

The burden to the public for these mandatory information collections is estimated to average 40 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. The U.S. Nuclear Regulatory Commission is seeking public comment on the potential impact of the information collection contained in the generic letter and on the following issues:

1. Is the proposed information collection necessary for the proper performance of the functions of the NRC, including whether the information will have practical utility?

2. Is the estimate of burden accurate?

3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?

4. How can the burden of the information collection be minimized, including the use of automated collection techniques?

Send comments regarding this burden estimate or any other aspect of these information collections, including suggestions for reducing the burden, to the Records and FOIA/Privacy Services Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet electronic mail to INFOCOLLECTS@NRC.GOV; and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0011), Office of Management and Budget, Washington, DC 20503.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

CONTACTS

Please direct any questions about this matter to the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/RA

Bruce A. Boger, Director
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

Technical Contact: Thomas Koshy, NRR
301-415-1176
E-mail: txk@nrc.gov

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