

## **XI.E2 INSULATION MATERIAL FOR ELECTRICAL CABLES AND CONNECTIONS NOT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS USED IN INSTRUMENTATION CIRCUITS**

### **Program Description**

The purpose of this aging management program (AMP) is to provide reasonable assurance that the intended functions of electrical cables and connections (that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are used in instrumentation circuits with sensitive, high-voltage, low-level current signals exposed to adverse localized environments caused by temperature, radiation, or moisture) are maintained consistent with the current licensing basis through the period of extended operation.

In most areas within a nuclear power plant, the actual ambient environments (e.g., temperature, radiation, or moisture) are less severe than the plant design environment. However, in a limited number of localized areas, the actual environments may be more severe than the design environment.

Insulation materials used in electrical cables or connections may degrade more rapidly in adverse localized environments. An adverse localized environment is a condition in a limited plant area that is significantly more severe than the plant design environment for the cable or connection insulation material that could increase the rate of aging of a component or have an adverse effect on operability. Exposure of electrical cable and connection insulation material to adverse localized environments caused by temperature, radiation, or moisture can result in reduced insulation resistance (IR). Reduced IR causes an increase in leakage currents between conductors and from individual conductors to ground. A reduction in IR is a concern for all circuits, but especially those with sensitive, high voltage, low-level current signals, such as radiation monitoring and nuclear instrumentation circuits, because a reduced IR may contribute to signal inaccuracies.

In this AMP, either of two methods can be used to identify the existence of aging degradation. In the first method, calibration results or findings of surveillance testing programs are evaluated to identify the existence of cable and connection insulation material aging degradation. In the second method, direct testing of the cable system is performed.

This AMP applies to high-range-radiation and neutron flux monitoring instrumentation cables in addition to other cables used in high voltage, low-level current signal applications that are sensitive to reduction in IR. For these cables, AMP XI.E1 does not apply.

As stated in NUREG/CR-5643, "the major concern is that failures of deteriorated cable systems (cables, connections, and penetrations) might be induced during accident conditions." Since the instrumentation cables and connections are not subject to the environmental qualification requirements of 10 CFR 50.49, an AMP is required to manage the aging effects. This AMP provides reasonable assurance the insulation material for electrical cables and connections will perform its intended function for the period of extended operation.

### **Evaluation and Technical Basis**

1. **Scope of Program:** This AMP applies to electrical cables and connections (cable system) used in circuits with sensitive, high voltage, low-level current signals, such as radiation

monitoring and nuclear instrumentation, that are subject to aging management review and installed in adverse localized environments caused by temperature, radiation, or moisture.

2. **Preventive Actions:** This is a performance monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.
3. **Parameters Monitored/Inspected:** The parameters monitored are determined from the specific calibration, surveillances, or testing performed and are based on the specific instrumentation circuit under surveillance or being calibrated, as documented in plant procedures.
4. **Detection of Aging Effects:** Review of calibration results or findings of surveillance programs can provide an indication of the existence of aging effects based on acceptance criteria related to instrumentation circuit performance. By reviewing the results obtained during normal calibration or surveillance, an applicant may detect severe aging degradation prior to the loss of the cable and connection intended function. The first reviews are completed prior to the period of extended operation and at least every 10 years thereafter. All calibration or surveillance results that do not meet acceptance criteria are reviewed for aging effects when the results are available.

Cable system testing is conducted when the calibration or surveillance program does not include the cabling system in the testing circuit, or as an alternative to the review of calibration results described above. A proven cable system test for detecting deterioration of the insulation system (such as insulation resistance tests, time domain reflectometry tests, or other testing judged to be effective in determining cable system insulation condition as justified in the application) is performed. The test frequency of the cable system is determined by the applicant based on engineering evaluation, but the test frequency is at least once every 10 years. The first test is to be completed prior to the period of extended operation.

5. **Monitoring and Trending:** Trending actions are not included as part of this AMP because the ability to trend test results is dependent on the specific type of test chosen. However, test results that are trendable provide additional information on the rate of cable or connection degradation.
6. **Acceptance Criteria:** Calibration results or findings of surveillance and cable system testing are to be within the acceptance criteria, as set out in the applicant's procedures.
7. **Corrective Actions:** Corrective actions, such as recalibration and circuit trouble-shooting, are implemented when calibration, surveillance, or cable system test results do not meet the acceptance criteria. An engineering evaluation is performed when the acceptance criteria are not met in order to ensure that the intended functions of the electrical cable system can be maintained consistent with the current licensing basis. Such an evaluation is to consider the significance of the calibration, surveillance, or cable system test results; the operability of the component; the reportability of the event; the extent of the concern; the potential root causes for not meeting the acceptance criteria; the corrective actions required; and likelihood of recurrence. When an unacceptable condition or situation is identified, a determination also is made as to whether the review of calibration and surveillance results or the cable system testing frequency needs to be increased. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. **Confirmation Process:** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address confirmation process.
9. **Administrative Controls:** The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.
10. **Operating Experience:** Operating experience has identified a case where a change in temperature across a high range radiation monitor cable in containment resulted in a substantial change in the reading of the monitor. Changes in instrument calibration can be caused by degradation of the circuit cable and are a possible indication of electrical cable degradation.

The vast majority of site-specific and industry wide operating experience regarding neutron flux instrumentation circuits is related to cable/connector issues inside containment near the reactor vessel.

This AMP considers the technical information and guidance provided in NUREG/CR-5643, IEEE Std. 1205-2000, SAND96-0344, EPRI TR-109619, NRC IN 97-45, and NRC IN 97-45, Supplement 1.

## References

- 10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.
- EPRI TR-109619, *Guideline for the Management of Adverse Localized Equipment Environments*, Electric Power Research Institute, Palo Alto, CA, June 1999.
- IEEE Std. 1205-2000, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations*.
- NRC Information Notice 97-45, *Environmental Qualification Deficiency for Cables and Containment Penetration Pigtails*, U. S. Nuclear Regulatory Commission, July 2, 1997.
- NRC Information Notice 97-45, Supplement 1, *Environmental Qualification Deficiency for Cables and Containment Penetration Pigtails*, U. S. Nuclear Regulatory Commission, February 17, 1998.
- NUREG/CR-5643, *Insights Gained From Aging Research*, U. S. Nuclear Regulatory Commission, March 1992.
- SAND96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations*, prepared by Sandia National Laboratories for the U.S. Department of Energy, September 1996.