

## **XI.E1 INSULATION MATERIAL FOR ELECTRICAL CABLES AND CONNECTIONS NOT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS**

### **Program Description**

The purpose of the aging management program (AMP) described herein 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 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 plant design environment.

Insulation materials used in electrical cables and connections may degrade more rapidly than expected in these 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. An adverse localized environment exists based on the most limiting condition for temperature, radiation, or moisture for the insulation material of cables or connections. Adverse localized environments can be identified through the use of an integrated approach. This approach may include, but is not limited to, (a) the review of Environmental Qualification (EQ) zone maps that show radiation levels and temperatures for various plant areas, (b) consultations with plant staff who are cognizant of plant conditions, (c) utilization of infrared thermography to identify hot spots on a real-time basis, and (d) the review of relevant plant-specific and industry operating experience.

The program described herein was written specifically to address cables and connections at plants whose configuration is such that most (if not all) cables and connections installed in adverse localized environments are accessible. Cables and connections from accessible areas are inspected and represent, with reasonable assurance, all cables and connections in the adverse localized environments. If an unacceptable condition or situation is identified for a cable or connection in the inspection, a determination is made as to whether the same condition or situation is applicable to inaccessible cables or connections. As such, this program does not apply to plants in which most cables are inaccessible.

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 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 accessible electrical cables and connections within the scope of license renewal that are located in adverse localized environments caused by temperature, radiation, or moisture.

2. **Preventive Actions:** This is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.
3. **Parameters Monitored/Inspected:** Accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable jacket and connection insulation surface anomalies indicating signs of reduced insulation resistance due to thermal/thermooxidative degradation of organics, radiolysis and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation, and moisture intrusion as indicated by signs of embrittlement, discoloration, cracking, melting, swelling or surface contamination. An adverse localized environment is a plant-specific condition; therefore, the applicant should clearly define how this condition is determined. The applicant should determine and inspect the adverse localized conditions for each of the most limiting temperature, radiation, or moisture conditions for the accessible cables and connections that are within the scope of license renewal.
4. **Detection of Aging Effects:** Insulation aging degradation from temperature, radiation, or moisture causes cable jacket and connection insulation surface anomalies. Accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable jacket and connection insulation surface anomalies, such as embrittlement, discoloration, cracking, melting, swelling or surface contamination. The inspection of cable jacket and connection insulation surfaces is used to infer the adequacy of the cables and connections. Accessible electrical cables and connections installed in adverse localized environments are visually inspected at least once every 10 years. This is an adequate period to preclude failures of the cables and connection insulation since experience has shown that aging degradation is a slow process. A 10-year inspection interval provides two data points during a 20-year period, which can be used to characterize the degradation rate. The first inspection for license renewal 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 visual inspection results is limited. However, inspection results that are trendable provide additional information on the rate of cable or connection degradation.
6. **Acceptance Criteria:** The accessible cables and connections are to be free from unacceptable visual indications of surface anomalies that suggest that cable jacket or connection insulation degradation exists. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss of the intended function.
7. **Corrective Actions:** All unacceptable visual indications of cable jacket and connection insulation surface anomalies are subject to an engineering evaluation. Such an evaluation is to consider the age and operating environment of the component as well as the severity of the anomaly and whether such an anomaly has previously been correlated to degradation of cables or connections. Corrective actions may include, but are not limited to, testing, shielding, or otherwise changing the environment or relocation or replacement of the affected cables or connections. When an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to inaccessible cables or connections. 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 the 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 shown that adverse localized environments caused by elevated temperature, radiation, or moisture for electrical cables and connections may exist. For example next to or above (within 3 feet of) steam generators, pressurizers, or hot process pipes, such as feedwater lines. These adverse localized environments have been found to cause degradation of the insulating materials on electrical cables and connections that are visually observable, such as color changes or surface cracking. These visual indications can be used as indicators of degradation.

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

## 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*.
- 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.