

NRCREP - Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02: Changes to Generic Aging Lesson Learned (GALL) Aging Management Program (AMP) XI.E6

From: "BUTLER, John" <jcb@nei.org>
 To: <nrcprep@nrc.gov>
 Date: 10/18/2007 4:27 PM
 Subject: Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02: Changes to Generic Aging Lesson Learned (GALL) Aging Management Program (AMP) XI.E6

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Subject: Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02: Changes to Generic Aging Lesson Learned (GALL) Aging Management Program (AMP) XI.E6, *Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements*

Project Number: 689

On September 6, 2007, the subject interim staff guidance (ISG) was published in the Federal Register for public comment (72 FR 51256). This proposed ISG clarifies and recommends a one-time inspection to ensure that either aging or metallic cable connections is not occurring or an existing maintenance program is effective, such that a periodic preventive inspection is not needed.

NEI has reviewed the proposed ISG and our comments are enclosed in the form of a markup of the ISG. Our comments, in general, reflect our determination that the revised program should provide options, where appropriate, for use of visual inspection to detect aging effects on covered connections. In a May 25, 2007 letter to Dr. P. T. Kuo, we identified the need for GALL XI.E6 to incorporate the use of visual inspections for covered connections and pointed to instances where the NRC staff has previously permitted its use. In addition, visual inspections are permitted in GALL XI.E4 as an alternative to performing themography and contact resistance measurements.

Although the proposed ISG permits testing components without removing insulation, it is important to note that testing frequently can not be performed on covered connections with the insulation in place. The insulation must be removed for resistance testing and, for reasons of safety, energized equipment frequently can not be accessed to perform themography. Visual inspection is used in the industry as an effective method for detecting loose connections and is preferable to potentially damaging sound connections while removing the insulation to perform testing. Including an option to perform visual inspections to detect aging effects for covered connections reduces the likelihood of damaging components and remains an effective and practical alternative to testing.

We welcome the opportunity to discuss with NRC staff any of the enclosed comments. If further discussion is desired, please contact me or Julie Keys at (202) 739-8128; jyk@nei.org.

John C. Butler
 Director, Safety Focused Regulation

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NUCLEAR ENERGY INSTITUTE

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October 18, 2007

Chief, Rulemaking, Directives, and Editing Branch
Office of Administration
US Nuclear Regulatory Commission
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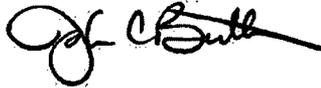
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Page 2

We welcome the opportunity to discuss with NRC staff any of the enclosed comments. If further discussion is desired, please contact me or Julie Keys at (202) 739-8128; jyk@nei.org.

Sincerely,

A handwritten signature in black ink, appearing to read "John C. Butler". The signature is written in a cursive style with a long horizontal stroke extending to the right.

John C. Butler

Enclosure

c: Dr. P. T. Kuo, NRC
Ms. Linh Tran, NRC
NRC Document Control Desk

XI.E6 ELECTRICAL CABLE CONNECTIONS NOT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS (REVISED)

Program Description

Cable connections are used to connect cable conductors to other cable conductors or electrical devices. Connections associated with cables within the scope of license renewal are part of this program. The most common types of connections used in nuclear power plants are splices (butt or bolted), crimp-type ring lugs, connectors, and terminal blocks. Most connections involve insulating material and metallic parts. This aging management program (AMP) focuses on the metallic parts of the electrical cable connections. This program provides a one-time inspection, on a sampling basis, to confirm the absence of age-related degradation of cable connections due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation.

Generic Aging Lesson Learned (GALL) XI.E1, "Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements," manages the aging of insulating material but not the metallic parts of the electrical connections. GALL XI.E1 is based on only a visual inspection of accessible cables and connections. Visual inspection may not be sufficient to detect the aging effects from thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation on the metallic parts of cable connections.

Electrical cable connections exposed to appreciable ohmic or ambient heating during operation may experience loosening caused by repeated cycling of connected loads or of the ambient temperature environment. Different materials used in various cable system components can produce situations where stresses between these components change with repeated thermal cycling. For example, under loaded conditions, ohmic heating may raise the temperature of a compression terminal and cable conductor well above the ambient temperature, thereby causing thermal expansion of both components. Thermal expansion coefficients of different materials may alter mechanical stresses between the components so that the termination may be impacted. When the current is reduced, the affected components cool and contract. Repeated cycling in this fashion can cause loosening of the termination, and may lead to high electrical resistance or eventual separation of compression-type terminations. Threaded connectors may loosen if subjected to significant thermally induced stress and cycling.

Cable connections within the scope of license renewal should be tested or inspected at least once prior to the period of extended operation to provide an indication of the integrity of the cable connections. The specific type of test or inspection to be performed will be determined based on the type of connection and will ~~is to~~ be a proven method test for detecting loose connections, such as thermography, contact resistance testing, visual inspection or another appropriate test or inspection justified in the application.

This program, as described, can be thought of as a sampling program. The following factors shall be considered for sampling: voltage level (medium and low voltage), circuit loading (high loading), and location (high temperature, high humidity, vibration, etc.). The technical basis for the sample selections should be documented. If an unacceptable condition or situation is identified in the selected sample, the corrective action program will be used to evaluate the condition and determine appropriate corrective action.

SAND 96-0344, "Aging Management Guidelines for Electrical Cable and Terminations," indicated loose terminations were identified by several plants. The major concern is that the

failures of a deteriorated cable system (cables, connections including fuse holders, and penetrations) that could prevent it from performing its intended function. This program is not applicable to cable connections in harsh environment since they are already addressed by the requirements of 10 CFR 50.49. Even though cable connections may not be exposed to harsh environments, loosening or high resistance of connection is a concern due to aging mechanisms discussed above.

Evaluation and Technical Basis

1. **Scope of Program:** Cable connections associated with cables within the scope of license renewal, which are ~~External~~ external connections terminating at an active or passive devices are in the scope of this program. Wiring connections internal to an active assembly are considered a part of the active assembly and therefore are not within the scope of this program. This program does not include high-voltage (>35 kV) switchyard connections. The cable connections covered under the EQ program are not included in the scope of this program.
2. **Preventive Actions:** No actions are taken as part of this program to prevent or mitigate aging degradation.
3. **Parameters Monitored/Inspected:** This program will focus on the metallic parts of the connection. The one-time inspection verifies that ~~monitoring includes~~ loosening of bolted connections or high resistance of cable connections due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation is not an aging affect that requires a periodic aging management program. A representative sample of electrical cable connections is tested or inspected. The following factors shall be considered for sampling: voltage level (medium and low voltage), circuit loading (high load), and location (high temperature, high humidity, vibration, etc.). The technical basis for the sample selection is to be documented.
4. **Detection of Aging Effects:** A representative sample of electrical connections within the scope of license renewal will be tested or inspected at least once prior to the period of extended operation to confirm that there are no aging effects requiring management during the period of extended operation. Inspection and ~~Testing~~ testing methods may include thermography, contact resistance testing, visual, or other appropriate testing methods without removing the connection insulation such as heat shrink tape, sleeving, insulating boots, etc. The one-time inspection provides additional confirmation to support industry operating experience that shows electrical connections have not experienced a high degree of failures, and that existing installation and maintenance practices are effective.
5. **Monitoring and Trending:** Trending actions are not included as part of this program because it is a one-time inspection program.
6. **Acceptance Criteria:** The acceptance criteria for each test or inspection are to be defined for the specific type of test or inspection performed and the specific type of cable connections tested or inspected.
7. **Corrective Actions:** If test or inspection acceptance criteria are not met, the corrective action program will be used to perform an evaluation that will consider the extent of the condition, the indications of aging effect, and potential changes to the one-time inspection program. Corrective actions may include, but are not limited to sample expansion,

increased inspection frequency, and replacement or repair of the affected cable connection components. As discussed in the appendix to this report, 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 to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.
9. **Administrative Controls:** As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.
10. **Operating Experience:** Electrical cable connections exposed to appreciable ohmic or ambient heating during operation may experience loosening caused by repeated cycling of connected loads or of the ambient temperature environment. There have been a limited number of age related failures of cable connections reported. This one-time inspection confirms the absence of aging degradation of metallic cable connections.

References

EPRI TR-109619, *Guideline for the Management of Adverse Localized Equipment Environments*, Electric Power Research Institute, Palo Alto, CA, June 1999.

IEEE Std. P1205-2000, *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.

EPRI TR - 104213, *Bolted Joint Maintenance & Application Guide*, Electric Power Research Institute, Palo Alto, CA, December 1995.

Staff's Response to the NEI White Paper on Generic Aging Lessons Learned (GALL) Report Aging Management Program (AMP) XI.E6, "Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements," dated March 16, 2007 (ADAMS Accession Number ML070400349)