

NUCLEAR REGULATORY COMMISSION

Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02:

Changes to Generic Aging Lesson Learned (GALL) Report

Aging Management Program (AMP) XI.E6, "Electrical Cable Connections Not Subject to

10 CFR 50.49 Environmental Qualification Requirements"

Solicitation of Public Comment

AGENCY: U.S. Nuclear Regulatory Commission

ACTION: Solicitation of public comment

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is soliciting public comment on its Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02 (LR-ISG) for changes to its Generic Aging Lesson Learned (GALL) Report Aging Management Program (AMP) XI.E6, "Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements." This LR-ISG clarifies and recommends a one-time inspection to ensure that either aging of metallic cable connections is not occurring or an existing preventive maintenance program is effective, such that a periodic inspection is not needed. The NRC staff issues LR-ISGs to facilitate timely implementation of the license renewal rule and to review activities associated with an LRA. Upon receiving public comments, the NRC staff will evaluate the comments and make a determination to incorporate the comments, as appropriate. Once the NRC staff completes the LR-ISG, it will issue the LR-ISG for NRC and industry use. The NRC staff will also incorporate the approved LR-ISG into the next revision of the license renewal guidance documents.

DATES: Comments may be submitted by (insert date 45 days after publication in the *Federal Register*). Comments received after this date will be considered, if it is practical to do so, but

the Commission is able to ensure consideration only for comments received on or before this date.

ADDRESSES: Comments may be submitted to: Chief, Rules and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

Comments should be delivered to: 11545 Rockville Pike, Rockville Maryland, Room T-6D59, between 7:30 a.m. and 4:15 p.m. on Federal workdays. Persons may also provide comments via e-mail at [NRCREP@NRC.GOV](mailto:NRCREP@NRC.GOV). The NRC maintains an Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents. These documents may be accessed through the NRC's Public Electronic Reading Room on the Internet at <http://www.nrc.gov/reading-rm/adams.html>. Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS should contact the NRC Public Document Room (PDR) reference staff at 1-800-397-4209, 301-415-4737, or by e-mail at [pdr@nrc.gov](mailto:pdr@nrc.gov).

FOR FURTHER INFORMATION CONTACT: Ms. Linh Tran, Project Manager, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington DC 20555-0001; telephone 301-415-4103 or by e-mail at [lntr@nrc.gov](mailto:lntr@nrc.gov).

SUPPLEMENTARY INFORMATION: Attachment 1 to this *Federal Register* notice, entitled *Staff Position and Rationale for the Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02: Changes to Generic Aging Lesson Learned (GALL) Report Aging Management Program (AMP) XI.E6, "Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,"* contains the NRC staff's rationale for publishing the proposed LR-ISG-2007-02. Attachment 2 to this *Federal Register* notice, entitled *Proposed License Renewal Interim Staff Guidance LR-ISG-2007-02: Changes to Generic Aging Lesson Learned (GALL) Report Aging Management Program (AMP) XI.E6, "Electrical*

Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,” contains the proposed revisions to GALL AMP XI.E6.

The NRC staff is issuing this notice to solicit public comments on the proposed LR-ISG-2007-02. After the NRC staff considers any public comments, it will make a determination regarding issuance of the proposed LR-ISG.

Dated at Rockville, Maryland this 29<sup>th</sup> day of August, 2007.

FOR THE NUCLEAR REGULATORY COMMISSION

*/RA/*

Pao-Tsin Kuo, Director  
Division of License Renewal  
Office of Nuclear Reactor Regulation

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

**STAFF POSITION:**

The staff is proposing to revise GALL AMP XI.E6 to recommend a one-time inspection for electrical cable connections not subject to 10 CFR 50.49 environmental qualification requirement instead of the period inspection as currently stated in GALL AMP XI.E6. The staff determined that this one-time inspection, on representative sample basis, is adequate to ensure that either aging of metallic cable connections is not occurring and/or existing preventive maintenance program is effective such that a periodic inspection program is not needed.

**RATIONALE:**

In reviewing the industry’s documents and comments, the staff determined that although the current GALL AMP XI.E6 was based on technical bases of Electric Power Research Institute documents, Sandia National Laboratories Report, SAND 96-0344, and thermography data, few operating experience related to failed connection due to aging had been identified. Most of the operating experience related to failed connection are due to human errors or maintenance practices. The operating experience cannot support a periodic inspection as currently recommended in GALL AMP XI.E6. However, because there have been limited number of age related failures of cable connections, a one-time inspection of the metallic portion of electrical cable connections is warranted. On this basis, the staff is revising GALL

AMP XI.E6 to clarify and recommend a one-time inspection, on a representative sampling basis, to ensure that either aging of metallic cable connections is not occurring or an existing preventive maintenance program is effective, such that a periodic inspection is not needed.

PROPOSED LICENSE RENEWAL INTERIM STAFF GUIDANCE LR-ISG-2007-02:  
CHANGES TO GENERIC AGING LESSON LEARNED (GALL) REPORT  
AGING MANAGEMENT PROGRAM (AMP) XI.E6, "ELECTRICAL CABLE CONNECTIONS  
NOT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS"

Introduction

Consistent with the requirements specified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54, Section 54.4(a), electrical cable connections support safety-related and non-safety-related functions in that the failure of the electrical cable connections precludes a function from being accomplished (10 CFR 54.4(a)(1), (a)(2), and (a)(3)).

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. Because of the potential loosening of bolted cable connections, the staff included, in its updated license renewal guidance documents, AMP XI.E6, "Electrical Cable Connections Not Subject to

10 CFR 50.49 Environmental Qualification Requirements,” to manage the potential aging of electrical cable connections not subject to 10 CFR 50.49 environmental qualification requirements.

### Background and Discussion

The staff included AMP XI.E6, “Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,” in Chapter XI of GALL Report, Revision 1, dated September 2005. By letter dated September 5, 2006, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML062770105), Nuclear Energy Institute (NEI) submitted a white paper regarding GALL AMP XI.E6 (ADAMS Accession No. ML062770111) . NEI stated that there was not enough operating experience to support a conclusion that cable connections are a significant aging concern and that the recommended program elements of GALL AMP XI.E6 duplicate aging management activities already defined and accepted in other AMPs. NEI also stated that the expanded scope of the program includes all voltage ranges regardless of the amount of evidence from operating experience. In addition, NEI identified wording in GALL AMP XI.E6 that included connections in active components. NEI asked the staff to review its white paper to eliminate GALL AMP XI.E6 or minimize its scope and redundancy so that the plant would not be burdened with activities that have no actual aging management benefit.

On November 30, 2006, the staff met with NEI representatives to discuss the white paper. In a letter dated March 16, 2007, (ADAMS Accession No. ML070400349), the staff provided responses to each of the industry’s concerns identified in the white paper. By letter dated

May 25, 2007, (ADAMS Accession Nos. ML071590175 and ML071590182), NEI submitted comments on the staff's responses.

In reviewing the industry's white paper and comments, the staff determined that although GALL AMP XI.E6 was based on the technical bases of Electric Power Research Institute documents, and Sandia National Laboratories Report, SAND 96-0344, little operating experience related to failed connections due to aging had been identified. Most of the operating experience related to failed connections were due to human errors or maintenance practices. The operating experience cannot support the periodic inspection recommended in AMP XI.E6 in GALL Report, Revision 1, dated September 2005. However, because there have been limited number of age related failures of cable connections, a one-time inspection of the metallic portion of electrical cable connections is warranted. On this basis, the staff is revising GALL AMP XI.E6 to clarify and recommend a one-time inspection, on a representative sampling, to ensure that either aging of metallic cable connections is not occurring or an existing preventive maintenance program is effective, such that a periodic inspection is not required.

#### Proposed Action

The staff is proposing to revise GALL AMP XI.E6 to recommend a one-time inspection prior to the period of extended operation for electrical cable connections not subject to 10 CFR 50.49 EQ requirement instead of the periodic inspection currently stated in GALL AMP XI.E6. The staff determined that this one-time inspection, on a representative sample basis, is adequate to ensure that either aging of metallic cable connections is not occurring and/or the existing preventive maintenance program is effective so that a periodic inspection program is not required. The one-time inspection verifies that loosening and/or high resistance of cable



connections due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation are not happening and periodic inspections are not required. The one-time inspection should include testing of a representative sample of the electrical cable connection population subject to an aging effect. The sample should include each type of electrical cable connection. 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 should be documented. The one-time inspection will confirm that there are no aging effects that require management during the period of extended operation.

The applicant will take corrective actions when acceptance criteria are not met. Corrective actions may include, but are not limited to sample expansion, increase inspection frequency, and replacement or repair of the affected cable connection components.

When an applicant performs periodic preventive maintenance that includes inspection and testing of cable connections, the applicant can credit this maintenance activity toward GALL AMP XI.E6. The applicant may also revise its preventive maintenance procedures to cover the inspection of cable connections to take credit for GALL AMP XI.E6.

Attached is the proposed revision to GALL AMP XI.E6. Although this proposed revision does not convey a change in the regulations or how they are being interpreted, it is being provided to facilitate preparation of future submittals in support of applications for license renewal. This LR-ISG provides a clarification of existing guidance with no additional requirements.

**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 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 to be performed and is to be a proven test for detecting loose connections, such as thermography, contact resistance testing, or another appropriate test 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, 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:** 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 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. A representative sample of electrical

cable connections is tested. 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 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. Testing may include thermography, contact resistance testing, 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 are to be defined for the specific type of test performed and the specific type of cable connections tested.
- 7. Corrective Actions:** If test 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 changes to the one-time inspection program. Corrective actions may include, but are not limited to sample expansion, increase 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 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)