7590-01-P

NUCLEAR REGULATORY COMMISSION

Proposed Interim Staff Guidance (ISG)-17 on

Periodic Inspection of Bus Ducts

For License Renewal Solicitation of Public Comment

AGENCY: Nuclear Regulatory Commission (NRC).

ACTION: Solicitation of public comment.

SUMMARY: The NRC is soliciting public comment on its proposed interim staff guidance (ISG) for license renewal. This ISG proposes an acceptable aging management program (AMP), "Periodic Inspection of Bus Ducts," to manage the effects of aging on bus ducts during the period of extended operation. The NRC staff issues ISGs to facilitate timely implementation of the license renewal rule and to review activities associated with a license renewal application. 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 ISG, it will issue the ISG for NRC and industry use. The NRC staff will also incorporate the approved ISG into the next revision of the license renewal guidance documents.

DATES: Comments may be submitted by (insert date 60 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, D.C., 20555-0001. Comments should be delivered to: 11545 Rockville Pike, Rockville, Maryland, Room T-6D59, between 7:30 am and 4:15 pm on Federal workdays. Persons may also provide

comments via e-mail at 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.

FOR FURTHER INFORMATION CONTACT: Mr. Mark Lintz, License Renewal Project Manager, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555-0001; telephone 301-415-4051 or e-mail mpl2@nrc.gov.

SUPPLEMENTARY INFORMATION: Attachment 1 to this *Federal Register* notice, entitled *Staff Position and Rationale for the Interim Staff Guidance (ISG)-17: Proposed Aging Management Program (AMP) XI.E4, "Periodic Inspection of Bus Ducts"* contains the NRC staff's rationale for publishing ISG-17. Attachment 2 to this *Federal Register* notice, entitled *Proposed Aging Management Program: Periodic Inspection of Bus Ducts*, contains the proposed AMP required to implement ISG-17.

NRC Information Notice 89-64, entitled *"Electrical Bus Bar Failures*," and NRC Information Notice 98-36, entitled *"Inadequate or Poorly Controlled, Non-Safety-Related Maintenance Activities Unnecessarily Challenged Safety Systems*," provide examples that illustrate the importance of periodic inspection of bus ducts and the potential problems that can arise from age-related bus duct failures. Instances of the loosening of the bus bar connecting bolts at several plants due to thermal cycling have been reported in Sandia National Laboratory Report entitled *Aging Management Guideline for Commercial Nuclear Power Plants*

(Sandia 96-0344; September 1996) and in NRC Information Notice 2000-14, entitled "*Non-Vital Bus Fault Leads to Fire and Loss of Offsite Power*." The last report identified torque relaxation of splice plate connecting bolts as one potential cause of a bus duct failure.

Operating experience has shown that electrical buses in bus ducts have failed due to cracked insulation in the presence of moisture, debris buildup, and loosening of bus connecting bolts. These failures could lead to loss of power to electrical loads connected to the buses and could cause unnecessary challenges to plant safety systems. To prevent such failures, NRC has developed ISG-17 to ensure that

(1) Internal portions of bus duct assemblies are free of corrosion, debris, excessive dust buildup, and moisture intrusion;

(2) Electrical buses and their supports are free of insulation cracking; and

(3) Bolted connections of the buses are secure.

Additionally, the external portions of bus ducts and structural supports will also be inspected in accordance with a plant-specific structural monitoring program.

Dated at Rockville, Maryland, this day 16th of December 2004.

For The Nuclear Regulatory Commission.

/RA/

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Attachments: As stated

STAFF POSITION AND RATIONALE FOR THE

INTERIM STAFF GUIDANCE (ISG)-17

STAFF POSITION:

Consistent with the requirements specified in 10 CFR 54.4(a), bus ducts (non-segregated phase bus and isolated phase buses) support safety-related and non-safety-related functions in that the failure of the bus ducts precludes a safety function from being accomplished [10 CFR Part 54.4(a)(1) and (a)(2)].

Thermal cycling of bus ducts can result in torque relaxation of connecting bolts, causing loose connections that lead to arcing, overheating, and explosive damage. Bus insulation material may experience a significant temperature rise during operation that may cause age-related degradation during the period of extended operation. Insulation failure, along with the presence of moisture or debris, may provide phase-to-phase or phase-to-ground electrical tracking paths that eventually result in catastrophic failure of the bus ducts. These bus ducts, therefore, need to be inspected periodically during the period of extended operation to preclude their failure.

In order to prevent such occurrences, the staff has developed an aging management program for periodic inspection of bus ducts for license renewal to ensure that

(1) Internal portions of bus duct assemblies are free of corrosion, debris, excessive dust buildup, and moisture intrusion; and

(2) Electrical buses and their supports are free of insulation cracking; and

(3) Bolted connections of the buses are secure.

Additionally, the external portions of bus ducts and structural supports will also be inspected in accordance with a plant-specific structural monitoring program.

RATIONALE:

An electrical bus is an assembly of bus conductors with the associated connections, joints, and insulating supports. Bus ducts are electrical buses installed on electrically insulated supports and are constructed with all phase conductors enclosed in either a separate metal enclosure or a common metal enclosure. The conductors are separated and insulated from each other and from the ground by insulating bus supports. Also, the conductors in the non-segregated bus are insulated throughout to reduce corona and electrical tracking. The bus ducts are used in power systems that connect various elements of electric power circuits, such as switchgears, transformers, main generators, and diesel generators.

Industry operating experience indicates that the failure of bus ducts is caused by the cracking of bus bar insulation (bus sleeving) combined with the accumulation of moisture or debris. Cracked insulation results from high ambient temperatures and contamination from bus bar joint compound. Cracked insulation in the presence of moisture or debris provides phase-to-phase or phase-to-ground electrical tracking paths, which results in catastrophic failure of the buses. Bus failure leads to loss of power to electrical loads connected to the buses, causes subsequent reactor trips, and initiates unnecessary challenges to plant safety systems.

Bus ducts exposed to appreciable ohmic heating during operation may experience loosening of bolted connections because of the repeated cycling of connected loads. This phenomenon can occur in heavily loaded circuits, i.e., those exposed to appreciable ohmic heating. A Sandia National Laboratory Report entitled, *Aging Management Guideline for Commercial Nuclear Power Plants* (Sandia 96-0344; September 1996) documents instances of bolted connection loosening at several plants due to thermal cycling. NRC Information Notice 2000-14, entitled *Non-Vital Bus Fault Leads to Fire and Loss of Offsite Power*, identified torque relaxation of splice plate connecting bolts as one potential cause of a bus duct fault.

In addition to NRC Information Notice 2004-14, NRC Information Notice 89-64, entitled *Electrical Bus Bar Failures*, and NRC Information Notice 98-36, entitled *Inadequate or Poorly Controlled, Non-Safety-Related Maintenance Activities Unnecessary Challenged Safety Systems,* also provide examples that underscore the safety significance of bus ducts and the potential problems that can arise from age-related bus duct failures.

PROPOSED AGING MANAGEMENT PROGRAM XI.E4:

PERIODIC INSPECTION OF BUS DUCTS

XI.E4 PERIODIC INSPECTION OF BUS DUCTS

PROGRAM DESCRIPTION:

An electrical bus is an assembly of bus conductors with the associated connections, joints, and insulating supports. Bus ducts are electrical buses installed on electrically insulated supports and are constructed with all phase conductors enclosed in either a separate metal enclosure or a common metal enclosure. The conductors are separated and insulated from each other and from the ground by insulating supports. Also, the conductors in the non-segregated bus are insulated throughout to reduce corona and electrical tracking. The bus ducts are used in power systems that connect various elements of electric power circuits, such as switchgears, transformers, main generators, and diesel generators.

Industry operating experience indicates that the failure of bus ducts is caused by the cracking of bus bar insulation (bus sleeving) combined with the accumulation of moisture or debris. Cracked insulation results from high ambient temperatures and contamination from bus bar joint compound. Cracked insulation in the presence of moisture or debris provides phase-to-phase or phase-to-ground electrical tracking paths, which results in catastrophic failure of the buses. Bus failure leads to loss of power to electrical loads connected to the buses, causes subsequent reactor trips, and initiates unnecessary challenges to plant systems.

Bus ducts exposed to appreciable ohmic heating during operation may experience loosening of bolted connections because of the repeated cycling of connected loads. This phenomenon can occur in heavily loaded circuits, i.e., those exposed to appreciable ohmic heating. Sandia 96-0344 identified instances of bolted connection loosening at several plants

due to thermal cycling. NRC Information Notice 2000-14 identified torque relaxation of splice plate connecting bolts as one potential cause of a bus duct fault.

One objective of the aging management program is to provide an inspection of bus ducts. In managing this aspect of the aging management program, bolted connections at sample sections of the buses in the bus ducts will be checked for proper torque, or the bolted joints will be checked for low resistance. This activity will include visual inspection of interior portions of bus ducts to identify aging degradation of insulating and metallic components and water/debris intrusion. The external portions of bus ducts and structural supports will be inspected in accordance with a plant-specific structural monitoring program.

Evaluation and Technical Basis:

1. Scope of Program: This program applies to all bus ducts within the scope of license renewal.
2. Preventive Actions: This is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.
3. Parameters Monitored/Inspected: A sample of accessible bolted connections (bus joints and ending devices) will be checked for proper torque, or the resistance of bolted joints will be checked using a micro-ohm meter of sufficient current capacity that is suitable for checking bus bar connections. This program will also inspect the internal portions of accessible bus ducts for cracks, corrosion, foreign debris, dust buildup, and moisture intrusion. The bus insulating system will be inspected for signs of embrittlement, cracking, melting, swelling, or discoloration, which may indicate overheating or aging degradation. The bus supports will be inspected for structural integrity and cracking.
4. Detection of Aging Effects: Visual inspection of internal portions of bus ducts detects cracks, corrosion, debris, dust and moisture. Visual inspection of the bus insulating

system detects embrittlement, cracking, melting, swelling and discoloration. Visual inspection of bus supports detects cracking and lack of structural integrity. Internal portions of bus ducts, the bus insulating system, and the bus supports are visually inspected at least once every 10 years.

A torque test or a resistance test of a sample of accessible bolted connections is performed at least once every 10 years. This program will be completed before the end of the initial 40-year license term and every 10-years thereafter. This is an adequate period to identify failures of the bus ducts since experience has shown that aging degradation is a slow process. A 10-year inspection frequency will provide two data points during a 20-year period, which can be used to characterize the degradation rate.

5. Monitoring and Trending: Trending actions are not included as part of this program because the ability to trend inspection results is limited. Although not a requirement, trending would provide additional information on the rate of degradation.

6. Acceptance Criteria: Bolted connections must meet the manufacturer's minimum torque specifications, or the resistance of bolted joints must meet required specifications. Bus ducts are to be free from any surface anomalies that suggest that conductor insulation degradation exists. An additional acceptance criterion includes no indication of unacceptable corrosion, cracking, foreign debris, dust buildup, or moisture intrusion. Any condition or situation that, if not corrected, could lead to a loss of intended function is considered unacceptable.

7. Corrective Actions: Further investigation and evaluation is performed when the acceptance criterion is not met. Corrective actions may include but are not limited to sample expansion, increased inspection frequency, and replacement or repair of the affected bus duct insulation components. When an unacceptable or situation is

identified, a determination shall be made as to whether the same condition or situation is applicable to other areas, and sample expansion shall include those areas. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address 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 administrative controls.

10. Operating experience: Industry operating experience has demonstrated that the failures of bus ducts are caused by cracked insulation of the bus combined with moisture or debris buildup internal to the bus ducts. It has also been shown that bus duct internals exposed to appreciable ohmic heating during operation may experience loosening of bolted connections related to repeated cycling of connected loads.

REFERENCES:

1. IEEE Std. P1205-2000, IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations.
2. SAND 96-0344, 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.
3. EPRI TR-109619, Guideline for the Management of Adverse Localized Equipment Environments, Electric Power Research Institute, Palo Alto, CA, June 1999.
4. EPRI TR-104213, Bolted Joint Maintenance & Application Guide, Electric Power Research Institute, Palo Alto, CA, December 1995.
5. NRC Information Notice 89-64, “Electrical Bus Bar Failures.”
6. NRC Information Notice 98-36, “Inadequate or Poorly Controlled, Non-Safety-Related Maintenance Activities Unnecessary Challenged Safety Systems.”
7. NRC Information Notice 2000-14, “Non-Vital Bus Fault Leads to Fire and Loss of Offsite Power.”

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For The Nuclear Regulatory Commission.

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Pao-Tsin Kuo, Program Director
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Office of Nuclear Reactor Regulation

Attachments: As stated
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