

**CHAPTER VI**  
**ELECTRICAL COMPONENTS**

This Page Intentionally Left Blank

## ELECTRICAL COMPONENTS

---

- A. Equipment, Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements
- B. Equipment Subject to 10 CFR 50.49 Environmental Qualification Requirements

*(refined outline to be added when issued for public comment)*

**Explanation of September 30, 2004 changes in preliminary interim draft chapter outline and aging management review (AMR) tables:** Within the AMR tables, this update process increases license renewal review efficiency by:

- Consolidating components (combining similar or equivalent components with matching materials, environment and AMP into a single line-item),
- Increasing consistency between **Material/Environment/Aging effects/aging management Program (MEAP)** combinations between systems (some existing MEAPs had multiple definitions that, based on the aging effect, could be broadened to envelope these into a single MEAP),
- Correcting any inconsistencies in the 2001 edition of the GALL Report,
- Updating references to the appropriate aging management programs, and
- Incorporating line-item changes based on approved staff SER positions or interim staff guidance.

The principal effect of this change is that the tables present the MEAP combinations at a higher level, and the prior detail within a structure or component line item is no longer explicitly presented. Consequently, the identifiers for subcomponents within a line item are no longer presented in the tables. As a result, the introductory listings of these subcomponents (originally in text preceding each table) have been deleted.

The following AMR tables contain a revised "Item" column and a new column titled "Link", which was not contained in the July 2001 revision. The "Item" number is a unique identifier that is used for traceability and, as mentioned above, no longer presents the detailed subcomponent identification. The link identifies the original item in the current version of the GALL Report when applicable (items added to this list refer to bases statements not yet available).

By January 30, 2005, the NRC staff plans to issue a revised GALL Report (NUREG-1801) and SRP-LR (NUREG-1800) for public comment. NRC anticipates re-numbering the line-items to provide an improved unique identifier as part of the public comment document. Also as part of the public comment process, the NRC will issue a NUREG documenting the basis for the proposed changes to the GALL Report and the SRP-LR. This NUREG bases document will be an aid for those reviewing the revised documents to understand what was changed and the basis for the proposed changes.

This Page Intentionally Left Blank

## **A. ELECTRICAL CABLES AND CONNECTIONS NOT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS**

### **Systems, Structures and Components**

This section addresses electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49, and that are installed in power and instrumentation and control (I&C) applications. The power cables and connections addressed are low-voltage (<1000V) and medium-voltage (2kV to 15kV). High voltage (>15kV) power cables and connections have unique, specialized constructions and must be evaluated on an application specific basis.

This section also addresses components, electrical cables and connections that are relied upon to meet the station blackout (SBO) requirements for restoration of offsite power. The plant system portion of the offsite power system that is used to connect the plant to the offsite power source is included in the SBO restoration equipment scope. This path typically includes the switchyard circuit breakers that connect to the offsite system power transformers (startup transformers), the transformers themselves, the intervening overhead or underground circuits between circuit breaker and transformer and transformer and onsite electrical distribution system, and associated control circuits and structures.

Electrical cables and their required terminations (i.e., connections) are typically reviewed as a single commodity. The types of connections included in this review are splices, mechanical connectors, fuse holders, and terminal blocks. This common review is translated into program actions, which treat cables and connections in the same manner.

Electrical cables and connections that are in the plant's environmental qualification (EQ) program are addressed in VI.B.

### **System Interfaces**

Electrical cables and connections functionally interface with all plant systems that rely on electric power or instrumentation and control. Electrical cables and connections also interface with and are supported by structural commodities (e.g., cable trays, conduit, cable trenches, cable troughs, duct banks, cable vaults and manholes) that are reviewed, as appropriate, in the Structures and Components Supports section.

VI A							
ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
L-01	VI.A.1-a	Conductor insulation for electrical cables and connections	Various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure/degradation of organics (Thermal/thermooxidative), radiolysis and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation, and moisture intrusion	Chapter XI.E1, "Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements"	No

VI A ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
L-02	VI.A.1-b	Conductor insulation for electrical cables used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance (IR)	Various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure/degradation of organics (Thermal/thermooxidative), radiolysis and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation, and moisture intrusion	Chapter XI.E2, "Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits"	No
L-03	VI.A.1-c	Conductor insulation for inaccessible medium-voltage (2kV to 15kV) cables (e.g., installed in conduit or direct buried)	Various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by exposure to moisture and voltage	Localized damage and breakdown of insulation leading to electrical failure/moisture intrusion, water trees	Chapter XI.E3, "Inaccessible Medium Voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements"	No

VI A							
ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
L-04	VI.A.2-a	Connector contacts for electrical connectors exposed to borated water leakage	Various metals used for electrical contacts	Air with borated water leakage	Corrosion of connector contact surfaces/ intrusion of borated water	Chapter XI.M10, "Boric Acid Corrosion"	No
LP-03	LP-03	Fuse Holders (Not Part of a Larger Assembly)	Insulation material – bakelite, phenolic melamine or ceramic, molded polycarbonate and other	Adverse localized environment caused by heat, radiation, or moisture in the presence of oxygen or > 60-year service limiting temperature	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure/ degradation (Thermal/thermooxidative) of organics/thermoplastics, radiation-induced oxidation, moisture intrusion and ohmic heating	Chapter XI.E1, "Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements"	No



VI A ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
LP-02	LP-02	Fuse Holders (Not Part of a Larger Assembly)	Insulation material – bakelite, phenolic melamine or ceramic, molded polycarbonate and other	Air – indoor uncontrolled (Internal/External)	None	None	No
LP-01	LP-01	Fuse Holders (Not Part of a Larger Assembly) Metallic Clamp	Copper alloy	Air – indoor	Fatigue/ ohmic heating, thermal cycling, electrical transients, frequent manipulation, vibration, chemical contamination, corrosion, and oxidation	A plant-specific aging management program is to be evaluated	Yes, plant specific
LP-07	LP-07	High voltage insulators	Porcelain, Malleable iron, aluminum, galvanized steel, cement	Air – outdoor	Degradation of insulator quality/ presence of any salt deposits and surface contamination	A plant-specific aging management program is to be evaluated	Yes, plant specific
LP-11	LP-11	High voltage insulators	Porcelain, Malleable iron, aluminum, galvanized steel, cement	Air – outdoor	Loss of material/ mechanical wear due to wind blowing on transmission conductors	A plant-specific aging management program is to be evaluated	Yes, plant specific

VI A							
ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
LP-04	LP-04	Phase bus Bus/connections	Aluminum / Silver Plated Aluminum Copper / Silver Plated Copper; Stainless steel, steel	Air – indoor and outdoor	Loosening of bolted connections/ thermal cycling and ohmic heating	A plant-specific aging management program is to be evaluated	Yes, plant specific
LP-10	LP-10	Phase bus Enclosure assemblies	Elastomers	Air – indoor and outdoor	Hardening and loss of strength/ elastomers degradation	Chapter XI.S6, “Structures Monitoring Program”	No
LP-06	LP-06	Phase bus Enclosure assemblies	Steel, galvanized steel	Air – indoor and outdoor	Loss of material/ general corrosion	Chapter XI.S6, “Structures Monitoring Program”	No

VI A							
ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
LP-05	LP-05	Phase bus Insulation/insulators	Porcelain, xenoy, thermo-plastic organic polymers	Air – indoor and outdoor	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure/ thermal/thermooxidative degradation of organics/thermoplastics, radiation-induced oxidation; moisture/debris intrusion, and ohmic heating	A plant-specific aging management program is to be evaluated	Yes, plant specific
LP-09	LP-09	Switchyard bus and connections	Aluminum, copper, bronze, stainless steel, galvanized steel	Air – outdoor	Loss of material/ wind induced abrasion and fatigue  Loss of conductor strength/ corrosion  Increased resistance of connection/ oxidation or loss of pre-load	A plant-specific aging management program is to be evaluated	Yes. plant specific

VI A							
ELECTRICAL COMPONENTS Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
LP-08	LP-08	Transmission conductors and connections	Aluminum, steel	Air – outdoor	Loss of material/ wind induced abrasion and fatigue  Loss of conductor strength/ corrosion  Increased resistance of connection/ oxidation or loss of pre-load	A plant-specific aging management program is to be evaluated	Yes, plant specific

## **B. EQUIPMENT SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS**

### **Systems, Structures and Components**

The Nuclear Regulatory Commission (NRC) has established nuclear station environmental qualification (EQ) requirements in 10 CFR Part 50 Appendix A, Criterion 4, and in 10 CFR 50.49. 10 CFR 50.49 specifically requires that an EQ program be established to demonstrate that certain electrical components located in harsh plant environments (i.e., those areas of the plant that could be subject to the harsh environmental effects of a loss of coolant accident [LOCA], high energy line breaks [HELBs] or post-LOCA radiation) are qualified to perform their safety function in those harsh environments after the effects of inservice aging. 10 CFR 50.49 requires that the effects of significant aging mechanisms be addressed as part of environmental qualification. Components in the EQ program have a qualified life, and the components are replaced at the end of that qualified life, if it is shorter than the current operating term. The qualified life may be extended by methods such as refurbishment or reanalysis, but the licensee is required by the EQ regulation (10 CFR 50.49) to replace the component when its qualified life has expired.

### **System Interfaces**

Equipment subject to 10 CFR 50.49 environmental qualification requirements functionally interface with all plant systems that rely on electric power or instrumentation and control.

VI B ELECTRICAL COMPONENTS Equipment Subject to 10 CFR 50.49 Environmental Qualification Requirements							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
L-05	VI.B.1-a	Electrical equipment subject to 10 CFR 50.49 EQ requirements	Various polymeric and metallic materials	Adverse localized environment caused by heat, radiation, oxygen, moisture, or voltage	Various degradation/ various mechanisms	EQ is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.4, "Environmental Qualification (EQ) of Electrical Equipment," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii).  See Chapter X.E1, "Environmental Qualification (EQ) of Electric Components," of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA

This Page Intentionally Left Blank