CHAPTER VI

ELECTRICAL COMPONENTS

Major Electrical Components

- A. Non-Environmentally Qualified (Non-EQ) Electrical Cables and Connections
- B. Environmentally Qualified (EQ) Equipment

- A.1 Conductor Insulation
 - A.1.1 Electrical cables and connections exposed to an adverse localized environment caused by heat or radiation
 - A.1.2 Electrical cables used in instrumentation circuits that are sensitive to reduction in conductor insulation resistance (IR) exposed to an adverse localized environment caused by heat or radiation
 - A.1.3 Inaccessible medium-voltage (2kV to 15kV) cables (e.g., installed in conduit or direct buried) exposed to an adverse localized environment caused by exposure to moisture and voltage
- A.2 Connector Contacts
 - A.2.1 Electrical connectors exposed to borated water leakage

A. Non-EQ Electrical Cables and Connections

Systems, Structures and Components

This review table addresses Non-EQ electrical cables and connections 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 are not normally used at nuclear power plants, have unique, specialized constructions and must be evaluated on an application-specific basis.

Electrical cables and their required terminations (i.e., connections) are reviewed as a single commodity. The types of connections included in this review are splices, mechanical connectors 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 and/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) which are reviewed, as appropriate, in the Structures and Components Supports section.

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Item	Structure/ Component	Region of Interest	Material	Environ- <u>men</u> t	Aging <u>Effe</u> ct	Aging Mechanism	References
A.1.1	Electrical Cables and Connections	Conductor insulation	Various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by heat or radiation in the presence of oxygen	Embrittle- ment, cracking, melting, discolora- tion, leading to reduced insulation resistance, electrical failure	Thermal/ thermoxida- tive degradation of organics, radiolysis and photolysis (UV sensitive materials only) of organics; radiation- induced oxidation	
A.1.2	Electrical cables used in instrumenta- tion circuits that are sensitive to reduction in conductor insulation resistance (IR)	Conductor insulation	various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by heat or radiation in the presence of oxygen	Embrittle- ment, cracking, melting, discolora- tion, leading to reduced insulation resistance, electrical failure	Thermal/ thermoxida- tive degradation of organics, radiation- induced oxidation	
A.1.3	Inaccessible Medium- Voltage (2kV to 15kV) Cables (e.g., installed in conduit or direct buried)	Conductor insulation	Various organic polymers (e.g., EPR, SR, EPDM, XLPE)	Adverse localized environment caused by exposure to moisture and voltage	Formation of water trees, localized damage, leading to electrical failure (breakdown of insulation)	Moisture intrusion, water trees	

VI. ELECTRICAL COMPONENTS A. Non-EQ Electrical Cables and Connections

Aging Management Program		Further
(AMP)	Evaluation and Technical Basis	Evaluation
Aging Management Program for Non-EQ Electrical Cables and Connections	See Chapter XI.E1 for an evaluation of the Aging Management Program for Non-EQ Electrical Cables and Connections.	No
Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits	See Chapter XI.E2 for an evaluation of the Aging Management Program for Non-EQ Electrical Cables used in Instrumentation Circuits.	No
Aging Management Program For Non-EQ Inaccessible Medium-Voltage Cables	See Chapter XI.E3 for an evaluation of the Aging Management Program for Non-EQ Inaccessible Medium Voltage Cables.	No

	Structuro /	Pogion of		Environ	Aging	Aging	
Itom	Component	Interact	Motorial	Environ-	Ffoot	Machaniam	Deferences
	Flootricel	Connector	Various	Fundament	Corrocion	Intrusion of	References
A. 2. 1	Connectors	contacto	various	Exposure to	of	horotod water	
	Connectors	contacts	for alastricial	Durated		borated water	
	Exposed to		ior electrical	water	connector		
	Dorated		contacts	јеакаде	contact		
	water				surfaces		
	Leakage						

Aging Management Program		Further
(AMP)	Evaluation and Technical Basis	Evaluation
Borated Water Leakage Surveillance	See Chapter XI.E4 for an evaluation of the Borated Water	No
Program for Non-EQ Electrical Connectors	Leakage Surveillance for Non-EQ Electrical Connectors.	

B. Environmentally Qualified (EQ) Equipment

B. EQ Equipment

Systems, Structures and Components

The Nuclear Regulatory Commission (NRC) has established nuclear station environmental qualification (EQ) requirements in 10CFR50 Appendix A, Criterion 4 and in 10CFR50.49. 10CFR50.49 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 in-service aging. 10CFR50.49 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. The qualified life may be extended by methods such as refurbishment or reanalysis, but the plant is required by the EQ regulation (10CFR50.49) to replace the component when its qualified life has expired.

System Interfaces

EQ equipment functionally interface with all plant systems that rely on electric power and/or instrumentation and control.

B. EQ Equipment

	Structure/	Region of		Environ-	Aging	Aging	
Item	Component	Interest	Material	ment	Effect	Mechanism	References
B.1.1	Electrical	EQ	Various	Adverse	Various	Various	
	equipment	equipment	polymeric	localized	degradation		
	subject to		and metallic	environment			
	10CFR50.49		materials	caused by			
	EQ require-			heat,			
	ments			radiation,			
				oxygen,			
				moisture,			
				and/or			
				voltage.			

B EQ Equipment

Aging Management Program		Further
(AMP)	Evaluation and Technical Basis	Evaluation
EQ Program	EQ is a time-limited aging analysis (TLAA) to be	Yes,
	performed for the period of license renewal. See the	TLAA
	Standard Review Plan, Section 4.4, "Environmental	
	Qualification (EQ) of Electrical Equipment" for acceptable	
	methods for meeting the requirements of	
	10CFR54.21(c)(1)(i) and (ii). See Chapter X of this report	
	for meeting the requirements of 10CFR54.21(c)(1)(iii).	

References

See Chapters X and XI.