Low Voltage AC and DC Power Cable Aging Management Program Elements

Note: The following program elements have been extracted from Draft 2 of the *Aging Management Program Development Guidance for AC and DC Low-Voltage Power Cable Systems for Nuclear Power Plants*, which is under development by EPRI. The document is in its early stage of development. Accordingly, these elements are subject to change during the iterative Technical Advisory Group development process.

1. Establishment of a Program

Each nuclear power plant should have a Low-Voltage AC and DC Power Cable Aging Management Program.[1] A program plan and implementing procedures should be prepared. Documentation of program development and implementation should be prepared and retained. Program Health should be monitored using established performance indicators.

2. Scope of the Program

The cables and associated connections and terminations within the scope of the Maintenance Rule should be within the scope of the Low-Voltage AC and DC Power Cable Aging Management Program. It is recommended that additional cables associated with the scope of the License Renewal Program be included in the scope of the Low-Voltage Cable Aging Management Program. It is recognized that plants could add these cables to the program when implementation of License Renewal actions are required. Cables required to support AP-913 critical functions should be considered for inclusion in the scope of the Low-Voltage Cable Aging Management Program. Low voltage power cables critical to power generation should also be within the scope of the program.

3. Definition of Adverse Localized Environments and Adverse Service Conditions

The program should identify those conditions that are considered to be adverse localized environments. This determination should consider elevated temperature, radiant heating from exposed process piping, radiation, water, chemical, and oil exposure.

In establishing the program, the severity of environment parameters and the associated duration at which aging would become a concern should be established. For example, the temperature above which aging would be a concern for a 40 or 60 year life could be established, or the radiation dose for a given life could be established. It is recommended that conservative values be assumed initially with revisions being allowed as experience is gained. The intent is not to require assessment of all cables exposed to the elevated stress levels, but rather identify areas of potential concern within the plant. Evaluation of the population of worst case applications will provide the insight necessary to determine when assessment of additional cables in lesser environments is necessary.

[1] While separate guides are being generated by EPRI to address medium voltage cable, low-voltage power, and instrumentation and control cable, utilities may develop a single cable aging management program or individual cable aging management programs as they wish.

The program should include a review of ohmic heating documentation to determine if significant aging from ohmic heating for low-voltage power cables is a concern especially if sections of the cable are located in areas with adverse localized environments.

The program should require verification that adequate controls exist on verification of the condition of thermal insulation on hot process piping in the vicinity of low-voltage power cable. If the removal of thermal insulation at power is part of the maintenance strategy for the plant, the program should require that the insulation is not removed in the vicinity of cable, or if it will be that the effects of the resulting thermal aging are evaluated and controlled.

The program should include identification of connections and terminations that could be subject to ohmic heating. Circuits that have inconsequential loads may be excluded as can circuits that are rarely loaded.

4. Identification of Cable Circuits Subject to Adverse Conditions

The subset of cables with scope requiring assessment should be determined either by identification of the adverse localized environments and then determining if cables are aging prematurely in those areas; or by identifying cables within the scope and then determining if they are located in areas with adverse environments. Plants may use either or both methods.

For cables in inaccessible or underground applications, if cables can be verified as being dry, they may be treated as not being in an adverse environment. However, this proof may be difficult and assessment of a representative sampling of cables is recommended.

5. Actions for Cable Circuits Subject to Dry Adverse Conditions

The Low-Voltage Power Cable Aging Management Program should include one or more methods of determining if significant aging of the cable is occurring for cables located in dry adverse environments. The techniques to be employed may include visual/tactile assessment, non-destructive in situ testing (e.g., indenter, near infrared spectroscopy, or acoustic velocity assessment), laboratory testing of samples, and electrical testing (e.g., Line Resonance analysis). Temperature monitoring and infrared thermography may be used to assess environments and heating of connections.

The techniques should be applied to cables representative of worst case conditions. The condition of these cables will indicate whether a broadening of the cables to be monitored is necessary. If the worst case cable circuits remain in good condition, cables in less severe conditions are assumed to be in acceptable condition. If the worst case cable circuits are found to be significantly degraded, appropriate corrective action should be taken and circuits subjected to conditions less severe than the worst case should be assessed. Where large numbers of cables are involved, sampling of the population may be used as long as the "worst" case cables are within the population to be assessed.

6. Actions for Cable Circuits Subject to Wet Conditions

Low-voltage ac and dc power cables subject to wet conditions should be periodically tested via insulation resistance to ground and as practicable, phase to phase or by another recognized test to determine if degradation has occurred. Results should be trended. Acceptance criteria should be developed.

7. Corrective Action

The low voltage power cable program should require that appropriate corrective action be taken if significant aging of cable insulation systems be identified. Those actions may include assessment, testing, repair, or replacement as appropriate. If the investigation of the failure or deterioration indicates a generic degradation mechanism, circuits with similar conditions should be reviewed to determine if they too require corrective action.