Medium Voltage Power Cable Aging Management Program Elements

Note: The following program elements have been extracted from Draft 2 of the *Aging Management Program Guidance for Medium Voltage Cable Systems for Nuclear Power Plants*, which is under development by EPRI and an Industry Technical Advisory Group. 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 Medium Voltage Cable Aging Management Program. A Program Plan/Guide 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 that support Maintenance Rule functions should be within the scope of the Medium Voltage Cable Aging Management Program. It is highly recommended that additional cables associated within the scope of the License Renewal Program be included in the scope of the Medium Voltage Cable Aging Management Program. These cables may be added to the program when implementation of License Renewal actions is required. Any commitments related to medium voltage cable aging management contained in plant specific regulatory correspondence should also be included in the development of the program and its scope. Cables required to support AP-913 critical functions should be considered for inclusion in the scope of the Medium Voltage Cable Aging Management Program. Medium voltage cables critical to power generation or outage length extension should be considered for inclusion in the scope of the program.

3. Identification of Cable Circuits Subject to Adverse Conditions

Cables Subject to Wetted Conditions

Cables subjected to long-term wetting should be identified.

If cables are subject to wetting or have been subject to wetting for long-periods in the past and energized for more than 25% of their life, aging management should be implemented starting with the assessment of the susceptibility of the insulations to wet conditions.

The condition of vaults and manholes subject to wet conditions and the cable support structures within them should be evaluated at least once to determine the condition. Appropriate repairs should be made. The need for further evaluations should be determined based on the conditions that are identified.

Cables Subject to Dry Adverse Conditions

Medium voltage cables in the scope of the program that are located in dry environments should be reviewed to determine if they are exposed to adverse localized environments, subject to elevated operating temperature from circuit currents, or have high resistance splices or terminations. Where other programs exist that will control and identify these conditions, credit may be taken for them and additional controls need not be added.

When plants remove thermal insulation from piping and equipment adjacent to cable in preparation for an outage, the effects on adjacent cable should be addressed. Procedures for restoration of thermal insulation in the vicinity of cable circuits should be reviewed to assure that the thermal insulation is inspected for acceptability and adequate protection from thermal stresses is given to the cable.

The actions for cable found to be in adverse thermal and radiation environments are described in Element 6.

4. Susceptibility Evaluation of Cable Circuits Subject to Wet Environments

The cables in the scope of the program subjected to long-term wetting should be identified and their susceptibility to wet aging reviewed. It is recommended that cables that are older than the periods stated in Table 4 (of the Program Development Guidance), and subject to energization for greater than 25 % of their life and long-term wetting be assessed for the effects of long-term aging in accordance with Element 5.

Wet circuits should be reviewed to determine if splices exist. If the splices are wet and the circuits are subject to lightning strikes and have no surge protection, their condition should be assessed.

5. Actions for Wet Environment Cables

If practicable, manholes and vaults should be kept clear of water that could submerge cables.

Cables within the scope of the medium voltage cable aging management program that are or have been subjected to long-term wet environments should be assessed for condition.

Wet environment cables with insulation shields should be assessed using an off-line ac test. VLF tan δ is recommended for cables commonly used in nuclear plants; however, the test type should be applicable to the nature of the degradation expected and the design of the cable. Alternate tests, such as dielectric spectroscopy, may be used. Partial discharge testing may be used if the shield configuration and insulation do not lead to excessive attenuation of PD signals.

For medium voltage cables within the scope of the medium voltage cable aging management program that do not have insulation shields, plants should commit to full forensics of failures that are potentially water related with corrective action appropriate to the findings and should follow research on related cables to gain insights on the water-

related aging. Testing of abandoned cable or cable removed from service that was subject to long-term wetting may be of benefit in assessing condition of similar cables in similar environments. Cable failure and aging experience from other plants having unshielded cables and insights from research on aging and assessment of unshielded cables should be taken into consideration to determine if corrective action is necessary.

6. Actions for Cable Circuits Subject to Dry Adverse Conditions

When the review of medium voltage cables circuits within the scope of the program determines that cables are subject to dry adverse localized environments, actions should be taken to determine the effect on condition of the cables.

Where hot process equipment is sufficiently close such that medium voltage cable could be affected by thermal damage, visual assessment of the condition of the cable should be performed and appropriate actions taken based on the identified condition. Physical and chemical tests of the jacket and/or insulation system may be performed to further define condition and the need to replace or repair the cable circuit. As appropriate, the source of the thermal damage should be mitigated or cable re-routing considered.

For circuits in which elevated conductor temperature from operating currents is determined to be a concern, visual assessment of the condition of the cable should be performed, documented, and appropriate actions taken based on the identified condition. Physical and chemical tests of the insulation system may be performed to further define condition and the need to replace or repair the cable circuit.

When inspection or infrared thermography indicates that connections are overheating, the degree of damage should be assessed and the connection repaired or replaced as appropriate.

7. Corrective Actions

The medium voltage cable aging management program should require that appropriate corrective action be taken if aging is identified or suspected that results from adverse localized environments. Those actions may include assessment, testing, repair, or replacement as appropriate. If the investigation of a failure or deterioration indicates a generic degradation mechanism, circuits with similar conditions should be reviewed to determine if they too require corrective action.