

IMPLEMENTATION OF LOW AND MEDIUM VOLTAGE CABLE AGING MANAGEMENT AT NUCLEAR POWER PLANTS

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ABSTRACT

U.S. nuclear plants are implementing cable aging management programs rapidly. This paper describes the Electric Power Research Institute's activities supporting cable aging management including:

- Program implementation guidance and issue resolution
- Forensic studies of medium voltage cables removed from wet, long-term service
- Development of accelerated wet-aging methodology for ethylene propylene rubber insulation

KEYWORDS

Electrical cable aging

Cable submergence

Cable aging management

Accelerated wet aging

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INTRODUCTION

The U.S. nuclear industry has committed to implementing electrical cable aging management programs designed to identify and resolve aging of cables that could affect plant safety and operations. Commitments have been made to the U.S. Nuclear Regulatory Commission [1] to implement aging management of safety-related cables and cables covered by the 10CRF50.65 Maintenance Rule [2]. The Institute of Nuclear Power Operations has also incorporated review of cable aging management into their plant assessment processes. These actions are causing U.S. nuclear plant operators to rapidly implement cable aging management programs. Reference [1] commits the plants to develop their programs based on the guidance of two Electric Power Research Institute (EPRI) cable aging management documents for low and medium voltage power cable [3, 4]. These guides identify the attributes of a cable aging management program, address the scope of the program, direct the user to identify adverse environments and service conditions, and then to assess the effects of the environments and service conditions on the cable system by means appropriate to the aging mechanism and cable type. Guidance is provided regarding the types of methods that apply to the cable designs in use.

The guidance is based on a combination of past research and on-going forensics research on cables removed from service especially medium voltage cables having 4 to 13.8 kV operating voltages. This research is identifying the nature of the failure mechanism and supports the recommendations for testing and acceptance criteria.

Two key problems are being addressed:

1. A number of plants have non-shielded 4 kV ethylene propylene rubber insulated cables that are not electrically testable.
2. A wet aging model does not exist that would support submergence environmental qualification.

EPRI nuclear plant cable research is focusing on establishing techniques for assessing medium voltage cable and developing accelerated aging methodology for submergence qualification of medium voltage cable.

CABLE SYSTEM AGING MANAGEMENT IMPLEMENTATION GUIDANCE

Three cable system aging management guides have been developed by EPRI through a technical advisory group process in which draft guides were prepared and then iteratively reviewed by an advisory group composed of consultants, cable manufacturing staff engineers, and numerous utility cable engineers. The three guides covered medium voltage cable, low-voltage (<1000V) ac and dc power cable, and instrumentation and control cable systems [3, 4, 5]. Three separate reports were issued because different techniques and issues apply to the different cable types such that developing one report would have led to significant confusion. The reports cover aging management of the cable system including the entire cable circuit (cable, its terminations, and its splices). Assessment of cable support systems including trays, conduits, and ducts is also covered.

Program Scope and Approach to Aging Management

The industry commitment to cable aging management has the same scope as the U.S. Nuclear Regulatory Commission's Maintenance Rule [2], which has a very broad scope and covers "Safety-related... systems and components that are relied on to remain functional during and following design basis events to ensure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure..." and "nonsafety-related...systems, or components: (i) That are relied on to mitigate accidents or transients or are used in