Improving Lifetime Prediction of Electrical Cables in Containment

PI: Leo Fifield, Pacific Northwest National Laboratory (PNNL)

Collaborators: Nicola Bowler, Iowa State University

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ABSTRACT:

The long-term viability and competitiveness of the existing U.S. reactor fleet is dependent upon effective aging management of passive components including the hundreds of miles of electrical cables in containment buildings and throughout the plants. Prediction of cable aging behavior based on accelerated aging is impeded by the fact that mechanisms for degradation in relatively mild operational environments can differ significantly from those observed in the harsher experimental conditions necessary to replicate decades of plant aging in the course of weeks or months in the laboratory. Commonly used methods to track aging indicate significant degradation relatively late in the lifetime curve, just prior to failure. Ultrasensitive techniques that can detect and trend aging early in the lifetime curve would be useful both for cable aging management in reactor operation and for predicting cable life from mildly accelerated conditions that more closely simulate in-service aging. Oxygen consumption, which tracks changes in the oxygen content of a sealed sample container during aging, has been proposed as a sensitive method to measure degradation of cable insulation polymers. Dielectric spectroscopy may also enable sensitive detection of aging through changes in the permittivity of the insulation.

This project seeks to use the Sandia Gamma Irradiation Facility (GIF) to expose nuclear cable insulation samples in sealed containers to a series of gamma doses at a series of dose rates. Oxygen concentration of the sealed containers and dielectric properties of the polymer samples will be measured before sending containers to the facility and upon receipt from the facility. Lifetime curves of the insulation will be determined at more extreme accelerated conditions to validate the metrics and at mild conditions to demonstrate the utility of the sensitive techniques in tracking and predicting damage early in the lifetime curve.

The goal of the project is to demonstrate sensitive measures of aging that might be used for 1) accelerated laboratory aging at conditions that more closely mimic in-service environments and that consequently produce lesser extent of aging in laboratory timeframes, and 2) non-destructive evaluation of cable status for installed in-service cables. These objectives support addressing of identified knowledge gaps related to lifetime prediction in extended operation and effect cable aging management.