



INNOVATING NUCLEAR TECHNOLOGY

ANALYSIS AND MEASUREMENT SERVICES CORPORATION

Kick Off Meeting

Cable Aging Acceptance Criteria to Support Plant Life Extension

Presented by:

AMS Corporation

Presented to:

NRC



October 27, 2023



AMS Team



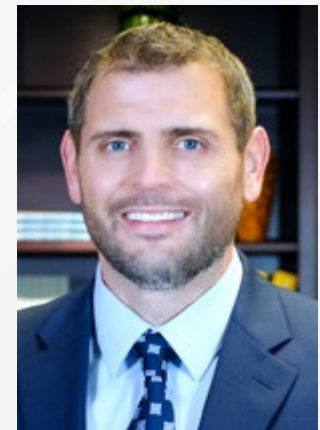
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President & CEO



Casey Sexton
Manager, Cable Services



Ryan O'Hagan
Marketing Manager



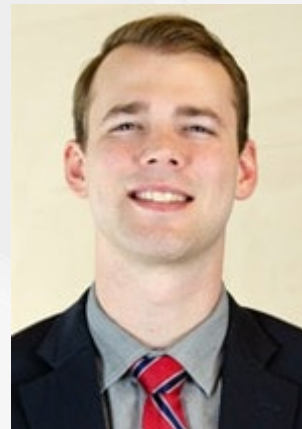
Chad Kiger
EMC Engineering Manager



Gary Harmon
Sr. Electrical Engineer



Trevor Toll
*Lead Engineer,
Materials Testing Lab*



Adam Deatherage
Applications Engineer



Mark Burzynski
AMS Consultant



Meeting Objective

- **AMS has developed acceptance criteria for cable condition monitoring technologies**
- **The project was done with \$3.5M in DOE funding and in partnership with PNNL and ORNL**

AMS is seeking NRC approval of its methodology as an acceptable method for satisfying GALL requirements and extending EQ life based on condition monitoring results



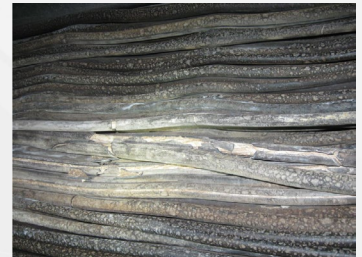
Cable Aging Management

Current Practice:

- Walkdowns
- IR Measurements
- Calibration/Surveillance Testing
- EQ cables: Reanalysis by Arrhenius

New Technology:

- In-Situ Electrical Measurements
- Mechanical Tests
- Thermo-Chemical Tests





Cable Condition Monitoring Methods

In – Situ Methods

Insulation Resistance

Frequency Domain
Reflectometry (FDR)

Time Domain
Reflectometry (TDR)

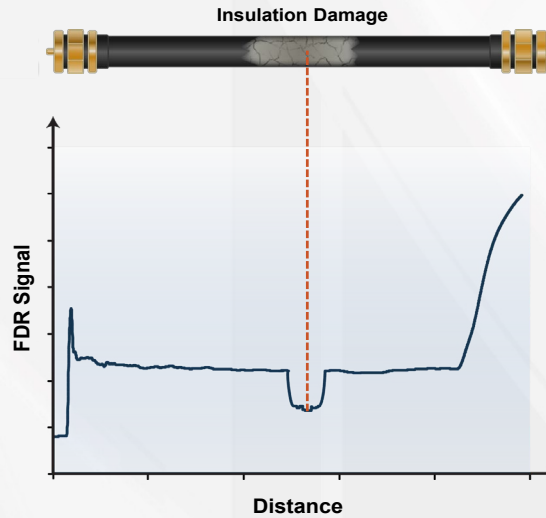
Indenter Modulus (IM)

Dielectric Spectroscopy

Tan Delta

Impedance

Fourier Transform Infrared
Spectroscopy (FTIR)



Laboratory Methods

Elongation at Break (EAB)

Oxidation Induction Time
(OIT)

Oxidation Induction
Temperature (OITP)

Thermo-gravimetric
Analysis (TGA)

Relative Density

Mass Spectroscopy (MS)

Electrical Permittivity



Development of Cable Aging Acceptance Criteria



Accelerated Aging



Condition Monitoring Tests

Laboratory

- Elongation at Break
- Oxidation Induction Time
- Thermogravimetric Analysis
- Density

In-Situ

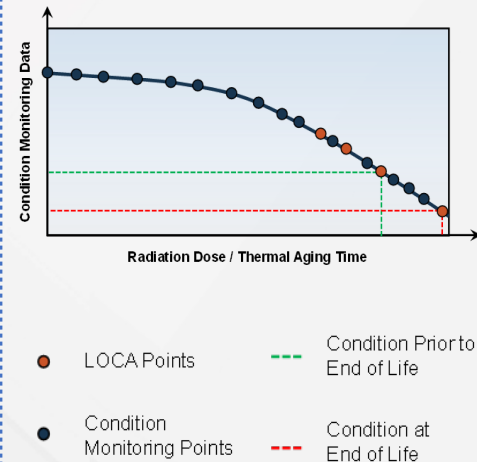
- Frequency Domain Reflectometry
- Indenter Modulus
- Impedance Measurements
- Fourier Transform Infrared Spectroscopy



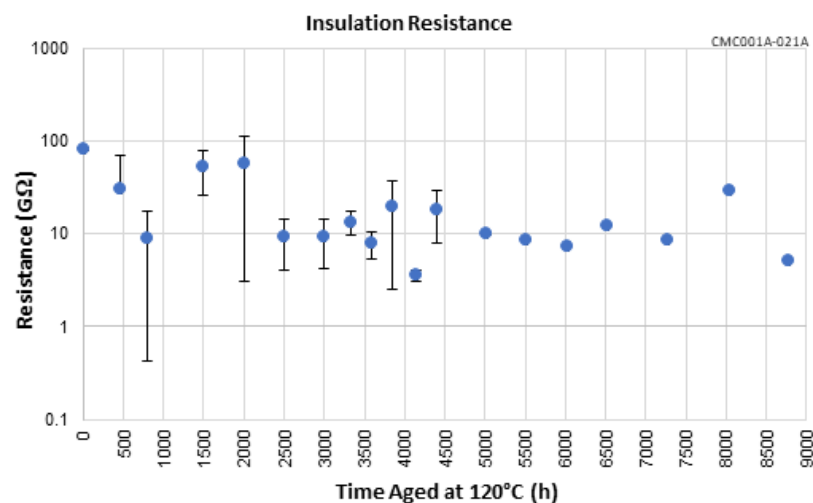
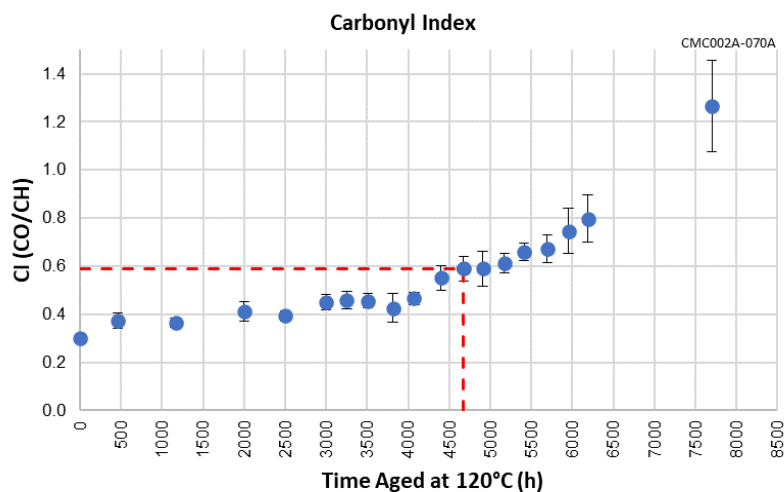
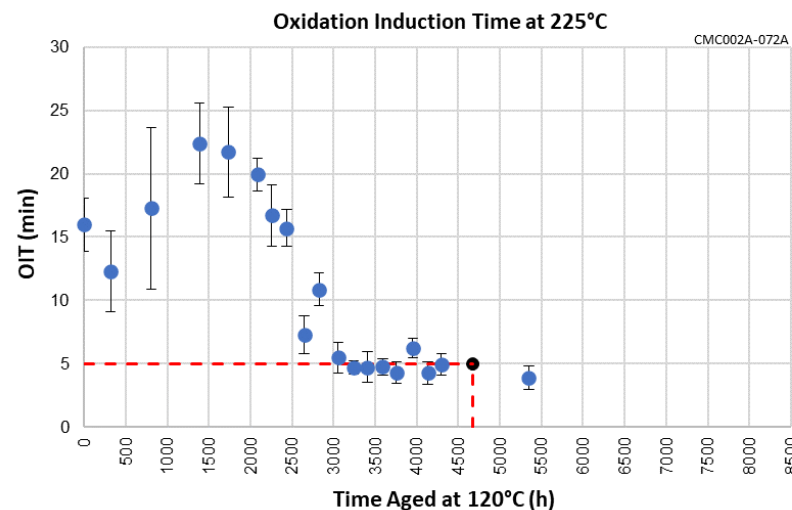
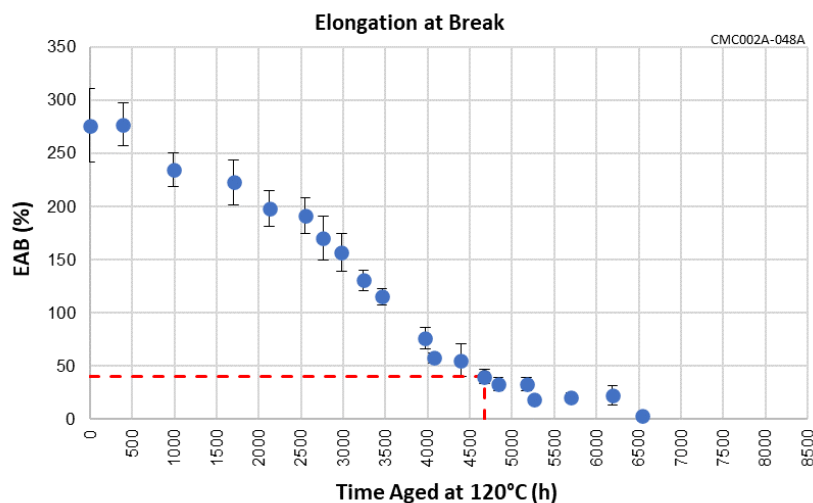
LOCA Exposure (Accident Scenario)



Established Acceptance Criteria



Examples of Research Results





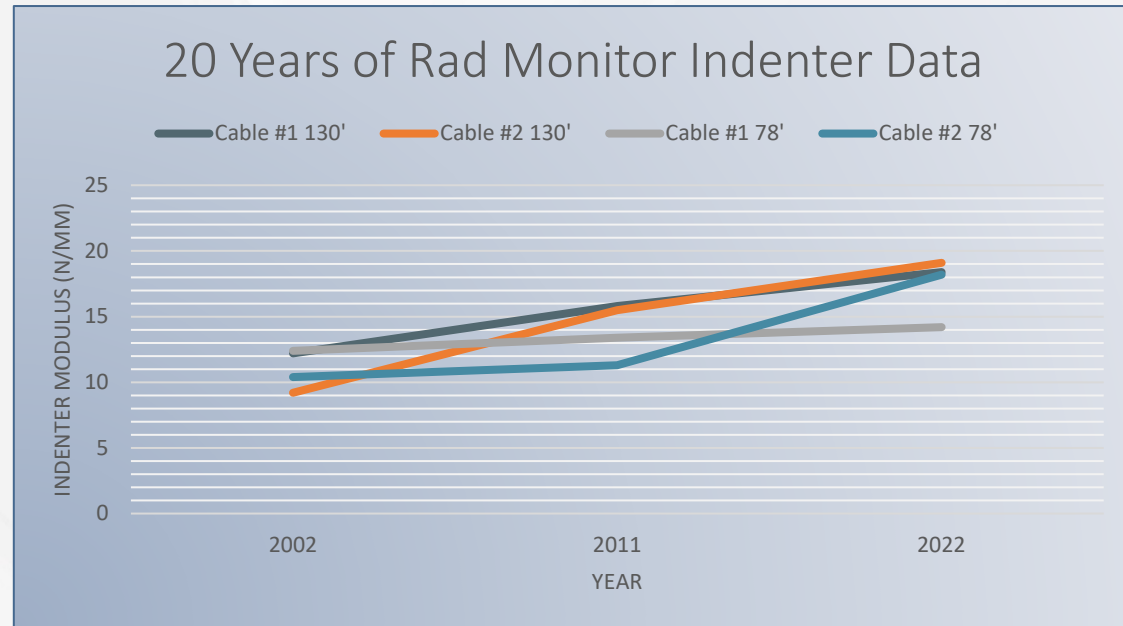
Cables Used in Development of Aging Acceptance Criteria

Cable	Insulation Polymer Type	Jacket Polymer Type	CM Tests with Acceptance Criteria
Firewall III, circa 2007	XLPE	CSPE	EAB, IM (Jacket), FDR, LCR (20 Hz to 1 MHz), FTIR-CI, OIT, OITP
Brand Rex	XLPE	CPE	EAB, IM (Jacket), FDR, LCR (1 mHz to 1 MHz), FTIR-CI, OIT, OITP, TGA
Firewall III, circa 1980	XLPE	CSPE	EAB, IM (Jacket), FDR, LCR (20 Hz to 1 MHz), FTIR-CI, OIT, OITP, TGA
Eaton/Dekoron	XLPO	CSPE	EAB, IM (Jacket), FDR, LCR (20 Hz to 1 MHz), FTIR-CI, OIT, OITP, TGA
AIW	EPR	CSPE	EAB, IM (Jacket), FDR, LCR (20 Hz to 1 MHz), FTIR-CI, OIT, OITP
Rockbestos	SR	Thermoset Polyolefin	EAB, IM (Jacket), LCR (1 mHz to 1 kHz)
Anaconda	EPR/CSPE Bonded	CSPE	EAB, IM (Insulation and Jacket), FDR, LCR (1 mHz Hz to 1 kHz), FTIR-CI, OIT, TGA, Density
Okonite	EPR/CSPE Bonded	CSPE	EAB, IM (Jacket), FDR, LCR (1 kHz), FTIR-CI



OE #1: EQ Radiation Monitor Testing




- **BIW Cable (CSPE Jacket / XLPE Insulation)**
- **IM data showed trending but below acceptance criteria**
- **Electrical test data (FDR, Capacitance, IR) all well within acceptance criteria**

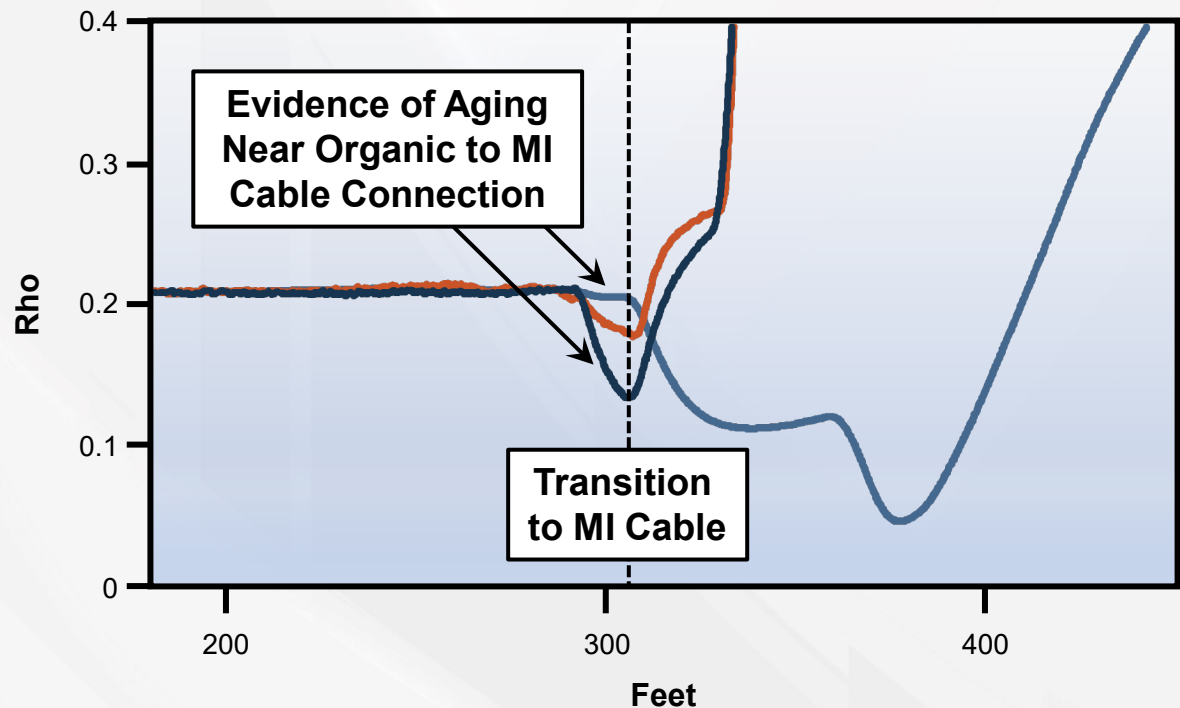


Cable ID	Elevation	Average IM 2002 (N/mm)	Average IM 2011 (N/mm)	Average IM 2022 (N/mm)
Cable #1	130'	12.2	15.8	18.4
Cable #2	130'	9.2	15.5	19.1
Cable #1	<78'	12.4	13.4	14.2
Cable #2	<78'	10.4	11.3	18.2



OE #2: XI.E2 Ex-Core Nuclear Instrumentation Cable Degradation

-  Little Degradation
Power Range Detector
-  Moderate Degradation
Source Range Detector
-  Severe Degradation
Source Range Detector





Planned Submittal Schedule

Activity	Deadline
Pre-Submittal Meeting	October 27, 2023
Submit TR	February 2024
Final SER	February 2025

AMS believes the Cable Condition Monitoring Topical Report fits in Compressed Review category based on NRC and other research on the topic.



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Thank You!

Questions?

