Medium Voltage Cables in Nuclear and Fossil Power Plants: Characteristics, Performance, Condition Assessment

July 14–16, 2014
Charlotte, North Carolina

- Determine the reliability of 4-13 kV cables installed in existing nuclear and fossil power plants
- Properly install medium voltage cables in conduits, duct banks, and trays
- Use correct testing methods for installed cables and accessories
- Understand condition assessment and rejuvenation techniques

Presented by the University of Wisconsin in cooperation with the Electric Power Research Institute
About This Course
This course will present important topics relating to the reliability of medium voltage (4-13 kV) cables installed in nuclear and fossil power plants and off-site feeds to 35 kV. There are important questions relating to the reliability of the medium-voltage cables and accessories installed in these plants:

- What is the present condition of these cables and accessories?
- What has been their historical performance?
- Are there non-destructive ways to test them?
- What failure modes can be anticipated?
- Are life extension methods effective?
- Is it possible to predict when replacement should be undertaken?

Course Objective
Your participation will help you understand the theory and practice of medium voltage power plant cable and accessory engineering and applications, with particular emphasis on:

- Properties of materials
- Cable manufacturing
- Standards and specifications
- Cable installation, splicing, and termination
- Cable replacement and pulling
- Cable system performance
- Cable system testing
- Failure modes and failure analysis
- Fault location
- On-line condition assessment and life extension
- Off-line condition assessment and testing
- Failure analysis
- Rejuvenation

Who Should Attend
This course is designed for engineers and senior technicians responsible for the reliable operation, maintenance, and aging management of medium voltage cable systems in nuclear power plants. It will also benefit technical personnel from fossil plants using extruded polymer cable and other industrial, utility, and plant electrical engineers. Cable and accessory manufacturers and materials suppliers will find this course of interest. Attendance is limited.

Course Development
This updated course has been developed with the guidance and support of the Electric Power Research Institute; EPRI members can enroll at a substantially reduced fee. The Electric Power Research Institute was established in 1973 as an independent, non-profit center for public interest energy and environmental research. EPRI brings together members, participants, the Institute’s scientists and engineers, and other leading experts to work collaboratively on solutions to the challenges of electric power. EPRI’s members represent more than 90% of the electricity generated in the United States. The University of Wisconsin–Madison is pleased to cooperate with EPRI in presenting this course and appreciates the advice and counsel of the course development task force.

View Cable Videos
Throughout the course you will view videos of cable installations and practices. This will increase your understanding of minimizing cable damage and protecting personnel.

Course Faculty
William A. Thue
Course Coordinator
Cable Engineering Consultant
Hendersonville, North Carolina

John T. Smith, III
Director, Marshall Technology Center
General Cable Corporation
Scottsville, Texas

Lauri J. Hiivala
Power Cable Consultant
Toronto, Ontario, Canada

Andrew J. Mantey
EPRI Representative and Senior Project Manager
Plant Support Engineering
Electric Power Research Institute
Trappe, Pennsylvania

Program Director
Willis F. Long
Professor Emeritus
Departments of Engineering Professional Development and Electrical and Computer Engineering
University of Wisconsin–Madison

Course Textbook on Power Cable Included

“I REALLY ENJOYED THE OFF-SCHEDULE TIME FOR DISCUSSION ABOUT TESTING. IT HELPED A LOT TO HEAR HOW OTHER PEOPLE ARE DEALING WITH THE TESTING AMBIGUITY.”
System Engineer, PSEG Nuclear

ENROLL ONLINE TODAY! Or visit our website.
Day 1
1 Welcome and Introductory Comments
   Willis F. Long and Andrew J. Mantey

2 Basic Dielectric Theory and Design of Cables
   • Insulation thickness
   • Faults on plant cables
   • Shielding and jacketing
   Lauri J. Hiivala

3 Basic Properties of Insulating Materials
   • Fundamentals of polymeric insulation for extruded cables
     – XLPE, TR-XLPE, EPR, EPDM, HMWPE
     – neoprene, hypalon, PVC, butyl, silicone
   • Comparison of insulating materials
   • Shield and jacket materials
   John T. Smith

4 Conductors
   • Resistivity vs. conductivity
   • Electrical properties of conductor materials
   • Stranded conductors
   Lauri J. Hiivala

5 Grounding System Impacts on MV Cable
   • Solid vs. resistance grounding
   • Impact on voltage during fault
   • Impact on insulation thickness
   • Effect on fault current
   • Fast trip or alarm?
   Lauri J. Hiivala

6 Arc Flash Hazards
   • What is an arc flash?
   • OSHA, NFPA, IEEE standards
   • Design solutions
   • Personal protective equipment (PPE) guidelines
   William Thue

7 Electrical Properties of Insulating Materials
   • Dissipation factor
   • Dielectric constant
   • Dielectric strength
   John T. Smith

8 Cable Manufacturing
   • Conductors
   • Extruded insulations
   • Finishing operations
   • Testing
   • Shipping
   Lauri J. Hiivala

9 Cable Standards and Specifications
   • Industry standards and specifications
   • Discrepancies between ICEA and AEIC specifications
   • User cable specifications
   • Choices for conductors, insulations, shielding, jacketing, packaging
   Lauri J. Hiivala

Day 2
10 Pictorial Views of Treeing in Extruded Dielectric Cables
   • Water trees vs. electrical trees
   • Vented and non-vented trees
   • Water trees in EPR cable
   • Mitigation of water treeing
   William Thue

11 Partial Discharge Fundamentals
   • Inception and extinction voltages
   • Void size–PD relationship
   • Degradation caused by PD
   John T. Smith

12 Medium Voltage Cable Installation
   • Pulling tension calculations
   • Sidewall bearing pressure
   • Jamming
   • Installation types
     – duct bank
     – conduit
     – tray
   William Thue

13 Ampacity, Impedance, and Voltage Drop
   • Cable operating temperatures
   • Thermal resistivity of insulating materials, soil/earth
   • Ampacity of cables in air
   • Cable resistance, reactance
   • Voltage drop–short lines
   • Successful parallel cable operation
   Lauri J. Hiivala

14 Splicing and Terminating Cables
   • Stress control
   • Cable preparation
   • Terminations
   • Splices
     – taped
     – cold shrink
     – heat shrink
   William Thue

15 Cable and Joint Failure Modes
   • Electrical treeing
   • Water treeing
   • Effects of DC testing
   • Issues unique to EPR
   • Failures of joints and accessories
   • Flammability
   John T. Smith

16 Medium Voltage Cable Aging Management Program Implementation
   • Impetus for aging management programs
   • EPR aging management program guides
   • Initial implementation issues
   Andrew J. Mantey

Day 3
17 In-plant Testing–Assessment Evaluation
   • Measured properties
   • On-line techniques
   • Off-line techniques
   • Predictions of future life
   William Thue

18 On-line Condition Assessment
   • Non-conventional on-line partial discharge detection
   • Testing while circuit energized
   John T. Smith

19 Off-line PD and Tan δ Testing
   • Partial discharge
   • Dissipation factor
   • Oscillating wave, 0.1 Hz vs. 50/60 Hz
   • Evaluation of member-supplied dissipation factor test results
   William Thue and Andrew J. Mantey

20 VLF as Substitute for Hi-Pot Testing
   • VLF testing
   • Voltage/time test conditions
   John T. Smith

21 Dielectric Spectroscopy
   • Frequency range
   • Correlation with insulation property changes
   • Global measurement issues
   John T. Smith

22 Cable Failure Analysis
   • Sample collection and retention
   • Evidence gathering and assessment
   • Examination sequence in a lab environment
   • The complete report
   William Thue

23 Locating Faults on Insulated Power Cables
   • Direct terminal measurements
   • Time domain reflectometry
   • Tracer methods
   • Modulated DC and AC methods
   • Fault locating for low voltage non-shielded cables
   William Thue

24 Rejuvenation
   • Fluid injection concept for life extension
   • Silicone injection procedure
   • Advances and caveats
   • Experience with service-aged black EPR
   John T. Smith and Andrew J. Mantey

Course Outline
Four Easy Ways to Enroll

Internet: epd.engr.wisc.edu/webP301
Phone: 800-462-0876 or 608-262-1299 (TDD 265-2370)
Mail to: The Pyle Center
        Attn: Engineering Registration
        702 Langdon Street
        Madison, Wisconsin 53706
Fax: 800-442-4214 or 608-265-3448

Course Information
Please enroll me in Medium Voltage Cables in Nuclear and Fossil Power Plants: Characteristics, Performance, Condition Assessment

- Course #P301 July 14 – 16, 2014 in Charlotte, North Carolina. Fee: $1495
- $1195 for EPRI members
- I cannot attend at this time. Please send me brochures on future courses.

Enroll Today!
This is a limited enrollment course. We require enrollment in advance.

Personal Information (Please print clearly.)
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Need to Know More?
Call toll free 800-462-0876 and ask for
Program Director: Willis F. Long, PE willis@engr.wisc.edu
Program Associate: Debbie Benell benell@engr.wisc.edu
Or e-mail custserv@epd.engr.wisc.edu

General Information
Fee of $1495, $1195 for EPRI members covers textbook, course materials, break refreshments, three lunches, and certificate. We do not publish proceedings.

Cancellation If you cannot attend please notify us at least seven days prior to the course start and we will refund your fee. Cancellations received after that date and no-shows will be subject to a $150 administrative fee per course. You may enroll a substitute at any time before the course starts.

Location This course will be held at the Electric Power Research Institute offices, 1300 W. T. Harris Boulevard, Building 1, Conference Room 402, Charlotte, NC. Phone messages: 704-595-2000.

Accommodations We have reserved a block of guest rooms (rates starting at $109) at SpringHill Suites Charlotte University Research Park, 8700 Research Drive, Charlotte, NC. To reserve a room call 888-287-9400 or 704-503-4800 and indicate that you will be attending this course under group code Medium Voltage Cables. Room requests after June 20 will be subject to availability. Other fees and restrictions may apply.

Earn Continuing Education Credits By participating in this course, you will earn 18 Professional Development Hours (PDH) or 1.8 Continuing Education Units (CEU).