EPRI Update

LTO and Plant Modernization

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Technical Executive

April 30, 2024

EPRI Update - Outline

LWRS Program – five R&D Pathways:

- Plant Modernization – EPRI Update
- Flexible Plant Operation and Generation
- Risk-Informed Systems Analysis – EPRI Update
- Materials Research – EPRI Update
- Physical Security

Plant Modernization
EPRI Update

PLANT MODERNIZATION

Industry

Vision

To preserve nuclear power as a carbon-free, safe, and reliable energy resource.

Mission

Achieve nuclear power plant economic viability through transformative technology and innovation that optimizes operations & maintenance while ensuring safety and reliability.

Collaborators

- Utilities
- Institute of Nuclear Power Operations (INPO)
- Nuclear Energy Institute (NEI)
- Owners, groups, other R&D organizations, vendors
- U.S. Department of Energy (DOE) and National Labs
- International Atomic Energy Agency (IAEA)

Strategic Goals

Feasibility

Show that modernization effort can be successful

Methods

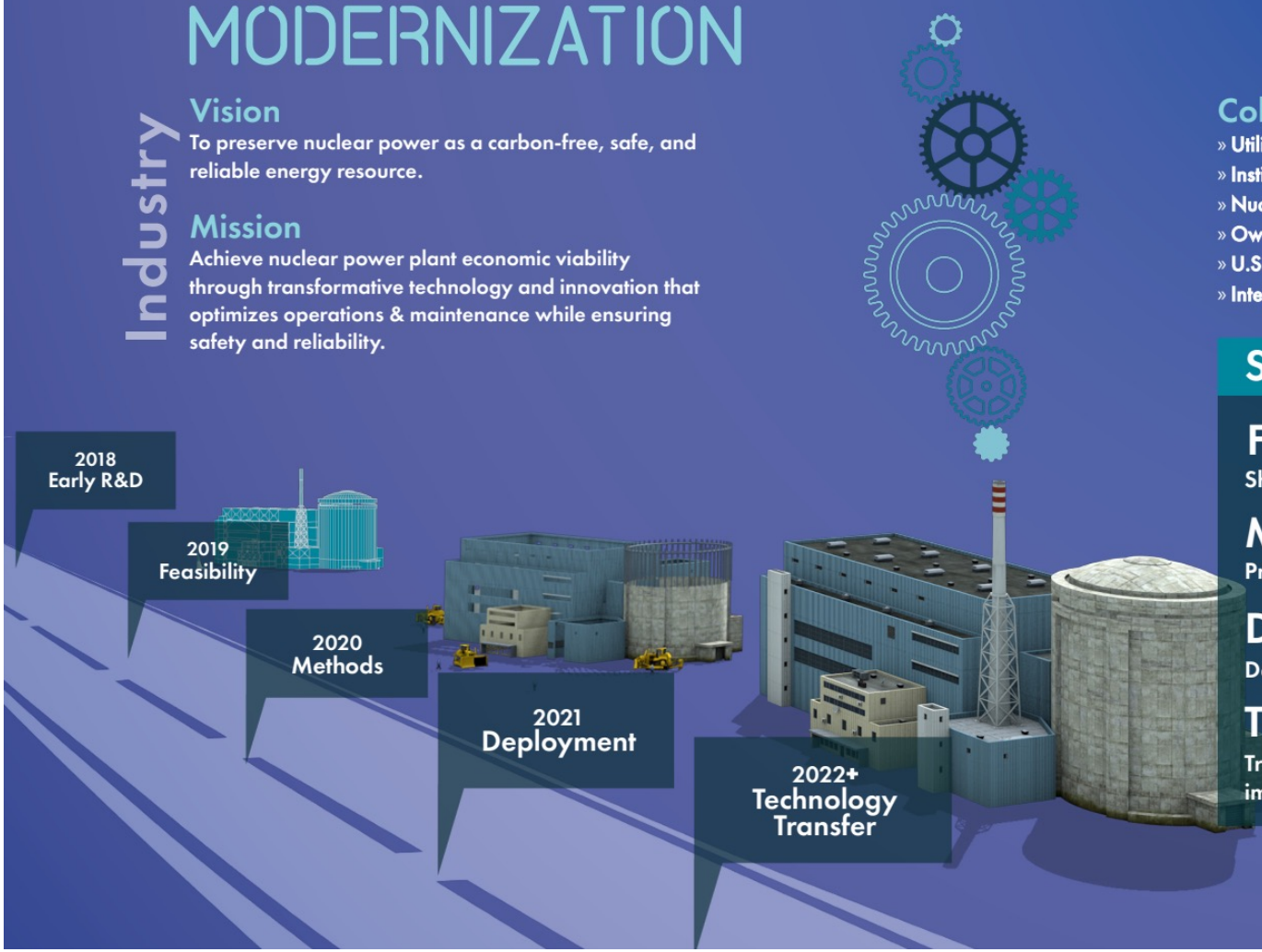
Provide the tools to implement modernization ideas

Deployment

Demonstrate modernization can be implemented

Technology Transfer

Transfer modernization tools for members implementation



EPRI

Plant Modernization Toolbox

- **Modernization Strategy** (3002020908)
  - Informs decision making on modernization projects
- **2 Business Case Analysis Model Tools**
  - On-line or Excel software that provides financial metrics for decision making (cash flows, net present value, break-even, and Internal Rate of Return, and operational metrics)
- **20 Business Case Examples**
  - Notional examples
  - Features of a successful project
  - References for implementation included
- **70 Modernization Technology Assessments**

Technology & Improvement Areas

- Digital I&C Upgrades
- Digital/New Replacement Technologies
- Equipment Monitoring
- Drones and Robotics
- Business Process Improvements
- Outage, Inspection, and Repair Improvements
- Risk-Informed Methodologies
- Automated Work Planning

https://nuclearplantmod.epri.com

PLANT MODERNIZATION

Technology Roadmap

2020

- **Structural Health Monitoring**
  Ultrasonic sensors
- **Digital Upgrades**
  Including work with Idaho National Labs (INL)
- **Monitoring & Diagnostics**
  Condition-based equipment maintenance, integrated monitoring and diagnostics, wireless connectivity, and electromagnetic compatibility
- **Hydrophobic Coatings**
  Reduced maintenance
- **Improved Thermal Performance**
  Increased power output through Data Validation and Reconciliation (DVR)
  Power recovery through Cycle Isolation Monitoring
- **Electronic Work Packages**
  Mobile work execution, wireless connectivity, and electromagnetic compatibility

2021

- **Structural Health Monitoring**
  Drones, containment tendons
- **Automated Chemistry Emergency Planning**
  Including the use of drones
- **Common Information Model**
  Application integration
- **Business Process Automation**
  Data analytics and artificial intelligence
- **Data Analytics Applications**
  Data analytics or artificial intelligence
- **Cyber Security Technical Assessment Methodology (TAM)**
  Digital upgrades including cyber security
- **Monitoring & Diagnostics Part 2.**
- **Centralized Training**
- **Unmanned Aircraft System (UAS) User's Guide**
  Implementation guidance, technologies and applications
- **Modernization Strategy Development Guide**
  Strategy development and implementation process

2022

- **Online BCAM Tool**
  High-level evaluations of modernization projects
- **Modernization Strategy Development**
  EPRI application offering for members
- **Energy Supply Common Information Model (ES-CIM) Testbed**
  ES-CIM interface testing software
- **Instructional BCAM CBT**
  Interactive training utilizing select BCAM examples
- **Digital Transformation Framework**
  Utility strategy and implementation guide
- **NextGen RP**
  Remote and automated emergency preparedness technology
- **Modernization Strategy Development Guide Update**
  Incorporates lessons learned from 2 U.S pilot projects

2023

- **Unmanned Ground Robotics Users Guide**
  Implementation guidance, technologies and applications 2023
- **Consolidated BCAM**
  Analysis and Insights from Combining EPRI BCAMs
- **Plant Modernization Benchmarking & Assessment**
  Collaborative supplemental group offering for members
- **Facilitating Power Uprates at Nuclear Power Plants**
  Feasibility Study Guideline
- **Program on Technology Innovation**
  Digital Transformation Maturity Model
- **Distributed Ledger Technologies in the Nuclear Industry**
  Examples of Application and Use Cases
- **Energy Supply Common Information Model (ES-CIM) Testbed v1.0**
  REST API designed to allow for the testing of client software with some of the ES-CIM interfaces
- **EPRI-Wide Digital Transformation Research Roadmap**
  Integrates research across the different DX strategic focus areas across EPRI
- **Radio Frequency Spectrum Management Guideline.**
  Guidance for Wireless Coexistence Management in Nuclear Power Facilities

2024

- **Modernization Strategy Development Guide Update**
  Incorporate lessons learned and international specific gaps from international pilot
- **Digital Upgrades for PWRs**
  Including work with Idaho National Labs (INL)
- **Monitoring & Diagnostics Update**
  Incorporate findings related to refurbishment PM deferrals due to OLM
- **Chubu Modernization Strategy Development Final Report**
  Publicly available report regarding the findings of the International Modernization Strategy Development pilot
- **Plant Modernization Benchmarking & Assessment**
  Collaborative supplemental group offering for members
- **New MTAs**
  Submitted by member, EPRI, and vendors
- -New BCAMs
  Submitted by member, EPRI, and vendors

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Risk-Informed Systems Analysis
EPRI Update

Leveraging Risk Insights for Aging Management (RIAM)

Technical Report 3002020713

"Leveraging Risk Insights for Aging Management Program Implementation: 2022"

This technical report provides an overview of the EPRI framework.

Appendix A provides the results of the selective leaching pilot study.

Appendix B provides the results of the inaccessible power cable AMP pilot study.

This technical report is publicly available

General Insights from this Research

Insights and Benefits

The EPRI pilots have demonstrated that risk insights can benefit aging management programs and extended plant operations.

The EPRI pilots have identified potential cost savings.

AMP Optimization

Considering risk information supports optimizing how plant resources (labor, funds, etc.) are allocated to support aging management activities.

Focus on the activities that add the most value!

Future Research

Application of the EPRI framework to AMPs at non-U.S. plants.

The impact of non-safety risk factors (e.g., enterprise, financial, operational, and regulatory risk).

Materials Research
EPRI Update

Selective Leaching Challenges

- Impact on power reactors licensed to operate beyond 40 years (and even more so for those licensed beyond 60 years)
  - NRC Information Notice 2020-04, Operating Experience Related to Failure of Buried Fire Protection Main Yard Piping
- Industry incurs significant expenses to meet aging management commitments for long term operations
  - Large inspection population sample sizes
  - Development of periodic inspection programs
- Inspection Challenges
  - Lack of previously demonstrated NDE techniques
  - Susceptible components can be difficult to inspect (e.g., valve & pump casing)

Selective Leaching NDE Reports
"Inspection Techniques" Research

- Technical Brief: 3002020830 "Ultrasonic Techniques for Selective Leaching in Gray Cast Iron Components"
  - Scope: detection of internal selective leaching from outside surface examination (opposite surface)
  - 3 techniques successful demonstrated on field removed components for detection and characterization of opposite surface SL

- Technical Brief: 3002020832 "Electromagnetic NDE Techniques for Gray Cast Iron Piping"
  - Four (4) different techniques evaluated on field removed piping components
  - Includes both internal and external techniques

- Technical Report: 3002023785 "Evaluation of Electromagnetic NDE Techniques for Detection of Wall Thinning Due to Selective Leaching Degradation in Gray Cast Iron Piping"
  - More details and analysis of results from EM techniques
  - Includes results for two (2) additional techniques evaluated in 2022

Reports Provide Techniques and Quantitative Results of Demonstration

EPRI Report 3002026340:

Purpose

Contains overview of approaches and considerations for developing, implementing, and managing a program for selective leaching degradation

2024 Cable User Group and Cable Aging Management Training

Event Details

EPRI Cable User Group & International Workshop on Age-Related Degradation of Cables – June 2024

June 11 - June 14, 2024

EPRI DC Office

1325 G Street Northwest
Washington, District of Columbia 20005
USA

View Map

[2024 Cable User Group Link]

EVENT

Low and Medium Voltage Cable Aging Management Training Course

Last Updated 12/18/2023 Duration 36 hours

Details

This training course for low and medium voltage cables will provide members and others responsible for managing cable aging, design, installation, testing and replacement of cables the technical foundation needed to understand the key concepts and knowledge to perform that function.

Target Audience
Technical staff responsible for managing electrical cables' aging management programs, electrical design engineers responsible for cable installations/replacements, or others interested in how cables are manufactured, installed, degrade, and how to monitor that degradation.

EPRI Charlotte, NC – Building 3
July 15 to 19 2024

Key Products for Aging Management

PEER Wiki - Cable Aging Handbooks - https://peer.epri.com/Cable_Aging

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ELECTRIC POWER RESEARCH INSTITUTE

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Cable Aging

Revision 0

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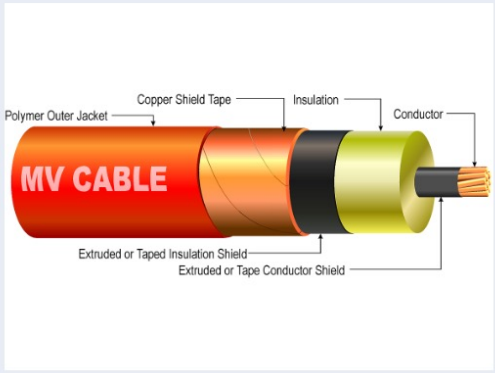
  - Instrument Cable Polymer Materials and Processing
  - Low Voltage Cable Polymer Compounds and Formulation
  - Medium Voltage Cable Installation
  - Low Voltage & Instrument Cable Installation
  - Medium Voltage

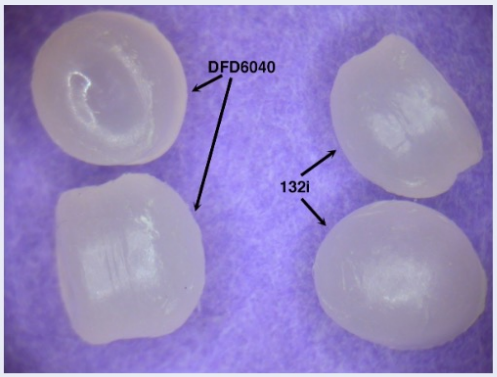
Background & History

- Medium Voltage Cable Background & History
- Instrument Cable Background & History
- Low Voltage Cable Background & History



Cable Construction

- Medium Voltage Cable Construction
- Instrument Cable Construction
- Low Voltage Cable Construction



Materials

- Medium Voltage Cable Materials
- Instrument Cable Polymer Materials and Processing
- Low Voltage Cable Polymer Compounds and Formulation

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