Transmission & Substations
New Components & Materials
Research Roadmap

Richard Ord
Transmission & Substations Area

Overhead Transmission Lines (P35)

Underground Transmission Lines (P36)

Substations (P37)

HVDC (P162)

Asset Related Research
EPRI’s Mission

Advancing safe, reliable, affordable and environmentally responsible electricity for society through global collaboration, thought leadership and science & technology innovation
Action Plans to Address Gaps: By Issue
Asset Management

- Increased Utilization of Right of Way
- New Components and Materials
- Asset Management Analytics
- Effective Field Practices
- Condition Monitoring and Automation
- Effective Inspection Assessment and Maintenance
- Improved Design and Construction
COMPONENTS OF THE FUTURE STATE

New components and materials promise higher performance, increased reliability, longer life expectancy, and lower costs, but knowledge gaps need to be addressed before utilities can specify and apply them with confidence.

1. Utilities will have the tools to specify and assess new and existing materials and component designs for failure modes, reliability, and life expectancy in a rapidly changing manufacturing environment.

2. New materials will be developed that are easier to apply, reliable, and cost-effective and enable real-time in-service assessment (predictive) of material condition and risk.

3. Materials and components will have a minimal impact on the environment.

4. Tools and techniques will enable the confident selection, specification, installation, and maintenance of new component technologies.

5. Components will be safe and friendly to work practices.

GAPS

1. Understanding of Degradation and Failure Modes
   A fundamental understanding of how new and emerging components and materials degrade and fail is vital when selecting, applying and installing them for maximum reliability.

2. Development of New Materials and Components
   More cost-effective reliable materials and components with equivalent or higher performance and lower life expectancy are required. One key feature of new material/component designs is the ability to enable increased power flow in existing rights of way (ROW) and assets.

3. Effective Selection, Specification, and Application
   Utilities need the ability to select, specify, and apply existing and new technologies confidently under a wide range of conditions ensuring optimal performance and appropriate life expectancy. Historically it was possible to rely on high-quality products from vendors that meet the application. As utilities procure new technologies with unknown long-term performance and vendors are more globally diverse, the importance of relevant tests and specifications has become paramount.

4. Effective Inspection and Remediation
   As new materials and components reach end of life, inspection and monitoring technologies are needed to identify high-risk units, manage the fleet, and perform remediation. In addition it needs to ensure that these new materials and components do not pose a barrier to life working techniques.

VALUE AND RISK

The value of developing and comprehensively evaluating new components and materials as well as addressing application, operation, inspection, and assessment includes:

- Access to lower-cost and more reliable assets which will have a longer life expectancy, and in turn will reduce capital and maintenance budgets.

- More environmentally compatible new materials and components.

- Increased power flow through existing rights of way (ROW) and assets.

- Materials and components that can potentially be applied to existing aging assets that will either increase performance or extend life.

- Access to new components that can potentially reduce capital and O&M costs.

Risks that may emerge if new materials and components are not developed or fully evaluated prior to being applied include:

- The power flow through existing rights of way will be limited to present levels.

- New materials and components may be applied that have not been fully evaluated, which may result in a reduction in the reliability, safety, and life expectancy of the transmission system.

- New materials and components that have not been fully evaluated may result in increased maintenance expenditures due to unforeseen challenges.
Understand Degradation & Failure Modes

Develop New Materials & Components

Effective Selection, Specification & Application

Effective Inspection & Remediation

NEW Components and Materials

APPLY NEW MATERIALS & COMPONENTS WITH CONFIDENCE
Example: Approach to Advanced Coatings for Conductors and Insulators

Self Cleaning

Icephobicity

Courtesy John Simpson

Courtesy NEI

PROPERTIES OF INTEREST
Opportunities for Power Delivery Applications

- Contaminated Insulation
- Iced Insulation
- Iced Conductors
- Iced Structures
EPRI Research Approach

Tier 1
- Identify Applications & Performance Criteria
- Identify Primary & Secondary Degradation Modes
- Small Scale Laboratory Testing on Sub Systems: Performance & Aging (TRL4)

Tier 2
- Full Scale Laboratory Testing on Sub Systems: Performance & Aging (TRL5)

Tier 3
- Field Demonstrations (TRL5)

Functional Specifications
Examples of Tier 1 Testing

- UV X 2
- High Humidity
- Mechanical X 5
- Thermal
- Icing & Snow
- Arcing
- Ice Adhesion
- Corona
- Contamination
Examples of Tier 2 Testing

- Contamination Accumulation
- Raptor Excretion
- Corona Cage
- Conductor Icing
- Energized Salt Fog
3 Field Tests in Planning

Contamination

Conductor Icing

Roadsalt Contamination
Together...Shaping the Future of Electricity