Enabling Transmission Asset Management Analytics

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"a structured, integrated series of processes aligned with business goals and values and designed to minimize the life-cycle costs and maximize the life cycle benefits of asset ownership, while providing required performance levels and sustaining the system forward"
Data Based Actionable Intelligence

Advanced knowledge, technologies, and tools to enable utilities to make informed decisions regarding the asset life-cycle

Industry focal point for collaboratively sharing asset data to make better decisions

Analytic algorithms and visualization for assets

Asset management framework, metrics and implementation guidelines

Acquire → Maintain → Operate → Dispose → Asset Lifecycle
### Industrywide T&S Asset Performance And Failure Database

**At a Glance – as of June 2018**

<table>
<thead>
<tr>
<th>Asset</th>
<th>In-service Records</th>
<th>Removed from Service*</th>
<th>Total Number of Records</th>
<th>Number of Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector**</td>
<td></td>
<td>127</td>
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<tr>
<td>Glass/Porcelain Insulator</td>
<td></td>
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<td>Line Arrester</td>
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<td>Polymer Insulator</td>
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<td>Bushing</td>
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<tr>
<td>Circuit Breaker**</td>
<td>61,340</td>
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<td>Transformer**</td>
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<td>Extruded Cable**</td>
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<tr>
<td>Extruded Joint**</td>
<td></td>
<td>8</td>
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<td>5</td>
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<tr>
<td>Extruded Termination**</td>
<td></td>
<td>15</td>
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<td>10</td>
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<tr>
<td>Wood Poles**</td>
<td></td>
<td></td>
<td>2,038,254</td>
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<td>Disconnect Switches</td>
<td>7,911</td>
<td>2,004</td>
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<td>CCVTs</td>
<td>9,459</td>
<td>1,084</td>
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<td>Conductor</td>
<td>2,814</td>
<td>131</td>
<td>2,945</td>
<td>6</td>
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</tbody>
</table>

*Failure, Impending Failure, Type Issue, Upgrade, Assessment

**A portion of these records are being processed**

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System where members can view and store their failure information

Online System – idb.epri.com

Ability to make selections using filters

Compare performance with aggregate
Advanced Analytics Using Industry wide Equipment Failure And Performance Data (Sparse Data Analysis)

1. Transformers
2. Tap Changers and Bushings
3. Circuit Breakers
4. Insulators
5. Wood Poles
Power Transformer Expert System (PTX)

**Measurements**
- DGA
- Oil Quality
- Furans
- Routine Electrical
- LTC DGA & Oil Quality
- LTC Operation Count

**Design Information**
- Manufacturer
- Vintage
- Nameplate Data

**Basis for Asset Management Decisions**

**Readily Available Data**

**EPRI PTX Algorithms (Rule-based)**

**Transformer Fleet Risks – Short Term/Long Term**

Integrates decades of expert knowledge in a rule-based framework.
PTX Deployment History

Utilities That Use EPRI To Implement

Utilities That Perform Periodic Desktop Analysis

Utilities That Integrated with IT Systems

28

15

8
Operating Spare Transformer Requirement Assessment

- Development and application of simulation based model to different transformer groups (e.g. 250 MVA 230/115 kV) to evaluate current spare stocking levels.

**Value**

- Independent assessment of spare levels provides validation of utility’ internal spares assessment methodology
- Provide *Technical Basis For Justifying Higher Spare Levels*

**Status**

- Currently implemented in R
- Prototype applied at four utilities
- Collecting utility feedback on meaningful ways to present simulation results
Transformer Asset Management Analytics

Industry wide Transformer Database
- Contains over 55,000 in-service and 7,000 failure records
- Opportunity:
  - Data mining and statistical analysis
  - Replacement rates
  - Uncover issues

Power Transformer Expert System Software
- In use at several utilities
- Performance validated using blind test approach
- Transformer condition assessment tool – unit as well as fleet

Spares Strategy Model Development
- Funded by 8 utilities
- Prototype method applied at 4 utilities
  - Example: Technical Basis For Justifying Higher Spare Levels

Integrating EPRI Analytics In Third Party Asset Health Systems
- Integrated at 8 utilities
- In-progress at 3 additional utilities
Circuit Breaker Asset Management Analytics

- Corrective Maintenance Data mining and Statistical Analysis to Uncover Differences In Performance By Family, Make, Model

- Using Readily Available Data, Identify Specific Maintenance Candidates And Necessary Tasks

- Risk Based Approach To Help Identify Replacement Candidates

- Statistical Analysis of In-service And Removal Records To Develop Technical Basis For Capital Planning
Fleet Management Strategy Development

Value:
- Provides technical basis for allocating budgets with measured risk
- Metrics to assess decision effectiveness
Investigate Performance of Different Wood Species:
- Hazard rates in different climates/environments
- Different treatment types
- Changes in inspection criteria –
  - Contractor to contractor variation
  - Contractor variations over time
- Degradation models from data with multiple inspections of same poles

Collect and analyze:
- Pole demographic data
  - E.g. age, wood species, in-service date
- Inspection results
  - E.g. date of inspection, reject status, other observations
- Replacement history
  - E.g. which, when and why

Wood Pole Reject Rate Modeling
Polymer Insulator Population Assessment

1. Potential degradation conditions, affected location and failure modes
   2. Estimated onset time and likelihood

<table>
<thead>
<tr>
<th>#</th>
<th>Condition</th>
<th>Location</th>
<th>Cond Stat (ys)</th>
<th>Prob. Of Condition</th>
<th>Failure Mode</th>
<th>Fail Start (ys)</th>
<th>Prob. Of Failure</th>
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<tr>
<td>1</td>
<td>Corona Compromised Seal</td>
<td>End fitting Seal</td>
<td>12.8</td>
<td>Medium High</td>
<td>Big Fracture</td>
<td>14.0</td>
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<td>21.0</td>
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<td>Medium High</td>
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<td>21.0</td>
<td>Medium High</td>
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<tr>
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<tr>
<td>10</td>
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<td>Shed / Sheath</td>
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<td>Cracks in High Field Region</td>
<td>Shed / Sheath</td>
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<td>Big Fracture</td>
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<td>Rashulator</td>
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<td>Rashulator</td>
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<td>Destructed by Discharges</td>
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<td>Shed / Sheath</td>
<td>2.0</td>
<td>High</td>
<td>Rashulator</td>
<td>25.7</td>
<td>Medium</td>
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</table>
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