Common Mode Event Perspectives from the Canadian Electricity Association Equipment Reliability Information System

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CEA Equipment Reliability Information System (ERIS) program

MEMBERSHIP – Participating Utilities
CEA Equipment Reliability Information System (ERIS) program

DEFINITIONS

Forced Outage consistent with IEEE Standard 346-1973 [1]:
• "An outage that results from emergency conditions directly associated with a component requiring that it be taken out of service immediately, either automatically or as soon as switching operations can be performed, or an outage caused by improper operation of equipment or human error."

Common Mode Outage consistent with IEEE Standard 859:
• “A Common Mode Outage is an event where a single primary cause results in more than one Component Forced Outage and the outages are not consequences of each other. In this reporting system, all Common Mode Outages should be noted, but special emphasis is placed on Common Mode Outages of transmission lines”.

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DEFINITIONS

**Frequency** (outages per 100km·a (lines); outages per component-year(major components))
- The Number of Outages divided by Kilometre Years which are in turn divided by 100.

**Unavailability** (%)
- The product of Frequency and Mean Duration (%) ; represents percent of time per year major component is out of service (due to forced outage)
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SCOPE & DATA STRUCTURE

- Annual data collection and report
- Equipment outage statistics for Transmission equipment
- Operating voltage of 60 kV and above
- Distinguish line from line terminal
- Aggregated component inventory

MAJOR COMPONENTS WITHIN THE CEA ERIS PROGRAM
- Major Component Type
  - Transmission Line
  - Cable
  - Transformer Bank
  - Circuit Breaker
  - Synchronous Compensator
  - Static Compensator
  - Shunt Reactor Bank
  - Shunt Capacitor Bank
  - Series Capacitor Bank
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SCOPE & DATA STRUCTURE

<table>
<thead>
<tr>
<th>Cat.</th>
<th>Voltage Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 109 kV</td>
</tr>
<tr>
<td>2</td>
<td>110 - 149 kV</td>
</tr>
<tr>
<td>3</td>
<td>150 - 199 kV</td>
</tr>
<tr>
<td>4</td>
<td>200 - 299 kV</td>
</tr>
<tr>
<td>5</td>
<td>300 - 399 kV</td>
</tr>
<tr>
<td>6</td>
<td>400 - 499 kV</td>
</tr>
<tr>
<td>7</td>
<td>500 - 599 kV</td>
</tr>
<tr>
<td>8</td>
<td>600 - 799 kV</td>
</tr>
<tr>
<td>9</td>
<td>800 kV and above (future use)</td>
</tr>
</tbody>
</table>

- several voltage classes have been excluded to avoid singling out specific utility results.
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## ANALYSIS

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Occurrence Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit Breaker</td>
<td>37%</td>
</tr>
<tr>
<td>Transmission Line</td>
<td>35%</td>
</tr>
<tr>
<td>Transformer Bank</td>
<td>21%</td>
</tr>
<tr>
<td>Other remaining major component categories</td>
<td>7%</td>
</tr>
</tbody>
</table>
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**ANALYSIS**

Line related outage frequency  \(\text{(outages per 100km} \cdot \text{a)}\)

Terminal related outage frequency  \(\text{(outages per terminal} \cdot \text{a)}\)

- Momentary  \(< 1 \text{ minute}\)
- Sustained  \(\geq 1 \text{ minute}\)
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ANALYSIS

Number of Simultaneous Major Component Outage Occurrences Associated with a Common Mode Event

Proportion of Common Mode Events

No. Common Mode Outages
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ANALYSIS

SUMMARY OF TRANSMISSION LINE STATISTICS FOR LINE-RELATED SUSTAINED FORCED OUTAGES
ALL FORCED OUTAGES VS. COMMON MODE FORCED OUTAGES

<table>
<thead>
<tr>
<th>Forced Outages</th>
<th>Common Mode Forced Outages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (per 100 Km.a)</td>
<td>Frequency (per 100 Km.a)</td>
</tr>
<tr>
<td>Unavailability (%)</td>
<td>Frequency % of All FO</td>
</tr>
<tr>
<td></td>
<td>Unavailability (%)</td>
</tr>
<tr>
<td></td>
<td>Unavailability % of All FO</td>
</tr>
<tr>
<td>0.865</td>
<td>0.065</td>
</tr>
<tr>
<td>0.162</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>6%</td>
</tr>
</tbody>
</table>
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ANALYSIS

SUMMARY OF TRANSMISSION LINE STATISTICS FOR LINE-RELATED MOMENTARY FORCED OUTAGES
ALL FORCED OUTAGES VS. COMMON MODE FORCED OUTAGES

<table>
<thead>
<tr>
<th>Forced Outages</th>
<th>Common Mode Forced Outages</th>
<th>Frequency % of All FO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (per 100 Km.a)</td>
<td>Frequency (per 100 Km.a)</td>
<td></td>
</tr>
<tr>
<td>1.211</td>
<td>0.101</td>
<td>8%</td>
</tr>
</tbody>
</table>
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ANALYSIS

Approximately 47% of transmission line related common mode events resulted from common tower outages.
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ANALYSIS

The majority (78%) of transmission line related common mode outages occur on the tower-line. Less than ¼ of CM outages occur at the line terminals.
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ANALYSIS

Graph represents further drilldown of the ¼ of CM outages emanating from the line terminals.
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ANALYSIS

Cause of transmission line related common mode events.

- Adverse Weather: 65%
- Defective Equipment: 15%
- Human Element: 6%
- System Condition: 2%
- Foreign Interference: 4%
- Adverse Environment: 2%
- Unknown: 6%
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ANALYSIS

Storms in the months of June, July and August typically contribute to transmission line common mode outage events. Higher voltages generally less susceptible.
Proportion of sustained outages due to common mode events is similar in nature to non-common mode events except for 500-599kV range events.
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CONCLUSIONS

• Although generally considered to be rare, common mode outage occurrences on transmission lines typically constitute about 8% of all forced outage occurrences and these events, when they occur on the tower-line, constitute approximately 6% of the unavailability of transmission lines.
• Almost ½ of transmission line common mode events involve common tower outage occurrences.
• Adverse weather is the dominant cause of transmission line common mode events.
• CEA ERIS program can support ongoing monitoring of common mode events and performance measurement.
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Program Improvements Presently Underway at CEA

- Highlight Common Mode events through data access Portal, presently under development
  - Bring more awareness, scrutiny to Common Mode Events
- Link of Component outage data (ERIS) with Load Interruption data (EPSRA/BES)
  - Determine the impact of the component outage on power delivery

Program Improvements Under Consideration at CEA

- Capture line length inventory (or categorisation)
- Capture common ROW line length inventory (or categorisation)
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BENEFITS to the INDUSTRY

• CEA CCOS data portal will provide more ready access to all data collected under the CCOS programs – more visibility, studies, promote collaboration within the industry

• CEA CCOS as an independent national source of reliability results can be compared with other sources (e.g. WECC, NERC TADS) to validate models and establish baselines and performance measurement

• Combine experience with CEA ERIS program with other event data collection systems to establish best practice and drive continual process improvements
Acknowledgments

**Paper**

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