SCE’s Wildfire & Contact with Energized Equipment Risk Assessments (SED RAMP Review Appendix C)

Wendy Al-Mukdad, P.E.
May 29, 2019
Main Sections

- Analysis of SCE’s Wildfire Risk Assessment
- Analysis of Contact with Energized Equipment (CEE) Risk Assessment
ANALYSIS OF SCE’S WILDFIRE RISK ASSESSMENT

• POLE DRIVER & RELATED MITIGATION PROGRAMS

• CIRCUIT BY CIRCUIT RISK ANALYSIS FOR WCCP
  • USING INDEX SCORE FOR RSEs
    (RSEs = RISK SPEND EFFICIENCIES)

• TREE TRIMMER SAFETY RISK ANALYSIS
  • WITH INCREASED VEGETATION MANAGEMENT

• WILDFIRE RELEVANT CONSEQUENCES
POLE DRIVER & RELATED MITIGATION PROGRAMS

- Pole Loading & Deterioration Pole Replacement Programs
  - NOT part of SCE’s Wildfire Risk Assessment
  - Disagree that Completely Compliance Programs
- Pole Drivers NOT Included as Wildfire Triggering Event
- Risk Analysis on Pole Failure Ignition Events Needed
- Pole Top Deterioration Causes Wire-Down
  - PL & Deterioration Assessments Programs do NOT detect
  - Can These High Cost Programs Mitigate this Pole Driver?
- Would Pole Top Inspections Be More Beneficial?
- Lack of Root Cause Analysis (1/31/2017 SED Report)
- Pole by Pole Risk Analysis - RSE calculations
**Ckt by Ckt Risk Analysis for WCCP Using Index Score for RSEs**

- **W. Kent Muhlbauer** - Pipeline Risk Management Authority
- **Index Score** Combined with **Average Cost of CC per Mile**
  - Estimated Cost per Ckt Improve RSE Calculations (Future?)
  - HFTA Circuits with Highest Risk Reduction per Cost
- **Compare Ckt Index Scores** For ALL Mitigation Measures
  - Refined Project Cost Estimates Per Ckt Improve RSEs

CC = Covered Conductor
WCCP = Wildfire Covered Conductor Program
# Top 9 Ranked OH Circuits for Fire Threat Characteristics

<table>
<thead>
<tr>
<th>Rank</th>
<th>Oh Circuit Name</th>
<th>Total Circuit Length (OH Primary) (Ckt Mls)</th>
<th>Total HFRA Length - OH Primary (Ckt Mls)</th>
<th>Length (Ckt MI.) Within Tier 3 - OH Primary</th>
<th>Length (Ckt MI.) Within Tier 2 - OH Primary</th>
<th>High Wind in HFRA Length (Ckt Miles) - OH Primary</th>
<th>Historical Wiredown Count (May 2014 - 2017)</th>
<th>Small Conductor (Ckt Miles)</th>
<th>Mitigated HFRA Fault / Total Ckt Length</th>
<th>HFRA Vegetation Fault Count</th>
<th>Index Score</th>
<th>Potentially Mitigated HFRA Faults (2015-2017)</th>
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<tbody>
<tr>
<td>1</td>
<td>Thacher</td>
<td>83.55</td>
<td>83.56</td>
<td>83.53</td>
<td>0.03</td>
<td>67.77</td>
<td>2</td>
<td>36.58</td>
<td>0.12</td>
<td>8</td>
<td>39.51</td>
<td>10</td>
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<tr>
<td>2</td>
<td>Mettler</td>
<td>130.09</td>
<td>130.09</td>
<td>129.45</td>
<td>0.64</td>
<td>111.59</td>
<td>2</td>
<td>45.80</td>
<td>0.12</td>
<td>0</td>
<td>36.93</td>
<td>16</td>
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<td>3</td>
<td>Cuddeback</td>
<td>89.07</td>
<td>89.42</td>
<td>87.77</td>
<td>1.65</td>
<td>60.59</td>
<td>2</td>
<td>29.46</td>
<td>0.09</td>
<td>5</td>
<td>34.09</td>
<td>8</td>
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<td>4</td>
<td>Jordan</td>
<td>164.04</td>
<td>164.04</td>
<td>0.00</td>
<td>164.04</td>
<td>65.33</td>
<td>2</td>
<td>151.23</td>
<td>0.04</td>
<td>3</td>
<td>32.47</td>
<td>6</td>
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<tr>
<td>5</td>
<td>Hughes Lake</td>
<td>102.19</td>
<td>89.59</td>
<td>67.84</td>
<td>21.51</td>
<td>80.37</td>
<td>2</td>
<td>56.25</td>
<td>0.06</td>
<td>2</td>
<td>28.76</td>
<td>6</td>
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<tr>
<td>6</td>
<td>Chawa</td>
<td>98.99</td>
<td>98.99</td>
<td>97.56</td>
<td>1.43</td>
<td>87.01</td>
<td>1</td>
<td>44.91</td>
<td>0.02</td>
<td>0</td>
<td>27.91</td>
<td>2</td>
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<tr>
<td>7</td>
<td>Galahad</td>
<td>57.33</td>
<td>57.36</td>
<td>57.05</td>
<td>0.31</td>
<td>57.36</td>
<td>5</td>
<td>32.92</td>
<td>0.09</td>
<td>3</td>
<td>27.50</td>
<td>5</td>
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<tr>
<td>8</td>
<td>Titan</td>
<td>118.74</td>
<td>103.15</td>
<td>46.45</td>
<td>27.17</td>
<td>102.83</td>
<td>3</td>
<td>81.72</td>
<td>0.03</td>
<td>1</td>
<td>26.86</td>
<td>4</td>
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<tr>
<td>9</td>
<td>Tenneco</td>
<td>100.36</td>
<td>100.36</td>
<td>47.08</td>
<td>51.09</td>
<td>57.74</td>
<td>1</td>
<td>55.00</td>
<td>0.11</td>
<td>3</td>
<td>26.53</td>
<td>11</td>
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</table>
TREE TRIMMER SAFETY RISK ANALYSIS
WITH INCREASED VEGETATION MANAGEMENT

- Increased Veg Mgt to Reduce WF Risks Due to WMP
  - Could Increase Tree Trimmer Worker Risk for CEE (Arc Flash)
- SED CEE Scenario with Potential Larger 3rd Party CEE Risks
  - Probability of Outcome 3, Intact Energized Wire Contact
  - If Tree Trimmers Inexperienced and/or Lack Sufficient Training
- SED has Concerns with CEE Historical Data Utilized
  - Recommend Risk Analysis with Recent & Projected Data
- CEE Section for Further Analysis
**Wildfire Relevant Consequences**

- **SCE’s Risk Assessment Modeling Consequences (25% each)**
  - Serious Injuries (SI), Fatalities, Reliability, and Financial
- **CalFIRE Consequences to Improve Risk Analysis**
  - Acres Burned; Structures Destroyed; & Structures Damaged
  - Beyond Financial Consequences similar to Fatalities & SI
- **U.S. EPA Air Quality Index (AQI)**
  - Unsafe AQI for Weeks due to Tragic Nov’18 Camp Fire
    - Very Unhealthy (AQI = 201 to 300)
    - Hazardous (AQI greater than 300)
  - Consequence for Incremental AQI After Wildfire
    - Area of Unsafe Air Quality & # People Impacted
    - Use AQI for each Day/Hour/15-minute Increment?
ANALYSIS OF CEE RISK ASSESSMENT

- SCE Data: Wire-Down & 3rd-Party Contact Events
- Pole Driver
- Metallic Balloons (including foil or foil-lined)
- Wire-Down Triggering Event Frequencies
- Compliance Program - CM1
- Control 1 – OH Conductor Program
- CEE Combined Risk Analysis & Arc Flash Risks
- Risk Analysis of Design, Construction & Operation including Grounding Methodologies
- Circuit/Line Section/Line Segment Risk Analysis
- Third Party (Tree Trimmers) Safety Risk Analysis
SCE DATA: WIRE-DOWN & 3RD-PARTY CONTACTS

- **Two Triggering Events** in SCE’s CEE Bowtie Risk Analysis
  1. Wire Down: Ave 1,154/Yr Events from 2015-2017
  2. Contact With Intact OH Conductor: 5/Yr from 2008-2016

- **Five Primary Wire-Down Drivers (D1 to D5)**
  - Two Main Wire-Down Drivers: D1 & D2
  - One Primary CEE (Intact) Driver (D6 – 3rd Party Contact)

<table>
<thead>
<tr>
<th>2018 Projected CEE Driver Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
</tr>
<tr>
<td>D1 - Equipment Caused</td>
</tr>
<tr>
<td>D2 - Equipment / Facility Contact</td>
</tr>
<tr>
<td>D3 - SCE Work / Operation</td>
</tr>
<tr>
<td>D4 - Unknown</td>
</tr>
<tr>
<td>D5 - Downstream Equipment</td>
</tr>
<tr>
<td>D6 - Third Party Contact</td>
</tr>
</tbody>
</table>

- **Why Different Historical Years Ranges for RSEs?**
  - Redo CEE RSE calculations for 2015-2018 Data
Pole Driver

- Annual Frequency of 11 Wire-Down Triggering Events
- 5% of all Equipment Cause drivers
- Only Tiny Fraction (i.e. 1%) ALL CEE Events
  - Pole Failure due to Vehicle Collision NOT included Here
  - Separate Sub-Driver D2E – Vehicle for Collisions

<table>
<thead>
<tr>
<th>Driver</th>
<th>Name</th>
<th>Annual Frequency</th>
<th>Percentage (Category)</th>
<th>Percentage (All Triggering Events)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1a</td>
<td>Connector / Splice / Wire</td>
<td>130</td>
<td>63%</td>
<td>11%</td>
</tr>
<tr>
<td>D1b</td>
<td>Other</td>
<td>65</td>
<td>32%</td>
<td>6%</td>
</tr>
<tr>
<td>D1c</td>
<td>Pole</td>
<td>11</td>
<td>5%</td>
<td>1%</td>
</tr>
<tr>
<td>D1</td>
<td>Equipment Cause</td>
<td>206</td>
<td>100%</td>
<td>18%</td>
</tr>
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</table>

- Lack of Root Cause Data related to Pole Failures
**METALLIC BALLOONS (INCLUDING FOIL OR FOIL-LINED)**

- Metallic Balloon Contacts with OH Lines
  - Can Create a Short Circuit
  - Can Trigger Ckt Damage, Overheating, Fire, or an Explosion
- Cal. Penal Code § 653.1 (Foil Balloon Law)
  - Requires All Helium-Filled Balloons to Be Weighted

<table>
<thead>
<tr>
<th>Driver</th>
<th>Name</th>
<th>Annual Frequency</th>
<th>Percentage (Category)</th>
<th>Percentage (All Triggering Events)</th>
</tr>
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<tbody>
<tr>
<td>D2a</td>
<td>Animal</td>
<td>53</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>D2b</td>
<td>Metallic Balloons</td>
<td>111</td>
<td>14%</td>
<td>10%</td>
</tr>
<tr>
<td>D2c</td>
<td>Other</td>
<td>39</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>D2d</td>
<td>Vegetation</td>
<td>171</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>D2e</td>
<td>Vehicle</td>
<td>206</td>
<td>27%</td>
<td>18%</td>
</tr>
<tr>
<td>D2f</td>
<td>Weather</td>
<td>193</td>
<td>25%</td>
<td>17%</td>
</tr>
</tbody>
</table>

| CEE D2 Equipment / Facility Contact | 773 | 100% | 68% |

- **No-Cost Solution = Ban Metallic Balloons in CA**
  - **New Law Could Eliminate/Significantly Reduce This Driver**
WIRE-DOWN TRIGGERING EVENT FREQUENCIES

- SED Combined into One Table for Better Perspective
  - Annotations included based on SCE’s RAMP info
- Addressed further for OH Conductor Program Control Measure

<table>
<thead>
<tr>
<th>Name</th>
<th>Annual</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector / Splice / Wire</td>
<td>130</td>
<td>11%</td>
</tr>
<tr>
<td>Other Equipment Cause</td>
<td>65</td>
<td>6%</td>
</tr>
<tr>
<td>Pole (normally top degradation)</td>
<td>11</td>
<td>1%</td>
</tr>
<tr>
<td>Animal (e.g. squirrel, bird etc.)</td>
<td>53</td>
<td>5%</td>
</tr>
<tr>
<td>Metallic Balloons</td>
<td>111</td>
<td>10%</td>
</tr>
<tr>
<td>Other (e.g. Gunshot damage, Drones, etc.)</td>
<td>39</td>
<td>3%</td>
</tr>
<tr>
<td>Vegetation</td>
<td>171</td>
<td>15%</td>
</tr>
<tr>
<td>Vehicle Accidents (usually into pole)</td>
<td>206</td>
<td>18%</td>
</tr>
<tr>
<td>Weather</td>
<td>193</td>
<td>17%</td>
</tr>
<tr>
<td>Unknown</td>
<td>168</td>
<td>15%</td>
</tr>
<tr>
<td><strong>TOTAL Annual Triggering Events:</strong></td>
<td>1147</td>
<td>100%</td>
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</tbody>
</table>

- SCE Should Work to Have Less Unknown Events (15%)
COMPLIANCE PROGRAM - CM1

- SCE Did NOT Model Compliance Activities in Risk Analysis

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Drive(s) Impacted</th>
<th>Outcome(s) Impacted</th>
<th>Consequence(s) Impact</th>
<th>2011 Recorded Cost (SMF)</th>
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<tbody>
<tr>
<td>CM1</td>
<td>Discuison/Dechlorinated Pole Remediation Program and Pole</td>
<td>Non-Modelled</td>
<td>Non-Modelled</td>
<td>None</td>
<td>272.0</td>
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<tr>
<td>CM2</td>
<td>Vegetative Management</td>
<td>Non-Modelled</td>
<td>Non-Modelled</td>
<td>None</td>
<td>2.0</td>
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<tr>
<td>CM3</td>
<td>Pole Replacement Impacts, Appropriate Improvements, and Preventive Maintenance</td>
<td>Not Modelled</td>
<td>Not Modelled</td>
<td>Not Modelled</td>
<td>5.0</td>
</tr>
<tr>
<td>CM4</td>
<td>Intensive Pole Inspections and Pole Loading Assessments</td>
<td>Not Modelled</td>
<td>Not Modelled</td>
<td>Not Modelled</td>
<td>5.0</td>
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<tr>
<td>C1</td>
<td>Overhead Conductor Program (OCP)</td>
<td>B1a,b, D2a,b</td>
<td>1</td>
<td>1</td>
<td>5</td>
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<tr>
<td>C2</td>
<td>Underground Conductor Program (UGP) Utilizing Targeted Covered</td>
<td>D3a,b, D2a,b</td>
<td>O1</td>
<td>O1, O2</td>
<td>5</td>
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<tr>
<td>C2</td>
<td>Public Outreach</td>
<td>E</td>
<td>G1, O1</td>
<td>G1, G2</td>
<td>5</td>
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</table>

- SED Does NOT believe CM1 (High Cost) is a Compliance Program
  - At Minimum, Portions of the PLP Replacements are NOT
    - Some of SCE’s Internal Standards Are More Stringent than GOs
      - High Fire Areas (HFAs)
      - Wind Loading
  - CM1 Risk Reduction Analysis with RSEs to Determine Effectiveness
    - What Triggering Events & Drivers does CM1 Mitigate?
CONTROL 1 – OH CONDUCTOR PROGRAM (OCP)

- Model of C1 – 100% Bare OH Conductor in 2018-2020
- SCE Plans Future Use of Covered Conductor (CC) in Non-HFRAs
  - Only 90% OCP for Years 2021-2023
  - 10% OCP Costs Allocated to C1a OCP & Targeted CC for 2021-2023
- Detailed Circuit/Line Segment RSEs Could Be Utilized

<table>
<thead>
<tr>
<th>Wire-Down Triggering Event Frequencies</th>
<th>Name</th>
<th>Annual</th>
<th>%</th>
<th>20% Less</th>
<th>New %</th>
<th>New/Old</th>
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<tbody>
<tr>
<td></td>
<td>Equipment Cause</td>
<td>206</td>
<td>21%</td>
<td>91</td>
<td>12%</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>Equipment/Facility Contact</td>
<td>173</td>
<td>79%</td>
<td>654</td>
<td>88%</td>
<td>85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>978</td>
<td>100%</td>
<td>745</td>
<td>100%</td>
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</table>

- OCP Impacts D1 (Equipment Cause) & D2 (Equip/Facility Contact)
  - Reduce D1 Wire-Downs with 10.9% Mitigation Effectiveness in 2018
    - Growing Significantly Each Year to 55.9% Effectiveness in 2023
    - Reduces the Frequency of Faults
  - Reduce D2 Wire-Downs with 3.0% Mitigation Effectiveness in 2018
    - Growing to 15.5% in 2023 since Reduce Faults Causing Wire-Downs
CONTROL 1 – OH CONDUCTOR PROGRAM (OCP)

- Driver Analysis basis is 1,965 OH Ckt Miles Reconductored 2018-23
- Based on 85% of Wire-Down Events due to **168 Unknown Drivers**
- 5.5% Deployment of Total 36,040 Distribution Ckt Miles
- **Two OH Conductor Failure Modes: Arcing & Melting**
  - Reconductoring 50% and 90% Effective for Arc & Melt Failures, respectfully
  - Branch Line Fusing 0% and 90% Effective for Arc & Melt Failures, respectfully
- Mitigation Effectiveness by Driver:
  - 90% for Connector/Splice/Wire
  - 80% for Other Equipment Causes (0% for Pole Drivers)
  - 55% for Animal Contact
  - 46% for Other Contact (e.g. Gunshot Damage & Drones)
  - **32% for Mylar Balloons** & 28% for Weather & 24% Vegetation
  - 0% for Vehicle (e.g. Hitting Pole/Equipment)
- Why 20% Baseline Wire-Down Risk Reduction for 5.5% Deployment?
CEE COMBINED RISK ANALYSIS & ARC FLASH RISKS

- SCE Defines CEE Risks As OH Public Safety Risks ONLY
- SCE Does NOT Include Risks to:
  - Employees; 3rd Party Contractors; or Alleged Vandals/Thieves
- Risk Analysis for All OH CEE for Distribution Lines
  - Some Drivers May be Different
  - Combined Evaluation May Highlight Certain Risk Drivers More

- Does CEE Risks Include Arc Flash Risks?
  - 3rd Party Arc Flash Risks
  - Arc Flash Well Studied in Past Decade
RISK ANALYSIS OF DESIGN, CONSTRUCTION & OPERATION INCLUDING GROUNDING METHODOLOGIES

- Protection Equipment Can Stop Flow Of Electricity
  - If Fault Temporary, Can Reclose In Secs/Mins
  - If Fault Permanent, Electricity Can Remain Interrupted (Lockout)

- SCE Estimates Almost 1/3 Wire-Down Events Are Energized

- Analysis of System Design to Improve Fault Detection
  - Can Fault Related Risks Be Further Reduced?
  - Can Grounding Methodologies Be Improved to Reduce Risks?
    - Wye vs Delta 3 Phase Systems Relative to Grounding?
    - Multi-Grounded System?

- Comparative Statistics to U.S. Distribution Systems?
CIRCUIT/LINE SECTION/LINE SEGMENT RISK ANALYSIS

• Risk Analysis with RSEs for Circuits is Feasible (Index Scores)
• IEEE Standard Dictionary of Electrical and Electronics Terms (1992)
  • Circuit (NESC): A conductor or system of conductors through which an
electric current is intended to flow. (C2-1984)
  • Line Section: A portion of OH line/cable bounded by 2 terminations, a
termination and a tap point, or 2 tap points. (859-1987)
  • Line Segment: A portion of a line section that has a particular type of
construction or is exposed to a particular type of failure, and
therefore which may be regarded as a single entity for the purpose of
reporting and analyzing failure and exposure data.
    • Note: A line segment is a subcomponent of a line section. (859-1987)
• Data Available for Line Section/Segment Risk Analysis?
  • Line Sections with Discrete Termination Points for RSEs
  • Further Line Segments Risk Analysis, If Feasible
THIRD PARTY (TREE TRIMMERS) SAFETY RISK ANALYSIS

Three Risk Model Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Name</th>
<th># of Triggering Events (2018)</th>
<th>%</th>
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<tbody>
<tr>
<td>CEE O1</td>
<td>Energized Wire-Down</td>
<td>362.80</td>
<td>31.30%</td>
</tr>
<tr>
<td>CEE O2</td>
<td>De-Energized Wire-Down</td>
<td>791.67</td>
<td>68.30%</td>
</tr>
<tr>
<td>CEE O3</td>
<td>Intact Energized Wire Contact</td>
<td>4.64</td>
<td>0.40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1159.11</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

- Primary Safety Impact is 3rd Party Contacts (SCE)
  - Even Though Only 0.4% of All CEE (Public) Outcomes
  - Inputs for O3 is Significantly Higher Than O1
    - 183 (SI) and 159 (Fatalities)
- Data Sources From Different Timeframes – Effective?
  - Risk analysis for Similar Years (i.e. 2015-2018)
  - Additional analysis focused on F & SI outcomes
For questions, please feel free to contact me.

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[https://www.cpuc.ca.gov/riskassessment/](https://www.cpuc.ca.gov/riskassessment/)