Vegetation Work Sites and Wildfire Risk Assessment

by

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Power Line Systems
Introduction

• Vegetation management of overhead transmission and distribution line corridors has been a major topic in our industry from many years.
• Tree contact with transmission lines is a leading cause of electric power outages
• Vegetation management practices are under ever increasing regulatory scrutiny
Introduction

• Texas experienced more than 4,000 power line caused wildfires in a 3 ½ year period around 2013\(^1\)
• Estimated about 5% of wildfires caused by power lines in California between 2007 and 2016 accounting for about 11% of total acres burned\(^2\)
• Power lines were found to cause 5 of the 11 major fires of the 2009 Black Saturday Fires in Victoria, Australia\(^3\)

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\(^1\) Texas Wildfire Mitigation Project (www.wildfiremitigation.tees.tamus.edu)
\(^2\) Kousky, Greig, Lingle & Kunreuther, “Wildfire Costs in California: The Role of Electric Utilities” August 2018
\(^3\) Thompson, Christodoulou & Cronau, “Powerline failures scrutinized as potential cause of brushfire crisis” October 2013
Presentation Outline

- Discuss vegetation clearances to overhead transmission and distribution lines
- Demonstrate vegetation clearance calculations in PLS-CADD
  - Grow-in clearances
  - Fall-in clearances
- Demonstrate creation of clearance Work Sites and graphical representations of clearance areas
National Regulations

- Overhead transmission lines above 200kV or lower voltage lines designated by NERC or WECC fall under NERC FAC 003
- Most lines below 200kV fall under individual state regulatory policies and procedures
- RUS utilities fall under RUS regulations, including specific requirements of Bulletin 1724E-200
NERC FAC 003 Highlights

• Prevent vegetation encroachments:
  – Into the Minimum Vegetation Clearance Distance (MVCD)
  – Due to fall-in from inside the ROW
  – Due to blowing together of applicable lines and vegetation located inside the ROW

• Prevent vegetation encroachments that account for:
  – Movement of conductors under their rating and all rated electrical operating conditions
### FAC-003-4 Transmission Vegetation Management

#### FAC-003 — TABLE 2 — Minimum Vegetation Clearance Distances (MVCD)

For Alternating Current Voltages (feet)

<table>
<thead>
<tr>
<th>(AC)</th>
<th>(AC) Maximum In System Voltage (kV)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
<th>MVCD (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Over 2500 feet up to 5000 ft</td>
<td>13.0</td>
<td>13.0</td>
<td>13.0</td>
<td>13.0</td>
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<td></td>
<td>5000 ft</td>
<td>13.0</td>
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<td>13.0</td>
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<tr>
<td>500</td>
<td>550</td>
<td>7.0</td>
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<td>7.0</td>
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<tr>
<td>345</td>
<td>361?</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
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<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
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<tr>
<td>240</td>
<td>214</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
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<tr>
<td>141</td>
<td>141</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>131</td>
<td>141</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>115</td>
<td>121</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>37</td>
<td>72</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* Such lines are applicable to this standard only if FC has determined such per FAC-014 (refer to the Applicability Section above).

* Table 2 — Table of MVCD values at 1.0 geyper factor (in U.S. customary units), which is located in the EPRI report filed with FERC on August 12, 2015. (The 14000-15000 foot values were subsequently provided by EPRI in an updated Table 2 on December 1, 2015, filed with the FAC-003-4 Petition at FERC)

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17 The distances in this Table are the minimums required to prevent Flash-over; however, prudent vegetation maintenance practices dictate that substantially greater distances will be achieved at time of vegetation maintenance.

18 Where applicable lines are operated at nominal voltages other than those listed, the applicable Transmission Owner or applicable Generator Owner should use the minimum system voltage to determine the appropriate clearance for that line.

19 The sharp increase over existing factors in the calculations are the driver in the decrease in MVCDs for voltages of 245 kV and above. Refer to ps 29-21 in the Supplemental Matter for additional information.
RUS 1724E-200 Highlights

- Applies to all lines 200kV and above or lower voltage lines designated as critical per NERC FAC 003
- Radial clearances provided and based on IEEE 516 Standard (Different than FAC 003-04)
- Clearances to be applied at all rated operating conditions
- Displacement of conductor to include movement of suspension insulators and deflection of flexible structures
FIGURE 5-2: RADIAL CLEARANCE REQUIREMENT TO VEGETATION

where:

- $\phi$ = conductor swing out angle in degrees under all rated operating conditions
- $S_f$ = conductor final sag at all rated operating conditions
- $x_v$ = radial clearance (include altitude correction if necessary)
- $\xi = \text{insulator string length ($\xi = 0$ for post insulators or restrained suspension insulators)}$
- $y_v$ = horizontal clearance at the time of vegetation management work
- $\delta$ = structure deflection at all rated operating conditions
### Table 5-2

Radial Operating Clearances (in feet) from IEEE 516 for Use in Determining Clearances to Vegetation from Conductors

(NEC Standard FAC-003.1 Transmission Vegetation Management Program, IEEE 516, Guideline for Maintenance Methods of Energized Power Lines)

<table>
<thead>
<tr>
<th>Conditions under which clearances apply:</th>
<th>34.5</th>
<th>69.3</th>
<th>115.0</th>
<th>138.0</th>
<th>161.0</th>
<th>230.0 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearances are based on the Maximum Operating Voltage.</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
</tr>
<tr>
<td>Nominal voltage, Phase to Phase, kV (_{L-L})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.5</td>
<td>69.3</td>
<td>115.0</td>
<td>138.0</td>
<td>161.0</td>
<td>230.0 kV</td>
<td></td>
</tr>
<tr>
<td>Max. Operating Voltage, Phase to Phase, kV (_{L-L})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72.5</td>
<td>120.8</td>
<td>144.9</td>
<td>169.1</td>
<td>241.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Operating Voltage, Phase to Ground, kV (_{L-G})</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.8</td>
<td>69.7</td>
<td>83.7</td>
<td>97.6</td>
<td>139.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Radial Table 6: IEEE Standard 516 Operating Clearances**

<table>
<thead>
<tr>
<th>Operating clearance at all rated operating conditions</th>
<th>1.8</th>
<th>1.8</th>
<th>1.9</th>
<th>2.3</th>
<th>2.5</th>
<th>2.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design adder for survey and installation tolerance</td>
<td>1.5 feet for all voltages</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
</tr>
<tr>
<td>Design adder for vegetation</td>
<td>Determined by designer (see Notes 3 below)</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
<td>&amp; &amp;</td>
</tr>
</tbody>
</table>

**Altitude Correction to be Added to Values Above**

<table>
<thead>
<tr>
<th>Additional feet of clearance per 1000 feet of altitude above 3300 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
</tr>
</tbody>
</table>

**Notes:**

1. These clearances apply to all transmission lines operated at 200 kV phase-to-phase and above and to any lower voltage lines designated as critical (refer to NERC FAC 003).
2. The 230 kV clearance is based on 3.0 For Unit switching factor.
3. The design adder for vegetation, applied to conductors displaced by wind, should account for reasonably anticipated tree movement, species type and growth rate, species factor (characteristics), and local climate and rainfall patterns.
4. The design adder for vegetation, applied to conductors at rest, should account for worker approach distance in addition to the aforementioned factors.
Vegetation Clearances in PLS-CADD

- Separate checks for Grow-in and Fall-in
- Simultaneously check up to 200 weather cases, including wind conditions (i.e. blowout)
- Wire positions including structure deflections can be calculated
- Group violations into Work Sites to easily identify clearing areas
- Create vegetation TIN and Work Site DXF/SHP files
Example Reports and Settings – Grow-In

- Select Grow-In analysis
- Select vegetation point feature code(s)
- Confirm clearances
- Confirm weather condition(s) for analysis
- Options available for range of structures, report info and graphical markers
Example Reports and Settings – Fall-In

- Select Falling Tree analysis
- Select vegetation point feature code(s)
- Confirm clearances
- Confirm weather condition(s) for analysis
- Options available for range of structures, report info and graphical markers
Including Structure Deflection in Calculations

- Can be used with Grow-In or Falling Tree analysis
- Structures must be modeled in PLS-POLE or TOWER
- Select either L3 or L4 analysis in Criteria/SAPS
- Finite Element Sag-Tension
- Then run the Grow-In or Falling Tree Analysis
Plan View of Grow-In Violations under Wind Condition
Plan View of Falling Tree Violations under No Wind Condition
Cross Section View of Falling Tree Violations at Angle Structure
Example Reports and Settings – Work Sites

- Can be used with Grow-In or Falling Tree analysis
- Input work site size parameters
- Options available for TIN, KMZ/KML and SHP file creation
- Options available for range of structures, report info and graphical markers
Plan View of Work Sites for Falling Tree Violations
Power Line Systems

Advanced Sag & Tension
Structural Analysis
Pole Analysis
Project Estimating

FAC 003
1000+ Users in 100+ Countries

IEC
NERC Ratings
Transmission

ASCE
Vegetation Management

IEEE
Storm Hardening

TOWER
Line Ratings

Materials Management

PLS-CADD

Joint Use

PLS-POLE

LiDAR Modeling

CSA

FAC 008/009

Distribution
Line Optimization

IT’S ALL ABOUT YOUR POWER LINES

IT’S THE SOLUTION