TADP 548 Transmission Line Design - Electrical Aspects

Presentation 3.3
Electrical Design Clearances
Part 6

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Electrical Design Clearances

Main Reference Documents


Topics of this Presentation

- Clearances for transmission structures from other objects
- Right of Width calculations
Clearances for Transmission Structures from Other Objects

- Rule 231
  - Explains where we can locate our structures?
Clearances for Transmission Structures from Other Objects

- Rule 231

- Explains where we can locate our structures from other objects such as
  - Fire Hydrants
  - Streets, Roads and Highways
  - Railroad tracks
Clearances for Transmission Structures from Other Objects

- Rule 231
- Clearances measured between nearest parts of transmission facility and object concerned
Clearances for Transmission Structures from Other Objects

- **From Fire Hydrants**
  - Clearance should allow space for connecting hoses and equipment to fire hydrant
  - Supporting structure be not less than 4 feet from fire hydrant
  - Where conditions do not permit, a clearance of not less than 3 feet is allowed
Clearances for Transmission Structures from Other Objects

- From Streets, Roads, and Highways
  - Transmission structures usually installed outside of street ROW
  - If located within street right-of-way, structures shall meet some rules
  - To avoid contact by ordinary vehicles
  - Rules vary for roads with Curbs and without Curbs
Clearances for Transmission Structures from Other Objects

- From Streets, Roads, and Highways with Redirectional Curb
  - Transmission structures, support arms, anchor guys and equipment attached thereto, up to 15 feet above the road surface must:
    - Not less than 6 inches behind the street side of a Redirectional Curb

Ref: Marne, D.J. (2007)
Clearances for Transmission Structures from Other Objects

- From Street, Roads, and Highways with **Swale-type Curb**

  - Transmission structures, support arms, anchor guys and equipment attached thereto, up to 15 feet above the road surface must:
    
    - be behind the curb for a Swale-type Curb

Ref: Marne, D.J. (2007)
Clearances for Transmission Structures from Other Objects

- From Streets, Roads, and Highways with No Curbs
  - Should be located a sufficient distance from the roadway to avoid contact by ordinary vehicles
  - No dimensions are specified
Clearances for Transmission Structures from Other Objects

- From Streets, Roads, and Highways
  - Consult with the owners of the streets, roads, and highways rights-of-way for any special restrictions they may have on the location of the facilities
  - In many cases a state highway department, county road dept, city or other government authority may require a permit to place in existing ROW
  - Requirement may be more restrictive than NESC
Clearances for Transmission Structures from Other Objects

- From Railroad tracks
  - Applies to structures in parallel lines or crossing lines
Clearances for Transmission Structures from Other Objects

- All portions of transmission structures and attachments less than 22 feet above the track rails shall be located
  - not less than 12 feet from the nearest track rail

Ref: Marne, D.J. (2007)
Clearances for Transmission Structures from Other Objects

- A clearance of not less than 7 feet may be allowed where the transmission structure is not the controlling obstruction provided sufficient space for a driveway is provided where cars are loaded or unloaded.

- In no case shall a transmission structure be located where it will obstruct the view of a railroad signal or sign along the tracks.

- There may be locations or situations where individual railroads may have more stringent clearance requirements. These should be assessed on an individual basis. Consult with the owner of the Railroad right-of-way for any restrictions and for additional clearance requirements.
ROW Calculations

• Right of Width (ROW) calculations
  • Depends on horizontal clearance requirements
ROW Calculations

• Transmission line right of way is strip of land upon which an electric utility has legal right to construct, operate and maintain transmission line facilities

• The right of way needs to be wide enough to allow for construction, reliable operation and maintenance of transmission facilities
ROW Calculations

- Factors that Impact ROW
  - Width of structure
  - Conductor displacement and structure deflection
    - At 6-psf wind, 60°F, final sag
  - NESC Horizontal Clearance at the maximum line voltage
ROW Calculations

- Factors that Impact ROW
  - Conductor displacement and structure deflection at extreme wind and application of electrical flashover clearances
  - Clearance to vegetation (Recent NERC Mandatory Zero Tolerance Vegetation Management Compliance Standard)
ROW Calculations

- Factors that Impact ROW
  - Maintenance/Construction activities and accessibility of both the line and the adjacent object or structure
  - Fire protection of any nearby buildings
ROW Calculations
ROW Calculations

- Insulator Swing: Suspension insulator strings supporting transmission conductors are usually free to swing about their point of support for tangent and angle structures.
ROW Calculations

- Conductor swing angle under wind (zero line angle, insulator weight neglected)

\[ \tan(\phi) = \frac{[(HS) (p_c)]}{[VS (w_c)]} \]

Where:
- \( \phi \) = Conductor Swing angle
- \( HS \) = horizontal span
- \( VS \) = vertical span
- \( p_c \) = wind load per unit length of the conductor
- \( w_c \) = weight per unit length of bare conductor
ROW Calculations

Conductor position with no wind blowing.

Conductor in blown out position.

Top view of line

x
ROW Calculations

\[ W = A + 2\left(l_i + S_f\right)\sin\phi + 2\delta + 2x \]

Ref: RUS Bulletin
ROW Calculations

\[ W = A + 2(l_i + S_f) \sin \phi + 2\delta + 2x \]

- \( W = \) total ROW
- \( A = \) Separation between points of suspension insulator strings for outer two phases
- \( \phi = \) Insulator Swing
- \( \delta = \) Structure deflection
- \( l_i = \) Insulator string length
- \( S_f = \) Conductor final sag
- \( x = \) required horizontal clearance per code/utility internal standard
ROW Calculations

- Conditions at which ROW calculated
  - At rest condition
  - At 6 lb/ft\(^2\) wind, 60°F final sag
  - At extreme wind, final sag
  - Vegetation management requirements
## ROW Calculations

- Minimum Value of ‘x’ in ft

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>At rest condition*</th>
<th>Under 6psf wind*</th>
<th>Under extreme wind**</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>8.2</td>
<td>5.2</td>
<td>1.0</td>
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<tr>
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<td>9.6</td>
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<td>13.8</td>
<td>10.8</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*Horizontal clearance requirements Per NESC from buildings

**Required Electrical Flashover Clearances per an electric practice
ROW Calculations

- Minimum Value of ‘x’ in ft
- NERC Mandatory Zero Tolerance VM Compliance Standard
- NERC Reliability Standard FAC-003-1
- Needs to take into account frequency of vegetation clearing practice
- Expected growth of trees
- Electrical Flashover Clearances
ROW Calculations

- Minimum Value of ‘x’ in ft
- A utility practice (230kV line)
  - 5-year cycle
  - Expected growth of trees = 10 ft
  - Electrical Flashover Clearance = 5 ft
  - Weather condition=Under 60 mph
  - Required value of x = 15 ft for 230 kV line
## ROW Calculations

### Typical ROW widths (RUS Bulletin)

<table>
<thead>
<tr>
<th>Line Voltage (kV)</th>
<th>ROW Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>75 - 100</td>
</tr>
<tr>
<td>115</td>
<td>100</td>
</tr>
<tr>
<td>138</td>
<td>100 - 150</td>
</tr>
<tr>
<td>161</td>
<td>100 - 150</td>
</tr>
<tr>
<td>230</td>
<td>125 - 200</td>
</tr>
</tbody>
</table>
ROW Calculations

• Parallel Lines

• In addition to the factors discussed before, clearance needs to be provided between adjacent wires and structures that is sufficient to meet Code requirements

• As well as to permit maintenance activities on either line without having to take an outage on the adjacent line.
ROW Calculations

• Refer RUS Bulletin for ROW calculations of Parallel Lines