Horizontal Post Insulator Properties

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PLS-CADD User’s Group Meeting
July 14 – 16, 2009
Madison, WI
• Typically engineers are concerned with 3 things when evaluating a post insulator.
  1. Vertical Load
  2. Transverse Load
  3. Longitudinal Load

• Can not use just one of these to determine if a post insulator is adequate for the anticipated loads.

• All 3 loads and their interactions should be used in the evaluation.
NESC Considerations

• Rule 277. Mechanical Strength of Insulators

   Insulators shall withstand all applicable loads specified in Rules 250, 251, and 252 except those of Rule 250C and Rule 250D without exceeding the following percentages of their strength rating for the respective insulator type shown in Table 277-1.

   Proper allowance should be made for the loads in Rule 250C and Rule 250D.

   (Rules 250, 251, and 252 do NOT specify load factors. These are covered in Rule 253. Therefore the strength factors in Table 277-1 are to be used under the weather conditions noted in Rules 250, 251, & 252 WITHOUT any load factors applied.)
### NESC Table 277-1
Allowed percentages of strength ratings

<table>
<thead>
<tr>
<th>Insulator Type</th>
<th>Percent</th>
<th>Strength Rating 1</th>
<th>Reference Standard</th>
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<tbody>
<tr>
<td><strong>Ceramic</strong></td>
<td></td>
<td></td>
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<tr>
<td>Suspension</td>
<td>50%</td>
<td>Combined mechanical and electric strength</td>
<td>ANSI C29.2-1992</td>
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<tr>
<td>Line post</td>
<td>40%</td>
<td>Cantilever strength</td>
<td>ANSI C29.7-1996</td>
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<tr>
<td></td>
<td>50%</td>
<td>Tension, compression strength</td>
<td></td>
</tr>
<tr>
<td>Station Post</td>
<td>40%</td>
<td>Cantilever, tension, compression or torsion</td>
<td>ANSI C29.9-1983 [B8]</td>
</tr>
<tr>
<td>Station Cap and Pin</td>
<td>40%</td>
<td>Cantilever, tension, compression or torsion</td>
<td>ANSI C29.8-1985 [B7]</td>
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<tr>
<td></td>
<td></td>
<td>strength</td>
<td></td>
</tr>
<tr>
<td><strong>Non-Ceramic</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Line post</td>
<td>50%</td>
<td>Specified cantilever load (SCL) or specified</td>
<td>ANSI C29.17-2002 [B13] and C29.18-2003 [B14]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tension load (STL)</td>
<td></td>
</tr>
<tr>
<td>Station Post</td>
<td>40%</td>
<td>All strength ratings</td>
<td></td>
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</tbody>
</table>
• Manufacturers do not directly provide ultimate load capacities of their post insulators.

• Typically they provide:
  ➢ MDCL (Maximum Design Cantilever Load) or RCL (Rated Cantilever Load)
  ➢ SCL (Specified Cantilever Load)
  ➢ RTL (Rated Tensile Load)
SCL

• Specified Cantilever Load
• Typically the ultimate vertical load of the insulator.
MDCL

- Maximum Design Cantilever Load
- Typically approximately \( \frac{1}{2} \) of the SCL or ultimate load.
- Assumes a load factor of 1.0 is used.
STL

• Specified Tensile Load
• Typically the ultimate tensile load of the insulator.
  – Usually the value shown is the load that puts the post in tension (away from the pole).
  – The compression (in towards the pole) is usually not shown.
RTL

• Rated Tensile Load
• Typically approximately ½ of the specified tensile load (STL).
• Assumes a load factor of 1.0 is used.
Since most manufactures will only provide the MDCL and RTL, you need to increase these according to the manufacturer’s notes to get the SCL and STL in order to use the strength factors listed in NESC Table 277-1.

Your insulator component file should reference the ultimate loads of the insulator.

Your criteria file should then be set up using the Strength Factors in NESC Table 277-1 and Load Factors $= 1.0$ for NESC Rule 250 Loads.
## PLS-POLE
### Post Insulator Component File
#### Part 1

<table>
<thead>
<tr>
<th></th>
<th>Label</th>
<th>Stock Number</th>
<th>Has Brace</th>
<th>Horz. Projection (ft)</th>
<th>Vert. Projection (ft)</th>
<th>Weight (lbs)</th>
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<td>NGK 69KV</td>
<td>NGK-L2-SN211-13</td>
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# PLS-POLE

## Post Insulator Component File

### Part 2

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MANUFACTURER’S COMBINED LOADING CHART

VS

PLS INTERACTION DIAGRAM
(using 115 kV Line Post and Braced Line Post)
Typical Manufacturer’s Combined Loading Charts

• Available for both braced and unbraced line post insulators.

• Should use the combined loading chart for unbraced insulators not just the MDCL and STL. Combined loading charts take into account the longitudinal loading and the interaction with the cantilever and tensile loading. Most manufacturers only provide the tensile strength of the insulator and not the compressive strength unless the Combined Loading Chart is requested.
Typical Manufacturer’s Combined Loading Charts

• Combined loading charts for braced line post insulators should take into account the connection hardware for a correct loading chart.

• Some manufacturer’s won’t provide a chart with the hardware limitation because they don’t provide complete assemblies.
Physical Characteristics
Section Length, in. 64.00
Creepage Distance, in. 140.31
Dry Arcing Distance, in. 51.65
Weight Approx., lb. 81.68

Mechanical Load Values
Specified Cantilever Load (SCL), lb. 2928
Reference Cantilever Load (RCL), lb. 1464
Deflection at RCL, in. 8.89

Voltage Values
50% Lightning Impulse Flashover, Pos., kV 836
50% Lightning Impulse Flashover, Neg., kV 886
Power Frequency Flashover, Wet, kV 495
Power Frequency Flashover, Dry, kV 568

Components (Qty. = 1)
1. Insulator w/ Mounting Base

Notes
1. Insulator Material: HTV Silicone / Fiberglass Core.
2. Ferrous Parts Are Hot Dip Galvanized.
3. Dimensions Are In Inches.
4. Tolerances As Per ANSI.
5. Testing As Per ANSI.
NGK
Unbraced Line Post

Combined Load Chart for L2-SN361-13 and -18

Note: These curves show the combined loads which equal to the MDCL (40%SCL).
PHYSICAL CHARACTERISTICS
Creepage Distance – Suspension, in. 140.20
Creepage Distance – Line Post, in. 140.31
Dry Arcing Distance – Assembly, in. 51.0
Approximate Weight – Assembly, lb. 100.1

MECHANICAL VALUES
Maximum Design Vertical Load (Vv) Without Transverse Load (Vt) @ Load Point (L.P.), lb.* 10700

VOLTAGE VALUES
50% Lightning Impulse Flashover, Pos., kV 825
50% Lightning Impulse Flashover, Neg., kV 875
Power Frequency Flashover Wet, kV 488
Power Frequency Flashover Dry, kV 560

* SEE COMBINED LOAD CHART FOR WORKING LOADS.
COMBINED LOAD CHART
BRACED LINE POST, 2.0 SF, Fv= WORKING LOAD
CBP2-064-138-02

MAX VERT LOAD (Fv) lbs

SAFE WORKING LOAD IS WITHIN THIS BOUNDARY

TRANSVERSE LOAD (Ft) lbs

TENSION

COMPRESSION

POST LIMIT (0 LONG)
BRACE LIMIT
MINIMUM LOAD
CONNECTING HARDWARE LIMIT
LONGITUDINAL= 600
LONGITUDINAL= 800
LONGITUDINAL= 1000
NGK
Braced Line Post w/o Hardware Limitations

Combined Load Chart

Note: These curves show the combined loads which are not greater than 50% or less of the design ultimate stress. The numerical simulations were implemented on the premise that the transverse load towards pole (compression load) faces to the pole.
PLS INTERACTION DIAGRAMS

• Differences between typical manufacturer’s Combined Loading Chart and the PLS Interaction Diagram.
  ➢ Tension and Compression forces are shown opposite. So the PLS Interaction Diagram will appear backwards to the manufacturer’s Combined Loading Chart.
  ➢ To create the PLS Interaction Diagram you need to scale the manufacturer’s combined loading chart or request the raw data file used to create the combined loading chart.
PLS INTERACTION DIAGRAMS

- Things to consider when creating Interaction Diagram within PLS-POLE.
  
  - Compression force is negative value.
  - Tensile force is positive value.
  - Vertical force is typically down and positive value.
  - Longitudinal load is positive value.
PLS INTERACTION DIAGRAMS

• You can create multiple interaction curves for an insulator. These are separated by the different longitudinal loads.

• Interaction diagrams are CLOSED curves that run counter-clockwise, and START and STOP at the same point.
  – You can NOT have bulges away from the closed curve as shown in the manufacturer’s Combined Loading Chart.

• Examples of PLS Interaction Diagrams:
LAPP
Unbraced Line Post
LAPP
Braced Line Post
Analysis Results

• PLS-POLE uses the interaction curve that best fits the calculated loads.

• The % usage reported is not necessarily the percentage of the ultimate strength of the insulator, but of the interaction curve chosen. So don’t get overly concerned about the % usage reported as long as it is less than 100%.

• Discussion...