Composite Poles for Electric Utility & Communication Applications

Technical Specification (USA)
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1.0 General

1.1 Scope

This specification covers the design, material, fabrication, testing, UV protection and delivery of modular or single-piece composite poles used in overhead distribution and transmission, monopole and H-Frame utility applications, as well as communication structures. The reference to specifications of organizations, together with any drawings or loading diagrams, shall be considered part of this specification.

The composite poles supplied under this specification shall present the most pleasing appearance possible consistent with strength, cost and serviceability requirements. In general, the poles shall be circular in cross section.

Foundation design and placement, unloading of poles at pole yard or job site and erection/installation of poles are not considered part of this specification.

1.2 Exceptions or Deviations

At the time of bid submittal the Manufacturer shall provide a written attachment detailing any comments and exceptions relating to this specification.

2.0 Definitions And Symbols

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>Entity responsible for engineering and procurement services and/or duly authorized representatives</td>
</tr>
<tr>
<td>NESC</td>
<td>National Electrical Safety Code, C2-2007 (or Latest Edition), Institute of Electrical and Electronics Engineers, Inc</td>
</tr>
<tr>
<td>Grade of Construction</td>
<td>Grade of construction for supporting structures as referenced in Section 24 of the NESC, with Grade B being the highest grade</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Company manufacturing the composite utility poles</td>
</tr>
<tr>
<td>Owner/Purchaser</td>
<td>Entity retaining final ownership of the product</td>
</tr>
</tbody>
</table>
3.0 Reference Standards

3.1
Reference to standards and/or specifications included herein shall be interpreted to mean the latest revisions unless otherwise noted. The following references apply to this specification:

ANSI  American National Standards Institute
• ANSI O5.1, American National Standard for Wood Products – Specifications and Dimensions

ASCE  American Society of Civil Engineers
• Manual No. 104, Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures

ASTM  American Society for Testing and Materials
• ASTM D1036, Standard Test Methods of Static Tests of Wood Poles
• ASTM G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

NESC  National Electrical Safety Code
• C2-2007

RUS  Rural Utilities Service
• RUS Bulletin 1724E-200 Design Manual for High Voltage Transmission Lines

TIA  Telecommunications Industry Association
• TIA/EIA-568-B which includes 568-B.1-2001, -B.2-2001, and -B.3-2001
• ANSI/TIA/EIA-222-G-2006, Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

3.2
Permission to deviate from these specifications and/or standards shall be obtained in writing from the Engineer. Otherwise, such deviations shall be indicated in a “List of Exceptions to the Specification.”
4.0 Products

4.1 Design

4.1.1

The design, materials, fabrication, inspection procedures, shipping and assembly procedures for the composite poles shall generally conform to latest best engineering practices. ASCE Manual No. 104, “Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures” may also be used as a general reference guide where appropriate.

4.1.2

To verify the ability of composite poles to meet given loading, deflection or other applicable requirements structural analysis software, may be utilized to perform the analysis. Non-linear analysis is required to take into account P-delta effects (deflected unbalance) and overall structure stability (buckling) under combined loading. National or regional design codes such as RUS (Rural Utilities Service) can also be used as a design reference, provided they are based on a comparable analysis methodology.

4.1.3

The composite poles shall present the most pleasing appearance possible consistent with the strength, cost and serviceability requirements. The composite poles shall be symmetrical about the transverse and longitudinal axes, and any tapered filament-wound composite poles shall have a gradual and relatively constant taper rate from top to bottom.

4.1.4

The Manufacturer certifies that the composite poles meet or exceed the loading or other requirements as specified by the Engineer, in accordance with the applicable provisions of the referenced NESC, ANSI/TIA/EIA or other relevant standards, and as verified by design calculations and/or full-scale testing. Design calculations are considered proprietary and are retained by the Manufacturer but may be provided to the Engineer upon request and subsequent approval by the Manufacturer.

4.1.5

Standard class direct-buried composite poles 40 ft. [12.19 m] and longer are typically embedded to a depth of 10% of total pole length plus 2 ft. [0.61 m]. Standard class direct-buried composite poles less than 40 ft. [12.19 m] in length are typically embedded to a depth of 10% of total pole length plus 2.5 ft. [0.76 m]. The Engineer has the option to vary the embedment depth based upon varying soil or other foundation conditions.

4.1.6 Recommended Procedure to Select Appropriate Composite Poles

The recommended procedure to select the appropriate composite pole for a given application is as follows:

4.1.6.1 Utility Structures

(i) Determine the factored loads on the composite pole structure:
   a. From loading trees provided by the Engineer/Owner, or;
   b. By calculation, using the applicable loading from the combined ice and wind district loads in Rule 250B, the extreme wind loading condition of Rule 250C, or the extreme ice with concurrent wind condition of Rule 250D, multiplied by the Load Factors from Table 253-1 of the NESC for Grade B or Grade C Construction appropriate.
4.1.6.1 Utility Structures (cont.)

(ii) Determine the required composite pole strength by multiplying the composite pole rated ultimate strength by the applicable Strength Factor from Table 261-1A of the NESC for Grade B or Grade C Construction.

(iii) The required composite pole strength must meet or exceed the factored loads.

(iv) If specified by the Engineer/Owner, in addition to composite pole strength requirements other design considerations such as maximum pole top deflection under unfactored (working) loads should also be checked.

4.1.6.2 Communication Structures

(i) Determine the factored loads on the composite pole structure:
   a. From loading trees provided by the Engineer/Owner, or;
   b. By calculation using the applicable loading from Section 2 of the ANSI/TIA/EIA-222-G-2006 standards.

(ii) Determine the required composite pole strength by multiplying the composite pole rated ultimate load capacity by the applicable strength and allowable stress increase factors from Section 3 of the ANSI/TIA/EIA-222-G-2006 standard or the comparable section of the ANSI/TIA/EIA-222-G-2006 standard.

(iii) The composite pole rated ultimate strength must meet or exceed the factored loads.

(iv) If specified by the Engineer/Owner, in addition to composite pole strength requirements, other design considerations, such as maximum pole top deflection under specified loading should also be checked.

4.1.7 Composite Pole Classification For Utility Applications

Due to the history and familiarity of wood pole class designations, there may be occasions where the Engineer/Owner requests composite poles for utility applications to be “equivalent” to particular wood pole classes. It is important to note that “equivalency” between composite poles and standard wood pole classes is strictly based on the poles ability to bare the horizontal load 2 ft. [0.61] from pole top as specified for a given wood pole class in ANSI O5.1. These class loads are adjusted to reflect the ratio of applicable strength and overload factors for each pole material type, loading criteria, and Grade of Construction.

It should also be noted that differences in material and sectional properties between composite poles and wood poles may result in differences in the characteristics, affecting structural capacity (i.e., deflections, secondary moment effects and localized stress concentrations at hardware attachment locations). Situations such as different Grades of Construction (i.e., NESC Grade B vs. C), other loading requirements such as extreme ice, extreme wind or longitudinal loading, or configurations such as guyed angle or dead-end structures, may result in different design loads and therefore different composite pole strength requirements.

The required composite pole horizontal factored load shall be calculated by multiplying the ANSI O5.1 wood pole horizontal load for the specified wood pole class by the following ratio:

\[
\text{CPC} = \text{WPC} \times \left[ \frac{\text{CSF}}{\text{WSF}} \right] \times \left[ \frac{\text{COF}}{\text{WOF}} \right]
\]

where:
- CPC = Composite Pole Class
- WPC = Wood Pole Class
- CSF = Composite Strength Factor
- WSF = Wood Strength Factor
- COF = Composite Overload Factor
- WOF = Wood Overload Factor

As an example, for NESC Grade B Construction the composite pole horizontal factored load “equivalent” to a Class 3 wood pole would be:

\[
\text{CPC} = 3,000 \text{ lb.} \times \left[ \frac{2.5}{2.75} \right] \times \left[ \frac{1.0}{0.65} \right] = 1,950 \text{ lb. OR CPC} = 13.34 \text{ kN} \times \left[ \frac{2.5}{2.75} \right] \times \left[ \frac{1.0}{0.65} \right] = 8.67 \text{ kN}
\]
4.1.7 “Pole Class Equivalent” Composite Poles for Utility Applications (cont.)

The following chart details wood pole class loads and the “equivalent” composite pole horizontal design loads for various pole classes:

<table>
<thead>
<tr>
<th>ANSI 05.1 Wood Pole Class</th>
<th>ANSI 05.1 Wood Pole Horizontal Load (lbs.) (kN)</th>
<th>Grade B Composite Pole Factored Load (lbs.) (kN)</th>
<th>Grade C Composite Pole Factored Load (lbs.) (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H6</td>
<td>11,400 50.71</td>
<td>7,410 32.96</td>
<td>9,690 43.10</td>
</tr>
<tr>
<td>H5</td>
<td>10,000 44.48</td>
<td>6,500 28.91</td>
<td>8,500 37.81</td>
</tr>
<tr>
<td>H4</td>
<td>8,700 38.70</td>
<td>5,655 25.15</td>
<td>7,395 32.89</td>
</tr>
<tr>
<td>H3</td>
<td>7,500 33.76</td>
<td>4,875 21.69</td>
<td>6,375 28.36</td>
</tr>
<tr>
<td>H2</td>
<td>6,400 28.47</td>
<td>4,160 18.50</td>
<td>5,440 24.20</td>
</tr>
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<td>H1</td>
<td>5,400 24.02</td>
<td>3,510 15.61</td>
<td>4,590 20.42</td>
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<td>1</td>
<td>4,500 20.02</td>
<td>2,925 13.01</td>
<td>3,825 17.01</td>
</tr>
<tr>
<td>2</td>
<td>3,700 16.46</td>
<td>2,405 10.70</td>
<td>3,145 13.99</td>
</tr>
<tr>
<td>3</td>
<td>3,000 13.34</td>
<td>1,950 8.67</td>
<td>2,550 11.34</td>
</tr>
<tr>
<td>4</td>
<td>2,400 10.68</td>
<td>1,560 6.94</td>
<td>2,040 9.07</td>
</tr>
<tr>
<td>5</td>
<td>1,900 8.45</td>
<td>1,235 5.49</td>
<td>1,615 7.18</td>
</tr>
</tbody>
</table>

4.1.8

The composite poles shall be single-piece or modular. For modular poles, adjacent sections shall be joined by means of slip joints. After assembly, slip joints shall be secured using appropriate hardware.

For modular poles, same sized modules will have the ability to be doubled or tripled stacked where required to create a reinforced pole.

4.1.9

The Engineer/Owner shall have the right to approve or modify grounding provisions on the composite poles.

4.1.10

All direct-buried composite poles shall be equipped with a base plate.

4.2 Material

4.2.1 Resin Binders

Only thermoset resin binders shall be used in the manufacture of the composite poles. The only acceptable binder is polyurethane resin. Thermoplastic resin binders, polyester resins and vinyl-ester resins are not acceptable for use in the composite poles.
4.2.2 Fiber Reinforcement

The fiber reinforcement used in the manufacture of the composite poles shall be “E-Glass” with acceptable forms being continuous strand and/or fabric.

4.3 Manufacturing

Fabrication shall be performed in accordance with the composite pole detail drawings. Material substitutions or deviations from the approved drawings shall not be made without prior written approval by the Engineer/Owner.

4.3.1 Acceptable Manufacturing Methods

The composite poles may be produced by filament winding or pultrusion methods as appropriate. If the poles are manufactured using filament winding, the wind schedule will include both circumferential and axial fiber placement in the pole wall laminate.

4.3.2 Holes for Hardware Attachment or Climbing Steps

4.3.2.1 Unless otherwise specified, no holes will be provided for hardware attachments or climbing steps.

4.3.2.2 When required and specified, drilling of holes shall be done in such a manner as to produce cylindrical holes perpendicular to the plane of the pole. The holes shall be circular and shall not vary in diameter by more than 1/16 in. [2 mm].

4.3.2.3 Drilling requirements for crossarms, climbing steps and other attachments shall be listed and included in a drawing in Appendix B, or otherwise provided by the Engineer/Owner.

5.0 Marking

Each composite pole section shall be identified with pertinent information including module number, production serial number and module weight. When a series of modular pole sections is being supplied to meet a specific pole length and class requirement, an aluminum I.D. tag shall also be provided for the complete pole that may include, but not be limited, to the following information: Manufacturer, length, class and month/year of manufacture. Additional information may be included on the I.D. tag, as mutually agreed by both the Engineer and the Manufacturer prior to fabrication. The I.D. tag is to be located at a minimum height of 3 ft. [0.91 m] above ground line.
6.0 Special Provisions

6.1 Top Caps and Base Plates

The composite poles shall be furnished with top caps and base plates. Base plates shall be provided with drainage holes.

6.2 Climbing Provisions

Unless otherwise specified, no provisions shall be made on the composite poles for climbing. When required, climbing provisions shall generally consist of the following:

6.2.1 Holes For Climbing Steps

For all composite poles requiring climbing steps, 1-1/8 in. [29 mm] maximum diameter holes shall be provided on the appropriate longitudinal faces specified by the Engineer. Unless otherwise specified, holes shall start at approximately 9 ft. [2.74 m] above the groundline and end approximately 4 ft. [1.22 m] from the pole top. The vertical spacing of holes for climbing steps shall be 15 in. [381 mm].

If ladder rest provisions are desired, 1-1/8 in. [29 mm] maximum diameter holes for two removable steps at 180° apart may be placed at approximately 9 ft. [2.74 m] above the groundline.

6.2.2 Holes For Work Steps

For ease of workability at strategic locations on the pole, 1-1/8 in. [29 mm] maximum diameter holes for four steps 90° apart may also be provided at the desired height(s) (i.e., at approximately 6 ft. [1.83 m] from the pole top).

6.2.3 Climbing Steps

Where required, climbing steps shall be “Senior Industries SI-0040”, or other approved equivalent steps.
7.0 UV Protection

7.1 General

The composite poles shall be manufactured with the best available protection against UV degradation. The use of UV-stable “aliphatic” resins with pigment additives is the preferred protection method. Resins enriched with UV inhibitors and UV stable color pigment additives are also acceptable. The use of standard paint or coatings for UV protection is not acceptable.

7.2 UV and Weathering Testing

The UV and weathering resistance of the composite poles shall be verified through ongoing accelerated aging tests in accordance with the procedures detailed in ASTM G154 for UV exposure (“h” and lamp setting of 0.89 W/nm). Coupon samples, representative of the composite poles shall be exposed continuously to the UV portion of sunlight, moisture and heat for a minimum of 14,000 hours. At the prescribed hourly intervals indicated in ASTM G154, a visual inspection report shall be completed and the composite pole coupons shall be visually inspected for chalking, flaking, blistering, cracking and checking. Upon completion of the visual inspection, the same coupons will be subjected to testing to check for changes in mechanical properties.

8.0 Physical Testing

8.1 Bending/Flex Tests

Full-scale bending/flex tests shall be conducted on representative composite pole samples in accordance with a modified ASTM D1036 test procedure. Each pole shall be tested in a horizontal cantilevered position, with the butt end of the pole secured inside a rigid test frame. Loading shall then be applied at 2 ft. [0.61 m] below the pole top, with load and deflection measured and recorded as the load is increased at a constant rate up to a pre-determined proof load, or to ultimate load, as appropriate.

8.2 Combined Load Tests

Full-scale combined load tests shall be conducted on representative composite pole samples to simulate the effects of combined vertical loads and horizontal loads. Each pole shall be tested in an upright or vertical position, with vertical loads applied on either end of a crossarm attached at 2 ft. [0.61 m] below the pole top and with horizontal loads also applied at 2 ft. [0.61 m] from the pole top.

8.3 Hardware Connection and Pole Wall Loading Tests

Full-scale testing shall be conducted on representative composite pole samples to simulate the load effects from guying hardware, crossarm attachments, crossbrace attachments, transformer attachments and various other types of hardware on the composite pole wall. Hardware connection and associated pole wall loading simulations shall include, but not be limited to:

8.3.1 Bolt bearing due to axial shear loads;
8.3.2 Bolt pull-through; and
8.3.3 Deformation of the pole wall due to radial compressive loads.

8.4 Other Tests

Other tests may also be conducted as agreed between the Engineer/Owner and the Manufacturer.
9.0 Guarantee and Warranty

9.1 Guarantee

Provided they have been selected, assembled and installed in strict adherence to the manufacturer’s procedures and engineering specifications, the composite poles themselves shall be protected by a lifetime performance guarantee that covers pole failure as a result of:

(i) the physical load of ice and/or snow on an electrical conductor line, the composite pole itself and/or an attachment;
(ii) the direct force of wind from storms, tornadoes, hurricanes or blizzards that has brought down an electrical conductor line and thereby caused the failure of a composite pole; or
(iii) a lightning strike on an electrical conductor line, the composite pole itself and/or an attachment.

For further clarity, the guarantee does not apply where a composite pole has failed as a result of the direct impact of any object whose movement or flight has been caused by an external force.

9.2 Warranty

Provided they have been selected, assembled and installed in strict adherence to the manufacturer’s procedures and engineering specifications, the composite poles themselves shall be covered by a minimum 40-year warranty against manufacturing defects.

Note: See the manufacturer’s official documents for complete information.

10.0 Software Compatibility

10.1 PLS®

The composite poles will have library files compatible with PLS-POLE® and PLS-CADD®.

11.0 Quality Assurance and Control

11.1 Quality Assurance

11.1.1

The Manufacturer shall conform to ISO 9001:2008, a recognized Quality Assurance program.

11.1.2

The Manufacturer shall afford the Owner/Purchaser’s representatives reasonable opportunity, without charge, to allow them to verify that the finished products and materials being furnished are in accordance with the requirements in this specification.
11.2 Quality Control

11.2.1 Visual Inspection

Each component of the composite poles shall be inspected for conformance to the manufacturing drawings and drill patterns. The inspection shall include, but not be limited to:

(i) Dimensional checks to verify manufacturing tolerances are being met.
(ii) Verification that drilled holes do not have ragged or torn edges; and
(iii) Aesthetic appearance such as color consistency and surface roughness.

11.2.2 Tip and Butt Diameters of Modular Composite Pole Sections

To ensure proper slip-joint overlaps are achieved when assembling modular composite poles, the following dimensions shall be checked and verified and the modular sections rejected if the dimensions are outside of acceptable tolerances:

(i) External diameter at tip of modular section.
(ii) Internal diameter at butt of modular section.

11.3 Rejection of Material

Issues relating to any material delivered under this specification, which as mutually agreed by the Manufacturer and the Owner/Purchaser does not meet the requirements set forth herein with regard to material, fabrication, shipment or delivery, shall be resolved in a manner satisfactory to both parties and consistent with the specifications.

12.0 Packing, Shipping and Delivery

12.1

Reasonable care shall be taken to avoid damage to the composite poles during handling and transportation.

12.2

The Manufacturer shall take all reasonable steps to ensure that the composite poles covered by this specification shall be delivered to the Owner/Purchaser’s designated storage facility during the period stated in the Bidder’s Proposal, or as previously agreed and detailed in the Purchase Order.

12.3

The Engineer and/or Owner/Purchaser shall be advised immediately of any change in the delivery schedule of the structures.

12.4

All bid correspondence and transmittals shall be addressed to:
## APPENDIX A

### Composite Pole Loading Diagram, Factored Load Table and Embedment Depths

#### NESC Composite Pole Factored Load Table

<table>
<thead>
<tr>
<th>ANSI 05.1 Wood Pole Class</th>
<th>ANSI 05.1 Wood Pole Horizontal Load (lbs.)</th>
<th>Grade B Composite Pole Factored Load (lbs.)</th>
<th>Grade C Composite Pole Factored Load (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(kN)</td>
<td>(kN)</td>
<td>(kN)</td>
</tr>
<tr>
<td>H6</td>
<td>11,400</td>
<td>7,410</td>
<td>9,690</td>
</tr>
<tr>
<td>H5</td>
<td>10,000</td>
<td>6,500</td>
<td>8,500</td>
</tr>
<tr>
<td>H4</td>
<td>8,700</td>
<td>5,655</td>
<td>7,395</td>
</tr>
<tr>
<td>H3</td>
<td>7,500</td>
<td>4,875</td>
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<td>6,400</td>
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</tr>
<tr>
<td>5</td>
<td>1,900</td>
<td>1,235</td>
<td>1,615</td>
</tr>
</tbody>
</table>

#### NESC Standard Embedment Depths

<table>
<thead>
<tr>
<th>Pole Length (ft.)</th>
<th>Embedment Depth (ft.)</th>
<th>Embedment Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>7.62</td>
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</tr>
<tr>
<td>95</td>
<td>28.96</td>
<td>9.15</td>
</tr>
</tbody>
</table>

**LEGEND**

- **L** = Pole Length (ft./m)
- **H** = Height of Load Above Groundline (ft./m)
- **P** = Factored Horizontal Load on Pole (lbs./kN)
- **E** = Embedment Depth (ft.) = (L /10) + 2 ft.
  (add 2.5 ft. for poles less than 40 ft.)
  = Embedment Depth (m) = (L /10) + 0.61 m
  (add 0.76 m for poles less than 12.2 m)
- **GL** = Groundline
Appendix B

Composite Pole Framing Detail Sheet
(Make Copies as Required)

Pole Length: ____  Class: ____  Quantity: ____  Catalog #: ____________

OPTIONAL ACCESSORIES (Check Required Ones Below):

1. Climbing Steps:
   - □ Senior Industries SI-0040 Removable Step
   - □ Other: ___________  Step Quantity: _________

2. Plastic Hole Plugs:
   - □ 1/2 in. [13 mm] hole  > Quantity: _________
   - □ 11/16 in. [17 mm] hole  > Quantity: _________
   - □ 13/16 in. [21 mm] hole  > Quantity: _________
   - □ 15/16 in. [24 mm] hole  > Quantity: _________
   - □ Other: ____________  > Quantity: _________

OTHER REQUIREMENTS:

________________________________________________________________________
________________________________________________________________________
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