ANSI O5.1-2017

Wood Poles:
Specifications and Dimensions

AMERICAN NATIONAL STANDARD FOR WOOD UTILITY PRODUCTS

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ANSI O5.1-2017, Wood Poles: Specifications and Dimensions

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American National Standard for Wood Utility Products

Wood Poles:
Specifications and Dimensions

Secretariat
American Wood Protection Association, Inc.

Approved February 23, 2017
American National Standards Institute, Inc.

Foreword

This American National Standard establishes specifications and dimensions for wood utility poles that are to be given preservative treatment as specified by the purchaser. The poles described are considered as simple cantilever members subject to transverse loads only. Requirements for the preservative treatment of poles are not included although the effects of conditioning are accounted for.

This standard was developed by Accredited Standards Committee O5 – Wood Utility Products (ASC O5) under the procedural administration of the American Wood Protection Association (AWPA). ASC O5 was organized in December 1924 and has produced revisions of this standard from time to time as required or deemed beneficial. This standard supersedes American National Standard ANSI O5.1-2015.

Suggestions for improvement of this standard will be welcomed. They should be sent to ASC O5 through its Secretariat: American Wood Protection Association, P.O. Box 361784, Birmingham, AL 35236 <www.awpa.com>.

This standard was processed and approved for submittal to ANSI by ASC O5. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it processed and approved this standard, ASC O5 had the following leadership and members:

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Wood Poles: Specifications & Dimensions

1 Scope & general requirements

1.1 Scope

This standard provides minimum specifications for the quality and dimensions of wood poles that are to be used as single-pole utility structures. The poles described herein are considered as simple cantilever members subject to transverse loads only. Fiber strength values, provided as a basis for determining pole class sizes, apply only to poles that meet or exceed the minimum quality specifications.

Requirements for the preservative treatment of poles are outside the scope of this standard. However, where such treatment or conditioning may affect strength, limitations are provided in section 5.1.2. [Also see standards such as those published by American Wood Protection Association (AWPA) and ASTM International (ASTM)].

1.2 General requirements

The species, the length, and class of poles; the type of treatment (including seasoning details, if seasoning is desired); aids to penetration such as incising, groundline boring, or kerfing; and complete details for roofing, gaining, boring, and branding not included in this standard shall be given in purchase orders.

Complete detailed instructions shall be given to the supplier whenever the requirements of this standard are modified to meet special conditions.

2 Normative references

The standards listed below contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision; therefore users of this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

ASC C2-2007, *National electrical safety code*.[1]

AWPA Standard M6-07, *Brands used on forest products*.[2]

ASTM D9-05, *Standard terminology relating to wood*.[3]

Wood Preservation Statistics, *Forest Service, U.S. Department of Agriculture, 1973.*[4]

3 Definitions

The following definitions shall apply to the terms used in this standard. Photographs depicting many of these terms may be found in Technical Report O5-TR-01, the Photographic Manual of Wood Pole Characteristics, which is based on this Standard.

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[1] Available from www.ieee.org

[2] Available from www.awpa.com

[3] Available from www.astm.org

[4] Available from the U.S. Government Printing Office, Washington, DC 20402.

3.1 air dried: Dried by exposure to air in a yard or shed, without artificial heat.

3.2 air seasoning: Drying by the use of ambient air either in the open or under cover.

3.3 Boulton drying: Drying by heating in nonaqueous solution under vacuum.

3.4 check: The lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

3.5 compression wood: Abnormal wood formed on the lower side of branches and inclined trunks of softwood trees. Compression wood is identified by its relatively wide annual rings, usually eccentric; relatively large amount of summerwood/latewood, sometimes more than 50% of the width of the annual rings in which it occurs; and its lack of demarcation between springwood and summerwood/latewood in the same annual rings. Compression wood, compared with normal wood, shrinks excessively lengthwise.

3.6 cone hole: A hole formed by the stalk of a pine cone during the radial growth of the main stem of several species of pine, principally Radiata. In Radiata pine, cone holes are typically less than 1/2 inch (13mm) in diameter, exist in the crown of the tree, and extend from the surface of the pole to the pith.

3.7 cross break: A separation of the wood cells across the grain. Such breaks may be due to internal strains resulting from unequal longitudinal shrinkage or to external forces.

3.8 dead streak: An area, devoid of bark, resulting from progressive destruction of the growth cells of wood and bark at the edges of the streak. On a pole, a dead streak is characterized by a discolored weathered appearance and by lack of evidence of overgrowth along the edges of the deadened surface.

3.9 decay: The decomposition of wood substance by fungi.

3.10 decay, advanced (or typical): The latter stage of decay in which the destruction is readily recognized because the wood may be punky, soft and spongy, stringy, pitted, crumbly, or is in a soggy condition. Decided discoloration or bleaching of the rotted wood is often apparent.

3.11 decay, incipient: The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. Although the wood is invaded and some of its properties may have deteriorated, no visible change has occurred, with perhaps the exception of minor discoloration. Incipient decay can occur in living trees.

3.12 decayed knot: A knot containing decay. Two types of decayed knot are recognized:

- *Type I*: Knots containing soft or loose fibers (decay) that may extend the full length of the knot into the pole and that are associated with heart rot;
- *Type II*: Knots containing soft or loose fibers (decay) that are not associated with heart rot.

3.13 Earlywood: The portion of the growth ring that is formed during the early part of the growing season. It is usually less dense and weaker mechanically than latewood.

3.14 face of pole: The concave side of greatest curvature in poles with sweep in one plane and one direction, or the side of greatest curvature between groundline and top in poles having reverse or double sweep.

3.15 groundline section: That portion of a pole between 1 foot (30cm) above and 2 feet (61cm) below the groundline, as defined in the pole dimension Tables (see Tables 3 through 10, or Tables 3M through 10M).

3.16 hollow heart: A void in the heartwood caused by decay or insect attack.

3.17 hollow pith center: A small hole at the pith center of the trunk or of a knot caused by disintegration of the pith (small soft core occurring in the structural center of a tree or branch).

3.18 insect damage: Damage resulting from the boring into the pole by insects or insect larvae. Scoring or channeling of the pole surface is not classed as insect damage.

3.19 kiln dried: Dried in a kiln with the use of artificial heat.

3.20 kiln drying: Drying by the use of artificially heated air in a chamber designed to control temperature, relative humidity, and air flow.

3.21 knot cluster: Two or more knots grouped together as a unit, the fibers of the wood being deflected around the entire unit; distinct from a group of single knots in which each is a unit. A knot cluster shall be considered as a single knot.

3.22 knot diameter: The diameter of a knot on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole. The sapwood as well as the heartwood portion of a knot shall be included in the measurement. NOTE – For a description of means for defining the limits of knots, see ASTM D9.

3.23 latewood: The portion of the growth ring that is formed after the earlywood formation has ceased. It is usually denser and stronger mechanically than earlywood.

3.24 red heart: A condition caused by a fungus, *Fomes pini*, which occurs in the living tree. It is characterized in the early stages of infection by a reddish or brownish color in the heartwood. This is known as "firm red heart." Later the wood of the living tree disintegrates (decays) in small, usually distinct, areas that develop into white lined pockets.

3.25 sap stain: A discoloration of the sapwood, caused by the action of certain molds and fungi, which is not accompanied by softening or other disintegration of the wood.

3.26 scar: A depression in the surface of the pole resulting from a wound where healing has not reestablished the normal cross section of the pole.

3.27 scar, turpentine acid face: An area in the lower portion of a southern pine pole where bark hack removal with acid applied has caused resin to flow. No removal of sapwood has occurred.

3.28 scar, turpentine cat face: A depression in the surface of a southern pine pole resulting from a wood hack into the sapwood, where healing has not reestablished the normal cross section of the pole.

3.29 seasoning: Removing moisture from green wood to improve serviceability.

3.30 shake: A separation along the grain, the greater part of which occurs between the rings of annual growth.

3.31 shelling: Ring separation extending to the surface of round or sawn timber normally following the growth rings and often associated with limiting defects such as knots, compression wood or shake. Ring separation usually becomes more pronounced as the product dries and may be further aggravated by stress developed during horizontal lifting or loading.

3.32 short crook: A localized deviation from straightness that, within any section 5 feet (1.5m) or less in length, is more than 1/2 the mean diameter of the crooked section. (See Figure 1, Diagram 3.)

3.33 spiral-grained (twist-grained) wood: Wood in which the fibers take a spiral course about the trunk of a tree instead of a vertical course. The spiral may extend in a right-handed or left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

3.34 split: A lengthwise separation of the wood extending completely through the piece from one surface to another.

3.35 springwood: (See **earlywood.**)

3.36 steam conditioning: Subjecting poles to steam prior to treatment in a closed vessel.

3.37 sweep: Deviation of a pole from straightness. (See Figure 1, Diagrams 1 and 2.)

3.38 summerwood: (See **latewood.**)

3.39 through-boring: A process applied prior to preservative treatment whereby holes 0.5 inches (12.5 mm) or less in diameter are drilled through a pole at a slight angle in a pattern designed to improve preservative treatment. This process is normally only used on Douglas-fir poles in the groundline zone, but the through-bored zone may be extended downwards to the butt or applied near the pole top.

4 Pole classes

Poles meeting the requirements of this standard are grouped in the classes identified in Tables 3 through 10 (or Tables 3M through 10M), based on their circumference measured 6 feet (1.8m) from the butt, after bark removal and/or shaving. Poles of a given class and length are designed to have approximately the same load-carrying capacity, regardless of species. Annex B provides further information.

5 Material requirements

5.1 General

5.1.1 Species & designated fiber strength values (Table 1)

The designated fiber strength values are for the pole groundline locations given in Tables 3 through 10 (or Tables 3M through 10M).

5.1.2 Conditioning, seasoning, & treatment limitations

Although preservative treatment of poles is outside the scope of this standard, where conditioning the wood for treatment or where the actual process of preservation could reduce the designated fiber strength values below those listed in 5.1.1, limitations on the processes are contained in this section. If the limitations in this section are exceeded, the minimum circumference 6 feet (1.8m) from the butt, as specified Tables 3 through 10 (or Tables 3M through 10M) must be adjusted to account for the reduced strength.

5.1.2.1 Air seasoning

Air seasoning is required for poles of species listed in Seasoning Treatment group A and not listed in any other group in Table 1. It is permitted for all other species. Such air seasoning shall be sufficient to ensure conformance with the user's specifications for preservative treatment. Pretreatment steaming and post treatment steaming are permitted for species in Treatment group A. However, if such steaming is employed, the maximum temperature shall not exceed 240°F (115°C). The total steaming time from the time steam is introduced into the cylinder, including both initial and final steam, shall not exceed 4 hours duration (see exception in 5.1.2.5). Up to 6 hours steam at temperatures up to 240°F (115°C) may be employed for ponderosa pine poles, provided the moisture content (calibrated to the basis of oven dry weight moisture content) measured with a resistance-type moisture meter with insulated pins is not over 25 percent at 2.5 inches (60mm) from the surface at midlength when steaming commences. Otherwise, the maximum steaming time for ponderosa pine poles is 4 hours.

5.1.2.2 Boulton drying temperature

The temperature employed in *Boulton drying* poles of species listed under Seasoning Treatment group B of Table 1 shall not exceed 220°F (104°C). These poles may be steamed up to 240°F (115°C) for a maximum time of 4 hours, but such steaming shall be limited to steaming after treatment.

5.1.2.3 Steam conditioning

The steam temperature employed in *steam conditioning* for poles of species in Seasoning Treatment group C of Table 1 shall not exceed 245°F (118°C). The time duration for poles with specified circumferences 37.5 inches (95cm) or less at 6 feet (1.8m) from the butt shall not exceed 17 hours and for poles with specified circumferences larger than 37.5 inches (95cm) at 6 feet (1.8m) from the butt shall not exceed 20 hours.

5.1.2.4 Kiln drying

Where *kiln drying* is employed, the maximum dry bulb temperature shall be increased gradually.

5.1.2.4.1 Temperature

In compartment kilns operating at temperatures up to 170°F (77°C), the maximum wet bulb depressions shall not exceed 50°F (28°C) with the exception that during the first 24 hours there is no limitation on wet bulb depression. In progressive-type kilns operating at temperatures up to 170°F (77°C), the maximum wet bulb depression shall not exceed 50°F (28°C) in the body of the kiln and 90°F (50°C) at the entrance to the kiln. For dry bulb temperatures over 200°F (93°C), the wet bulb depression shall be not less than 50°F (28°C) with the exception that during the first 24 hours there is no limitation on wet bulb depression.

5.1.2.4.2 Species

1. Where *kiln drying* is employed on southern pine, red pine, lodgepole pine, Douglas-fir, and western larch species the maximum dry bulb temperature shall not exceed 230°F (110°C).
2. Where *kiln drying* is employed on ponderosa pine and jack pine the maximum dry bulb temperature shall not exceed 170°F (77°C).
3. Where *kiln drying* is employed on western red cedar, the maximum dry bulb temperature shall not exceed 160°F (71°C).
4. Where *kiln drying* is employed on Chilean radiata pine, the maximum dry bulb temperature and shall not exceed 180° F (82° C).

5.1.2.5 Steaming (Douglas-fir & Western larch)

Douglas-fir and western larch poles that are to be treated with water-borne preservatives and that have not been Boulton dried may be *steamed* at a maximum temperature of 240°F (115°C). For poles in this category, the maximum duration starting with the time steam is introduced into the cylinder, including both initial and final steam, shall not exceed 8 hours, provided each pole before steaming has a maximum moisture content not exceeding 25 percent when measured with a resistance-type moisture meter (calibrated to the basis of oven dry weight moisture content) with insulated pins at 2.0 inches (50mm) from the surface at mid-height.

5.1.2.6 Sterilization

When specified, suppliers shall provide the purchaser with certification that *sterilization* has occurred during the conditioning or treating process. To assure sterilization, heating times and temperatures shall be sufficient to obtain a temperature of at least 150°F (66°C) at the center of the entire pole for at least one hour.

5.1.3 Solvent recovery

When poles of any species have been treated with a system using an organic solvent-based preservative solution, a *solvent recovery* cycle of not over 15 hours at a maximum temperature of 225°F (107°C) is permitted, provided each pole before treatment has a maximum moisture content of 25 percent when measured with a resistance-type moisture meter (calibrated to the basis of oven dry weight moisture content) with insulated pins at 2.0 inches (50mm) from the surface at mid-height.

5.1.4 Rate of growth

The average *rate of growth* measured on the butt in the outer 2 inches (50mm) of poles having a minimum required circumference of 37.5 inches (95cm) or less at 6 feet (1.8m) from the butt, and in the outer 3 inches (8cm) of poles having a minimum required circumference of more than 37.5 inches (95cm) at 6 feet (1.8m) from the butt, shall be not less than 6 rings per inch (25mm). For poles that exhibit a non-uniform growth rate around the circumference, the average growth shall be determined at the midpoint of the shortest arc between the point showing the fewest growth rings in the required zone and the point showing the most growth rings in the required zone.

Exception: Poles with an average of as few as 4 rings per inch (25mm) in the required zone are acceptable if 50% or more summerwood/latewood (portion of the annual growth ring that is formed after the springwood/earlywood formation has ceased) is present in the zone where the average rate of growth is determined.

As an alternative, or in cases where the determination in the butt is uncertain, the ring count and summerwood/latewood measurements mentioned above may be made on an increment core taken at 6 feet (1.8m) from the butt directly above the place where the average rate of growth is indicated on the butt surface.

5.1.5 Through boring

Where specified for Douglas-fir poles, through-boring shall be at a minimum from 2 feet above to 3 feet below (600 mm above to 900 mm below) the intended groundline, but may be extended up or down as needed for the intended risk of decay. Through boring holes shall be no more than 0.5 inches in diameter (12.5 mm) must be inward from the pole edge a minimum of 2.0 inches (50 mm) and shall be applied on the pole face with the tag so that the holes, in most applications, are in the line direction. A sample pattern can be found in Figure 2.

5.2 Prohibited defects

1. Cross breaks;
2. Decay, except as permitted for firm red heart in 5.3.1, defective butts in 5.4.4, and decayed knots in 5.4.6;
3. Dead streaks, except as permitted in 5.4.3;
4. Holes, open or plugged, are prohibited, except for those deliberately placed holes for explicit use as increment boring holes, framing holes, or through-boring holes. All increment boring holes should be plugged with treated wood plugs;
5. Hollow butts or tops, except as permitted under hollow pith centers and defective butts;
6. Marine borer damage; and
7. Nails, spikes, and other metal not specifically authorized by the purchaser.

5.3 Permitted defects

5.3.1 Firm red heart

Firm red heart not accompanied by softening or other disintegration (decay) of the wood is permitted.

5.3.2 Hollow pith centers

Hollow pith centers in the tops or butts and in knots are permitted in poles that are to be given full-length treatment.

5.3.3 Sap stain

Sap stain that is not accompanied by softening or other disintegration (decay) of the wood is permitted.

5.3.4 Scars

Turpentine acid face scars are permitted anywhere on the pole surface.

5.4 Limited defects

5.4.1 Bark inclusions

Depressions containing bark inclusions shall be not more than 2 inches (5cm) in depth, measured from the surface of the pole.

5.4.2 Compression wood

The outer 1-inch (25mm) of all poles shall be free from visible compression wood.

5.4.3 Dead streaks

A single, sound dead streak is permitted in western red cedar and northern white cedar, provided the greatest width of the streak is less than 1/4 of the circumference of the pole at the point of measurement.

5.4.4 Defective butts

Hollowing in the butt caused by "splinter pulling" in felling the tree is permitted, provided that the area of such a hollow is less than 10% of the butt area. Hollow heart or decay, or both, is permitted in cedar poles only, provided the aggregate area of the hollow heart or decay, or both, does not exceed 10% of the entire butt area and does not occur closer than 2 inches (50mm) to the side surface and provided that the depth of the hollow does not exceed 2 feet (0.61m), as probed and measured from the butt surface.

5.4.5 Insect damage

Insect damage, consisting of holes 1/16 inch (2mm) or less in diameter, or surface scoring or channeling is permitted. All other forms of insect damage are prohibited, except those associated with hollow heart in cedar poles.

5.4.6 Knot

The diameter of any single knot and the sum of knot diameters in any 1-foot (31cm) section shall not exceed the limits of Table 2.

In determining the sum of the knot diameters in any 1-foot (0.31m) section, only those knots with diameters over 0.5 inch (13mm) whose pith centers fall within the section shall be included in the sum, and the 1-foot (0.31m) section shall be located so as to include the maximum number of knots (i.e., the most severe condition).

Type II "decayed knots" are permitted.

5.4.7 Scars (cat face)

No pole shall have a scar or turpentine cat face (southern pine) located within 2 feet (0.61m) of the groundline. Turpentine scars need be trimmed only to the extent necessary for examination for evidence of fungus infection and insect damage. Other sound scars are permitted elsewhere on the pole surface, provided they are smoothly trimmed and do not interfere with the cutting of any gain, and provided that:

1. The circumference at any point on trimmed surfaces located between the butt and 2 feet (0.61m) below the groundline is not less than the minimum circumference specified at 6 feet (1.8m) from the butt for the class and length of the pole;
2. The depth of the trimmed scar is not more than 2 inches (50mm), if the diameter is 10 inches (0.25m) or less, or 1/5 the pole diameter at the location of the scar if the diameter is more than 10 inches (0.25m).

5.4.8 Shakes

Shakes in the butt surface that are not closer than 2 inches (50mm) to the side surface of the pole are permitted, provided they do not extend to the groundline. Shakes or a combination of connected shakes that are closer than 2 inches (50mm) to the side surface of the pole are permitted, provided they do not extend farther than 2 feet (0.61m) from the butt surface and do not have an opening wider than 1/8 inch (3mm). Shakes in the top surface are permitted in poles that are to be given full-length preservative treatment, provided that the shake is not closer to the surface of the pole than the midpoint of a line extending from the pith to the surface (i.e., the shake is permitted if it is closer to the pith than to the surface of the pole).

5.4.9 Shape

Poles shall be free from short crooks. A pole may have sweep subject to the following limitations:

1. *Where sweep is in one plane and one direction only:* For poles of all species, except northern white cedar, a straight line joining the surface of the pole at the groundline and the edge of the pole at the top shall not be distant from the surface of the pole at any point by more than 1 inch (25mm) for each 10 feet (3m) in length. The deviation for northern white cedar poles is 1 inch (25mm) for each 5 feet (1.5m) in length. (See Figure 1, Diagram 1.)
2. *Where sweep is in two planes (double sweep) or in two directions in one plane (reverse sweep):* Except in northern white cedar poles[5], a straight line connecting the midpoint at the groundline with the midpoint at the top shall not at any intermediate point pass through the surface of the pole. (See Figure 1, Diagram 2.)

5.4.10 Spiral grain

Spiral grain (twist grain) is permitted as follows:

Length of pole (feet)	Maximum twist of grain permitted
30 (9.1m) and shorter	1 complete twist in any 10 feet (3m)
35 (10.7m) to 45 (13.7m), inclusive	1 complete twist in any 16 feet (5m)
50 (15.2m) and longer	1 complete twist in any 20 feet (6m)

[5] The double sweep limitation for northern white cedar poles shall be as follows: Where sweep is in two planes (double sweep), the sum of the sweeps in the two planes (each sweep being measured as shown in Figure 1, Diagram 1) shall be not greater than the allowance for sweep in one plane and one direction for a pole of the same length.

5.4.11 Splits & checks

5.4.11.1 In the top

A split or a combination of two single checks (each check terminating at the pith center and separated by not less than 1/6 of the circumference) having one or both portions located in a vertical plane within 30 degrees of the top bolt hole shall not extend downward along the pole more than 6 inches (15cm). All other combinations of checks or a split shall not extend downward along the pole more than 12 inches (0.31m).

5.4.11.2 In the butt

A split or a combination of two single checks, as defined above, shall not extend upward along the pole more than 2 feet (0.61m).

5.4.12 Shelling

Shelling on the surface of the pole shall be limited to no more than one inch (25mm) in depth nor exceed 1/3 of the pole's circumference at the point of shelling.

5.4.13 Cone holes

For species containing cone holes, the sum of the diameter of all cone holes greater than 0.5 inch (13 mm) shall be combined with the sum of the diameter of all knots greater than 0.5 inch (13 mm) knot diameters in any 1-foot (0.31m) section, and the result shall not exceed the limits of Table 2. In determining the combined sum of cone hole and knot diameters, the 1-foot (0.31m) section shall be located so as to include the maximum sum of cone hole and knot diameters greater than 0.5 inch (13 mm).

6 Dimensions

For dimensions of particular species of poles, see Tables 3 through 10 (or Tables 3M through 10M).

6.1 Length

Poles less than 50 feet (15.2m) in length shall be not more than 3 inches (80mm) shorter or 6 inches (150mm) longer than nominal length. Poles 50 feet (15.2m) or more in length shall be not more than 6 inches (150mm) shorter or 12 inches (0.31m) longer than nominal length.

Length shall be measured between the extreme ends of the pole.

6.2 Circumference

6.2.1 General

Poles are classed while in the green condition, after bark removal and/or shaving. Subsequently, there may be some shrinkage due to conditioning, seasoning, or while in service. Therefore, this shrinkage, which is usually about 2 percent as the pole dries below fiber saturation, should be recognized if re-measuring circumference at a later date.

6.2.2 Circumference

The minimum circumferences at 6 feet (1.8m) from the butt and at the top, for each length and class of pole, are listed in Tables 3 through 10 (or Tables 3M through 10M). The circumference at 6 feet (1.8m) from the butt of a pole shall be not more than 7 inches (0.18m) or 20 percent larger than the specified minimum, whichever is greater. The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

6.3 Classification

The true circumference class shall be determined as follows: Measure the circumference at 6 feet (1.8m) from the butt. This dimension will determine the true class of the pole, provided that its top (measured at the minimum length point) is large enough. Otherwise, the circumference at the top will determine the true class, provided that the circumference at 6 feet (1.8m) from the butt does not exceed the specified minimum by more than 7 inches (0.18m) or 20 percent, whichever is greater.

7 Manufacturing requirements

7.1 Bark removal

Outer bark shall be completely removed from all poles.

On all poles, no patch of inner bark more than 1 inch (25mm) wide shall be left on the pole surface between the butt and 2 feet (0.61m) below the groundline.

On poles that are to be given full-length treatment, no patch of inner bark larger than 1 inch (25mm) wide and 6 inches (15cm) long shall be left on the pole surface between the top and 2 feet (0.61m) below the groundline.

On poles that are to be butt-treated, no patch of inner bark larger than 1 inch (25mm) wide and 6 inches (150mm) long shall be left on the pole surface between points 1 foot (0.30m) above and 2 feet (0.61m) below the groundline.

7.2 Sawing

All poles shall be neatly sawed at the top and at the butt along a plane that shall not be out of square with the axis of the pole by more than 2 inches (5cm) per foot (0.31m) of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than 1/12 the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.

7.3 Trimming

Completely overgrown knots, rising more than 1 inch (25mm) above the pole surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 1 inch (25mm) high need not be trimmed. Trimming may be done by shaving machine or by hand.

7.4 Shaving

If shaving is used, the depth of cut shall not be more than necessary to remove inner bark and to trim smoothly and closely all branch stubs and overgrown knots. There shall be no abrupt change in the contour of the pole surface between the groundline and the aboveground sections. The lower 2 feet (0.61m) of poles may be trimmed to remove wood fibers causing butt flare, provided sufficient sapwood remains to obtain customer’s minimum penetration requirement.

7.5 Marking & code letters

The following information shall be burn-branded legibly and permanently on the face and the butt of each pole or included on a metal or weather-durable color coded tag (the latter allowable on the butt only) affixed thereto (see note below):

1. The supplier’s code or trademark;
2. The plant location and the year of treatment;
3. Code letters denoting the pole species and preservative used; and
4. The true circumference-class numeral and numerals showing the length of the pole. Metal (non-corrosive) or weather-durable, color coded tags attached to the butt of a pole shall be securely affixed to serve the intended purpose.

NOTE – The supplier’s code or trademark, the plant location, the year of treatment, and code letters denoting the pole species and preservative used may be omitted from the butt by agreement between supplier and purchaser. Information included in (4) above may then be die-stamped or hammer-stamped. By agreement between supplier and purchaser, oversized poles may be substituted for a smaller true class and be marked with the smaller true class numeral.

The code letters, not less than 5/8-inch (16mm) high if burn-branded, and not less than 1/8-inch (3mm) high if on a metal or weather-durable, color coded tag, designating the pole species and preservative used, shall be as follows:

Species	**Code letters**
Cedar	
Alaska yellow	YC
Northern white (eastern)	EC
Western red	WC
Douglas-fir	DF
Larch, western	WL
Pine	
Jack	JP
Lodgepole	LP
Ponderosa	WP
Radiata (Chilean)	CP
Red (Norway)	NP
Scots	PS
Southern	SP
Loblolly	
Longleaf	
Shortleaf	
Slash	

NOTE – The preservative will be designated by adding to the species code the proper preservative code from the latest edition of American Wood Protection Association Standard M6.

The bottom of the brand or mark shall be placed squarely on the face of the pole and at 10 feet (3m) +/- 2 inches (5cm) from the butt of poles 50 feet (15.2m) or less in length and at 14 feet (4.3m) +/- 2 inches (5cm) from the butt of poles 55 feet (16.8m) or more in length or as otherwise specified in the purchase order. The arrangement and order of the code letters and figures shall be as follows:

PTC	Supplier's code or trademark (for example, Pole Treating Company)
F-15	Plant location and year of treatment (for example, Forestville - 2015)
SPC	Species and preservative code (for example, southern pine, creosote)
5-35	Size (for example, Class 5 - 35-foot pole or Class 5 - 10.7m pole)

5. When color coded tags are attached to the butt to identify class, the tag colors shall correspond to the Pantone Matching System (PMS) colors for each pole class as follows:

Class H6	PMS 259 (Purple)
Class H5	Warm Grey 7
Class H4	PMS 146 (Brown)
Class H3	PMS 2975 (Light Blue)
Class H2	PMS 604 (Mustard Yellow)
Class H1	PMS 2635 (Lavender)
Class 1	White
Class 2	PMS 485 (Red)
Class 3	Process Blue
Class 4	PMS 151 (Orange)
Class 5	PMS 354 (Green)
Class 6	PMS 211 (Bright Pink)
Class 7	PMS 155 (Tan)
Class 9	PMS 3252 (Aqua Blue)
Class 10	PMS 802 (Light Green)

8 Storage & handling

8.1 Storage

When it is necessary to hold poles in storage, they shall be stacked on treated or other nondecaying skids of such dimensions and so arranged as to support the poles without producing noticeable distortion of any of them. The height of the piles shall be limited to avoid damage to poles on the bottom layers. Poles shall be piled and supported in such a manner that all poles are at least 1 foot (0.30m) above the general ground level and any vegetation growing thereon. No decayed or decaying wood shall be permitted to remain underneath stored poles.

8.2 Handling

Poles shall not be dragged along the ground. Cant hooks, pole tongs, or other pointed tools shall not be applied to the groundline section of any pole.

8.3 Mechanical damage

Poles are not acceptable if they contain indentations attributed to loading or handling slings that are 1/4 inch (6mm) or more deep over 20% or more of the pole circumference, or more than 1/2 inch (12mm) deep at any point. Other indentations or abrasions, for example, forklift damage, kiln sticker damage, chain-saw damage, etc., shall not be more than 1/10 the pole diameter at the point of damage up to a maximum of 1 inch (25mm). Such damage is permitted in an oversized section, where the excess of wood shall be taken into consideration in evaluating the effects of the damage. In any case, the circumference for a given class is still required to be not less than the specification minimum.

Table 1 - Designated Fiber Strength and Modulus of Elasticity Specifically for Wood Utility Poles

Seasoning Treatment Group	Genus and Species	Fiber Strength[1] (psi)	Fiber Strength[1] (kPa)	Modulus of Elasticity[1),7] (10^6 psi)	Modulus of Elasticity[1),7] (GPa)
Group A (air seasoning)					
Cedar, northern white (eastern)	*Thuja occidentalis*	4000	27600		
Cedar, western red [4]	*Thuja plicata*	6000	41400	1.43	9.86
Pine, ponderosa	*Pinus ponderosa*	6000	41400		
Fir, western (true fir)		6600	45500		
California red[2]	*Abies magnifica*				
Grand[2]	*Abies grandis*				
Noble[2]	*Abies procera*				
Pacific silver[2]	*Abies amabilis*			1.67	11.51
White[2]	*Abies concolor*				
Pine, jack	*Pinus banksiana*	6600	45500		
Pine, lodgepole	*Pinus contorta*	6600	45500	1.66	11.44
Pine, red (Norway)	*Pinus resinosa*	6600	45500	1.47	10.13
Pine, Scots[6]	*Pinus sylvestris*	7800	53800	1.16	8.00
Cedar, Alaska yellow	*Chamaecyparis nootkatensis*	7400	51000		
Douglas-fir, interior north [5]	*Pseudotsuga menziesii*	8000	55200		
Group B (Boulton drying)					
Douglas-fir, coast [4,5]	*Pseudotsuga menziesii*	8000	55200	2.38	16.40
Larch, western	*Larix occidentalis*	8400	57900	2.65	18.27
Group C (steam conditioning)					
Pine, southern [4]		8000	55200	2.13	14.68
Loblolly	*Pinus taeda*				
Longleaf	*Pinus palustris*				
Shortleaf	*Pinus echinata*				
Slash	*Pinus elliottii*				
Group D (kiln drying)					
Cedar, western red [4]	*Thuja plicata*	6000	41400	1.43	9.86
Douglas-fir, interior north [5]	*Pseudotsuga menziesii*	8000	55200		
Douglas-fir, coastal [4,5]	*Pseudotsuga menziesii*	8000	55200	2.38	16.40
Larch, western	*Larix occidentalis*	8400	57900	2.65	18.27
Pine, jack	*Pinus banksiana*	6600	45500		
Pine, lodgepole	*Pinus contorta*	6600	45500	1.66	11.44
Pine, ponderosa	*Pinus ponderosa*	6000	41400		
Pine, radiata (Chilean) [3]	*Pinus Radiata D. Don*	6600	45500	1.54	10.62
Pine, red	*Pinus resinosa*	6600	45500	1.47	10.13
Pine, Scots[6]	*Pinus sylvestris*	7800	53800	1.16	8.00
Pine, southern [4]		8000	55200	2.13	14.68
Loblolly	*Pinus taeda*				
Longleaf	*Pinus palustris*				
Shortleaf	*Pinus echinata*				
Slash	*Pinus elliottii*				

NOTES:

1) The fiber strength and MOE values in Table 1 apply only to wood utility poles meeting this standard. The effects of conditioning on fiber strength and MOE have been accounted for in the Table 1 values provided that conditioning was performed within the limits herein prescribed.
2) Not in common use according to *Wood Preservation Statistics*, Forest Service, U.S. Department of Agriculture, 1973.
3) Radiata pine includes only material produced in Chile between south 33° and south 40° latitude, is limited to no more than 45 feet in length, and limited to pole class sizes 4-10.
4) The designated fiber strength represents a mean, groundline, fiber strength value with a coefficient of variation equal to 0.20.
5) Where Douglas-fir (Coastal or Interior North) are through bored prior to treatment, to account for the process, the designated fiber strength shall be reduced 5 % to 7600 psi (52440 kPa).
6) Data source for Scots Pine MOE is BS EN 14229.
7) The Modulus of Elasticity (MOE) represents a mean value.

Table 2 - Limits of Knot Sizes

	Maximum sizes permitted		
	Diameter of any single knot (in) and (mm)		**Sum of diameters of all knots (and cone holes, if applicable) greater than 0.5 inch (13mm) in any 1-foot (0.31m) section** (in) and (mm)
Length of Pole	**Classes H6 to 3**	**Classes 4 to 10**	**All Classes**
45 feet (13.7m) and shorter Lower half of length Upper half of length	 3 in (80mm) 5 in (130mm)	 2 in (50mm) 4 in (100mm)	1/3 of the average circumference of the same 1-foot (0.31m) section or 8 inches (.20m), whichever is greater, but not to exceed 12 inches (0.31m) [1)]
50 feet (15.2m) and longer Lower half of length Upper half of length	 4 in (100mm) 6 in (150mm)	 4 in (100mm) 6 in (150mm)	1/3 of the average circumference of the same 1-foot (0.31m) section or 10 inches (0.25m), whichever is greater, but not to exceed 14 inches (.36m) [1)]

NOTE - See clause 4 and Tables 3 through 10 (or Tables 3M through 10M) for pole classes.

[1)] Both upper and lower halves

Table 3 - Dimensions of Northern white cedar poles (Fiber Strength 4000 psi)

Class		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (in)		**27**	**25**	**23**	**21**	**19**	**17**	**15**	**15**	**12**
Length of pole (ft)	**Approximate Groundline[1)] distance from butt** (ft)	**Minimum circumference at 6 ft from butt** (in)								
20	4	38.0	35.5	33.0	30.5	28.0	**26.0**	**24.0**	**22.0**	**17.5**
25	5	42.0	39.5	36.5	34.0	31.5	**29.0**	**27.0**	**24.0**	**19.5**
30	5.5	45.5	**43.0**	**40.0**	**37.0**	**34.5**	**32.0**	**29.5**	**26.0**	-
35	6	49.0	**46.0**	**42.5**	**39.5**	**37.0**	**34.0**	**31.5**	-	-
40	6	**51.5**	**48.5**	**45.0**	**42.0**	**39.0**	**36.0**	-	-	-
45	6.5	**54.5**	**51.0**	**47.5**	**44.0**	**41.0**	-	-	-	-
50	7	**57.0**	**53.5**	**49.5**	46.0	43.0	-	-	-	-
55	7.5	**59.0**	**55.5**	**51.5**	48.0	-	-	-	-	-
60	8	**61.0**	**57.5**	**53.5**	50.0	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

1) The figures in this column are not recommended embedment depths; rather these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 3M - Metric dimensions of Northern white cedar poles (Fiber Strength 27.6 MPa)

Class		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (m)		**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	**Approximate Groundline[1)] distance from butt** (m)	**Minimum circumference at 1.8 m from butt** (m)								
6.1	1.2	0.97	0.90	0.84	0.77	0.71	**0.66**	**0.61**	**0.56**	**0.44**
7.6	1.5	1.07	1.00	0.93	0.86	0.80	**0.74**	**0.69**	**0.61**	**0.50**
9.1	1.7	1.16	**1.09**	**1.02**	**0.94**	**0.88**	**0.81**	**0.75**	**0.66**	-
10.7	1.7	1.24	**1.17**	**1.08**	**1.00**	**0.94**	**0.86**	**0.80**	-	-
12.2	1.8	**1.31**	**1.23**	**1.14**	**1.07**	**0.99**	**0.91**	-	-	-
13.7	2.0	**1.38**	**1.30**	**1.21**	**1.12**	**1.04**	-	-	-	-
15.2	2.1	**1.45**	**1.36**	**1.26**	1.17	1.09	-	-	-	-
16.8	2.3	**1.50**	**1.41**	**1.31**	1.22	-	-	-	-	-
18.3	2.4	**1.55**	**1.46**	**1.36**	1.27	-	-	-	-	

NOTE - Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1)] The figures in this column are not recommended embedment depths; rather these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 4 - (Intentionally left blank)

Table 4M - (Intentionally left blank)

Table 5 - Dimensions of Western red cedar[1)] and Ponderosa pine poles (Fiber Strength 6000 psi)

Class		**H6**	**H5**	**H4**	**H3**	**H2**	**H1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (in)		**39**	**37**	**35**	**33**	**31**	**29**	**27**	**25**	**23**	**21**	**19**	**17**	**15**	**15**	**12**
Length of pole (ft)	**Approximate Groundline[2)] distance from butt** (ft)	**Minimum circumference at 6 ft from butt** (in)														
20	4	-	-	-	-	-	-	33.5	31.5	29.5	27.0	25.0	**23.0**	**21.5**	**18.5**	**15.0**
25	5	-	-	-	-	-	-	37.0	34.5	32.5	30.0	28.0	**25.5**	**24.0**	**20.5**	**16.5**
30	5.5	-	-	-	-	-	-	40.0	**37.5**	**35.0**	**32.5**	**30.0**	**28.0**	**26.0**	**22.0**	-
35	6	-	-	-	-	**48.0**	**45.5**	42.5	**40.0**	**37.5**	**34.5**	**32.0**	**30.0**	**27.5**	-	-
40	6	-	-	**56.5**	**53.5**	**51.0**	**48.0**	**45.0**	**42.5**	**39.5**	**36.5**	**34.0**	**31.5**	-	-	-
45	6.5	**64.5**	**62.0**	**59.0**	**56.0**	**53.5**	**50.0**	**47.5**	**44.5**	**41.5**	**38.5**	**36.0**	33.0	-	-	-
50	7	**67.0**	**64.5**	**61.5**	**58.5**	**55.5**	**52.5**	**49.5**	**46.5**	**43.5**	40.0	37.5	-	-	-	-
55	7.5	**70.0**	**67.0**	**64.0**	**61.0**	**57.5**	**54.5**	**51.5**	**48.5**	**45.0**	42.0	-	-	-	-	-
60	8	**72.0**	**69.0**	**66.0**	**63.0**	**59.5**	**56.5**	**53.5**	**50.0**	**46.5**	43.5	-	-	-	-	-
65	8.5	**74.5**	**71.5**	**68.0**	**65.0**	**61.5**	**58.5**	**55.0**	**51.5**	**48.0**	45.0	-	-	-	-	-
70	9	**76.5**	**73.5**	**70.0**	**67.0**	**63.5**	**60.0**	**56.5**	**53.0**	**49.5**	46.0	-	-	-	-	-
75	9.5	**78.5**	**75.5**	**72.0**	**68.5**	**65.0**	**61.5**	**58.0**	**54.5**	**51.0**	-	-	-	-	-	-
80	10	**80.5**	**77.0**	**74.0**	**70.5**	**67.0**	**63.0**	**59.5**	**56.0**	52.0	-	-	-	-	-	-
85	10.5	**82.5**	**79.0**	**75.5**	**72.0**	**68.5**	**64.5**	**61.0**	**57.0**	53.5	-	-	-	-	-	-
90	11	**84.5**	**81.0**	**77.0**	**73.5**	**70.0**	**66.0**	**62.5**	**58.5**	54.5	-	-	-	-	-	-
95	11	**86.0**	**82.5**	**79.0**	**75.0**	**71.5**	**67.5**	**63.5**	**59.5**	-	-	-	-	-	-	-
100	11	**87.5**	**84.0**	**80.5**	**76.5**	**72.5**	**69.0**	**65.0**	**61.0**	-	-	-	-	-	-	-
105	12	**89.5**	**85.5**	**82.0**	**78.0**	**74.0**	**70.0**	**66.0**	**62.0**	-	-	-	-	-	-	-
110	12	**91.0**	**87.0**	**83.5**	**79.5**	**75.5**	**71.5**	**67.5**	**63.0**	-	-	-	-	-	-	-
115	12	**92.5**	**88.5**	**84.5**	**80.5**	**76.5**	**72.5**	**68.5**	**64.0**	-	-	-	-	-	-	-
120	12	**94.0**	**90.0**	**86.0**	**82.0**	**78.0**	**74.0**	**69.5**	**65.0**	-	-	-	-	-	-	-
125	12	**95.5**	**91.5**	**87.5**	**83.0**	**79.0**	**75.0**	**70.5**	**66.0**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

1) Dimensions of H Classes are applicable for western red cedar only.

2) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 5M - Metric dimensions of Western red cedar[1)] and Ponderosa pine poles (Fiber Strength 41.4 MPa)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (m)		**0.99**	**0.94**	**0.89**	**0.84**	**0.79**	**0.74**	**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	**Approximate Groundline[2)] distance from butt** (m)	**Minimum circumference at 1.8m from the butt** (m)														
6.1	1.2	-	-	-	-	-	-	0.85	0.80	0.75	0.69	0.64	**0.58**	**0.55**	**0.47**	**0.38**
7.6	1.5	-	-	-	-	-	-	0.94	0.88	0.83	0.76	0.71	**0.65**	**0.61**	**0.52**	**0.42**
9.1	1.7	-	-	-	-	-	-	1.02	**0.95**	**0.89**	**0.83**	**0.76**	**0.71**	**0.66**	**0.56**	-
10.7	1.7	-	-	-	-	**1.22**	**1.16**	1.08	**1.02**	**0.95**	**0.88**	**0.81**	**0.76**	**0.70**	-	-
12.2	1.8	-	-	**1.44**	**1.36**	**1.30**	**1.22**	**1.14**	**1.08**	**1.00**	**0.93**	**0.86**	**0.80**	-	-	-
13.7	2.0	**1.64**	**1.57**	**1.50**	**1.42**	**136**	**1.28**	**1.21**	**1.13**	**1.05**	**0.98**	**0.91**	0.84	-	-	-
15.2	2.1	**1.70**	**1.64**	**1.56**	**1.49**	**1.41**	**1.33**	**1.26**	**1.18**	**1.10**	1.02	0.95	-	-	-	-
16.8	2.3	**1.78**	**1.70**	**1.63**	**1.55**	**1.46**	**1.38**	**1.31**	**1.23**	**1.14**	1.07	-	-	-	-	-
18.3	2.4	**1.83**	**1.75**	**1.68**	**1.60**	**1.51**	**1.44**	**1.36**	**1.27**	**1.18**	1.10	-	-	-	-	-
19.8	2.6	**1.89**	**1.82**	**1.73**	**1.65**	**1.56**	**1.49**	**1.40**	**1.31**	**1.22**	1.14	-	-	-	-	-
21.3	2.7	**1.94**	**1.87**	**1.78**	**1.70**	**1.61**	**1.52**	**1.44**	**1.35**	**1.26**	1.17	-	-	-	-	-
22.9	2.9	**1.99**	**1.92**	**1.83**	**1.74**	**1.65**	**1.56**	**1.47**	**1.38**	**1.30**	-	-	-	-	-	-
24.4	3.1	**2.04**	**1.96**	**1.88**	**1.79**	**1.70**	**1.60**	**1.51**	**1.42**	1.32	-	-	-	-	-	-
25.9	3.2	**2.10**	**2.01**	**1.92**	**1.83**	**1.74**	**1.64**	**1.55**	**1.45**	1.36	-	-	-	-	-	-
27.4	3.4	**2.15**	**2.06**	**1.96**	**1.87**	**1.78**	**1.68**	**1.59**	**1.49**	1.38	-	-	-	-	-	-
29.0	3.4	**2.18**	**2.10**	**2.01**	**1.91**	**1.82**	**1.71**	**1.61**	**1.51**	-	-	-	-	-	-	-
30.5	3.4	**2.22**	**2.13**	**2.04**	**1.94**	**1.84**	**1.75**	**1.65**	**1.55**	-	-	-	-	-	-	-
32.0	3.7	**2.27**	**2.17**	**2.08**	**1.98**	**1.88**	**1.78**	**1.68**	**1.57**	-	-	-	-	-	-	-
33.5	3.7	**2.31**	**2.21**	**2.12**	**2.02**	**1.92**	**1.82**	**1.71**	**1.60**	-	-	-	-	-	-	-
35.1	3.7	**2.35**	**2.25**	**2.15**	**2.04**	**1.94**	**1.84**	**1.74**	**1.63**	-	-	-	-	-	-	-
36.6	3.7	**2.39**	**2.29**	**2.18**	**2.08**	**1.98**	**1.88**	**1.77**	**1.65**	-	-	-	-	-	-	-
38.1	3.7	**2.43**	**2.32**	**2.22**	**2.11**	**2.01**	**1.91**	**1.79**	**1.68**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

1) Dimensions of H Classes are applicable for western red cedar only.

2) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 6 - Dimensions of Jack pine, Lodgepole pine, Red pine, Western fir, and Radiata pine[2] (Fiber Strength 6600 psi)

Class		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (in)		**27**	**25**	**23**	**21**	**19**	**17**	**15**	**15**	**12**
Length of pole (ft)	**Approximate Groundline[1] distance from butt** (ft)	**Minimum circumference at 6 ft from butt** (in)								
20	4	32.5	30.5	28.5	26.5	24.5	**22.5**	**21.0**	**18.0**	**14.5**
25	5	36.0	33.5	31.0	29.0	27.0	**25.0**	**23.0**	**20.0**	**15.5**
30	5.5	39.0	**36.5**	**34.0**	**31.5**	**29.0**	**27.0**	**25.0**	**21.0**	-
35	6	41.5	**38.5**	**36.0**	**33.5**	**31.0**	**28.5**	**26.5**	-	-
40	6	**44.0**	**41.0**	**38.0**	**35.5**	**33.0**	**30.5**	-	-	-
45	6.5	**46.0**	**43.0**	**40.0**	**37.0**	**34.5**	32.0	-	-	-
50	7	**48.0**	**45.0**	**42.0**	39.0	36.0	-	-	-	-
55	7.5	**49.5**	**46.5**	**43.5**	40.5	-	-	-	-	-
60	8	**51.5**	**48.0**	**45.0**	42.0	-	-	-	-	-
65	8.5	**53.0**	**49.5**	**46.0**	43.0	-	-	-	-	-
70	9	**54.5**	**51.0**	**47.5**	44.5	-	-	-	-	-
75	9.5	**56.0**	**52.5**	**49.0**	-	-	-	-	-	-
80	10	**57.5**	**54.0**	50.5	-	-	-	-	-	-
85	10.5	**58.5**	**55.0**	51.5	-	-	-	-	-	-
90	11	**60.0**	**56.5**	52.5	-	-	-	-	-	-
95	11	**61.5**	**57.5**	-	-	-	-	-	-	-
100	11	**62.5**	**58.5**	-	-	-	-	-	-	-
105	12	**63.5**	**60.0**	-	-	-	-	-	-	-
110	12	**65.0**	**61.0**	-	-	-	-	-	-	-
115	12	**66.0**	**62.0**	-	-	-	-	-	-	-
120	12	**67.0**	**63.0**	-	-	-	-	-	-	-
125	12	**68.0**	**64.0**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

[2] Radiata pine includes only material produced in Chile between south 33° and south 40° latitude, is limited to no more than 45 feet in length, and limited to pole class sizes 4-10.

Table 6M - Metric dimensions of Jack pine, Lodgepole, Red pine, Western fir, and Radiata pine [2] (Fiber Strength 45.5 MPa)

Class		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (m)		**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	**Approximate Groundline[1] distance from butt** (m)	**Minimum circumference at 1.8 m from butt** (m)								
6.1	1.2	0.83	0.77	0.72	0.67	0.62	**0.57**	**0.53**	**0.46**	**0.37**
7.6	1.5	0.91	0.85	0.79	0.74	0.69	**0.64**	**0.58**	**0.51**	**0.39**
9.1	1.7	0.99	**0.93**	**0.86**	**0.80**	**0.74**	**0.69**	**0.64**	**0.53**	-
10.7	1.7	1.05	**0.98**	**0.91**	**0.85**	**0.79**	**0.72**	**0.67**	-	-
12.2	1.8	**1.12**	**1.04**	**0.97**	**0.90**	**0.84**	**0.77**	-	-	-
13.7	2.0	**1.17**	**1.09**	**1.02**	**0.94**	**0.88**	0.81	-	-	-
15.2	2.1	**1.22**	**1.14**	**1.07**	0.99	0.91	-	-	-	-
16.8	2.3	**1.26**	**1.18**	**1.10**	1.03	-	-	-	-	-
18.3	2.4	**1.31**	**1.22**	**1.14**	1.07	-	-	-	-	-
19.8	2.6	**1.35**	**1.26**	**1.17**	1.09	-	-	-	-	-
21.3	2.7	**1.38**	**1.30**	**1.21**	1.13	-	-	-	-	-
22.9	2.9	**1.42**	**1.33**	**1.24**	-	-	-	-	-	-
24.4	3.1	**1.46**	**1.37**	1.28	-	-	-	-	-	-
25.9	3.2	**1.49**	**1.40**	1.31	-	-	-	-	-	-
27.4	3.4	**1.52**	**1.44**	1.33	-	-	-	-	-	-
29.0	3.4	**1.56**	**1.46**	-	-	-	-	-	-	-
30.5	3.4	**1.59**	**1.49**	-	-	-	-	-	-	-
32.0	3.7	**1.61**	**1.52**	-	-	-	-	-	-	-
33.5	3.7	**1.65**	**1.55**	-	-	-	-	-	-	-
35.1	3.7	**1.68**	**1.57**	-	-	-	-	-	-	-
36.6	3.7	**1.70**	**1.60**	-	-	-	-	-	-	-
38.1	3.7	**1.73**	**1.63**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

[2] Radiata pine includes only material produced in Chile between south 33° and south 40° latitude, is limited to no more than 13.7m in length, and limited to pole class sizes 4-10.

Table 7 - Dimensions of Alaska yellow cedar poles (Fiber Strength 7400 psi)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (in)		39	37	35	33	31	29	27	25	23	21	19	17	15	15	12
Length of pole (ft)	Approximate Groundline[1)] distance from butt (ft)	Minimum circumference at 6 ft from butt (in)														
20	4	-	-	-	-	-	-	31.5	29.5	27.5	25.5	23.5	22.0	20.0	17.5	14.0
25	5	-	-	-	-	-	-	34.5	32.5	30.0	28.0	26.0	24.0	22.0	19.5	15.0
30	5.5	-	-	-	-	-	-	37.5	35.0	32.5	30.0	28.0	26.0	24.0	20.5	-
35	6	-	-	-	-	**45.0**	**42.5**	40.0	37.5	35.0	32.0	30.0	27.5	25.5	-	-
40	6	-	-	**52.5**	**50.0**	**47.5**	**45.0**	42.0	39.5	37.0	34.0	31.5	29.0	25.5	-	-
45	6.5	**60.0**	**57.5**	**55.0**	**52.5**	**49.5**	**47.0**	44.0	41.5	38.5	36.0	33.0	30.5	-	-	-
50	7	**62.5**	**60.0**	**57.0**	**54.5**	**51.5**	**49.0**	46.0	43.0	40.0	37.5	34.5	-	-	-	-
55	7.5	**65.0**	**62.0**	**59.5**	**56.5**	**53.5**	**50.5**	47.5	44.5	41.5	39.0	-	-	-	-	-
60	8	**67.0**	**64.0**	**61.5**	**58.5**	**55.5**	**52.5**	49.5	46.0	43.0	40.0	-	-	-	-	-
65	8.5	**69.0**	**66.0**	**63.0**	**60.0**	**57.0**	**54.0**	51.0	47.5	44.5	41.5	-	-	-	-	-
70	9	**71.0**	**68.0**	**65.0**	**62.0**	**58.5**	**55.5**	52.5	49.0	46.0	42.5	-	-	-	-	-
75	9.5	**73.0**	**69.5**	**66.5**	**63.5**	**60.0**	**57.0**	53.5	50.5	47.0	-	-	-	-	-	-
80	10	**74.5**	**71.5**	**68.0**	**65.0**	**61.5**	**58.5**	55.0	51.5	48.5	-	-	-	-	-	-
85	10.5	**76.0**	**73.0**	**70.0**	**66.5**	**63.0**	**59.5**	56.0	53.0	49.5	-	-	-	-	-	-
90	11	**78.0**	**74.5**	**71.0**	**68.0**	**64.5**	**61.0**	57.5	54.0	50.5	-	-	-	-	-	-
95	11	**79.5**	**76.0**	**72.5**	**69.5**	**66.0**	**62.0**	58.5	55.0	-	-	-	-	-	-	-
100	11	**81.0**	**77.5**	**74.0**	**70.5**	**67.0**	**63.5**	60.0	56.0	-	-	-	-	-	-	-
105	12	**82.5**	**79.0**	**75.5**	**72.0**	**68.5**	**64.5**	61.0	57.0	-	-	-	-	-	-	-
110	12	**84.0**	**80.5**	**77.0**	**73.0**	**69.5**	**65.5**	62.0	58.0	-	-	-	-	-	-	-
115	12	**85.5**	**81.5**	**78.0**	**74.5**	**70.5**	**67.0**	63.0	59.0	-	-	-	-	-	-	-
120	12	**86.5**	**83.0**	**79.5**	**75.5**	**72.0**	**68.0**	64.0	60.0	-	-	-	-	-	-	-
125	12	**88.0**	**84.5**	**80.5**	**76.5**	**73.0**	**69.0**	65.0	61.0	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1)] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 7M - Metric dimensions of Alaska yellow cedar poles (Fiber Strength 51.0 MPa)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (m)		**0.99**	**0.94**	**0.89**	**0.84**	**0.79**	**0.74**	**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	Approximate Groundline[1)] distance from butt (m)	Minimum circumference at 1.8 m from butt (m)														
6.1	1.2	-	-	-	-	-	-	0.80	0.75	0.70	0.65	0.60	0.56	0.51	0.44	0.36
7.6	1.5	-	-	-	-	-	-	0.88	0.83	0.76	0.71	0.66	0.61	0.56	0.50	0.38
9.1	1.7	-	-	-	-	-	-	0.95	0.89	0.83	0.76	0.71	0.66	0.61	0.52	-
10.7	1.7	-	-	-	-	**1.14**	**1.08**	1.02	0.95	0.89	0.81	0.76	0.70	0.65	-	-
12.2	1.8	-	-	**1.33**	**1.27**	**1.21**	**1.14**	1.07	1.00	0.94	0.86	0.80	0.74	0.65	-	-
13.7	2.0	**1.52**	**1.46**	**1.40**	**1.33**	**1.26**	**1.19**	1.12	1.05	0.98	0.91	0.84	0.77	-	-	-
15.2	2.1	**1.59**	**1.52**	**1.45**	**1.38**	**1.31**	**1.24**	1.17	1.09	1.02	0.95	0.88	-	-	-	-
16.8	2.3	**1.65**	**1.57**	**1.51**	**1.44**	**1.36**	**1.28**	1.21	1.13	1.05	0.99	-	-	-	-	-
18.3	2.4	**1.70**	**1.63**	**1.56**	**1.49**	**1.41**	**1.33**	1.26	1.17	1.09	1.02	-	-	-	-	-
19.9	2.6	**1.75**	**1.68**	**1.60**	**1.52**	**1.45**	**1.37**	1.30	121	1.13	1.05	-	-	-	-	-
21.3	2.7	**1.80**	**1.73**	**1.65**	**1.57**	**1.49**	**1.41**	1.33	1.24	1.17	1.08	-	-	-	-	-
22.9	2.9	**1.85**	**1.77**	**1.69**	**1.61**	**1.52**	**1.45**	1.36	1.28	1.19	-	-	-	-	-	-
24.4	3.1	**1.89**	**1.82**	**1.73**	**1.65**	**1.56**	**1.49**	1.40	1.31	1.23	-	-	-	-	-	-
25.9	3.2	**1.93**	**1.85**	**1.78**	**1.69**	**1.60**	**1.51**	1.42	1.35	1.26	-	-	-	-	-	-
27.4	3.4	**1.98**	**1.89**	**1.80**	**1.73**	**1.64**	**1.55**	1.46	1.37	1.28	-	-	-	-	-	-
29.0	3.4	**2.02**	**1.93**	**1.84**	**1.77**	**1.68**	**1.57**	1.49	1.40	-	-	-	-	-	-	-
30.5	3.4	**2.06**	**1.97**	**1.88**	**1.79**	**1.70**	**1.61**	1.52	1.42	-	-	-	-	-	-	-
32.0	3.7	**2.10**	**2.01**	**1.92**	**1.83**	**1.74**	**1.64**	1.55	1.45	-	-	-	-	-	-	-
33.5	3.7	**2.13**	**2.04**	**1.96**	**1.85**	**1.77**	**1.66**	1.57	1.47	-	-	-	-	-	-	-
35.1	3.7	**2.17**	**2.07**	**1.98**	**1.89**	**1.79**	**1.70**	1.60	1.50	-	-	-	-	-	-	-
36.6	3.7	**2.20**	**2.11**	**2.02**	**1.92**	**1.83**	**1.73**	1.63	1.52	-	-	-	-	-	-	-
38.1	3.7	**2.24**	**2.15**	**2.04**	**1.94**	**1.85**	**1.75**	1.65	1.55	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

1) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc

Table 8 - Dimensions of Douglas-fir (both types) and Southern pine poles (Fiber Strength 8000 psi)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (in)		**39**	**37**	**35**	**33**	**31**	**29**	**27**	**25**	**23**	**21**	**19**	**17**	**15**	**15**	**12**
Length of pole (ft)	**Approximate Groundline[1)] distance from butt** (ft)	**Minimum circumference at 6 ft from butt** (in)														
20	4	-	-	-	-	-	-	31.0	29.0	27.0	25.0	23.0	**21.0**	**19.5**	**17.5**	**14.0**
25	5	-	-	-	-	-	-	33.5	31.5	29.5	27.5	25.5	**23.0**	**21.5**	**19.5**	**15.0**
30	5.5	-	-	-	-	-	-	36.5	**34.0**	**32.0**	**29.5**	**27.5**	**25.0**	**23.5**	**20.5**	-
35	6	-	-	-	-	**43.5**	**41.5**	39.0	**36.5**	**34.0**	**31.5**	**29.0**	**27.0**	**25.0**	-	-
40	6	-	-	**51.0**	**48.5**	**46.0**	**43.5**	**41.0**	**38.5**	**36.0**	**33.5**	**31.0**	**28.5**	-	-	-
45	6.5	**58.5**	**56.0**	**53.5**	**51.0**	**48.5**	**45.5**	**43.0**	**40.5**	**37.5**	**35.0**	**32.5**	30.0	-	-	-
50	7	**61.0**	**58.5**	**55.5**	**53.0**	**50.5**	**47.5**	**45.0**	**42.0**	**39.0**	36.5	34.0	-	-	-	-
55	7.5	**63.5**	**60.5**	**58.0**	**55.0**	**52.0**	**49.5**	**46.5**	**43.5**	**40.5**	38.0	-	-	-	-	-
60	8	**65.5**	**62.5**	**59.5**	**57.0**	**54.0**	**51.0**	**48.0**	**45.0**	**42.0**	39.0	-	-	-	-	-
65	8.5	**67.5**	**64.5**	**61.5**	**58.5**	**55.5**	**52.5**	**49.5**	**46.5**	**43.5**	40.5	-	-	-	-	-
70	9	**69.0**	**66.5**	**63.5**	**60.5**	**57.0**	**54.0**	**51.0**	**48.0**	**45.0**	41.5	-	-	-	-	-
75	9.5	**71.0**	**68.0**	**65.0**	**62.0**	**59.0**	**55.5**	**52.5**	**49.0**	**46.0**	-	-	-	-	-	-
80	10	**72.5**	**69.5**	**66.5**	**63.5**	**60.0**	**57.0**	**54.0**	**50.5**	47.0	-	-	-	-	-	-
85	10.5	**74.5**	**71.5**	**68.0**	**65.0**	**61.5**	**58.5**	**55.0**	**51.5**	48.0	-	-	-	-	-	-
90	11	**76.0**	**73.0**	**69.5**	**66.5**	**63.0**	**59.5**	**56.0**	**53.0**	49.0	-	-	-	-	-	-
95	11	**77.5**	**74.5**	**71.0**	**67.5**	**64.5**	**61.0**	**57.0**	**54.0**	-	-	-	-	-	-	-
100	11	**79.0**	**76.0**	**72.5**	**69.0**	**65.5**	**62.0**	**58.5**	**55.0**	-	-	-	-	-	-	-
105	12	**80.5**	**77.0**	**74.0**	**70.5**	**67.0**	**63.0**	**59.5**	**56.0**	-	-	-	-	-	-	-
110	12	**82.0**	**78.5**	**75.0**	**71.5**	**68.0**	**64.5**	**60.5**	**57.0**	-	-	-	-	-	-	-
115	12	**83.5**	**80.0**	**76.5**	**72.5**	**69.0**	**65.5**	**61.5**	**58.0**	-	-	-	-	-	-	-
120	12	**85.0**	**81.0**	**77.5**	**74.0**	**70.0**	**66.5**	**62.5**	**59.0**	-	-	-	-	-	-	-
125	12	**86.0**	**82.5**	**78.5**	**75.0**	**71.0**	**67.5**	**63.5**	**59.5**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1)] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 8M - Metric dimensions of Douglas-fir (both types) and Southern pine poles (Fiber Strength 55.2 MPa)

Class		**H6**	**H5**	**H4**	**H3**	**H2**	**H1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (m)		**0.99**	**0.94**	**0.89**	**0.84**	**0.79**	**0.74**	**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	**Approximate Groundline[1] distance from butt** (m)	**Minimum circumference at 1.8 m from butt** (m)														
6.1	1.2	-	-	-	-	-	-	0.79	0.74	0.69	0.64	0.58	**0.53**	**0.50**	**0.44**	**0.36**
7.6	1.5	-	-	-	-	-	-	0.85	0.80	0.75	0.70	0.65	**0.58**	**0.55**	**0.50**	**0.38**
9.1	1.7	-	-	-	-	-	-	0.93	**0.86**	**0.81**	**0.75**	**0.70**	**0.64**	**0.60**	**0.52**	-
10.7	1.7	-	-	-	-	**1.10**	**1.05**	0.99	**0.93**	**0.86**	**0.80**	**0.74**	**0.69**	**0.64**	-	-
12.2	1.8	-	-	**1.30**	**1.23**	**1.17**	**1.10**	**1.04**	**0.98**	**0.91**	**0.85**	**0.79**	**0.72**	-	-	-
13.7	2.0	**1.49**	**1.42**	**1.36**	**1.30**	**1.23**	**1.16**	**1.09**	**1.03**	**0.95**	**0.89**	**0.83**	0.76	-	-	-
15.2	2.1	**1.55**	**1.49**	**1.41**	**1.35**	**1.28**	**1.21**	**1.14**	**1.07**	**0.99**	0.93	0.86	-	-	-	-
16.8	2.3	**1.61**	**1.54**	**1.47**	**1.40**	**1.32**	**1.26**	**1.18**	**1.10**	**1.03**	0.97	-	-	-	-	-
18.3	2.4	**1.66**	**1.59**	**1.51**	**1.45**	**1.37**	**1.30**	**1.22**	**1.14**	**1.07**	0.99	-	-	-	-	-
19.8	2.6	**1.71**	**1.64**	**1.56**	**1.49**	**1.41**	**1.33**	**1.26**	**1.18**	**1.10**	1.03	-	-	-	-	-
21.3	2.7	**1.75**	**1.69**	**1.61**	**1.54**	**1.45**	**1.37**	**1.30**	**1.22**	**1.14**	1.05	-	-	-	-	-
22.9	2.9	**1.80**	**1.73**	**1.65**	**1.57**	**1.50**	**1.41**	**1.33**	**1.24**	**1.17**	-	-	-	-	-	-
24.4	3.1	**1.84**	**1.77**	**1.69**	**1.61**	**1.52**	**1.45**	**1.37**	**1.28**	1.19	-	-	-	-	-	-
25.9	3.2	**1.89**	**1.82**	**1.73**	**1.65**	**1.56**	**1.49**	**1.40**	**1.31**	1.22	-	-	-	-	-	-
27.4	3.4	**1.93**	**1.85**	**1.77**	**1.69**	**1.60**	**1.51**	**1.42**	**1.35**	1.24	-	-	-	-	-	-
29.0	3.4	**1.97**	**1.89**	**1.80**	**1.71**	**1.64**	**1.55**	**1.45**	**1.37**	-	-	-	-	-	-	-
30.5	3.4	**2.01**	**1.93**	**1.84**	**1.75**	**1.66**	**1.57**	**1.49**	**1.40**	-	-	-	-	-	-	-
32.0	3.7	**2.04**	**1.96**	**1.88**	**1.79**	**1.70**	**1.60**	**1.51**	**1.42**	-	-	-	-	-	-	-
33.5	3.7	**2.08**	**1.99**	**1.91**	**1.82**	**1.73**	**1.64**	**1.54**	**1.45**	-	-	-	-	-	-	-
35.1	3.7	**2.12**	**2.03**	**1.94**	**1.84**	**1.75**	**1.66**	**1.56**	**1.47**	-	-	-	-	-	-	-
36.6	3.7	**2.16**	**2.06**	**1.97**	**1.88**	**1.78**	**1.69**	**1.59**	**1.50**	-	-	-	-	-	-	-
38.1	3.7	**2.18**	**2.10**	**1.99**	**1.91**	**1.80**	**1.71**	**1.61**	**1.51**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 9 - Dimensions of Western larch poles (Fiber Strength 8400 psi)

Class		H6	H5	H4	H3	H2	H1	1	2	3	4	5	6	7	9	10
Minimum circumference at top (in)		39	37	35	33	31	29	27	25	23	21	19	17	15	15	12
Length of pole (ft)	Approximate Groundline[1] distance from butt (ft)	Minimum circumference at 6 ft from butt (in)														
20	4	-	-	-	-	-	-	30.0	28.5	26.5	24.5	22.5	**21.0**	**19.0**	**17.0**	**13.5**
25	5	-	-	-	-	-	-	33.0	31.0	29.0	26.5	24.5	**23.0**	**21.0**	**18.5**	**14.5**
30	5.5	-	-	-	-	-	-	35.5	**33.5**	**31.0**	**29.0**	**26.5**	**24.5**	**23.0**	**19.5**	-
35	6	-	-	-	-	**43.0**	**40.5**	38.0	**35.5**	**33.0**	**31.0**	**28.5**	**26.5**	**24.5**	-	-
40	6	-	-	**50.5**	**48.0**	**45.5**	**43.0**	**40.0**	**37.5**	**35.0**	**32.5**	**30.0**	**28.0**	-	-	-
45	6.5	**57.5**	**55.0**	**52.5**	**50.0**	**47.5**	**45.0**	**42.0**	**39.5**	**37.0**	**34.0**	**31.5**	**29.0**	-	-	-
50	7	**60.0**	**57.5**	**55.0**	**52.0**	**49.5**	**47.0**	**44.0**	**41.0**	**38.5**	35.5	33.0	-	-	-	-
55	7.5	**62.0**	**59.5**	**57.0**	**54.0**	**51.5**	**48.5**	**45.5**	**42.5**	**40.0**	37.0	-	-	-	-	-
60	8	**64.5**	**61.5**	**59.0**	**56.0**	**53.0**	**50.0**	**47.0**	**44.0**	**41.0**	38.5	-	-	-	-	-
65	8.5	**66.0**	**63.5**	**60.5**	**57.5**	**55.0**	**52.0**	**48.5**	**46.0**	**42.5**	39.5	-	-	-	-	-
70	9	**68.0**	**65.0**	**62.5**	**59.5**	**56.5**	**53.5**	**50.0**	**47.0**	**44.0**	41.0	-	-	-	-	-
75	9.5	**70.0**	**67.0**	**64.0**	**61.0**	**58.0**	**54.5**	**51.5**	**48.0**	**45.0**	-	-	-	-	-	-
80	10	**71.5**	**68.5**	**65.5**	**62.5**	**59.0**	**56.0**	**52.5**	**49.5**	46.0	-	-	-	-	-	-
85	10.5	**73.0**	**70.0**	**67.0**	**64.0**	**60.5**	**57.5**	**54.0**	**50.5**	47.0	-	-	-	-	-	-
90	11	**74.5**	**71.5**	**68.5**	**65.0**	**62.0**	**58.5**	**55.0**	**51.5**	48.5	-	-	-	-	-	-
95	11	**76.5**	**73.0**	**70.0**	**66.5**	**63.0**	**60.0**	**56.5**	**53.0**	-	-	-	-	-	-	-
100	11	**78.0**	**74.5**	**71.0**	**68.0**	**64.5**	**61.0**	**57.5**	**54.0**	-	-	-	-	-	-	-
105	12	**79.0**	**76.0**	**72.5**	**69.0**	**65.5**	**62.0**	**58.5**	**55.0**	-	-	-	-	-	-	-
110	12	**80.5**	**77.0**	**73.5**	**70.0**	**66.5**	**63.0**	**59.5**	**56.0**	-	-	-	-	-	-	-
115	12	**82.0**	**78.5**	**75.0**	**71.5**	**68.0**	**64.0**	**60.5**	**57.0**	-	-	-	-	-	-	-
120	12	**83.0**	**79.5**	**76.0**	**72.5**	**69.0**	**65.0**	**61.5**	**58.0**	-	-	-	-	-	-	-
125	12	**84.5**	**81.0**	**77.5**	**73.5**	**70.0**	**66.0**	**62.5**	**58.5**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 6 feet from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

[1] The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 9M - Metric dimensions of Western larch poles (Fiber Strength 57.9 MPa)

Class		**H6**	**H5**	**H4**	**H3**	**H2**	**H1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**
Minimum circumference at top (m)		**0.99**	**0.94**	**0.89**	**0.84**	**0.79**	**0.74**	**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**	**0.38**	**0.30**
Length of pole (m)	**Approximate Groundline[1)] distance from butt** (m)	**Minimum circumference at 1.8 m from butt** (m)														
6.1	1.2	-	-	-	-	-	-	0.76	0.72	0.67	0.62	0.57	**0.53**	**0.48**	**0.43**	**0.34**
7.6	1.5	-	-	-	-	-	-	0.84	0.79	0.74	0.67	0.62	**0.58**	**0.53**	**0.47**	**0.37**
9.1	1.7	-	-	-	-	-	-	0.90	**0.85**	**0.79**	**0.74**	**0.67**	**0.62**	**0.58**	**0.50**	-
10.7	1.7	-	-	-	-	**1.09**	**1.03**	0.97	**0.90**	**0.84**	**0.79**	**0.72**	**0.67**	**0.62**	-	-
12.2	1.8	-	-	**1.28**	**1.22**	**1.16**	**1.09**	**1.02**	**0.95**	**0.89**	**0.83**	**0.76**	**0.71**	-	-	-
13.7	2.0	**1.46**	**1.40**	**1.33**	**1.27**	**1.21**	**1.14**	**1.07**	**1.00**	**0.94**	**0.86**	**0.80**	**0.74**	-	-	-
15.2	2.1	**1.52**	**1.46**	**1.40**	**1.32**	**1.26**	**1.19**	**1.12**	**1.04**	**0.98**	0.90	0.84	-	-	-	-
16.8	2.3	**1.57**	**1.51**	**1.45**	**1.37**	**1.31**	**1.23**	**1.16**	**1.08**	**1.02**	0.94	-	-	-	-	-
18.3	2.4	**1.64**	**1.56**	**1.50**	**1.42**	**1.35**	**1.27**	**1.19**	**1.12**	**1.04**	0.98	-	-	-	-	-
19.8	2.6	**1.68**	**1.61**	**1.54**	**1.46**	**1.40**	**1.32**	**1.23**	**1.17**	**1.08**	1.00	-	-	-	-	-
21.3	2.7	**1.73**	**1.65**	**1.59**	**1.51**	**1.44**	**1.36**	**1.27**	**1.19**	**1.12**	1.04	-	-	-	-	-
22.9	2.9	**1.78**	**1.70**	**1.63**	**1.55**	**1.47**	**1.38**	**1.31**	**1.22**	**1.14**	-	-	-	-	-	-
24.4	3.1	**1.82**	**1.74**	**1.66**	**1.59**	**1.50**	**1.42**	**1.33**	**1.26**	1.17	-	-	-	-	-	-
25.9	3.2	**1.85**	**1.78**	**1.70**	**1.63**	**1.54**	**1.46**	**1.37**	**1.28**	1.19	-	-	-	-	-	-
27.4	3.4	**1.89**	**1.82**	**1.74**	**1.65**	**1.57**	**1.49**	**1.40**	**1.31**	1.23	-	-	-	-	-	-
29.0	3.4	**1.94**	**1.85**	**1.78**	**1.69**	**1.60**	**1.52**	**1.44**	**1.35**	-	-	-	-	-	-	-
30.5	3.4	**1.98**	**1.89**	**1.80**	**1.73**	**1.64**	**1.55**	**1.46**	**1.37**	-	-	-	-	-	-	-
32.0	3.7	**2.01**	**1.93**	**1.84**	**1.75**	**1.66**	**1.57**	**1.49**	**1.40**	-	-	-	-	-	-	-
33.5	3.7	**2.04**	**1.96**	**1.87**	**1.78**	**1.69**	**1.60**	**1.51**	**1.42**	-	-	-	-	-	-	-
35.1	3.7	**2.08**	**1.99**	**1.91**	**1.82**	**1.73**	**1.63**	**1.54**	**1.45**	-	-	-	-	-	-	-
36.6	3.7	**2.11**	**2.02**	**1.93**	**1.84**	**1.75**	**1.65**	**1.56**	**1.47**	-	-	-	-	-	-	-
38.1	3.7	**2.15**	**2.06**	**1.97**	**1.87**	**1.78**	**1.68**	**1.59**	**1.49**	-	-	-	-	-	-	-

NOTE – Classes and lengths for which circumferences at 1.8m from the butt are listed in boldface type are the preferred standard sizes. Those shown in light type are included for engineering purposes only.

1) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 10 - Dimensions of Scots pine (Scandinavian) poles[1) 2)] (Fiber Strength 7800 psi)

Class		1	2	3	4	5	6	7
Minimum circumference at top (in)		**27**	**25**	**23**	**21**	**19**	**17**	**15**
Length of pole (ft)	**Approximate Groundline[3)] distance from butt** (ft)	**Minimum circumference at 6 ft from butt** (in)						
20	4	30.5	29.0	27.0	25.0	23.0	21.0	19.5
25	5	33.5	31.5	29.5	27.5	25.0	23.5	21.5
30	5.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5
35	6	39.0	36.5	34.0	31.5	29.0	27.0	25.0
40	6	41.0	38.5	36.0	33.5	31.0	28.5	26.5
45	6.5	43.5	40.5	38.0	35.0	32.5	30.0	28.0

NOTE -

1) Scots pine (Scandinavian) must have a minimum of 11 rings in the outer one (1) inch of wood.

2) This table pertains only to material produced in Scandinavia between north 60° and north 65° latitude. Scots pine produced in areas other than noted here must supply strength data as required in the ANSI 05.1, Annex C.

3) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

Table 10M - Metric dimensions of Scots pine (Scandinavian) poles[1) 2)] (Fiber Strength 53.8 MPa)

Class		1	2	3	4	5	6	7
Minimum circumference at top (m)		**0.69**	**0.64**	**0.58**	**0.53**	**0.48**	**0.43**	**0.38**
Length of pole (m)	**Approximate Groundline[3)] distance from butt** (m)	**Minimum circumference at 1.8 m from butt** (m)						
6.1	1.2	0.78	0.73	0.68	0.63	0.58	0.54	0.50
7.6	1.5	0.86	0.80	0.75	0.69	0.64	0.59	0.55
9.1	1.7	0.93	0.87	0.81	0.75	0.69	0.64	0.59
10.7	1.8	0.99	0.93	0.86	0.80	0.74	0.69	0.64
12.2	1.8	1.05	0.98	0.91	0.85	0.79	0.73	0.67
13.7	2.0	1.10	1.03	0.96	0.89	0.82	0.76	0.71

NOTE -

1) Scots pine (Scandinavian) must have a minimum of 11 rings in the outer 25mm of wood.

2) This table pertains only to material produced in Scandinavia between north 60° and north 65° latitude. Scots pine produced in areas other than noted here must supply strength data as required in the ANSI 05.1, Annex C.

3) The figures in this column are not recommended embedment depths; rather, these values are intended for use only when a definition of groundline is necessary in order to apply requirements relating to scars, straightness, etc.

DIAGRAM 1 - MEASUREMENT OF SWEEP IN ONE PLANE AND ONE DIRECTION

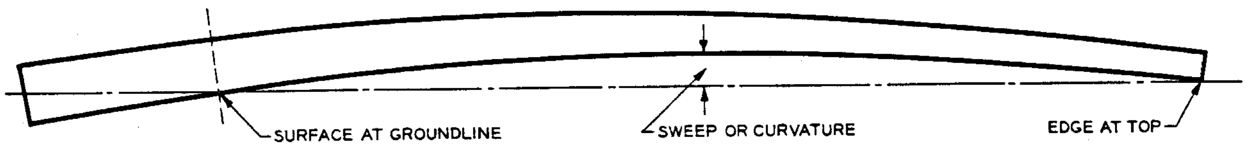


DIAGRAM 2 - MEASUREMENT OF SWEEP IN TWO PLANES (DOUBLE SWEEP) OR IN TWO DIRECTIONS IN ONE PLANE (REVERSE SWEEP)

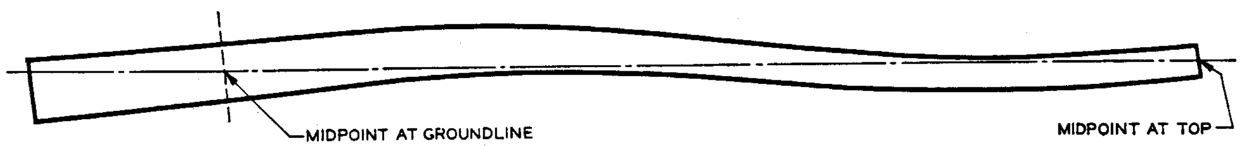
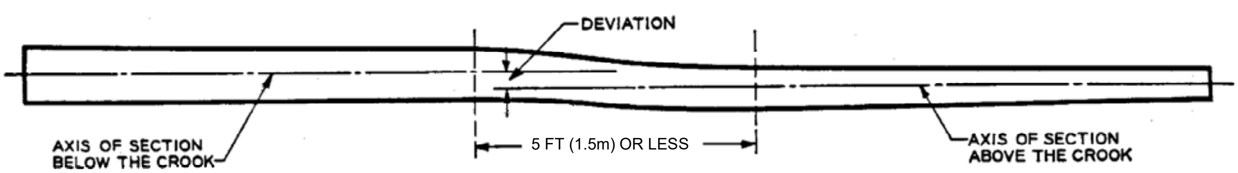
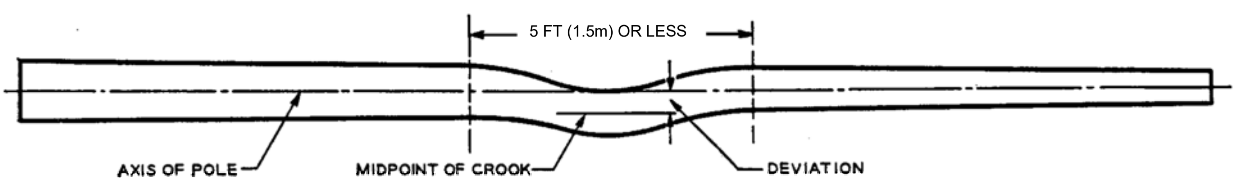


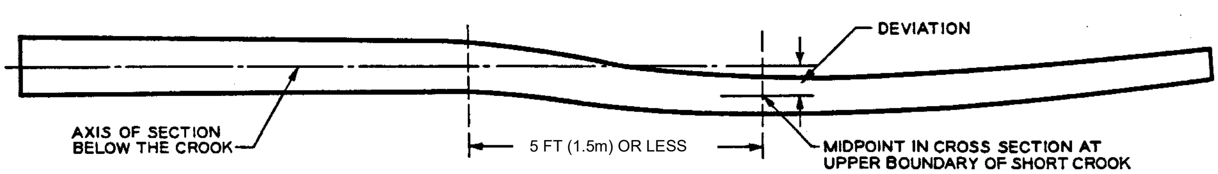
DIAGRAM 3 - MEASUREMENT OF SHORT CROOK (THREE CASES SHOWN)



CASE 1: WHERE THE REFERENCE AXES ARE APPROXIMATELY PARALLEL



CASE 2: WHERE AXES OF SECTIONS ABOVE AND BELOW THE CROOK COINCIDE OR ARE PRACTICALLY COINCIDENT



CASE 3: WHERE AXIS OF SECTION ABOVE SHORT CROOK IS NOT PARALLEL OR COINCIDENT WITH AXIS BELOW THE CROOK

NOTE - The three cases shown under Diagram 3 are typical and are intended to establish the principle of measuring short crooks. There may be other cases not exactly like those illustrated.

Figure 1 - Measurement of sweep and short crook in poles

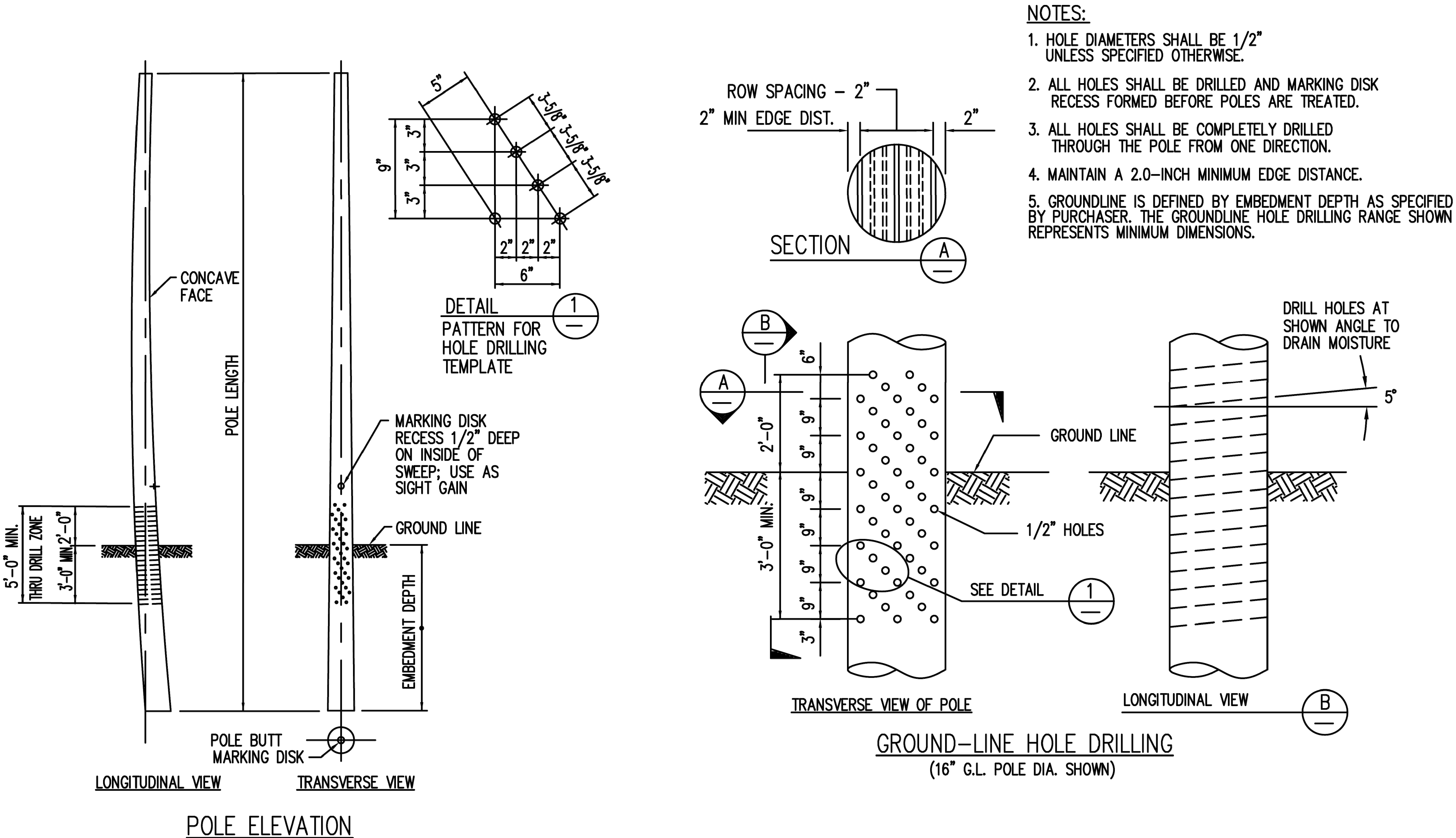


Figure 2 - Through-boring diagram showing minimum height above and depth below intended groundline

Annex A
(informative)

Annex A: Design practice

The designated fiber strengths in Table 1 may be used to estimate the average groundline moment capacity of treated poles, given the limitations discussed in this Annex. For the following species, Douglas-fir, Southern pine, and Western red cedar, the designated fiber strength represents a mean groundline fiber strength value with a corresponding coefficient of variation equal to approximately 0.20.

Round timbers are known to decrease in ultimate unit strength with height above groundline. At the same time, the actual circumference dimensions of wood poles are typically larger than the minimum requirements established in ANSI O5.1.2008 at the top and 6 feet from the butt. To validate the dimensions on current wood pole production, the industry created a database of actual circumference measurements from current production of over 22,000 poles in North America.[6] Measurements were taken for the four major pole species: Southern pine, Douglas-fir, Western red cedar, and Red pine.

The results showed that pole sizes most common for distribution applications have an average top circumference that is approximately one and one-half to two classes larger than the minimum requirement. The actual oversize of the poles, especially in the upper portion of the pole, serves to offset the fact that the fiber strength reduces with height above ground.

The theoretical point of maximum stress for a single pole with a uniform taper loaded as a simple cantilever is located where the circumference is one and a half times the circumference at the point of the applied load. For distribution poles 55 feet and shorter, the point of maximum bending stress is usually at or near the groundline and testing showed that those poles are able to support their Annex B class bending load. Guyed applications of these pole lengths may have the maximum stress point located in the upper portion of the pole; however, the circumference data showed that the oversize of the pole more than offsets the reduction in fiber strength. Therefore, the fiber stress height effect does not apply to poles that are 55 feet or shorter.

For single pole applications, 60 feet (18.3m) in length and longer, the theoretical point of maximum stress should be determined while assuming a linear taper based on minimum circumferences. When the theoretical point of maximum bending stress is at a location above the groundline, a reduction in fiber strength for height should be applied.

A.1 Poles not included in the size study

Testing showed that the actual reduction in fiber strength reaches a maximum of approximately 25% at the mid-height of a pole. In general, *for species not included in the size study*, when assuming minimum pole dimensions, the fiber strength should be reduced depending on the height above ground using Equation A.1.

Equation A.1: $$F_2 = F_1\left(1 - \frac{0.5\,H}{L}\right)$$

Where:

$\boldsymbol{F_1}$ is the tabulated fiber strength value

$\boldsymbol{F_2}$ is the calculated fiber strength value at distance *H*;

H is the distance from groundline to a point above ground where the fiber strength is F_2 (maximum value of *H* can be *L*/2); and

L is the length from groundline to the top of the pole.

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[6] The data are provided in a presentation contained in Attachment VI, Pole Dimension Data Presentation, Accredited Standards Committee (ASC) O5 Draft Meeting Minutes, April 20, 2005; available via AWPA <www.awpa.com>

A.2 Southern pine, Douglas-fir, & Western red cedar

The pole dimension data for poles 60 feet and longer for Southern pine, Douglas-fir, and Western red cedar supports a smaller net adjustment from combining the fiber strength height effect and pole oversize. This is reflected in Equation A.2. This equation accounts for the pole oversize offsetting some of the fiber strength reduction with height and results in a maximum reduction of 15% in the upper half of the pole. Since long Red pine poles are rare, no size data was developed for poles 60 feet and longer -- therefore, Equation A.1 would apply to Red pine poles 60 feet and longer.

$$\text{Equation A.2:} \qquad F_2 = F_1\left(1 - \frac{0.3\,H}{L}\right)$$

Where:

F_1 is the tabulated fiber strength value in Table 1.

F_2 is the calculated fiber strength value at distance *H*;

H is the distance from groundline to a point above ground where fiber strength is F_2 (maximum value of *H* can be *L*/2); and

L is the distance from groundline to the top of the pole.

Although Equation A.2 may be used to generally evaluate the strength of poles 60 feet and longer in the species shown, the Equation does not reflect the full potential positive benefit of the observed oversize at some pole locations, particularly in the upper portion of the poles. Tables A.1 through A.3 contain height effect factors for various locations along the pole for each of the three species that may be applied in lieu of Equation A.2 if a more precise estimate of strength is desired. These tables were prepared from the observed average dimensions. Although the dimension data suggests that height effect factors greater than 1.0 may be appropriate for some species at some locations, values larger than 1.0 should not be used in design. The calculated values greater than 1.0 are retained in the table for use in interpolation.

As an example, assume that a design for a structure composed of a 90-foot, class 1, Douglas-fir pole determines that the point of maximum stress is 18 feet above ground. Assuming a setting depth of 11 feet, the above ground pole height is 79 feet. Using Equation A.2 the value of F_2 becomes 0.93 times the Table 1 fiber strength value for this species. Alternatively a designer could use Table A.1, and interpolating between the 1/6 and 1/3 height locations yields a value of 0.95, which would be applied to the Table 1 fiber strength value, not significantly different than the Equation A.2 value.

However, for comparison purposes, assume the same pole was guyed at 15 feet from the top resulting in the point of maximum stress being at that location. In this case the Equation A.2 value would be 0.85 times the Table 1 strength value, and the value from Table A.1, interpolated between the 2/3 and 5/6 height locations would be 1.048, resulting in a recommended design height effect factor of 1.0 times the Table 1 strength value, or no reduction in the Table 1 fiber strength value. In the last example, there is a significant advantage in using the Table A.1 value as opposed to the Equation A.2 value. These factors would be used to determine the design strength value, and the NESC material strength factors for wood, which depend on the grade of construction, would be applied to this design strength value.

When the theoretical point of maximum stress is above groundline, the ultimate bending capacity of a pole varies according to the height of the applied horizontal load. An example of this can be seen in a pole with a transverse load applied 2 feet (61cm) from the top that causes the theoretical maximum bending stress to occur at a cross section located above the groundline. When a load that creates the same groundline bending moment is applied at a lower height, the point of theoretical maximum stress occurs lower on the pole. This lower cross section has a larger circumference with a higher fiber strength value. Therefore, this lower cross section where the maximum stress occurs has a higher bending capacity and the pole is expected to fail at a higher ultimate bending capacity.

Both the application heights of the applied bending loads and the fiber strength height effect adjustments should be considered for single poles 60 feet (18.3m) in length and longer.

Although vertical loading is not addressed in ANSI O5.1.2008, designers should consider the fact that vertical, as well as eccentric loads, tend to force the point of maximum stress higher on the pole.

A.3 Multi-pole structures

Multi-pole structures, especially braced structures, often have a theoretical maximum stress point that occurs above the groundline. Testing of these types of full size structures suggests that the reduction in fiber strength due to height may not be required.

Table A.1 - Douglas-fir Above-Ground Height Effect Factors for Use as Alternatives to Equation A.2[1]

Species	Length	Top	5/6 Pole Height Above Ground	2/3 Pole Height Above Ground	1/2 Pole Height Above Ground	1/3 Pole Height Above Ground	1/6 Pole Height Above Ground
CDF	60	1.28	1.12	1.01	0.93	0.95	0.99
CDF	65	1.28	1.12	1.01	0.93	0.94	0.98
CDF	70	1.28	1.11	1.01	0.92	0.94	0.98
CDF	75	1.26	1.11	1.00	0.91	0.93	0.97
CDF	80	1.25	1.10	0.99	0.91	0.93	0.97
CDF	85	1.23	1.08	0.99	0.90	0.92	0.97
CDF	90	1.20	1.06	0.98	0.89	0.92	0.97
CDF	95	1.17	1.04	0.96	0.88	0.91	0.97
CDF	100	1.13	1.02	0.95	0.87	0.91	0.97
CDF	105	1.09	1.00	0.94	0.86	0.91	0.98
CDF	110	1.04	0.97	0.92	0.85	0.90	0.98
CDF	115	0.99	0.93	0.90	0.84	0.90	0.99
CDF	120	0.94	0.90	0.88	0.83	0.90	0.99
CDF	125	0.87	0.86	0.86	0.82	0.89	1.00

1) Factors larger than 1.0 should be reduced to 1.0 for calculating strengths

Table A.2 - Southern pine Above-Ground Height Effect Factors for Use as Alternatives to Equation A.2[1]

Species	Length	Top	5/6 Pole Height Above Ground	2/3 Pole Height Above Ground	1/2 Pole Height Above Ground	1/3 Pole Height Above Ground	1/6 Pole Height Above Ground
SYP	60	1.14	1.03	0.92	0.89	0.91	0.94
SYP	65	1.13	1.02	0.91	0.88	0.91	0.94
SYP	70	1.11	1.01	0.90	0.88	0.90	0.94
SYP	75	1.09	0.99	0.89	0.88	0.90	0.94
SYP	80	1.07	0.98	0.87	0.87	0.89	0.94
SYP	85	1.04	0.96	0.85	0.87	0.89	0.94

1) Factors larger than 1.0 should be reduced to 1.0 for calculating strengths

Table A.3 - Western red cedar Above-Ground Height Effect Factors for Use as Alternatives to Equation A.2[1]

Species	Length	Top	5/6 Pole Height Above Ground	2/3 Pole Height Above Ground	1/2 Pole Height Above Ground	1/3 Pole Height Above Ground	1/6 Pole Height Above Ground
WRC	60	1.05	0.98	0.91	0.88	0.95	1.00
WRC	65	1.02	0.96	0.90	0.88	0.95	1.01
WRC	70	0.99	0.94	0.89	0.87	0.96	1.01
WRC	75	0.95	0.92	0.88	0.87	0.96	1.02
WRC	80	0.93	0.90	0.87	0.87	0.97	1.04
WRC	85	0.90	0.89	0.87	0.87	0.99	1.05
WRC	90	0.87	0.88	0.86	0.88	1.00	1.07
WRC	95	0.85	0.87	0.86	0.89	1.02	1.09

1) Factors larger than 1.0 should be reduced to 1.0 for calculating strengths

Annex B
(informative)

Annex B: Groundline stresses

Pole classes in this standard are defined so that poles of various species will have approximately equal load-carrying capability. This annex explains the methods and assumptions used to establish these classes.

The minimum circumferences specified at 6 feet (1.8m) from the butt in Tables 3 through 10 (or Tables 3M through 10M) have been calculated such that each species in a given class will not exceed the groundline stresses approximately equal to those shown in 5.1.1 when a given horizontal load is applied 2 feet (61cm) from the top of the pole. The horizontal loads used in the calculations for separating the 15 classes are as follows:

Class	Horizontal load (pounds)	Newtons	Class	Horizontal load (pounds)	Newtons
H6	11,400	50,710	3	3,000	13,300
H5	10,000	44,480	4	2,400	10,680
H4	8,700	38,700	5	1,900	8,450
H3	7,500	33,360	6	1,500	6,670
H2	6,400	28,470	7	1,200	5,340
H1	5,400	24,020	9	740	3,290
1	4,500	20,020	10	370	1,650
2	3,700	16,500			

In making the calculations, it was assumed that the pole is used as a simple cantilever and that the maximum fiber stress in the pole subjected to the bending moment applied will occur at the assumed groundline location. Allowance was not made for the reduction in fiber strength value from groundline to top of pole and for the taper of the pole as described in Annex A. For a given horizontal load and fiber strength value from 5.1.1, a minimum circumference at the groundline was calculated using standard engineering formula. This circumference value was then translated to a location 6 feet (1.8m) from the butt using recognized average circumference tapers[7] per foot of length between the assumed approximate groundline and the 6 feet (1.8m) from the butt distance.

The assumed stress limit, location for analyzing the stress, and the location, direction, and magnitude of the load were selected for the purpose of assigning minimum circumferences presented in this standard. These assumptions may or may not be applicable when designing a pole to fit a specific application, particularly for taller poles.

[7] Average circumference tapers (inches change in circumference per foot of length) used in determining the required 6-feet (1.8m) from butt circumference from the calculated requirement groundline circumference are as follows:

	Inches	mm
Western red cedar	0.38	10
Ponderosa pine	0.29	7
Jack pine, Lodgepole pine and red pine	0.30	8
Southern pine	0.25	6
Douglas-fir	0.21	5
Western larch	0.21	5
Western hemlock	0.20	5

Annex C
(informative)

Annex C: Reliability based design

C.1 Scope

This annex provides wood pole strength and stiffness data for use with reliability-based design (RBD) procedures. Data provided in this annex were adapted, in part, from *Wood Pole Properties – Review and Recommendations for Design Resistance Data*, Volumes 1, 2, and 3 which contain detailed background and literature upon which this annex is based. The data in this annex are not intended for use with deterministic design procedures such as those embodied in ANSI C2-1987 or Bulletin 62-1. Many of the clauses and sub-clauses in the body of this standard apply directly and completely to Annex C (i.e., clauses 3, 6, 7, and 8 and sub-clauses 1.2, 5.1.2 – 5.1.4, and 5.2 – 5.4). The remaining clauses in the body of the standard are either partially or entirely inappropriate for use with the strength and stiffness values provided in this annex.

Requirements for the preservative treatment of poles are not included in this standard. These requirements are detailed in other standards (for example, those of the American Wood Protection Association and ASTM) and in customer specifications. Those conditioning and treatment processes in common use, which are known to affect pole strength or stiffness, are accounted for in this annex. Modifications in pole strength and stiffness caused by new conditioning or treating processes or chemicals must be sufficiently documented such that appropriate adjustment factors can be established.

Note that the intent of this annex is to provide reliable strength and stiffness values for wood poles. These values may be directly taken from the tabulated data in this annex or obtained for a specific set of poles through nondestructive evaluation (NDE) or through destructive testing of representative poles with the use of appropriate statistical sampling procedures.

C.2 Pole classes & geometry

Pole classes identified in Tables 3 through 10 (or Tables 3M through 10M) in the body of this standard are applicable to this annex. The sizes given in Tables 3 and 10 (or Tables 3M through 10M) apply to poles at moisture contents above fiber saturation for use with this annex. Poles of a given class and length may not have the same load-carrying capacity from species to species and are, therefore, not interchangeable.

The class minimum circumferences provided in Tables 3 through 10 (or Tables 3M through 10M), along with an assumed straight-line taper between those points, describe the pole geometry used to determine the strength and stiffness values given in Tables C.1 through C.3. Therefore, the values given in Tables C.1 through C.3 are valid for design only when used with the class minimum dimensions provided in Tables 3 through 10 (or Tables 3M through 10M).

C.3 Adjustments to special conditions

The strength (at groundline) and stiffness values in Tables C.1 through C.3 are given for new, green, untreated poles. Therefore, the tabulated strength and stiffness values for a specific manufactured pole need further adjustments. In general, this adjustment procedure utilizes the following format:

$$\text{Equation C.1:} \qquad MOR_m \bullet k_1 \bullet k_2 \ldots k_n \ \ldots$$

$$\text{Equation C.2:} \qquad MOE_m \bullet k_1 \bullet k_2 \ldots k_n \ \ldots$$

Where:

$\boldsymbol{R_m}$ is the adjusted mean groundline strength;

$\boldsymbol{MOR_m}$ is the mean modulus of rupture (MOR) at groundline for new, green, untreated poles based on pole class dimensions given in Tables 3 through 10 (or Tables 3M through 10M);

$\boldsymbol{E_m}$ is the adjusted mean effective modulus of elasticity (MOE);

$\boldsymbol{MOE_m}$ is the mean effective modulus of elasticity for new, green, untreated poles based on pole class dimensions and linear taper given in Tables 3 through 10 (or Tables 3M through 10M); and

$\boldsymbol{k_i}$ is the adjustment factor to account for the *i*th effect of the characteristics and processes influencing pole strength and stiffness.

The MOR_m and MOE_m values along with their respective coefficients of variation (*COV*), are provided in Tables C.1 through C.3. The numerical values for the k_i factors are provided in Tables C.4 and C.5. Note that no adjustment factor is allowed for drying.

The values of *MOR* and *MOE* were determined from cantilever bending tests conducted on new, green full-size poles. The load-pole top deformation relationship and the ultimate breaking load, applied transversely 2 feet (61cm) from the top of the pole, were used to compute *MOE* and *MOR* at the groundline. These data are based on the pole class circumference at 6 feet (1.8m) from butt and at the top, assuming linear pole taper, as given in Tables 3 through 10 (or Tables 3M through 10M), rather than actual pole dimensions.

The values provided in Table C.1 are valid only for poles shorter than 50 feet (15.2m). Adjustment factors for processing effects are provided in Table C.4. Height-effect correction is not needed for poles less than 50 feet (15.2m) in length when used as unguyed single-pole structures.

The values provided in Table C.2 apply to poles 50 feet (15.2m) and longer when used in unguyed single-pole structures only. The appropriate correction factors in Table C.4 must be used with the strength and stiffness values in Table C.2. The mean *MOR* and *COV* values in Table C.2 already include height effects for poles used in simple cantilever bending and are included to simplify the design procedure for unguyed single-pole structures. These *MOR* values were adjusted for size effect to Class 2, 65-foot (Class 2-19.8m) poles -- see Tables 3 through 10 (or Tables 3M through 10M) -- in accordance with *Wood Pole Properties – Review and Recommendations for Design Resistance Data*, volume 3.

The values provided in Table C.3 also apply to poles 50 feet (15.2m) and longer. Table C.3 values, however, are valid for poles used in structures other than unguyed single pole structures. Appropriate adjustment factors from Table C.4 must be used with the data given in Table C.3. Height-effect correction factors from Table C.5 must be applied for mean *MOR* and its *COV* for southern pine. No height correction is needed for effective *MOE* or its *COV*.

C.4 Generation of material resistance data

The strength and stiffness data provided in Tables C.1 through C.3 were obtained through testing of full-size pole samples representing various species used in North America. Local variations are represented only by their effects on the *COV*. No data are available representing a single supplier, a different grading method, or poles in service. The intent of this clause is to provide an opportunity to allow the use of material resistance data more closely reflecting special conditions or the effects of localized in-service conditions. The requirement for allowing the use of such alternate data in lieu of Tables C.1 through C.3 is that the user provides a statement about the confidence of the generated mean value evaluated by standard statistical procedures. This uncertainty is then accounted for in the design procedure.

There are two approaches currently available for determining strength and stiffness data for a specific group of new or in-service poles. One approach is to evaluate a statistically representative sample of the poles by destructive testing. Sampling plans must be established according to recognized statistical sampling procedures.

The second approach utilizes NDE and established correlations along with computer simulation to estimate the distribution of strength and stiffness properties. This annex does not specify any particular NDE or simulation procedure, however, the method must be proven reliable and able to provide confidence values before any particular NDE-simulation procedure can be considered as acceptable for use in determining wood pole properties.

Table C.1 - Groundline strength and stiffness values for new, green poles less than 50 feet (15.2m) long[1),2)]

Species	*MOR*				*MOE*			
	Sample Size	Psi	(MPa)	COV	Sample Size	Mean 10^6 psi	(GPa)	COV
Northern white cedar	28	4100	(28.3)	0.173	--	--	--	--
Western red cedar	387	6310	(43.5)	0.204	268	1.59	(10.96)	0.224
Pacific silver fir	51	6380	(44.0)	0.173	51	1.67	(11.51)	0.215
Douglas-fir:								
Coastal	118	9620	(66.3)	0.135	39	3.35	(23.10)	0.194
Interior	99	8020	(55.3)	0.179	--	--	--	--
Western hemlock	154	7530	(51.9)	0.180	154	2.23	(15.38)	0.216
Western larch	48	10000	(69.0)	0.120	48	2.94	(20.27)	0.190
Jack pine	189	7300	(50.3)	0.190	--	--	--	--
Lodgepole pine	218	6650	(45.9)	0.194	108	1.84	(12.69)	0.223
Red pine	331	6310	(43.6)	0.174	229	1.63	(11.24)	0.234
Southern pine [3)]	143	10190	(70.3)	0.169	67	2.68	(18.48)	0.201
White spruce	56	5520	(38.1)	0.208	56	1.44	(9.93)	0.239
Radiata Pine (Chilean) [4)]	105	7180	(48.2)	0.170	105	1.71	(11.79)	0.250

NOTES

1.) Data were adapted from *Wood Pole Properties – Review, and Recommendations for Design Resistance Data, Volume* 1, and are based on class minimum circumferences (rather than measured circumferences as provided in the referenced volume at the top and at 6 feet (1.8m) from the butt and linear taper between these points. Red pine data was supplemented with Michigan Utilities Association test results.)

2.) Values must be adjusted using the appropriate factors from Table C.4.

3.) Longleaf, shortleaf, slash, and loblolly pines.

4) Radiata pine includes only material produced in Chile between south 33° and south 40°, is limited to no more than 45 feet in length, and limited to pole class sizes 4-10.

Table C.2 - Groundline strength and stiffness values for new, green poles, 50 feet (15.2m) and longer, used in unguyed, single-pole structures only[1), 2)]

Species	Sample Size	*MOR*			*MOE*		
		Mean Psi	(MPa)	*COV*	Mean 10^6 Psi	(GPa)	*COV*
Southern pine [3)]	120	8430	(58.1)	0.206	2.51	(17.31)	0.184
Douglas-fir:							
Coastal	165	7860	(54.2)	0.144	2.64	(18.20)	0.182
Western red cedar	100	5200	(35.9)	0.192	1.59	(10.96)	0.229

NOTES

[1)] Data are based on class minimum circumferences at the top and at 6 feet (1.8m) from the butt and linear taper between these points.

[2)] Values must be adjusted using the appropriate factors from Table C.4. Height correction not required for Table C.2 *MOR* values.

[3)] Longleaf, shortleaf, slash, and loblolly pines.

Table C.3 - Groundline strength and stiffness values for new, green poles, 50 feet (15.2m) and longer, used in structures other than unguyed single-pole structures [1), 2)]

Species	Sample Size	*MOR*			*MOE*		
		Mean Psi	(MPa)	*COV*	Mean 10^6 Psi	(GPa)	*COV*
Southern pine [3)]	120	9400	(64.8)	0.125	2.51	(17.31)	0.184
Douglas-fir:							
Coastal	165	7860	(54.2)	0.144	2.64	(18.20)	0.182
Western red cedar	100	5200	(35.9)	0.192	1.59	(10.96)	0.229

NOTES

[1)] Data are based on class minimum circumferences at the top and at 6 feet (1.8m) from the butt and linear taper between these points.

[2)] Values must be adjusted using the appropriate factors from Table C.4 and C.5.

[3)] Longleaf, shortleaf, slash, and loblolly pines.

Table C.4 - Correction factors for pole strength and stiffness (k_i factors for Equations 2 and 3)

MOR and *MOE*	
Kiln drying:	0.90
Boultonizing:	0.90
Steam conditioning: (southern pine only)	0.85

Table C.5 - Height-effect correction factors for MOR

Species	Mean	*COV*
Southern pine	$\left(1-\frac{0.176\ H}{L}\right)$	$\left(1+\frac{2.072\ H}{L}\right)$
Douglas-fir, coastal:	1.0	1.0
Western red cedar	1.0	1.0

Where:

H is the distance from the groundline to a location above; and

L is the distance from groundline to the top of the pole.

Annex D
(Normative)

Annex D: Requirements for consideration of species not presently standardized in ANSI O5.1

D.1 Scope

This requirement covers all poles not presently standardized in ANSI O5.1. Information must be submitted demonstrating that the material properties of the species do not vary within geographic range of the species. Full-scale evaluation of poles harvested outside the United States and Canada must be performed on material that has been subjected to the mitigation requirements specified in the United States Department of Agriculture Animal and Plant Health Inspection Service (APHIS) regulations.

D.2 Requirements

1. SPECIES:	Must provide the botanical name and the common name.
2. LOCATION:	Describe in detail the location material will come from. At a minimum it must include country of origin and geographic boundaries.
3. SPECIES VERIFICATION:	Species verification must accompany the data package. The verification must be done microscopically by an independent third party or an alternative must be submitted to the subcommittee for approval of the data package. The independent third party must be knowledgeable in forest anatomy (i.e., government forest products lab, university lab, or other qualified organization).
4. USE:	List all standards, both foreign and United States, where the proposed species is presently approved for structural use.
5. MATERIAL REQUIREMENTS:	Identify all material requirements that differ from ANSI O5.1 (i.e., spiral grain, knots, ring knots, etc.).
6. MANUFACTURING:	Provide information on the effect of manufacturing on the strength of the wood, including seasoning, steaming, and kiln drying.
7. FULL-SCALE EVALUATION:	Full-scale structural evaluation testing shall be conducted in accordance with ASTM D-1036 (latest edition). Data previously attained by alternative test methods and/or proposed alternative methods of full-scale testing shall be accepted provided it is reviewed and determined to be equivalent to ASTM D1036 (latest edition) by the O5 Committee. In that regard, prior data must include full-scale pole bending strength data and a detailed description of the testing procedure. Proposed alternative evaluation methods must include a complete description of the test procedures and comply with sample collection methods as outlined in ASTM D1036 (latest edition). Species qualification testing shall include the full range of sizes in accordance with ANSI O5.1, or include only those predominant sizes anticipated to be supplied. Sample sizes shall be sufficient to support a standard error no greater than 10% on the estimate of the lower 5% tolerance value in accordance with ASTM D2915 (latest edition), section 3.4.3.2.
8. ENGINEERING CERTIFICATION:	The full-scale evaluations and fiber strength calculations must be reviewed by an independent third party with a professional engineer's certification. The engineer must be registered in the U.S. or Canada and be experienced in timber mechanics. Full-length break tests and strength data -- modulus of rupture at break point (MORBP) and modulus of rupture at ground line (MORGL) -- must accompany the professional engineer's certification.
9. SOURCE CERTIFICATION (for species harvested outside the U.S. or Canada):	An independent third-party certification verifying the source of the wood must be provided. The proponent shall describe how the source of each pole will be controlled and assured. Each shipment or lot must be certified.

1. *Receipt of data package*: The data package meeting all the requirements listed above shall be sent to the Secretariat of the O5 Committee electronically. The electronic media and format of data must be agreed upon by the submitter and secretariat prior to submittal of the data package. Hard copies of the data package may also be requested.

2. *Review of the data*: The Secretariat shall forward the data package to the Chairman of the O5 Committee, who shall appoint a review committee of not less than three (3) members of the O5 Committee to review the data and provide the general committee with a summary. The appointed members must be familiar with the requirements, have working knowledge, and be proficient in reviewing this type of data. One member shall be chosen from each of the following categories: 1) user; 2) producer; and 3) general interest. The Chairman of the O5 Committee shall provide the review committee with procedural guidelines for the review, including time frame, requests for additional information, etc.

3. *Summary Report*: At the conclusion of the review, a Summary Report shall be sent to the Secretariat of O5. The information, including both the data package and the summary, shall be sent to all members of the committee for review, discussion, and vote at the next meeting. Based on the results of the review and vote by the committee, the data package will either be approved or sent back to the proponent with a request for additional information.

Annex E
(informative)

Annex E: Bibliography

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Annex F
(informative)

Annex F: Acronyms & abbreviations

ANSI	American National Standards Institute
APHIS	Animal and Plant Health Inspection Service
ASTM	ASTM International (formerly American Society for Testing and Materials)
AWPA	American Wood Protection Association
COV	Coefficient of Variation
MOE	Modulus of Elasticity
MOR	Modulus of Rupture
MORBP	Modulus of Rupture at Break Point
MORGL	Modulus of Rupture at Ground Line
NDE	Nondestructive Evaluation
RBD	Reliability-Based Design