New Standard Specifications for Wood Poles

By R. L. JONES*

This paper summarizes the work of the Sectional Committee on Wood Poles of the American Standards Association covering the preparation of specifications for northern white cedar, western red cedar, chestnut and southern pine poles. The major problems underlying the development of standard ultimate fiber stresses, standard dimension tables and practical knot limitations are discussed and illustrated by supporting tables or figures. Graphical charts comparing the old and the new dimensional classifications are described. The main points relating to the material requirements for the four pole species are outlined briefly.

REPRESENTATIVES of communication, power and light, and transportation utilities, of producers, and of public and general interests have cooperated in the preparation of the new uniform standard specifications for wood poles that were recently approved by the American Standards Association.[1] The new specifications cover dimensions and material requirements for northern white cedar, western red cedar, chestnut and southern pine poles, but rules for preservative treatment are not included. Specifications for lodgepole pine and Douglas fir poles are in preparation.

Pole specifications deal with natural rather than fabricated products. Heretofore, the larger utilities have purchased poles of the various species under specifications that have grown up more or less independently. Confusing differences in material requirements and in the dimensional tables have resulted. Economic production and utilization require the arrangement of the natural cut of pole timbers into groups defined either by top diameters and lengths, or by classes in which circumferences at the top and butt are specified in addition to length. The letter designations, such as *A*, *B*, and *C*, that have been applied to these classes, have had no common meaning. A pole of a given length and class of one species has not generally been equivalent in strength rating to one of the same length and class of another species; and in most cases, the longer poles of a given class have not had the same strength rating as the shorter poles of the same class.

It is perhaps quite obvious that before rational improvement could be made in the system of dimensional classification, it was necessary to create a foundation for comparison of the strength of the different

* Chairman, Sectional Committee on Wood Poles, American Standards Association.

[1] These specifications were approved on June 20, 1931.

species. For illustrative purposes a summary of part of the test results used in arriving at fiber stress values is shown in Table 1. A detailed study of the results of these tests and of other tests made on full length poles and on small clear specimens of wood of the species

TABLE 1

SUMMARY OF STATISTICAL ANALYSIS OF MODULUS OF RUPTURE VALUES OBTAINED FROM TESTS ON FULL SIZE POLES

Modulus of Rupture Pounds per Square Inch	Northern White Cedar		Western Red Cedar		Chestnut		Southern Pine (Creosoted)	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
2000–2499	2	3.57						
2500–2999	13	23.21	1	0.66				
3000–3499	11	19.64	4	2.65				
3500–3999	14	25.00	5	3.31	1	1.02		
4000–4499	8	14.29	10	6.62	4	4.08		
4500–4999	1	1.79	21	13.91	7	7.14	1	0.83
5000–5499	5	8.93	21	13.91	8	8.16	1	0.83
5500–5999	2	3.57	18	11.92	14	14.29	6	4.96
6000–6499			21	13.91	15	15.31	4	3.31
6500–6999			25	16.55	11	11.22	12	9.92
7000–7499			16	10.60	14	14.29	28	23.12
7500–7999			7	4.64	13	13.27	10	8.26
8000–8499			1	0.66	7	7.14	15	12.40
8500–8999			1	0.66	3	3.06	15	12.40
9000–9499							12	9.92
9500–9999					1	1.02	5	4.13
10000–10499							5	4.13
10500–10999							6	4.96
11000–11499							1	0.83
Total No.	56		151		98		121	
Average		3670		5813		6536		8039
Standard deviation		860 [2]		1184		1223		1348
Coefficient of variation (per cent)		23.43		20.39		18.71		16.77

[2] Uncorrected for sample size.

under investigation led to the recommendation of the following figures as standard ultimate fiber stresses:

Northern white cedar	3600 lbs. per sq. in.
Western red cedar	5600 " " " "
Chestnut	6000 " " " "
Southern yellow pine (creosoted)	7400 " " " "

The fiber stress for a given species finds application in pole line engineering through the conversion of the stress value into terms of moment of resistance, usually at the ground line. The poles act as a series of supports for the wires. With this in mind one of the studies conducted in connection with the application of the new fiber stresses, which is cited here by way of illustration, was directed toward an analysis of the variation in size and variation in modulus of rupture that might be expected to affect the average ground line moment of resistance of random 3 pole groups. Approximately 400 creosoted southern pine and 500 western red cedar, class 3, thirty foot (see Table 2) poles were used in this particular study. It was found that in more than 95 per cent. of the cases the average moment of resistance of such 3-pole groups was higher than the minimum calculated for the given class and length. The result is considered reasonably representative of what would be found in a similar study of other sizes. It may be concluded that with the new standard fiber stress values as a basis practically all parts of a line when new should be equal to or better than the strength rating for the specified minimum of the class of poles used; and that when the reduced loads under the conditions usually obtaining in the higher grades of construction are considered, the bending moment developed at the ground line should rarely, if ever, approach the actual moment of resistance.

Since the standard ultimate fiber stresses are based upon tests of representative poles, they are believed to be satisfactory for all ordinary purposes. They are directly applicable in the engineering of pole lines without further adjustment or compensation for knots, variation in moisture content, or density of wood. In any case, the question of density classification may be limited for practical purposes to southern pine poles; and studies of current production show that approximately 75 per cent of such poles passing through the producers' yards could be classified as dense. The creosoting process seems to reduce the variation found in the modulus of rupture values of untreated poles. The comparatively low coefficient of variation of creosoted southern pine shown in Table 1 indicates that for general purposes an attempt to classify pine poles according to density is an unnecessary refinement.

With the standard fiber stresses as bases, dimension tables for the four species were developed in accordance with the following principles:

(*a*) The tables should specify dimensions in terms of circumference in inches at the top, and circumference in inches at six feet from the butt for poles of the respective lengths and classes except for three classes with "no butt requirement."

(*b*) All poles of the same length and class should have, when new, approximately equal strength, or in more precise terms, equal moments of resistance at the ground line.

(*c*) All poles of different lengths within the same class should be of suitable sizes to withstand approximately the same breaking load assuming that the load is applied two feet from the top and that the break would occur at the ground line.

(*d*) The classes from the lowest to the highest should be arranged in approximate geometric progression, the increments in breaking load between classes being about 25 per cent.

Item "*d*" is in accord with the preferred number principle, and the increments chosen provide the lowest number of classes that are required in service.

Tables of ten classes for each species, as shown in Table 2, have been made a part of the standard specifications. Classes 8, 9, and 10, defined simply by minimum top circumferences, have been provided to cover poles purchased on a top size basis or for rural or other lightly-loaded lines. Classes 1 to 7, defined primarily by their circumferences at six feet from the butt, have been designed to meet the following breaking loads in pounds, assuming the conditions of item (*c*):

Class 1—4500
Class 2—3700
Class 3—3000
Class 4—2400
Class 5—1900
Class 6—1500
Class 7—1200

The required circumferences at the ground line for the respective species were calculated by means of the formula $Mr = .000264f\ C^3$, which is the well-known flexure formula applied to a cantilever beam of circular cross section, and reduced to foot pound units. The ground line circumferences thus obtained were converted into circumferences at six feet from the butt by means of approximate average taper values for the respective species.

The breaking loads are ratings for the minimum size pole for the given length and class based on the standard ultimate fiber stress for the species. The average pole of a given class will usually be considerably stronger than the class rating. The choice of sizes provided in the tables is sufficiently extensive to enable the engineer to make an economical selection of poles to meet specific requirements after the load conditions of the line have been determined.

Graphical charts have been prepared which show the relation between the dimension tables of some current specifications and the new standards. These charts should be of material assistance to suppliers and consumers who wish to compare the old with the new for inventory or record purposes. Representative blocks from the charts appear in Fig. 1. Comparisons for all lengths and classes may be found in the complete charts that are obtainable from the American Standards Association.

TABLE 2

STANDARD DIMENSIONS OF CREOSOTED SOUTHERN PINE, WESTERN RED CEDAR, NORTHERN WHITE CEDAR AND CHESTNUT POLES

Creosoted Southern Yellow Pine Poles

Class		1	2	3	4	5	6	7	8	9	10
Min. Top Circ. (Inches)		27	25	23	21	19	17	15	18	15	12
Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)							NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
16	3½					21.5	19.5	18.0			
18	3½			26.5	24.5	22.5	21.0	19.0			
20	4	31.5	29.5	27.5	25.5	23.5	22.0	20.0			
22	4	33.0	31.0	29.0	26.5	24.5	23.0	21.0			
25	5	34.5	32.5	30.0	28.0	26.0	24.0	22.0			
30	5½	37.5	35.0	32.5	30.0	28.0	26.0	24.0			
35	6	40.0	37.5	35.0	32.0	30.0	27.5	25.5			
40	6	42.0	39.5	37.0	34.0	31.5	29.0	27.0			
45	6½	44.0	41.5	38.5	36.0	33.0	30.5	28.5			
50	7	46.0	43.0	40.0	37.5	34.5	32.0	29.5			
55	7½	47.5	44.5	41.5	39.0	36.0	33.5				
60	8	49.5	46.0	43.0	40.0	37.0	34.5				
65	8½	51.0	47.5	44.5	41.5	38.5					
70	9	52.5	49.0	46.0	42.5	39.5					
75	9½	54.0	50.5	47.0	44.0						
80	10	55.0	51.5	48.5	45.0						
85	10½	56.5	53.0	49.5							
90	11	57.5	54.0	50.5							

Western Red Cedar Poles

Class		1	2	3	4	5	6	7	8	9	10
Min. Top Circ. (Inches)		27	25	23	21	19	17	15	18	15	12
Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)							NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
16	3½					23.0	21.5	19.5			
18	3½			28.5	26.5	24.5	22.5	21.0			
20	4	34.5	32.0	30.0	28.0	25.5	23.5	22.0			
22	4	36.0	33.5	31.5	29.0	27.0	25.0	23.0			
25	5	38.0	35.5	33.0	30.5	28.5	26.0	24.5			
30	5½	41.0	38.5	35.5	33.0	30.5	28.5	26.5			
35	6	43.5	41.0	38.0	35.5	32.5	30.5	28.0			
40	6	46.0	43.5	40.5	37.5	34.5	32.0				
45	6½	48.5	45.5	42.5	39.5	36.5					
50	7	50.5	47.5	44.5	41.0	38.0					
55	7½	52.5	49.5	46.0	42.5	39.5					
60	8	54.5	51.0	47.5	44.0						
65	8½	56.0	52.5	49.0	45.5						
70	9	57.5	54.0	50.5	47.0						
75	9½	59.5	55.5	52.0	48.5						
80	10	61.0	57.0	53.5	49.5						
85	10½	62.5	58.5	54.5							
90	11	63.5	60.0	56.0							

Table 2—*Continued*

Chestnut Poles

Class		1	2	3	4	5	6	7	8	9	10
Min. Top Circ. (Inches)		27	25	23	21	19	17	15	18	15	12
Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)							NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
16	3½					22.5	21.0	19.5			
18	3½			28.0	26.0	24.0	22.0	20.5			
20	4	33.5	31.5	29.5	27.0	25.0	23.0	21.5			
22	4	35.0	33.0	30.5	28.5	26.5	24.5	22.5			
25	5	37.0	34.5	32.5	30.0	28.0	25.5	24.0			
30	5½	40.0	37.5	35.0	32.5	30.0	28.0	26.0			
35	6	42.5	40.0	37.5	34.5	32.0	30.0	27.5			
40	6	45.0	42.5	39.5	36.5	34.0	31.5	29.5			
45	6½	47.5	44.5	41.5	38.5	36.0	33.0	31.0			
50	7	49.5	46.5	43.5	40.0	37.5	34.5	32.0			
55	7½	51.5	48.5	45.0	42.0	39.0	36.0				
60	8	53.5	50.0	46.5	43.5						
65	8½	55.0	51.5	48.0	45.0						
70	9	56.5	53.0								

Northern White Cedar Poles

Class		1	2	3	4	5	6	7	8	9	10
Min. Top Circ. (Inches)		27	25	23	21	19	17	15	18	15	12
Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)							NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
16	3½					26.0	24.0	22.0			
18	3½			32.5	30.0	28.0	25.5	23.5			
20	4	39.5	37.0	34.0	31.5	29.0	27.0	25.0			
22	4	41.0	38.5	36.0	33.0	30.5	28.0	26.0			
25	5	43.5	41.0	38.0	35.5	32.5	30.0	28.0			
30	5½	47.5	44.5	41.5	38.5	35.5	33.0	30.5			
35	6	50.5	47.5	44.0	41.0	38.0	35.0	32.5			
40	6	53.5	50.0	46.5	43.5	40.0	37.0				
45	6½	56.0	52.5	49.0	45.5	42.0					
50	7	58.5	55.0	51.5	47.5	44.0					
55	7½	61.0	57.5	53.5	49.5	46.0					
60	8	63.5	59.5	55.5	51.5						

Employment of the new standard ultimate fiber stresses of wood poles is provided for under rule 261-4-c of the National Safety Code. With the revisions necessitated by their adoption, Table 20 of the Code will appear as indicated in Table 3.

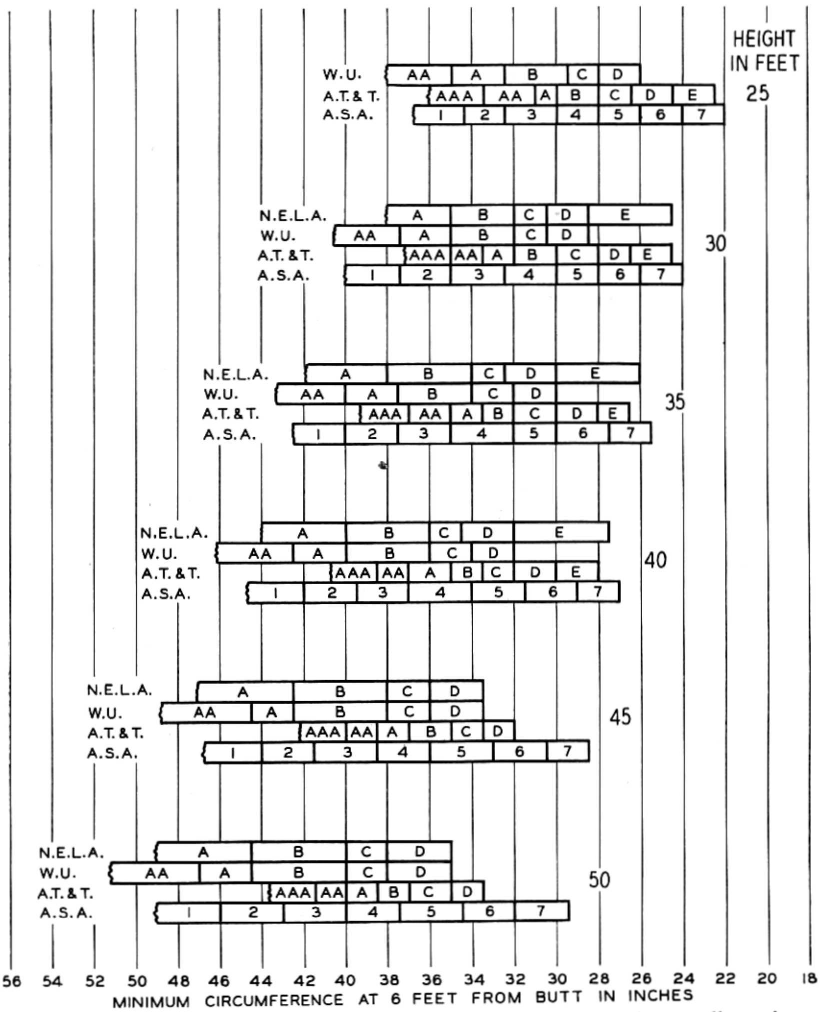


Fig. 1—Representative block from the graphical charts for southern yellow pine—current dimensions compared with the new standard tables.

The material requirements of the several specifications cover shape, and straightness of grain, and limit or prohibit such defects as knots, checks, insect damage and decay. Without detailed reference to what might be called the appearance requirements, it may be said that the

TABLE 3

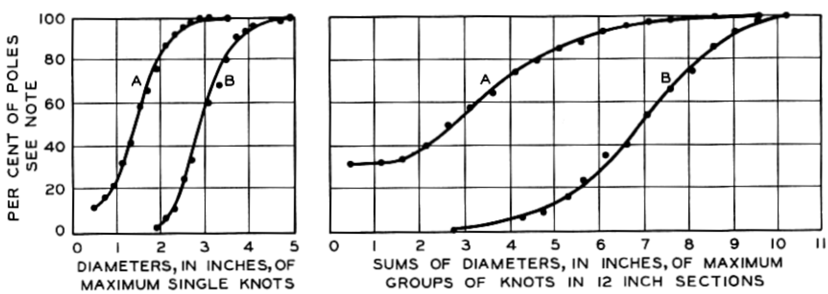
ALLOWABLE FIBER STRESSES. REVISED FORM OF TABLE 20, PAGE 154, HANDBOOK NO. 3, FOURTH EDITION, NATIONAL ELECTRICAL SAFETY CODE

	When Installed									At Replacement				
	Treated Poles					Untreated Poles				Treated or Untreated Poles				
	For Ultimate Fiber Stress of—					For Ultimate Fiber Stress of—				For Ultimate Fiber Stress of—				
	7,400	6,000	5,600	5,000	3,600	6,000	5,600	5,000	3,600	7,400	6,000	5,600	5,000	3,600
At crossings:														
Poles in lines of one grade of construction throughout—														
Grade A	2,470	2,000	1,870	1,670	1,200	2,000	1,870	1,670	1,200	3,700	3,000	2,800	2,500	1,800
Grade B	3,700	3,000	2,800	2,500	1,800	3,000	2,800	2,500	1,800	5,550	4,500	4,200	3,750	2,700
Grade C	5,550	4,500	4,200	3,750	2,700	4,500	4,200	3,750	2,700	11,100	9,000	8,400	7,500	5,400
Poles in isolated sections of higher grade of construction in lines of a lower grade of construction—														
Grade A	2,470	2,000	1,870	1,670	1,200	1,500	1,400	1,250	900	3,700	3,000	2,800	2,500	1,800
Grade B	3,700	3,000	2,800	2,500	1,800	2,000	1,870	1,670	1,200	5,550	4,500	4,200	3,750	2,700
Grade C	5,550	4,500	4,200	3,750	2,700	3,600	3,360	3,000	2,160	11,100	9,000	8,400	7,500	5,400
Elsewhere than at crossings:														
Grade A	2,960	2,400	2,240	2,000	1,440	2,000	1,870	1,670	1,200	4,440	3,600	3,360	3,000	2,160
Grade B	4,440	3,600	3,360	3,000	2,160	3,000	2,800	2,500	1,800	7,400	6,000	5,600	5,000	3,600
Grade C	7,400	6,000	5,600	5,000	3,600	4,500	4,200	3,750	2,700	11,100	9,000	8,400	7,500	5,400

specifications define poles of a quality that the major utilities have found to be satisfactory. Departures from straightness are held within practical limits for ordinary use.

Decay and the presence of wood-rotting fungi are generally prohibited. Minor exceptions are made with respect to the butts of the cedars, which are usually treated with creosote. The question of including poles cut from sound dead trees received careful consideration. Blighted chestnut is acceptable with certain restrictions, but in the case of the other three species poles from live timber are specified. While it might appear economical to salvage and use all sound dead trees standing in the woods, practical opinion at present strongly favors eliminating dead timber as a source of pole material because of the extra costs involved in handling and inspection.

It has proved impracticable to limit checks in a precise manner. Checks or lengthwise separations of the wood fibers vary so much with the age, seasoning, and moisture content of the pole that although definite limitation seemed desirable the compromise finally adopted is one which simply prohibits injurious checks. Practically the matter is left to the judgment of the supplier and consumer concerned.



CURVE A POLES UP TO AND INCLUDING 45 FEET IN LENGTH
CURVE B POLES 50 FEET AND LONGER

NOTE: "PER CENT OF POLES" REFERS TO THE PER CENT OF POLES HAVING SINGLE KNOTS OR GROUPS OF KNOTS SMALLER THAN THE SIZES INDICATED ON THE BASE LINE. FOR EXAMPLE, 58 PER CENT OF THE POLES 50 FEET AND LONGER HAVE MAXIMUM SINGLE KNOTS SMALLER THAN 3 INCHES IN DIAMETER

Fig. 2—Knot sizes in southern pine poles.

The limitation of knots was a matter of special study. Previous specifications were at variance and data were lacking to establish acceptable limits. Measurements of knots larger than one half inch were therefore made on representative poles of the four species. The size and location of about twenty-three thousand knots in some 567 poles were tabulated, and as might have been anticipated, the occurrences of large knots or large groups of knots were found to increase with the length of pole. This led to a division of the data into a group for short poles and one for long poles of each species. Figure 2, for southern pine, is a typical illustration of the curves drawn from the data. It shows, first, the per cent of poles that have single knots of the given diameters, (*A*) for poles up to 45 feet long, and (*B*) for poles 50 feet and longer; and second, the per cent of poles having groups of knots with the indicated sums of diameters in any 12 inch section, separately plotted for the same two cases. The limits set by this study for single knots and for groups of knots in a twelve inch section are shown in Table 4.

TABLE 4

Specification Limits for Knots

	Southern Pine	Chestnut	Western Red Cedar	Northern White Cedar
	(Diameter—Inches)			
Single Knots				
Poles 45 ft. and under *.	3 and 4†	4	3	2.5
Poles 50 ft. and over *.	5	5.5	3	4.5
Group of Knots				
(12 in. Sections)	(Sum of Diameters—Inches)			
Poles 45 ft. and under.	8	7	10	9
Poles 50 ft. and over.	10	9	10	11

* Except for Northern White Cedar where the length division points are 35 ft. and 40 ft.

† 3 inches for Classes 4 to 10; 4 inches for Classes 1 to 3.

The standards referred to above which have been prepared and approved under the procedure of the American Standards Association are nine in number. One prescribes the ultimate fiber stresses for poles of northern white cedar, western red cedar, chestnut and southern pine, and four prescribe the dimensional classifications for each of the above species according to lengths and circumferences as shown in Table 2. These five are American Standards. The situation with respect to checks and dead timber led to recommending the remaining four specifications covering material requirements as American Tentative Standards. They are the first American standards for wood poles and their adoption on the sound basis outlined marks an important step toward simplified practice in an essential public utility commodity.

The application of the results of the work, as is true of other well-conceived standardization projects, should yield many engineering and economic advantages. The specifications will facilitate good engineering and help to clarify questions bearing on the joint use of poles. No attempt has been made to evaluate the economic savings, but, in the long run, bringing substantially all production and utilization together upon the basis of rational uniform sizes and specifications may be expected to produce economies and benefits in which all concerned should share.