U. S. DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

WOOD POLES FOR OVERHEAD ELECTRICAL LINES

HANDBOOK, BUREAU OF STANDARDS, No. 16

U. S. DEPARTMENT OF COMMERCE
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INTRODUCTION

The American Standards Association, under date of November 28, 1930, approved the following standard values for ultimate fiber stresses of wood poles as used in electrical line construction.

Northern white cedar, 3,600 lbs. per sq. in.
Western red cedar, 5,600 lbs. per sq. in.
Chestnut, 6,000 lbs. per sq. in.
Southern yellow pine (creosoted), 7,400 lbs. per sq. in.

The employment of these standard values in designing lines to meet strength requirements is provided for in the National Electrical Safety Code. (See rule 261 A4(c).)

The value approved by the American Standards Association for northern white cedar is the same as that already recognized in the National Electrical Safety Code. The values for the three other woods will supersede those previously in use. (Dense yellow pine, 6,500; chestnut and western cedar, 5,000.)

The application of these values under the requirements of the code will introduce changes in Tables 19 and 20 of the code. The new standards also require certain changes in the tables of Appendix F, Wood Poles.

To make these changes available the requirements dealing with wood poles and parts of Appendix F are reprinted here, incorporating the changes due to the new standard values of ultimate fiber stress.

The information in Appendix F has been augmented to include tables and a nomogram from which the transverse bending moment caused by the wind pressure on the projected area of the pole may be readily obtained.

STRENGTH REQUIREMENTS FOR WOOD POLES

(Being the requirements of the National Electrical Safety Code revised in accordance with American Standard for Ultimate Fiber Stresses of Wood Poles, ASA 05a–1930.)

261. GRADES A, B, AND C CONSTRUCTION.

A. Poles and Towers.

4. Wood Poles.

Wood poles shall be of such material and dimensions as to meet the following requirements. Where guys are used see rule 261, C.

(*a*) TRANSVERSE STRENGTH.—Wood poles shall withstand the transverse and vertical loads assumed in rule 254, A and B, without exceeding at the ground line for unguyed poles, or at the point of guy attachment for guyed poles, the appropriate allowable fiber stresses given in Table 20.

(*b*) LONGITUDINAL STRENGTH.—

Grades A and B.—The longitudinal strength of wood poles shall be maintained at all times so that they will withstand the longitudinal loading specified in rule 254, C, without exceeding at the ground line for unguyed poles, or at the point of guy attachment for guyed poles, the appropriate ultimate fiber stresses given in Table 19.

Grade C.—No longitudinal strength requirements except at dead ends.

(*c*) ULTIMATE FIBER STRESS.—Different kinds of wood poles are considered as having the ultimate fiber stresses given in Table 19. These ultimate fiber stresses are given so as to identify different kinds of pole timbers with the ultimate fiber stresses appearing at the heads of the columns in Table 20.

Table 19—Ultimate fiber stresses of wood poles

Kind of wood	Ultimate fiber stress
	*Lbs./in.*²
Southern yellow pine (creosoted)	7,400
Chestnut	6,000
Western red cedar (western cedar)	5,600
Other yellow pine	5,000
Cypress	
Northern white cedar (eastern cedar)	3,600
Redwood	

(*d*) TREATED POLES.—The use of treated poles is not required. However, under certain circumstances Table 20 permits higher allowable stresses for treated than for untreated poles. Treated poles are poles meeting the following requirements:

(1) PRESERVATIVES.—The preservatives used shall be coal-tar creosote or other preservative equally satisfactory with regard to electrical resistance, retention of the preservative within the timber, and efficacy as to preservation. In the case of poles which are butt treated only, the electrical resistance of the preservative may be disregarded.

(2) FULL-LENGTH TREATMENT.—Pine and other timber subject to rapid decay above ground shall be treated full length by a pressure process or some other equally effective method.

(3) BUTT TREATMENT.—Cedar, chestnut, and other timber not subject to rapid decay above ground shall be treated by any process which will produce impregnation of most of the sapwood from at least 2 feet below the ground line to at least 1 foot above the ground line. In the case of treatments which require perforation, no method shall be used which results in perforation to the cross section required at replacement.

(*e*) ALLOWABLE FIBER STRESSES.—The allowable fiber stresses to be used in computing the strength of treated and untreated poles to withstand vertical and transverse loads are given in Table 20.

Table 20.—Allowable fiber stresses (in pounds per square inch) for wood poles under vertical and transverse loading

	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

(*f*) FREEDOM FROM DEFECTS.—Wood poles shall be selected timber free from observable defects that would decrease their strength and durability.

(*g*) MINIMUM POLE SIZES.—Wood poles shall have nominal top diameters not less than the following:

Table 21.—Minimum top diameters for wood poles

Grade of construction	Minimum top diameters for different loading districts		
	Heavy (H)	Medium (M)	Light (L)
	Inches	*Inches*	*Inches*
A	7	7	6
B	6	6	6
C	6	6	6

(*h*) SPLICED POLES.—Spliced poles shall not be used at crossings, conflicts, or joint-use sections requiring grade A, B, or C construction.

REVISED TABLES FOR APPENDIX F OF NATIONAL ELECTRICAL SAFETY CODE—WOOD POLES

MOMENTS OF RESISTANCE OF POLES

The resisting moments of wood poles of various ground-line circumferences are given in the accompanying tables for each value of allowable fiber stress recognized in Table 20, for poles when installed. The tables are applicable to all woods having the recognized ultimate fiber stresses mentioned in the titles. Table 83A applies especially to southern yellow pine (creosoted); Table 83B applies especially to chestnut; Table 83C applies especially to western red cedar; Table 84 applies especially to cypress; and Table 85 to northern white cedar and redwood.

Southern yellow pine should not be used for supporting structures unless first given a preservative treatment, as otherwise the rapid deterioration will require early replacement.

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The resisting moment of a pole is expressed by the well-known structural formula

$$M=\frac{fI}{y}$$

where

M = moment.

f = allowable fiber stress.

$\frac{I}{y}$ = section modulus.

For poles with circular cross section, this formula may be expressed in terms of the allowable fiber stress and circumference as follows:

$$M=0.0002638\,fG^3$$

where

M = moment in pound-feet.

f = allowable fiber stress in pounds per square inch.

G = circumference of the pole at ground line in inches.

While the ground-line section may not be the most stressed section in poles with considerable taper, it is so regarded here. Since the wood usually deteriorates most rapidly at this point, it is here that sufficient strength must be provided.

The last column in each of the Tables 83A, 83B, 83C, 84, and 85 is for fiber stress 50 per cent greater than the ultimate. This value is included because, in construction of grade C, poles are permitted to deteriorate to such a point, before replacement is called for, that the factor of safety is only two-thirds. This factor is based, however, upon an assumed loading which in some localities is experienced only at rare intervals, and by some individual poles perhaps never. Such a condition does not, therefore, indicate failure.

Table 83A.—Resisting moments for poles of woods having an ultimate fiber stress of 7,400 pounds per square inch (southern yellow pine, creosoted)

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)						
	2,470	2,960	3,700	4,440	5,550	7,400	11,100
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
20	5,200	6,250	7,800	9,350	11,700	15,600	23,450
21	6,050	7,250	9,050	10,850	13,550	18,100	27,100
22	6,950	8,300	10,400	12,450	15,600	20,800	31,200
23	7,950	9,500	11,900	14,250	17,800	23,750	35,650
24	9,000	10,800	13,500	16,200	20,250	27,000	40,500
25	10,200	12,200	15,250	18,300	22,900	30,500	45,750
26	11,450	13,700	17,150	20,600	25,750	34,300	51,450
27	12,850	15,350	19,200	23,050	28,800	38,400	57,650
28	14,300	17,150	21,450	25,700	32,150	42,850	64,300
29	15,900	19,050	23,800	28,550	35,700	47,600	71,400
30	17,600	21,100	26,350	31,600	39,550	52,700	79,050
31	19,400	23,250	29,100	34,900	43,600	58,150	87,250
32	21,350	25,600	32,000	38,400	48,000	63,950	95,950
33	23,400	28,050	35,100	42,100	52,600	70,150	105,250
34	25,600	30,700	38,350	46,050	57,550	76,750	115,100
35	27,950	33,500	41,850	50,200	62,750	83,700	125,550
36	30,400	36,450	45,550	54,650	68,300	91,100	136,600
37	33,000	39,550	49,450	59,350	74,150	98,900	148,300
38	35,750	42,850	53,550	64,250	80,350	107,100	160,700
39	38,650	46,300	57,900	69,500	86,850	115,800	173,700
40	41,700	49,950	62,450	74,950	93,700	124,950	187,400
41	44,900	53,800	67,250	80,750	100,900	134,550	201,800
42	48,250	57,850	72,300	86,800	108,450	144,650	216,950
43	51,800	62,100	77,600	93,100	116,400	155,200	232,800
44	55,500	66,500	83,150	99,750	124,700	166,300	249,450
45	59,400	71,150	88,950	106,750	133,400	177,900	266,850
46	63,400	76,000	95,000	114,000	142,500	190,000	285,000
47	67,650	81,050	101,350	121,600	152,000	202,650	304,000
48	72,050	86,350	107,950	129,550	161,900	215,900	323,850
49	76,650	91,850	114,850	137,800	172,250	229,650	344,500
50	81,450	97,600	122,000	146,400	183,000	244,000	366,000
51	86,450	103,600	129,500	155,350	194,200	258,950	388,450
52	91,600	109,800	137,250	164,700	205,850	274,500	411,750
53	97,000	116,250	145,300	174,400	217,950	290,650	435,950
54	102,600	122,950	153,700	184,450	230,550	307,400	461,100
55	108,400	129,900	162,400	194,850	243,600	324,800	487,200
56	114,450	137,150	171,400	205,700	257,100	342,800	514,250
57	120,650	144,600	180,750	216,900	271,150	361,500	542,300
58	127,150	152,350	190,450	228,550	285,650	380,900	571,300
59	133,800	160,350	200,450	240,550	300,700	400,900	601,400
60	140,750	168,650	210,850	253,000	316,250	421,650	632,500
61	147,900	177,250	221,550	265,850	332,300	443,100	664,650
62	155,300	186,100	232,600	279,150	348,950	465,250	697,850
63	162,950	195,250	244,050	292,850	366,100	488,100	732,200
64	170,800	204,700	255,850	307,050	383,800	511,750	767,600
65	178,950	214,450	268,050	321,650	402,100	536,100	804,150

Table 83A.—Resisting moments for poles of woods having an ultimate fiber stress of 7,400 pounds per square inch (southern yellow pine, creosoted)—Continued

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)						
	2,470	2,960	3,700	4,440	5,550	7,400	11,100
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
66	187,350	224,500	280,600	336,750	420,900	561,250	841,850
67	195,950	234,850	293,550	352,300	440,350	587,150	880,700
68	204,900	245,500	306,900	368,300	460,350	613,800	920,700
69	214,050	256,500	320,650	384,750	480,950	641,300	961,950
70	223,500	267,850	334,800	401,750	502,200	669,600	1,004,350
71	233,200	279,450	349,350	419,200	524,000	698,700	1,048,050
72	243,200	291,450	364,300	437,150	546,450	728,600	1,092,950
73	253,500	303,750	379,700	455,650	569,550	759,400	1,139,100
74	264,050	316,400	395,500	474,650	593,300	791,050	1,186,550
75	274,900	329,400	411,800	494,150	617,650	823,550	1,235,350
76	286,050	342,750	428,450	514,150	642,700	856,950	1,285,400
77	297,450	356,500	445,600	534,700	668,400	891,200	1,336,800
78	309,200	370,550	463,200	555,850	694,800	926,400	1,389,550
79	321,250	385,000	481,250	577,500	721,850	962,450	1,443,700
80	333,600	399,800	499,750	599,700	749,600	999,500	1,499,250

Table 83B.—Resisting moments for poles of woods having an ultimate fiber stress of 6,000 pounds per square inch (chestnut)

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,500	2,000	2,400	3,000	3,600	4,500	6,000	9,000
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
20	3,150	4,200	5,050	6,350	7,600	9,500	12,650	19,000
21	3,650	4,900	5,850	7,350	8,800	11,000	14,650	22,000
22	4,200	5,700	6,850	8,550	10,200	12,750	16,950	25,400
23	4,800	6,400	7,700	9,650	11,550	14,450	19,250	28,900
24	5,450	7,300	8,750	10,950	13,150	16,400	21,900	32,800
25	6,200	8,250	9,900	12,350	14,850	18,550	24,750	37,100
26	6,950	9,250	11,150	13,900	16,700	20,850	27,800	41,750
27	7,800	10,400	12,450	15,600	18,700	23,350	31,150	46,750
28	8,700	11,600	13,900	17,350	20,850	26,050	34,750	52,100
29	9,650	12,850	15,450	19,300	23,150	28,950	38,600	57,900
30	10,700	14,250	17,100	21,350	25,650	32,050	42,750	64,100
31	11,800	15,700	18,850	23,600	28,300	35,350	47,150	70,750
32	12,950	17,300	20,750	25,950	31,100	38,900	51,850	77,800
33	14,200	18,950	22,750	28,450	34,150	42,650	56,900	85,300
34	15,550	20,750	24,900	31,100	37,350	46,650	62,200	93,300
35	16,950	22,600	27,150	33,950	40,700	50,900	67,850	101,800

Table 83B.—Resisting moments for poles of woods having an ultimate fiber stress of 6,000 pounds per square inch (chestnut)—Continued

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,500	2,000	2,400	3,000	3,600	4,500	6,000	9,000
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
36	18,450	24,600	29,550	36,900	44,300	55,400	73,850	110,750
37	20,050	26,700	32,050	40,100	48,100	60,150	80,150	120,250
38	21,700	28,950	34,750	43,450	52,100	65,150	86,850	130,300
39	23,450	31,300	37,550	46,950	56,350	70,400	93,900	140,850
40	25,300	33,750	40,500	50,650	60,800	75,950	101,300	151,950
41	27,250	36,350	43,650	54,550	65,450	81,800	109,100	163,650
42	29,300	39,100	46,900	58,650	70,350	87,950	117,250	175,900
43	31,450	41,950	50,350	62,900	75,500	94,400	125,850	188,750
44	33,700	44,950	53,950	67,400	80,900	101,100	134,850	202,250
45	36,050	48,100	57,700	72,100	86,550	108,150	144,250	216,350
46	38,500	51,350	61,650	77,050	92,450	115,550	154,050	231,100
47	41,100	54,800	65,750	82,150	98,600	123,250	164,350	246,500
48	43,750	58,350	70,000	87,500	105,050	131,300	175,050	262,550
49	46,550	62,050	74,500	93,100	111,750	139,650	186,200	279,300
50	49,450	65,950	79,150	98,950	118,700	148,400	197,850	296,800
51	52,500	70,000	84,000	105,000	126,000	157,450	209,950	314,950
52	55,650	74,200	89,000	111,300	133,550	166,900	222,550	333,850
53	58,900	78,550	94,250	117,800	141,400	176,750	235,650	353,450
54	62,300	83,100	99,700	124,600	149,550	186,950	249,250	373,850
55	65,850	87,800	105,350	131,650	158,000	197,500	263,350	395,000
56	69,500	92,650	111,200	139,000	166,800	208,450	277,950	416,950
57	73,300	97,700	117,250	146,550	175,850	219,850	293,100	439,700
58	77,200	102,950	123,550	154,400	185,300	231,600	308,800	463,250
59	81,250	108,350	130,050	162,550	195,050	243,800	325,050	487,600
60	85,450	113,950	136,750	170,950	205,150	256,400	341,900	512,850
61	89,800	119,750	143,700	179,650	215,550	269,450	359,250	538,900
62	94,300	125,750	150,900	188,600	226,350	282,900	377,250	565,850
63	98,950	131,900	158,300	197,900	237,450	296,850	395,750	593,650
64	103,750	138,300	165,950	207,450	248,950	311,200	414,900	622,400
65	108,650	144,900	173,850	217,350	260,800	326,000	434,700	652,000
66	113,750	151,700	182,000	227,500	273,050	341,300	455,050	682,550
67	119,000	158,700	190,400	238,000	285,650	357,050	476,050	714,050
68	124,400	165,900	199,050	248,850	298,600	373,250	497,700	746,500
69	130,000	173,300	208,000	260,000	312,000	389,950	519,950	779,950
70	135,750	180,950	217,150	271,450	325,750	407,200	542,900	814,350
71	141,650	188,850	226,600	283,250	339,900	424,900	566,500	849,750
72	147,700	196,950	236,300	295,400	354,450	443,100	590,800	886,150
73	153,950	205,250	246,300	307,850	369,450	461,800	615,750	923,600
74	160,350	213,800	256,550	320,700	384,850	481,050	641,400	962,100
75	166,950	222,600	267,100	333,850	400,650	500,800	667,750	1,001,600
76	173,700	231,600	277,900	347,400	416,900	521,100	694,800	1,042,200
77	180,650	240,850	289,050	361,300	433,550	541,950	722,600	1,083,900
78	187,800	250,350	300,450	375,550	450,650	563,350	751,100	1,126,700
79	195,100	260,150	312,150	390,200	468,250	585,300	780,400	1,170,550
80	202,600	270,150	324,150	405,200	486,250	607,800	810,400	1,215,600

Table 83C.—Resisting moments for poles of woods having an ultimate fiber stress of 5,600 pounds per square inch (western red cedar)

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,400	1,870	2,240	2,800	3,360	4,200	5,600	8,400
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.- ft.*
20	2,950	3,950	4,750	5,900	7,100	8,850	11,800	17,750
21	3,400	4,550	5,450	6,850	8,200	10,250	13,700	20,500
22	3,950	5,250	6,300	7,850	9,450	11,800	15,750	23,600
23	4,500	6,000	7,200	9,000	10,800	13,500	17,950	26,950
24	5,100	6,800	8,150	10,200	12,250	15,300	20,400	30,650
25	5,750	7,700	9,250	11,550	13,850	17,300	23,100	34,600
26	6,500	8,650	10,400	13,000	15,600	19,450	25,950	38,950
27	7,250	9,700	11,650	14,550	17,450	21,800	29,100	43,600
28	8,100	10,850	12,950	16,200	19,450	24,300	32,450	48,650
29	9,000	12,050	14,400	18,000	21,600	27,000	36,050	54,050
30	9,950	13,300	15,950	19,950	23,950	29,900	39,900	59,850
31	11,000	14,700	17,600	22,000	26,400	33,000	44,000	66,000
32	12,100	16,150	19,350	24,200	29,050	36,300	48,400	72,600
33	13,250	17,750	21,250	26,550	31,850	39,800	53,100	79,650
34	14,500	19,400	23,250	29,050	34,850	43,550	58,050	87,100
35	15,850	21,150	25,350	31,650	38,000	47,500	63,350	95,000
36	17,250	23,000	27,550	34,450	41,350	51,700	68,900	103,400
37	18,700	25,000	29,950	37,400	44,900	56,100	74,850	112,250
38	20,250	27,050	32,400	40,550	48,650	60,800	81,050	121,600
39	21,900	29,250	35,050	43,800	52,600	65,700	87,650	131,450
40	23,650	31,550	37,800	47,250	56,750	70,900	94,550	141,800
41	25,450	34,000	40,750	50,900	61,100	76,350	101,800	152,700
42	27,350	36,550	43,800	54,700	65,650	82,100	109,450	164,150
43	29,350	39,200	47,000	58,750	70,450	88,100	117,450	176,200
44	31,450	42,000	50,350	62,900	75,500	94,400	125,850	188,750
45	33,650	44,950	53,850	67,300	80,750	100,950	134,600	201,950
46	35,950	48,000	57,500	71,900	86,300	107,850	143,800	215,700
47	38,350	51,200	61,350	76,700	92,050	115,050	153,400	230,050
48	40,850	54,550	65,350	81,700	98,050	122,550	163,400	245,050
49	43,450	58,050	69,500	86,900	104,300	130,350	173,800	260,700
50	46,150	61,650	73,850	92,350	110,800	138,500	184,650	277,000
51	49,000	65,450	78,400	98,000	117,600	147,000	195,950	293,950
52	51,950	69,350	83,100	103,850	124,650	155,800	207,700	311,600
53	55,000	73,450	87,950	109,950	131,950	164,950	219,950	329,900
54	58,150	77,700	93,050	116,300	139,550	174,450	232,600	348,950
55	61,450	82,050	98,300	122,900	147,450	184,350	245,800	368,650
56	64,850	86,650	103,750	129,700	155,650	194,600	259,450	389,150
57	68,400	91,350	109,450	136,800	164,150	205,200	273,600	410,350
58	72,050	96,250	115,300	144,100	172,950	216,200	288,250	432,350
59	75,850	101,300	121,350	151,700	182,050	227,550	303,400	455,100
60	79,750	106,550	127,650	159,550	191,450	239,300	319,100	478,650
61	83,850	111,950	134,150	167,650	201,200	251,500	335,300	502,950
62	88,000	117,550	140,850	176,050	211,250	264,050	352,100	528,100
63	92,350	123,350	147,750	184,700	221,650	277,050	369,400	554,100
64	96,800	129,300	154,900	193,600	232,350	290,450	387,250	580,900
65	101,400	135,450	162,300	202,850	243,400	304,250	405,700	608,550

Table 83C.—Resisting moments for poles of woods having an ultimate fiber stress of 5,600 pounds per square inch (western red cedar)—Contd.

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,400	1,870	2,240	2,800	3,360	4,200	5,600	8,400
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.- ft.*
66	106,200	141,800	169,900	212,350	254,850	318,550	424,700	637,050
67	111,100	148,350	177,700	222,150	266,600	333,250	444,300	666,450
68	116,150	155,100	185,800	232,250	278,700	348,400	464,500	696,750
69	121,300	162,050	194,100	242,650	291,200	363,950	485,300	727,950
70	126,700	169,200	202,700	253,350	304,000	380,050	506,700	760,050
71	132,200	176,550	211,500	264,350	317,250	396,550	528,750	793,100
72	137,850	184,150	220,550	275,700	330,850	413,550	551,400	827,100
73	143,650	191,900	229,850	287,350	344,800	431,000	574,700	862,050
74	149,650	199,900	239,450	299,300	359,200	448,950	598,650	897,950
75	155,800	208,100	249,300	311,600	373,950	467,400	623,250	934,850
76	162,100	216,550	259,400	324,250	389,100	486,350	648,500	972,750
77	168,600	225,200	269,750	337,200	404,650	505,800	674,450	1,011,650
78	175,250	234,100	280,400	350,500	420,650	525,800	701,050	1,051,550
79	182,100	243,200	291,350	364,200	437,000	546,250	728,350	1,092,550
80	189,100	252,550	302,550	378,200	453,800	567,300	756,350	1,134,550

Table 84.—Resisting moments for poles of woods with an ultimate fiber stress of 5,000 pounds per square inch (other yellow pine, cypress)

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,250	1,670	2,000	2,500	3,000	3,750	5,000	7,500
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
20	2,650	3,500	4,200	5,300	6,350	7,900	10,550	15,850
21	3,050	4,100	4,900	6,100	7,350	9,150	12,200	18,300
22	3,500	4,700	5,600	7,000	8,450	10,550	14,050	21,050
23	4,000	5,350	6,400	8,000	9,650	12,050	16,050	24,050
24	4,550	6,100	7,300	9,100	10,950	13,700	18,250	27,350
25	5,150	6,900	8,250	10,300	12,350	15,450	20,600	30,900
26	5,800	7,750	9,250	11,600	13,900	17,400	23,200	34,750
27	6,500	8,650	10,400	13,000	15,600	19,450	25,950	38,950
28	7,250	9,650	11,600	14,500	17,350	21,700	28,950	43,450
29	8,050	10,750	12,850	16,100	19,300	24,150	32,150	48,250
30	8,900	11,900	14,250	17,800	21,350	26,700	35,600	53,400
31	9,800	13,100	15,700	19,650	23,600	29,450	39,300	58,950
32	10,800	14,450	17,300	21,600	25,950	32,400	43,200	64,850
33	11,850	15,850	18,950	23,700	28,450	35,550	47,400	71,100
34	12,950	17,300	20,750	25,900	31,100	38,900	51,850	77,750
35	14,150	18,900	22,600	28,300	33,950	42,400	56,550	84,850

Table 84.—Resisting moments for poles of woods with an ultimate fiber stress of 5,000 pounds per square inch (other yellow pine, cypress)—Continued

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)							
	1,250	1,670	2,000	2,500	3,000	3,750	5,000	7,500
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
36	15,400	20,550	24,600	30,750	36,900	46,150	61,550	92,300
37	16,700	22,300	26,700	33,400	40,100	50,100	66,800	100,200
38	18,100	24,150	28,950	36,200	43,450	54,300	72,400	108,550
39	19,550	26,150	31,300	39,100	46,950	58,700	78,250	117,350
40	21,100	28,200	33,750	42,200	50,650	63,300	84,400	126,600
41	22,750	30,350	36,350	45,450	54,550	68,200	90,900	136,350
42	24,450	32,650	39,100	48,850	58,650	73,300	97,700	146,600
43	26,200	35,050	41,950	52,450	62,900	78,650	104,850	157,300
44	28,100	37,550	44,950	56,200	67,400	84,250	112,350	168,550
45	30,050	40,150	48,100	60,100	72,100	90,150	120,200	180,300
46	32,100	42,900	51,350	64,200	77,050	96,300	128,400	192,600
47	34,250	45,750	54,800	68,450	82,150	102,700	136,950	205,400
48	36,450	48,700	58,350	72,950	87,500	109,400	145,850	218,800
49	38,800	51,850	62,050	77,600	93,100	116,400	155,200	232,750
50	41,200	55,050	65,950	82,450	98,950	123,650	164,900	247,300
51	43,750	58,450	70,000	87,500	105,000	131,250	174,950	262,450
52	46,350	61,950	74,200	92,750	111,300	139,100	185,450	278,200
53	49,100	65,600	78,550	98,200	117,800	147,300	196,350	294,550
54	51,900	69,350	83,100	103,850	124,600	155,750	207,700	311,550
55	54,850	73,300	87,800	109,700	131,650	164,600	219,450	329,150
56	57,900	77,350	92,650	115,800	139,000	173,750	231,650	347,450
57	61,050	81,600	97,700	122,150	146,550	183,200	244,250	366,400
58	64,350	85,950	102,950	128,700	154,400	193,000	257,350	386,050
59	67,700	90,500	108,350	135,450	162,550	203,150	270,900	406,350
60	71,250	95,150	113,950	142,450	170,950	213,700	284,900	427,350
61	74,850	100,000	119,750	149,700	179,650	224,550	299,400	449,100
62	78,600	105,000	125,750	157,200	188,600	235,750	314,350	471,550
63	82,450	110,150	131,900	164,900	197,900	247,350	329,800	494,700
64	86,450	115,500	138,300	172,900	207,450	259,350	345,750	518,650
65	90,550	121,000	144,900	181,100	217,350	271,650	362,250	543,350
66	94,800	126,650	151,700	189,600	227,500	284,400	379,200	568,800
67	99,200	132,500	158,700	198,350	238,000	297,550	396,700	595,050
68	103,700	138,500	165,900	207,350	248,850	311,050	414,750	622,100
69	108,350	144,700	173,300	216,650	260,000	325,000	433,300	649,950
70	113,100	151,100	180,950	226,200	271,450	339,300	452,400	678,650
71	118,000	157,700	188,850	236,050	283,250	354,050	472,100	708,150
72	123,100	164,450	196,950	246,150	295,400	369,250	492,300	738,450
73	128,300	171,400	205,250	256,550	307,850	384,850	513,100	769,650
74	133,600	178,500	213,800	267,250	320,700	400,850	534,500	801,750
75	139,100	185,850	222,600	278,250	333,850	417,350	556,450	834,700
76	144,750	193,400	231,600	289,500	347,400	434,250	579,000	868,500
77	150,550	201,100	240,850	301,100	361,300	451,650	602,150	903,250
78	156,500	209,050	250,350	312,950	375,550	469,450	625,950	938,900
79	162,600	217,200	260,150	325,150	390,200	487,750	650,300	975,500
80	168,850	225,550	270,150	337,650	405,200	506,500	675,350	1,013,000

Table 85.—Resisting moments for poles of woods having ultimate fiber stress of 3,600 pounds per square inch (northern white cedar, redwood)

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)—							
	900	1,200	1,440	1,800	2,160	2,700	3,600	5,400
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
20	1,900	2,550	3,050	3,800	4,550	5,700	7,600	11,400
21	2,200	2,950	3,500	4,400	5,300	6,600	8,800	13,200
22	2,550	3,350	4,050	5,050	6,050	7,600	10,100	15,150
23	2,900	3,850	4,600	5,800	6,950	8,650	11,550	17,350
24	3,300	4,400	5,250	6,550	7,900	9,850	13,150	19,700
25	3,700	4,950	5,950	7,400	8,900	11,150	14,850	22,250
26	4,150	5,550	6,700	8,350	10,000	12,500	16,700	25,050
27	4,650	6,250	7,500	9,350	11,200	14,000	18,700	28,050
28	5,200	6,950	8,350	10,400	12,500	15,650	20,850	31,250
29	5,800	7,700	9,250	11,600	13,900	17,350	23,150	34,750
30	6,400	8,550	10,250	12,800	15,400	19,250	25,650	38,450
31	7,050	9,450	11,300	14,150	17,000	21,200	28,300	42,450
32	7,800	10,350	12,450	15,550	18,650	23,350	31,100	46,700
33	8,550	11,400	13,650	17,050	20,500	25,600	34,150	51,200
34	9,350	12,450	14,950	18,650	22,400	28,000	37,350	56,000
35	10,200	13,550	16,300	20,350	24,450	30,550	40,700	61,100
36	11,100	14,750	17,700	22,150	26,600	33,250	44,300	66,450
37	12,050	16,050	19,250	24,050	28,850	36,100	48,100	72,150
38	13,050	17,350	20,850	26,050	31,250	39,100	52,100	78,150
39	14,100	18,800	22,550	28,150	33,800	42,250	56,350	84,500
40	15,200	20,250	24,300	30,400	36,450	45,600	60,800	91,150
41	16,350	21,800	26,200	32,750	39,250	49,100	65,450	98,200
42	17,600	23,450	28,150	35,200	42,200	52,750	70,350	105,550
43	18,900	25,150	30,200	37,750	45,300	56,650	75,500	113,250
44	20,200	26,950	32,350	40,450	48,550	60,650	80,900	121,350
45	21,650	28,850	34,600	43,250	51,900	64,900	86,550	129,800
46	23,100	30,800	37,000	46,200	55,450	69,350	92,450	138,650
47	24,650	32,850	39,450	49,300	59,150	73,950	98,600	147,900
48	26,250	35,000	42,000	52,500	63,000	78,750	105,050	157,550
49	27,950	37,250	44,700	55,850	67,050	83,800	111,750	167,600
50	29,700	39,550	47,500	59,350	71,250	89,050	118,700	178,050
51	31,500	42,000	50,400	63,000	75,600	94,500	126,000	188,950
52	33,400	44,500	53,400	66,750	80,100	100,150	133,550	200,300
53	35,350	47,150	56,550	70,700	84,850	106,050	141,400	212,100
54	37,400	49,850	59,800	74,750	89,700	112,150	149,550	224,300
55	39,500	52,650	63,200	79,000	94,800	118,500	158,000	237,000
56	41,700	55,600	66,700	83,400	100,050	125,100	166,800	250,150
57	43,950	58,600	70,350	87,950	105,500	131,900	175,850	263,800
58	46,300	61,750	74,100	92,650	111,200	138,950	185,300	277,950
59	48,750	65,000	78,000	97,500	117,050	146,300	195,050	292,550
60	51,300	68,400	82,050	102,550	123,100	153,850	205,150	307,700
61	53,900	71,850	86,200	107,800	129,350	161,650	215,550	323,350
62	56,600	75,450	90,550	113,150	135,800	169,750	226,350	339,500
63	59,350	79,150	95,000	118,750	142,500	178,100	237,450	356,200
64	62,250	83,000	99,600	124,500	149,350	186,700	248,950	373,450
65	65,200	86,950	104,300	130,400	156,500	195,600	260,800	391,200
66	68,250	91,000	109,200	136,500	163,800	204,750	273,050	409,550
67	71,400	95,200	114,250	142,800	171,400	214,200	285,650	428,450
68	74,650	99,550	119,450	149,300	179,150	223,950	298,600	447,900
69	78,000	104,000	124,800	156,000	187,200	234,000	312,000	467,950
70	81,450	108,600	130,300	162,850	195,450	244,300	325,750	488,600

Table 85.—Resisting moments for poles of woods having ultimate fiber stress of 3,600 pounds per square inch (northern white cedar, redwood)—Continued

Circumference at ground line (inches)	Resisting moments for fiber stress of (pounds per square inch)—							
	900	1,200	1,440	1,800	2,160	2,700	3,600	5,400
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
71	85,000	113,300	135,950	169,950	203,950	254,950	339,900	509,850
72	88,600	118,150	141,800	177,250	212,700	265,850	354,450	531,700
73	92,350	123,150	147,800	184,700	221,650	277,100	369,450	554,150
74	96,200	128,300	153,950	192,400	230,900	288,600	384,850	577,250
75	100,150	133,550	160,250	200,300	240,400	300,500	400,650	600,950
76	104,200	138,950	166,750	208,450	250,150	312,650	416,900	625,350
77	108,400	144,500	173,400	216,800	260,150	325,150	433,550	650,350
78	112,650	150,200	180,250	225,350	270,400	338,000	450,650	676,000
79	117,050	156,100	187,300	234,100	280,950	351,150	468,250	702,350
80	121,550	162,100	194,500	243,100	291,750	364,700	486,250	729,350

When pole timbers are used that have ultimate strengths different from those listed, the dimensions of the poles of grades A, B, or C to withstand the vertical and transverse loads assumed in the National Electrical Safety Code, section 25, may be determined by application of the ratios of ultimate fiber stress of the wood to allowable fiber stress as installed under the various conditions stipulated in Table 87A.

Table 87A.—Ratio of ultimate fiber stresses of wood poles to allowable fiber stresses under vertical and transverse loading, grade A, B, or C

Situation and grade	When installed		At replacement
	Treated poles	Untreated poles	Treated or untreated poles
At crossings:			
Poles in lines of one grade of construction throughout—			
Grade A	3	3	2
Grade B	2	2	1⅓
Grade C	1⅓	1⅓	⅔
Poles in isolated sections of higher grade of construction in lines of a lower grade of construction—			
Grade A	3	4	2
Grade B	2	3	1⅓
Grade C	1⅓	1⅔	⅔
Elsewhere than at crossings:			
Grade A	2½	3	1⅔
Grade B	1⅔	2	1
Grade C	1	1⅓	⅔

TRANSVERSE LOADS ON POLES

Transverse and vertical loads on poles of grades A, B, C, D, or E are assumed to act simultaneously. The fiber stresses caused by the transverse wind forces on poles and wires must therefore be added to the fiber stresses caused by the weights of the loaded conductors supported when determining the safety of the pole.

Transverse loads on a line result in a bending moment on unguyed poles. The bending moment at the ground line is determined by multiplying the transverse force resulting from the assumed loads of section 25, by the height of the transverse force.

The transverse force acting on the conductors in lines of grades A, B, C, D, and E for any given loading district may be found by use of the values of transverse loads on conductors per foot of length given in National Electrical Safety Code, Table 82. The transverse force in pounds contributed by each conductor is obtained by multiplying the transverse force per foot by the span length in feet or by one-half the sum of the adjacent spans. The moment in pound-feet due to the transverse force on each conductor, acting at the ground line of the pole, is found by multiplying this force by the height in feet at which it is applied. The total moment in pound-feet acting at the ground line of the pole is the sum of the moments resulting from conductors or messengers contributing to the transverse load under the loading assumptions, and the moment resulting from the transverse wind pressure on the pole itself. The moment in pound-feet resulting from the transverse wind force on the pole itself, assuming a pole of circular cross section tapering uniformly, may be obtained from Table 87B, or from the following formulas:

For heavy and medium loading, $M = 4\ (D + 2d)\ h^2/3$ pound-feet.

For light loading, $M = 2\ (D + 2d)\ h^2$ pound-feet.

where

D = diameter at ground line in feet.
d = diameter at top in feet.
h = height of pole in feet.

Table 87B.—Moments due to wind pressure on poles

HEAVY AND MEDIUM LOADING

T=Top circumference in inches G=Ground-line circumference in inches	Moment due to wind pressure on poles of various heights above ground							
	15 feet	17 feet	20 feet	24.5 feet	29 feet	34 feet	38.5 feet	43 feet
$2T+G=K$	For intermediate value of K interpolate by using these differences per unit							
	8	10	14	21	30	41	52	65
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
52	414	532	736					
56	446	572	792	1,189	1,666			
60	477	613	849	1,274	1,785	2,453	3,145	3,924
64	509	654	905	1,359	1,904	2,617	3,355	4,185
68	541	695	962	1,444	2,023	2,780	3,565	4,447
72	573	736	1,019	1,529	2,142	2,944	3,775	4,708
76	605	777	1,075	1,613	2,261	3,107	3,984	4,970
80	637	818	1,132	1,698	2,380	3,271	4,194	5,232
84	668	859	1,188	1,783	2,499	3,434	4,404	5,493
88	700	899	1,245	1,868	2,617	3,598	4,613	5,755
92	732	940	1,302	1,953	2,736	3,761	4,823	6,016
96	764	981	1,358	2,038	2,855	3,925	5,033	6,278
100	796	1,022	1,415	2,123	2,974	4,089	5,242	6,539
104	828	1,063	1,471	2,208	3,093	4,252	5,452	6,801
108	859	1,104	1,528	2,293	3,212	4,416	5,662	7,063
112	891	1,145	1,584	2,378	3,331	4,579	5,871	7,324
116		1,186	1,641	2,463	3,450	4,743	6,081	7,586
120		1,227	1,698	2,548	3,569	4,906	6,291	7,847
124			1,754	2,632	3,688	5,070	6,501	8,109
128				2,717	3,807	5,233	6,710	8,371
132				2,802	3,926	5,397	6,920	8,632
136					4,045	5,560	7,130	8,894
140					4,164	5,724	7,339	9,155
144						5,887	7,549	9,417
148						6,051	7,759	9,678
152						6,215	7,968	9,940
156						6,378	8,178	10,200
160						6,542	8,388	10,460
164						6,705	8,598	10,720
168						6,869	8,807	10,990

Table 87B.—Moments due to wind pressure on poles—Continued

HEAVY AND MEDIUM LOADING—Continued

T=Top circumference in inches G=Ground-line circumference in inches	Moment due to wind pressure on poles of various heights above ground					
	48 feet	52.5 feet	57 feet	62 feet	66.5 feet	71 feet
$2T+G=K$	For intermediate values of K interpolate by using these differences per unit					
	82	98	115	136	156	178
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
68	5,541					
72	5,867	7,019				
76	6,193	7,409				
80	6,519	7,799	9,193	10,880		
84	6,845	8,189	9,652	11,420		
88	7,171	8,578	10,110	11,960	13,760	15,690
92	7,497	8,968	10,570	12,510	14,390	16,400
96	7,823	9,358	11,030	13,050	15,010	17,120
100	8,149	9,748	11,490	13,600	15,640	17,830
104	8,475	10,140	11,950	14,140	16,270	18,540
108	8,801	10,530	12,410	14,680	16,890	19,260
112	9,127	10,920	12,870	15,230	17,520	19,970
116	9,453	11,310	13,330	15,770	18,140	20,680
120	9,778	11,700	13,790	16,310	18,770	21,390
124	10,100	12,090	14,250	16,860	19,390	22,110
128	10,430	12,480	14,710	17,400	20,020	22,820
132	10,760	12,870	15,170	17,950	20,650	23,530
136	11,080	13,260	15,630	18,490	21,270	24,250
140	11,410	13,650	16,090	19,030	21,900	24,960
144	11,730	14,040	16,550	19,580	22,520	25,670
148	12,060	14,430	17,010	20,120	23,150	26,390
152	12,390	14,820	17,470	20,660	23,770	27,100
156	12,710	15,210	17,930	21,210	24,400	27,810
160	13,040	15,600	18,390	21,750	25,020	28,530
164	13,360	15,990	18,850	22,300	25,650	29,240
168	13,690	16,380	19,300	22,840	26,280	29,950
172	14,020	16,770	19,760	23,380	26,900	30,670
176	14,340	17,160	20,220	23,930	27,530	31,380

Table 87B.—Moments due to wind pressure on poles—Continued

LIGHT LOADING

T=Top circumference in inches G=Ground-line circumference in inches	Moment due to wind pressure on poles of various heights above ground							
	15 feet	17 feet	20 feet	24.5 feet	29 feet	34 feet	38.5 feet	43 feet
$2T+G=K$	For intermediate values of K interpolate by using these differences per unit							
	12	15	21	32	45	61	79	98
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
52	620	797	1,103					
56	668	859	1,188	1,783	2,499			
60	716	920	1,273	1,911	2,677	3,680	4,718	5,886
64	764	981	1,358	2,038	2,855	3,925	5,033	6,278
68	811	1,043	1,443	2,165	3,034	4,170	5,347	6,670
72	859	1,104	1,528	2,293	3,212	4,416	5,662	7,063
76	907	1,165	1,613	2,420	3,391	4,661	5,976	7,455
80	955	1,227	1,698	2,548	3,569	4,906	6,291	7,847
84	1,002	1,288	1,783	2,675	3,748	5,152	6,605	8,240
88	1,050	1,349	1,867	2,802	3,926	5,397	6,920	8,632
92	1,098	1,411	1,952	2,930	4,105	5,642	7,234	9,025
96	1,146	1,472	2,037	3,057	4,283	5,887	7,549	9,417
100	1,193	1,533	2,122	3,184	4,462	6,133	7,864	9,809
104	1,241	1,595	2,207	3,312	4,640	6,378	8,178	10,200
108	1,289	1,656	2,292	3,439	4,819	6,623	8,493	10,590
112	1,337	1,717	2,377	3,567	4,997	6,869	8,807	10,990
116		1,779	2,462	3,694	5,176	7,114	9,122	11,380
120		1,840	2,546	3,821	5,354	7,359	9,436	11,770
124			2,631	3,949	5,532	7,605	9,751	12,160
128				4,076	5,711	7,850	10,070	12,560
132				4,203	5,889	8,095	10,380	12,950
136					6,068	8,341	10,690	13,340
140					6,246	8,586	11,010	13,730
144						8,831	11,320	14,130
148						9,076	11,640	14,520
152						9,322	11,950	14,910
156						9,567	12,270	15,300
160						9,812	12,580	15,700
164						10,060	12,900	16,090
168						10,300	13,210	16,480

Table 87B.—Moments due to wind pressure on poles—Continued

LIGHT LOADING—Continued

T=Top circumference in inches G=Ground-line circumference in inches	Moment due to wind pressure on poles of various heights above ground					
	48 feet	52.5 feet	57 feet	62 feet	66.5 feet	71 feet
$2T+G=K$	For intermediate values of K interpolate by using these differences per unit					
	122	145	172	205	235	270
	Lb.-ft.	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*	*Lb.-ft.*
68	8,312					
72	8,801	10,530				
76	9,290	11,110				
80	9,778	11,700	13,790	16,310		
84	10,270	12,280	14,480	17,130		
88	10,760	12,870	15,170	17,950	20,650	23,530
92	11,250	13,450	15,860	18,760	21,580	24,600
96	11,730	14,040	16,550	19,580	22,520	25,670
100	12,220	14,620	17,240	20,390	23,460	26,740
104	12,710	15,210	17,930	21,210	24,400	27,810
108	13,200	15,790	18,620	22,020	25,340	28,880
112	13,690	16,380	19,300	22,840	26,280	29,950
116	14,180	16,960	19,990	23,660	27,210	31,020
120	14,670	17,550	20,680	24,470	28,150	32,090
124	15,160	18,130	21,370	25,290	29,090	33,160
128	15,650	18,720	22,060	26,100	30,030	34,230
132	16,130	19,300	22,750	26,920	30,970	35,300
136	16,620	19,890	23,440	27,730	31,910	36,370
140	17,110	20,470	24,130	28,550	32,850	37,440
144	17,600	21,060	24,820	29,370	33,780	38,510
148	18,090	21,640	25,510	30,180	34,720	39,580
152	18,580	22,230	26,200	31,000	35,660	40,650
156	19,070	22,810	26,890	31,810	36,600	41,720
160	19,560	23,400	27,580	32,630	37,540	42,790
164	20,050	23,980	28,270	33,440	38,480	43,860
168	20,530	24,570	28,960	34,260	39,410	44,930
172	21,020	25,150	29,650	35,080	40,350	46,000
176	21,510	25,740	30,340	35,890	41,290	47,070

The values of moments due to wind pressure given in Table 87B are based upon a number K which is found by adding the ground-line circumference to twice the value of the pole-top circumference in inches. By combining the two circumferences in this way, the table is simplified and greatly reduced in extent. Having found K, the value for the

moment due to wind pressure is given in the same line as the value for K and in the column which is headed by the height above ground of the given pole. For intermediate values of K the proper value can be found by interpolation, using the differences given at the head of each column. The tabulated values give more significant figures than would otherwise be warranted, in order to avoid inaccuracies in interpolation.

Another method of determining the moment due to wind pressure on the pole is given in the nomogram of Figure 1. To use this nomogram, one determines, as before, the value of K, and this can be done graphically by laying a straight-edge between proper points on the scales labeled T and G. On scale T find the value representing the circumference of the top of the pole in inches. On scale G find the value for the ground-line circumference. The straight line joining these two points will intersect the scale for K at a point giving its value. Now find on the scale of pole heights the proper point for a given pole and connect this point with the point already found on the K scale. Where this straight line intersects the scale of moments will be found the desired value for the moment due to wind pressure on the given pole, in heavy or medium loading territory. For light loading territory, 50 per cent must be added to this value, since the loading specification for light loading territory is based upon a wind pressure of 12 lbs./ft.^{2} whereas in heavy and medium territory the wind pressure is assumed to be only 8 lbs./ft.^{2} No consideration is given to a coating of ice in computing the wind pressure or bending moment on the pole.

When computing the total moment to be resisted by a pole under heavy or medium loading, supporting 10 wires or less, not including cables carried by messengers, it is found by adding together the moments due to each conductor and each cable and messenger and that due to the pole itself.

When the pole is carrying more than 10 wires not including cables supported by messengers, and the pin spacing does not exceed 15 inches, the moment due to the wires is calculated for two-thirds of the total number, but for not less than 10 wires. The moment due to the wires thus calculated is added to that due to the cables and messengers and the pole

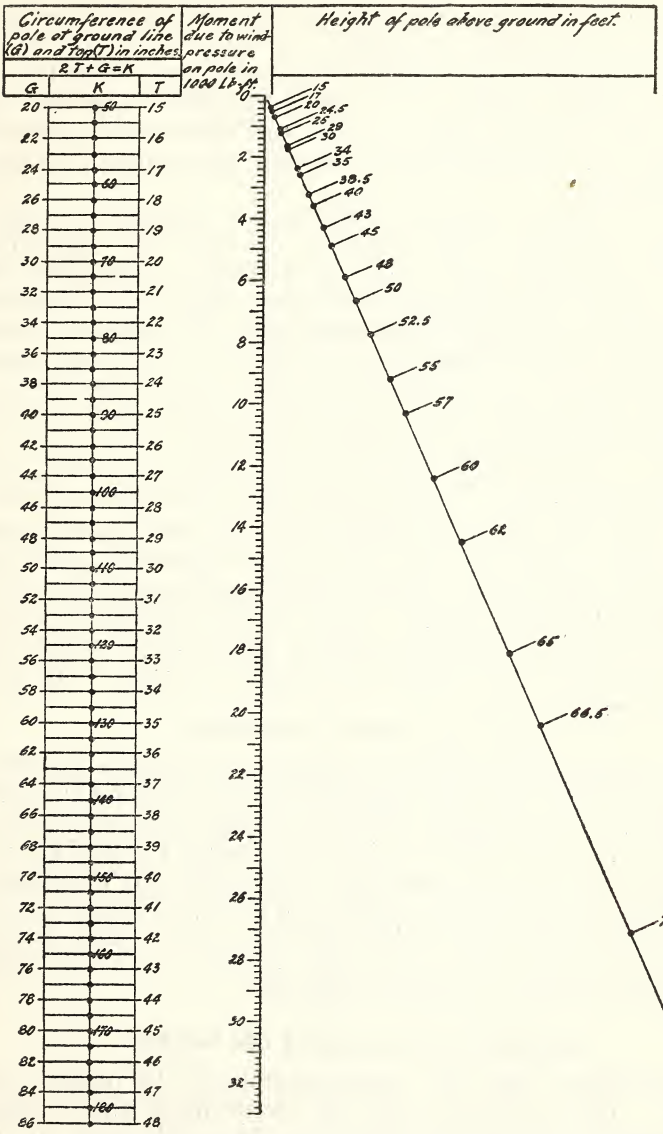

FIGURE 1.—*Moments due to wind pressure on poles*

HEAVY AND MEDIUM LOADING

(For light loading, increase moments by 50 per cent)

itself to find the total moment to be resisted by the pole under heavy or medium loading.

When computing the total moment to be resisted by a pole under light loading, it is found by adding together the moment due to each wire or cable and that due to the pole itself with no mitigation even though the number of wires carried is large.

When a trolley contact conductor is supported from a pole also carrying other wires or cables, the transverse moment resulting from the trolley contact conductors is added as part of the total moment to be resisted by the pole.

At angles in a line an unbalanced side pull is imposed on the corner pole due to change in direction of the conductors. The total moment to be resisted in this case is that due to a transverse load equal to the resultant of all conductor and messenger tensions under loaded conditions.

When considering the safety of poles of grades A, B, C, D, or E, the fiber stress caused by the moments of the transverse wind forces on poles and conductors must be added to the fiber stresses caused by the vertical loads carried by the pole. The sum of these fiber stresses should be less than the maximum allowable fiber stress. Table 20 lists maximum allowable fiber stresses for certain timbers, and Table 87A gives the factors of safety for different situations of grade A, B, or C construction.

VERTICAL LOADS ON POLES

The vertical force acting on conductors in lines of grades A, B, C, D, or E for any loading district may be found by use of the values of the weight of loaded conductors per foot of length given in the National Electrical Safety Code, Table 81. The vertical force in pounds for each conductor is obtained by multiplying the loaded weight per foot by the span in feet or by one-half the sum of the adjacent spans. The vertical force supported by the pole is the sum of conductor loads. The weight of the pole itself is neglected.

LONGITUDINAL LOADS ON POLES

Longitudinal loads on a pole result from the pulls of conductors. The conductor pulls are determined under loaded conditions in conformity with the assumed loads of the National Electrical Safety Code, section 25.

The bending moment in pound-feet at the ground line is determined by multiplying the pull in pounds of each conductor contributing to the longitudinal load under the loading assumptions by its height in feet. If the conductors are strung to the recommended sags of Appendix A, the pull in the conductors under loaded conditions may be found in Tables 38 to 43, inclusive, of Appendix A, National Electrical Safety Code. These tables cover various types of copper conductors. If the conductors are strung to the minimum permissible sags of grades A, B, or C, the tensions will be 50 per cent of the breaking tension for grades A and B and 60 per cent for grade C. The breaking tensions of various types of line conductors may be found in the tables of mechanical data for wires and cables of Appendix D, National Electrical Safety Code. If the conductors are strung to sags differing from those mentioned above, the tensions under loaded conditions may be obtained by calculation.

The longitudinal pull of communication conductors may always be assumed to be one-half their breaking tension regardless of the sag (see N. E. S. C., Appendix D, for tables of breaking strength), except in grade A or B joint lines, where this is applicable only if conductors are smaller than No. 8 Stl. W. G. steel or No. 6 A. W. G. copper.

At dead ends and angles the longitudinal moment is computed by adding together the moments of all unbalanced conductor and cable pulls. In these situations the resisting moment of the pole is based on the allowable maximum fiber stresses for transverse loads in the same loading district and of the same grade of construction. In all other situations the resisting moment of the pole is based on the allowable fiber stresses for longitudinal loads.

When computing the longitudinal moment where a change of grade occurs in a line, the longitudinal loading upon poles at the ends of sections required to be grade A or B construction in lines of a lower grade is taken as an unbalanced pull in the direction of the higher-grade section equal to the total pull in one direction of all conductors and cables supported. This longitudinal load may be mitigated for higher-grade sections having no span exceeding 500 feet in length where the total pull in the direction of the higher grade exceeds 30,000 pounds.

In this case the longitudinal force is modified to 30,000 pounds plus one-fourth the excess above 30,000, with a maximum of 50,000 pounds.

When computing the longitudinal moment where a line is built throughout its length, or between dead-ended points, of grade A or B construction, although not so required, the longitudinal force upon poles at crossings, at ends of sections of joint use, and at ends of conflicts required to be of grade A or B construction, respectively, is taken as an unbalanced pull in the direction of the crossing, conflict or joint-use section equal to the pull of one-third of the total number of conductors carried, not including overhead ground wires. The one-third selected for computation must be a whole number or the next larger whole number and must be selected to produce the maximum stress in the pole.

DEPRECIATION OF WOOD POLES

The original Tables 86 and 88 in the National Electrical Safety Code depend upon the ratio of fiber stress when installed to fiber stress when depreciated and consequently are not affected by the absolute value of the ultimate fiber stress. These tables consequently remain unchanged and it is not considered necessary to reproduce them here.

ALLOWABLE NUMBER OF WIRES ON A GIVEN POLE WITHOUT SIDE GUYS

Table 89 in the National Electrical Safety Code gives the allowable number of No. 4 wires to be carried by 35-foot poles of woods having an ultimate fiber stress of 5,000 lbs./in.^{2} This table will no longer apply to chestnut and western red cedar, which under the new standards are permitted to carry a larger load.

Tables 90 and 91 applying to poles which are supported by side guys are not affected.

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