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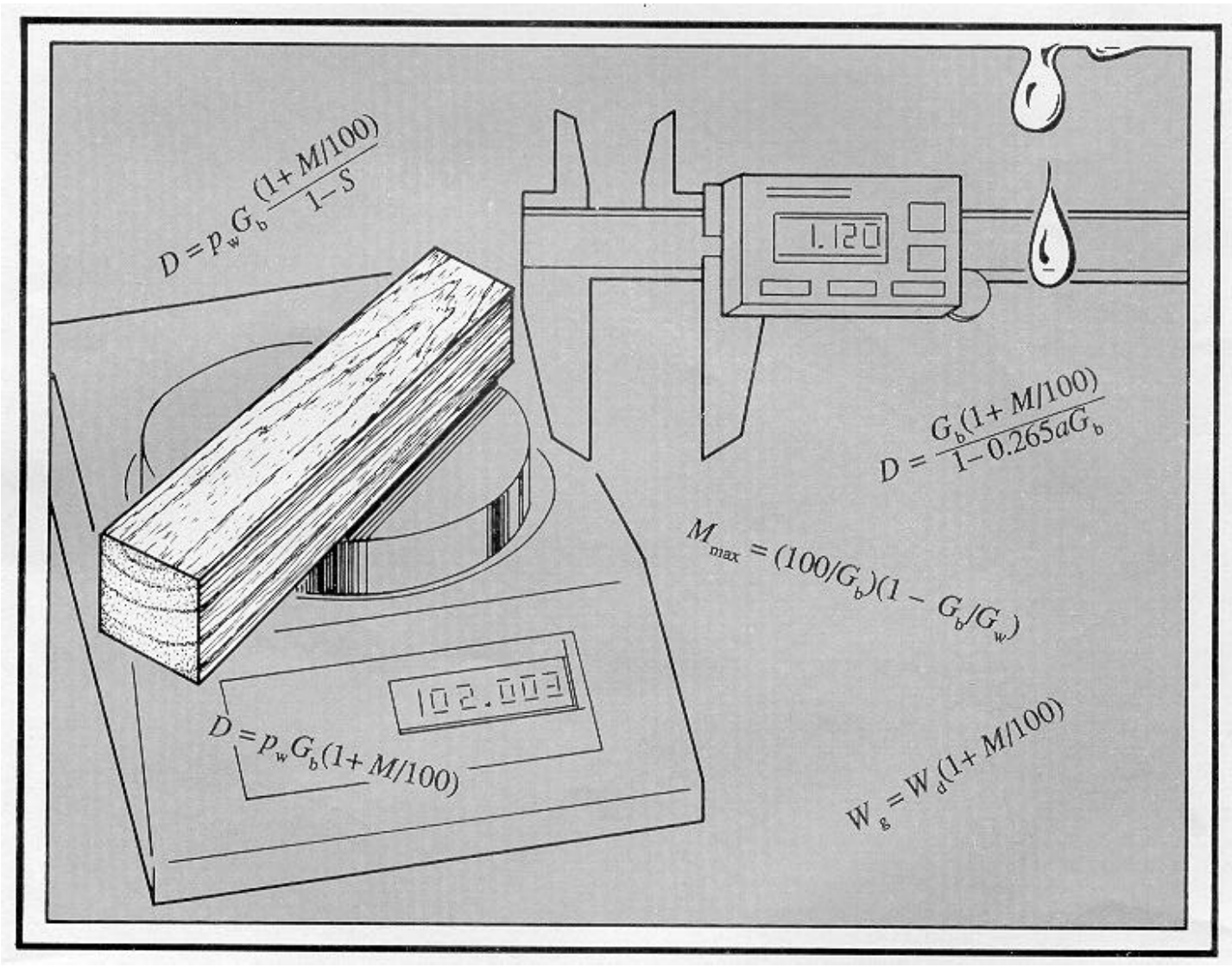
General
Technical
Report
FPL-GTR-76

Specific Gravity, Moisture Content, and Density Relationship for Wood

William T. Simpson



Abstract

This report reviews the basis for determining values for the density of wood as it depends on moisture content and specific gravity. The data are presented in several ways to meet the needs of a variety of users.

Keywords: Specific gravity, density, wood weight

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Errata

Page 1, column 2, Equation (2)

$$D = (W_d/V_g)\,(1 + M/100) \qquad (2)$$

The term W_d/V_g is related to basic specific gravity G_b by

Pages 9-12, Tables 5-8. Note on tables should read

Exceeds maximum possible moisture content

Page 13, Appendix, Equation (la)

$$G_b = (W_d/V_g)p_w \qquad (1a)$$

where W_d is oven-dry weight of wood, V_{gg} is volume of green wood, and p_w is density of water.

Page 13, Appendix, Equation (4*a*)

$$S = (V_g - V_M)/V_g$$

or

$$V_M = V_g\,(1 - S) \qquad (4a)$$

Specific Gravity, Moisture Content, and Density Relationship for Wood

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Introduction

Knowledge about the density of wood is useful for estimating shipping weights. The density of wood depends on specific gravity and moisture content. A common way to present density data is in tabular and graphical form, where density in pounds per cubic foot or kilograms per cubic meter is shown for a series of specific gravity and moisture content values. This kind of system is shown in the *Wood Handbook* (FPL 1987). However, the system has several shortcomings.

One shortcoming is that density values in the *Wood Handbook* are shown for moisture contents above the maximum possible for those specific gravity values (Tables 1 and 2). Another shortcoming is that this system requires two steps: first, a graphical conversion of specific gravity from one volume base to another, and then a reading from a table. Furthermore, no equations are offered for direct calculation of density as a function of moisture content and specific gravity, which precludes easy use of the system in computer programs or spreadsheet calculations. Finally, the system is subject to misinterpretation and thus can yield erroneous density values if the user is not aware of the various definitions of specific gravity as it applies to wood.

This report discusses these shortcomings and develops equations, graphs, and tables for determining density as a function of moisture content and several common definitions of specific gravity.

System for Determining Wood Density

The common definition of wood moisture content on a dry basis can be written as

$$W_g = W_d(1 + M/100) \quad (1)$$

where W_g is the green weight of wood (pounds or kilograms) at moisture content M (percent), and W_d is the oven-dry weight of wood.

Dividing both sides of Equation (1) by the volume of wood at moisture content $M(V_g)$, the density D is

$$D = (W_d/a_g)(1 + M/100) \quad (2)$$

The term $W_d V_g$ is related to basic specific gravity G_b by

$$W_d/V_g = p_w G_b \quad (3)$$

where p_w is the density of water (62.4 lb/ft^3 or 1,000 kg/m^3) based on volume when above 30 percent moisture content. Substituting Equation (3) into Equation (2) results in the following equation for calculating density:

$$D = p_w G_b(1 + M/100) \quad (4)$$

A possible misapplication of Equation (4) is to use it at <30 percent moisture content with no correction in specific gravity for volumetric shrinkage. It is also possible to overlook or misunderstand the definition of specific gravity in the ***Wood Handbook,*** which could cause a user to read incorrect density values from the tables. Specific gravity is defined on the basis of volume at the tabulated moisture content- not on the more common basis of green volume, as is used to define basic specific gravity. Misunderstandings can cause errors 115 percent, as will be illustrated in another section of this report.

The ***Wood Handbook*** describes a graphical way to convert basic specific gravity to specific gravity based

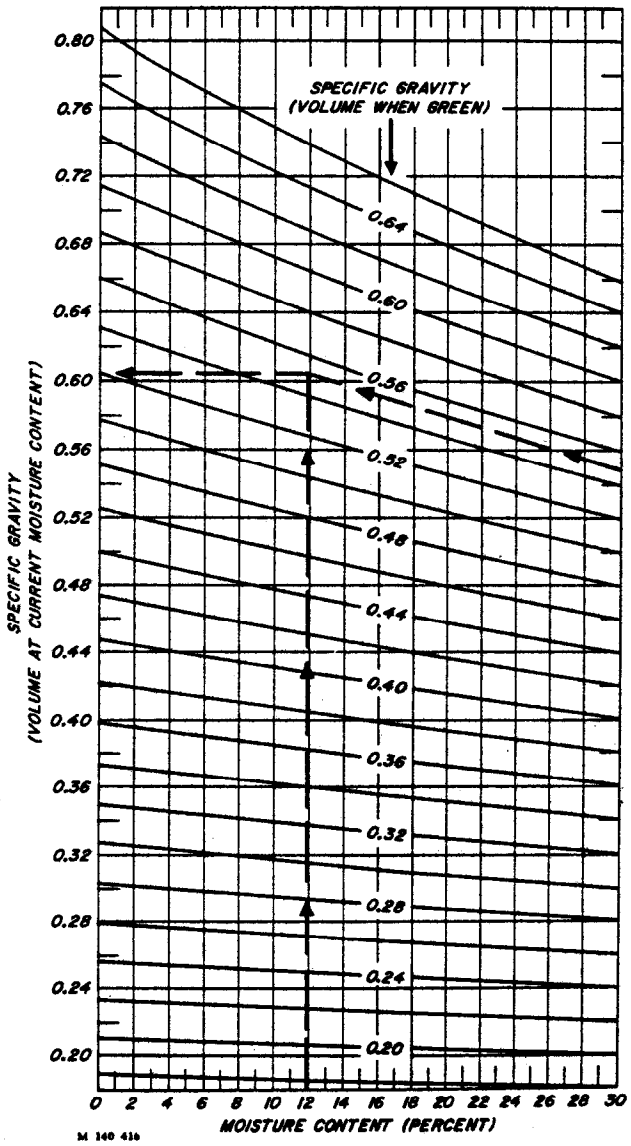

Figure 1—Relation of specific gravity to moisture content. Follow line for specific gravity (volume when green) to desired moisture content, then read specific gravity (volume at current moisture content) from vertical axis. Source: Wood Handbook, Figures 3 and 4 (FPL 1987).

on volume at any of the tabulated moisture contents (Fig. 1). Density values can then be read from the tables after the conversion. Although this system of determining density values is valid, it requires two steps and the use of both a graph and a table. The same density information can be presented in one table or one graph.

The maximum moisture content of wood is reached when the cell walls and cell lumens are completely filled with water. When specific gravity is high, lumen volume is low and maximum moisture content is

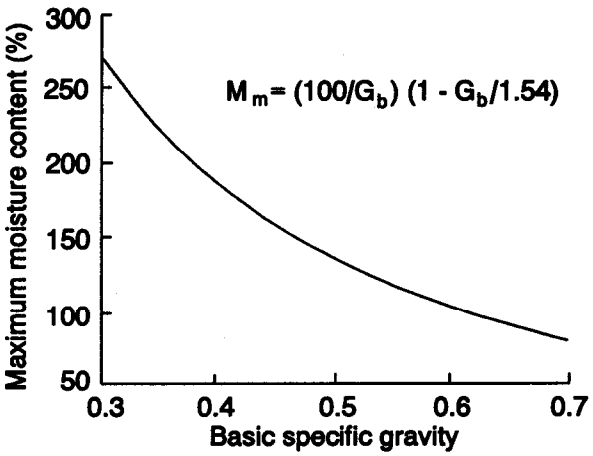

Figure 2—Theoretical maximum possible moisture content of wood (M_{max}) as a function of basic specific gravity (G_b).

therefore restricted. This relationship can be estimated by

$$M_{max} = (100/G_b)(1 - G_b/G_w) \quad (5)$$

where M_{max} is maximum moisture content and G_w is the specific gravity of wood substance, equal to approximately 1.54 (Skaar 1988). Equation (5) is shown in Figure 2.

Therefore, some density values at high specific gravity and moisture content values in Table 1 are not possible because the tabulated moisture content exceeds the maximum possible moisture content. These conditions will be discussed later in this report.

Density Tables

Basic Specific Gravity

Equation (4) can be used to change the basis of tabulated density values below 30 percent moisture content from specific gravity baaed on volume at tabulated moisture content to basic specific gravity if volume is corrected for shrinkage. Assuming a linear relationship between shrinkage and moisture content from 30 to 0 percent (Stamm 1964), the volumetric shrinkage S at any moisture content is

$$S = aS_t \quad (6)$$

where a is (30 - M)/30 and S_t is total volumetric shrinkage from 30 to 0 percent moisture content.

Introducing Equation (6) into Equation (4) to account for shrinkage

$$D = p_w G_b \frac{(1 + M/100)}{1 - S} \quad (7)$$

Volumetric shrinkage data are necessary for using Equation (7). Each species has its own S_t value, and ideally there would be a density table for each species. However, this would be somewhat cumbersome and may not be necessary, given the inherent variability of wood and the known relationship between volumetric shrinkage and basic specific gravity. Stamm (1964) summarized the background on this relationship. The result is that volumetric shrinkage of both hardwoods and softwoods can be reasonably approximated by

$$S_t = 0.265 G_b \quad (8)$$

Therefore, even if a density table is not constructed for each species, Equation (8) accounts for the major source of variation in shrinkage between species.

Combining Equations (6) to (8) results in

$$D = \frac{G_b(1 + M/100)}{1 - 0.265 a G_b} \quad (9)$$

The results of Equation (9) are listed in Table 3 and shown in Figure 3. Table 3 also shows maximum moisture content and density values. (The data in Table 3 are expressed in SI units in Table 4.)

The following example illustrates how using the incorrect specific gravity results in an incorrect density value. Suppose the user wants to know the density of wood when specific gravity is 0.56 and moisture content is 8 percent. If the volume basis for this given specific gravity is not clear, or if the user is not aware of the importance of the volume basis, the user might go directly to the tabular data (Table 1) and read a density of 37.7 lb/ft^3 (605 kg/m^3). If the given specific gravity of 0.56 is the basic specific gravity, the correct density is 42.3 lb/ft^3 (679 kg/m^3) (Table 3) and the incorrect value is in error by 11 percent. Although this may seem an unlikely error for specialists in wood technology, it does not seem unlikely for someone who does not realize the necessity of knowing the exact definition of specific gravity for specific tables or handbooks. These definitions, if present, are often cited in footnotes that can be overlooked or ignored.

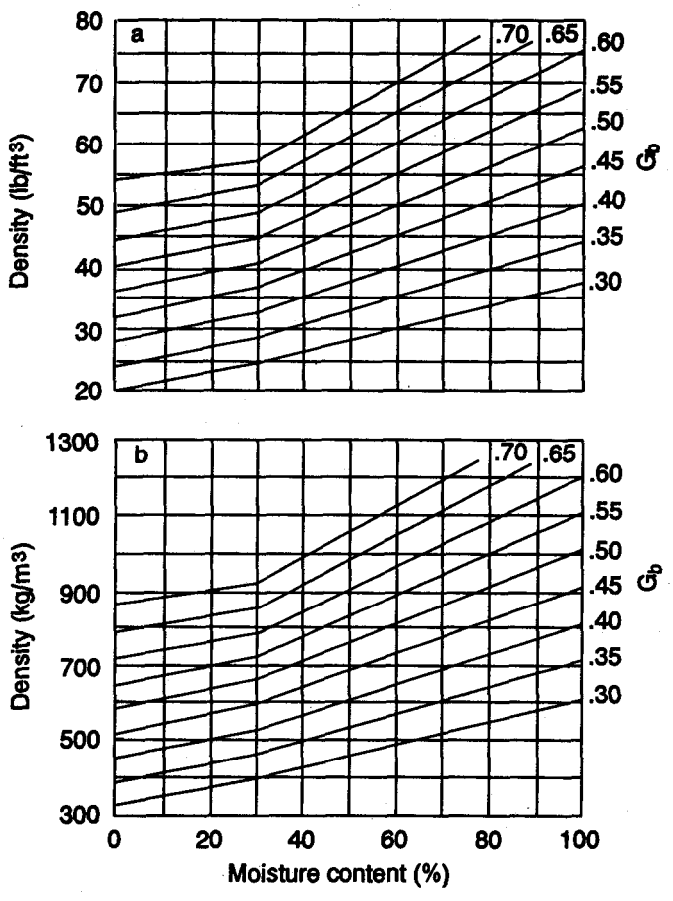

Figure 3—Density of wood as a function of moisture content and basic specific gravity (G_b); (a) English units, (b) SI units.

Other Specific Gravity Values

Some references list specific gravity values on a basis other than green volume; in those cases, Table 3 is of no use in determining density values. Oven-dry volume (Hildebrand 1970) and volume at 12 percent moisture content (Chichignoud and others 1990) are common alternative bases. Equation (9) can be generalized for specific gravity baaed on volume at any moisture content if we develop the relationship between basic specific gravity and specific gravity based on the other volumes (Appendix). The result of this relationship is

$$G_b = \frac{G_M}{1 + 0.265 a G_M} \quad (10)$$

where G_M is specific gravity based on volume at moisture content M. Equation (10) is substituted into Equation (9) for moisture contents <30 percent and into Equations (3) and (4) for moisture contents ≥30 percent.

Table 5 is a density table for specific gravity based on volume at 12 percent moisture content ($G_M = G_{12}$)

(see Table 6 for SI units). Table 7 shows specific gravity values based on oven-dry volume ($G_M = G_O$) (see Table 8 for SI values).

Concluding Remarks

The validity and efficiency of a method for determining the density of wood at various combinations of specific gravity and moisture content depend on an understanding of the definition of specific gravity. Because specific gravity depends on wood volume, shrinkage must be accounted for when determining specific gravity below the fiber saturation point. The equations and tables described in this report can be used to determine density at any moisture content and specific gravity.

References

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Stamm, A.J. 1964. Wood and cellulose science. New York: The Ronald Press. 549 p.

Table 1—*Wood Handbook* data for determining wood density[a]

M[b]	Density (lb/ft^3) at various levels of specific gravity[c]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	18.7	20.0	21.2	22.5	23.7	25.0	26.2	27.5	28.7	30.0	31.2	32.4	33.7	34.9	36.2	37.4	38.7	39.9	41.2	42.4	43.7
4	19.5	20.8	22.1	23.4	24.7	26.0	27.3	28.6	29.9	31.2	32.4	33.7	35.0	36.3	37.6	38.9	40.2	41.5	42.8	44.1	45.4
8	20.2	21.6	22.9	24.3	25.6	27.0	28.3	29.7	31.0	32.3	33.7	35.0	36.4	37.7	39.1	40.4	41.8	43.1	44.5	45.8	47.2
12	21.0	22.4	23.8	25.2	26.6	28.0	29.4	30.8	32.1	33.5	34.9	36.3	37.7	39.1	40.5	41.9	43.3	44.7	46.1	47.5	48.9
16	21.7	23.2	24.6	26.1	27.5	29.0	30.4	31.8	33.3	34.7	36.2	37.6	39.1	40.5	42.0	43.4	44.9	46.3	47.8	49.2	50.7
20	22.5	24.0	25.5	27.0	28.5	30.0	31.4	32.9	34.4	35.9	37.4	38.9	40.4	41.9	43.4	44.9	46.4	47.9	49.4	50.9	52.4
24	23.2	24.8	26.3	27.9	29.4	31.0	32.5	34.0	35.6	37.1	38.7	40.2	41.8	43.3	44.9	46.4	48.0	49.5	51.1	52.6	54.2
28	24.0	25.6	27.2	28.8	30.4	31.9	33.5	35.1	36.7	38.3	39.9	41.5	43.1	44.7	46.3	47.9	49.5	51.1	52.7	54.3	55.9
32	24.7	26.4	28.0	29.7	31.3	32.9	34.6	36.2	37.9	39.5	41.2	42.8	44.5	46.1	47.8	49.4	51.1	52.7	54.4	56.0	57.7
36	25.5	27.2	28.9	30.6	32.2	33.9	35.6	37.3	39.0	40.7	42.4	44.1	45.8	47.5	49.2	50.9	52.6	54.3	56.0	57.7	59.4
40	26.2	28.0	29.7	31.4	33.2	34.9	36.7	38.4	40.2	41.9	43.7	45.4	47.2	48.9	50.7	52.4	54.2	55.9	57.7	59.4	61.2
44	27.0	28.8	30.6	32.3	34.1	35.9	37.7	39.5	41.3	43.1	44.9	46.7	48.5	50.3	52.1	53.9	55.7	57.5	59.3	61.1	62.9
48	27.7	29.6	31.4	33.2	35.1	36.9	38.8	40.6	42.5	44.3	46.2	48.0	49.9	51.7	53.6	55.4	57.3	59.1	61.0	62.8	64.6
52	28.5	30.4	32.2	34.1	36.0	37.9	39.8	41.7	43.6	45.5	47.4	49.3	51.2	53.1	55.0	56.9	58.8	60.7	62.6	64.5	66.4
56	29.2	31.2	33.1	35.0	37.0	38.9	40.9	42.8	44.8	46.7	48.7	50.6	52.6	54.5	56.5	58.4	60.4	62.3	64.2	66.2	68.1
60	30.0	31.9	33.9	35.9	37.9	39.9	41.9	43.9	45.9	47.9	49.9	51.9	53.9	55.9	57.9	59.9	61.9	63.9	65.9	67.9	69.9
64	30.7	32.7	34.8	36.8	38.9	40.9	43.0	45.0	47.1	49.1	51.2	53.2	55.3	57.3	59.4	61.4	63.4	65.5	67.5	69.6	71.6
68	31.4	33.5	35.6	37.7	39.8	41.9	44.0	46.1	48.2	50.3	52.4	54.5	56.6	58.7	60.8	62.9	65.0	67.1	69.2	71.3	73.4
72	32.2	34.3	36.5	38.6	40.8	42.9	45.1	47.2	49.4	51.5	53.7	55.8	58.0	60.1	62.3	64.4	66.5	68.7	70.8	73.0	75.1
76	32.9	35.1	37.3	39.5	41.7	43.9	46.1	48.3	50.5	52.7	54.9	57.1	59.3	61.5	63.7	65.9	68.1	70.3	72.5	74.7	76.9
80	33.7	35.9	38.2	40.4	42.7	44.9	47.2	49.4	51.7	53.9	56.2	58.4	60.7	62.9	65.1	67.4	69.6	71.9	74.1	76.4	78.6
84	34.4	36.7	39.0	41.3	43.6	45.9	48.2	50.5	52.8	55.1	57.4	59.7	62.0	64.3	66.6	68.9	71.2	73.5	75.8	78.1	80.4
88	35.2	37.5	39.9	42.2	44.6	46.9	49.3	51.6	54.0	56.3	58.7	61.0	63.3	65.7	68.0	70.4	72.7	75.1	77.4	79.8	82.1
92	35.9	38.3	40.7	43.1	45.5	47.9	50.3	52.7	55.1	57.5	59.9	62.3	64.7	67.1	69.5	71.9	74.3	76.7	79.1	81.5	83.9
96	36.7	39.1	41.6	44.0	46.5	48.9	51.4	53.8	56.3	58.7	61.2	63.6	66.0	68.5	70.9	73.4	75.8	78.3	80.7	83.2	85.6
100	37.4	39.9	42.4	44.9	47.4	49.9	52.4	54.9	57.4	59.9	62.4	64.9	67.4	69.9	72.4	74.9	77.4	79.9	82.4	84.9	87.4
110	39.3	41.9	44.6	47.2	49.8	52.4	55.0	57.7	60.3	62.9	65.5	68.1	70.8	73.4	76.0	78.6	81.2	83.9	86.5	89.1	91.7
120	41.2	43.9	46.7	49.4	52.2	54.9	57.7	60.4	63.1	65.9	68.6	71.4	74.1	76.9	79.6	82.4	85.1	87.9	90.6	93.4	96.1
130	43.1	45.9	48.8	51.7	54.5	57.4	60.3	63.1	66.0	68.9	71.8	74.6	77.5	80.4	83.2	86.1	89.0	91.9	94.7	97.6	100.5
140	44.9	47.9	50.9	53.9	56.9	59.9	62.9	65.9	68.9	71.9	74.9	77.9	80.9	83.9	86.9	89.9	92.9	95.8	98.8	101.8	104.8
150	46.8	49.9	53.0	56.2	59.3	62.4	65.5	68.6	71.8	74.9	78.0	81.1	84.2	87.4	90.5	93.6	96.7	99.8	103.0	106.1	109.2

[a]Values based on mass when ovendry and volume at tabulated moisture content. From the *Wood Handbook* (FPL 1987); Tables 3 to 7.

[b]M is moisture content.

[c]$D = 62.4G_b(1 + M/100)$ for all levels of moisture content.

Table 2—*Wood Handbook* data in SI units of measurement

M	Density (kg/m^3) at various levels of specific gravity[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700
4	312	333	354	374	395	416	437	458	478	499	520	541	562	582	603	624	645	666	686	707	728
8	324	346	367	389	410	432	454	475	497	518	540	562	583	605	626	648	670	691	713	734	756
12	336	358	381	403	426	448	470	493	515	538	560	582	605	627	650	672	694	717	739	762	784
16	348	371	394	418	441	464	487	510	534	557	580	603	626	650	673	696	719	742	766	789	812
20	360	384	408	432	456	480	504	528	552	576	600	624	648	672	696	720	744	768	792	816	840
24	372	397	422	446	471	496	521	546	570	595	620	645	670	694	719	744	769	794	818	843	868
28	384	410	435	461	486	512	538	563	589	614	640	666	691	717	742	768	794	819	845	870	896
32	396	422	449	475	502	528	554	581	607	634	660	686	713	739	766	792	818	845	871	898	924
36	408	435	462	490	517	544	571	598	626	653	680	707	734	762	789	816	843	870	898	925	952
40	420	448	476	504	532	560	588	616	644	672	700	728	756	784	812	840	868	896	924	952	980
44	432	461	490	518	547	576	605	634	662	691	720	749	778	806	835	864	893	922	950	979	1008
48	444	474	503	533	562	592	622	651	681	710	740	770	799	829	858	888	918	947	977	1006	1036
52	456	486	517	547	578	608	638	669	699	730	760	790	821	851	882	912	942	973	1003	1034	1064
56	468	499	530	562	593	624	655	686	718	749	780	811	842	874	905	936	967	998	1030	1061	1092
60	480	512	544	576	608	640	672	704	736	768	800	832	864	896	928	960	992	1024	1056	1088	1120
64	492	525	558	590	623	656	689	722	754	787	820	853	886	918	951	984	1017	1050	1082	1115	1148
68	504	538	571	605	638	672	706	739	773	806	840	874	907	941	974	1008	1042	1075	1109	1142	1176
72	516	550	585	619	854	688	722	757	791	826	860	894	929	963	998	1032	1066	1101	1135	1170	1204
76	528	563	598	634	669	704	739	774	810	845	8B0	915	950	986	1021	1056	1091	1126	1162	1197	1232
80	540	576	612	648	684	720	756	792	828	864	900	936	972	1008	1044	1080	1116	1152	1188	1224	1260
84	552	589	626	662	699	736	773	810	846	883	920	957	994	1030	1067	1104	1141	1178	1214	1251	1288
88	564	602	639	677	714	752	790	827	865	902	940	978	1015	1053	1090	1128	1166	1203	1241	1278	1316
92	576	614	653	691	730	768	806	845	883	922	960	998	1037	1075	1114	1152	1190	1229	1267	1306	1344
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100	600	640	680	720	760	800	840	880	920	960	l000	1040	1080	1120	1160	1200	1240	1280	1320	1360	1400
110	630	672	714	756	798	840	832	924	966	1008	1050	1092	1134	1176	1218	1260	1302	1344	1386	1428	1470
120	660	704	748	792	836	880	924	968	1012	1056	1100	1144	1188	1232	1276	1320	1364	1408	1452	1496	1540
130	690	736	782	828	874	920	966	1012	1058	1104	1150	1196	1242	1288	1334	1380	1426	1472	1518	1564	1610
140	720	768	816	864	912	960	1008	1056	1104	1152	1200	1248	1296	1344	1392	1440	1488	1536	1584	1632	1680
150	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750

[a] $D = 1000G_b(1 + M/100)$ for all levels of moisture content.

Table 3—Results of Equation (9) for determining wood density

M	Density (lb/ft^3) at various levels of specific gravity (ovendry weight/green volume)[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	20.3	21.8	23 3	24.8	26.4	27.9	29.5	31.1	32.7	34.3	36.0	37.6	39.3	41.0	42.8	44.5	46.3	48.1	49.9	51.8	53.6
4	20.9	22.4	23.9	25.5	27.0	28.6	30.2	31.8	33.4	35.0	36.7	38.3	40.0	41.7	43.4	45.2	46.9	48.7	50.5	52.3	54.1
8	21.5	23.0	24.5	26.1	27.7	29.2	30.8	32.4	34.0	35.7	37.3	39.0	40.7	42.3	44.1	45.8	47.5	49.3	51.0	52.8	54.6
12	22.0	23.6	25.1	26.7	28.3	29.9	31.5	33.1	34.7	36.3	38.0	39.6	41.3	43.0	44.7	46.4	48.1	49.8	51.5	53.3	55.0
16	22.6	24.1	25.7	27.3	28.9	30.5	32.1	33.7	35.3	36.9	38.6	40.2	41.9	43.6	45.2	46.9	48.6	50.3	52.0	53.7	55.5
20	23.1	24.7	26.2	27.8	29.4	31.0	32.7	34.3	35.9	37.5	39.2	40.8	42.5	44.1	45.8	47.4	49.1	50.8	52.5	54.2	55.9
24	23.6	25.2	26.8	28.4	30.0	31.6	33.2	34.9	36.5	38.1	39.7	41.4	43.0	44.7	46.3	48.0	49.6	51.3	52.9	54.6	56.3
28	24.1	25.7	27.3	28.9	30.6	32.2	33.8	35.4	37.0	38.7	40.3	41.9	43.5	45.2	46.8	48.4	50.1	51.7	53.3	55.0	56.6
32	24.7	26.4	28.0	29.7	31.3	32.9	34.6	36.2	37.9	39.5	41.2	42.8	44.5	46.1	47.8	49.4	51.1	52.7	54.4	56.0	57.7
36	25.5	27.2	28.9	30.6	32.2	33.9	35.6	37.3	39.0	40.7	42.4	44.1	45.8	47.5	49.2	50.9	52.6	54.3	56.0	57.7	59.4
40	26.2	28.0	29.7	31.4	33.2	34.9	36.7	38.4	40.2	41.9	43.7	45.4	47.2	48.9	50.7	52.4	54.2	55.9	57.7	59.4	61.2
44	27.0	28.8	30.6	32.3	34.1	35.9	37.7	39.5	41.3	43.1	44.9	46.7	48.5	50.3	52.1	53.9	55.7	57.5	59.3	61.1	62.9
48	27.7	29.6	31.4	33.2	35.1	36.9	38.8	40.6	42.5	44.3	46.2	48.0	49.9	51.7	53.6	55.4	57.3	59.1	61.0	62.8	64.6
52	28.5	30.4	32.2	34.1	36.0	37.9	39.8	41.7	43.6	45.5	47.4	49.3	51.2	53.1	55.0	56.9	58.8	60.7	62.6	64.5	66.4
56	29.2	31.2	33.1	35.0	37.0	38.9	40.9	42.8	44.8	46.7	48.7	50.6	52.6	54.5	56.5	58.4	60.4	62.3	64.2	66.2	68.1
60	30.0	31.9	33.9	35.9	37.9	39.9	41.9	43.9	45.9	47.9	49.9	51.9	53.9	55.9	57.9	59.9	61.9	63.9	65.9	67.9	69.9
64	30.7	32.7	34.8	36.8	38.9	40.9	43.0	45.0	47.1	49.1	51.2	53.2	55.3	57.3	59.4	61.4	63.4	65.5	67.5	69.6	71.6
68	31.4	33.5	35.6	37.7	39.8	41.9	44.0	46.1	48.2	50.3	52.4	54.5	56.6	58.7	60.8	62.9	65.0	67.1	69.2	71.3	73.4
72	32.2	34.3	36.5	38.6	40.8	42.9	45.1	47.2	49.4	51.5	53.7	55.8	58.0	60.1	62.3	64.4	66.5	68.7	70.8	73.0	75.1
76	32.9	35.1	37.3	39.5	41.7	43.9	46.1	48.3	50.5	52.7	54.9	57.1	59.3	61.5	63.7	65.9	68.1	70.3	72.5	74.7	76.9
80	33.7	35.9	38.2	40.4	42.7	44.9	47.2	49.4	51.7	53.9	56.2	58.4	60.7	62.9	65.1	67.4	69.6	71.9	74.1	76.4	
84	34.4	36.7	39.0	41.3	43.6	45.9	48.2	50.5	52.8	55.1	57.4	59.7	62.0	64.3	66.6	68.9	71.2	73.5	75.8		
88	35.2	37.5	39.9	42.2	44.6	46.9	49.3	51.6	54.0	56.3	58.7	61.0	63.3	65.7	68.0	70.4	72.7	75.1			
92	35.9	38.3	40.7	43.1	45.5	47.9	50.3	52.7	55.1	57.5	59.9	62.3	64.7	67.1	69.5	71.9	74.3				
96	36.7	39.1	41.8	44.0	46.5	48.9	51.4	53.8	56.3	58.7	61.2	63.6	66.0	68.5	70.9	73.4	75.8				
100	37.4	39.9	42.4	44.9	47.4	49.9	52.4	54.9	57.4	59.9	62.4	64.9	67.4	69.9	72.4	74.9					
110	39.3	41.9	44.6	47.2	49.8	52.4	55.0	57.7	60.3	62.9	65.5	68.1	70.8	73.4							
120	41.2	43.9	46.7	49.4	52.2	54.9	57.7	60.4	63.1	65.9	68.6	71.4	74.1								
130	43.1	45.9	48.8	51.7	54.5	57.4	60.3	63.1	66.0	68.9	71.8										
140	44.9	47.9	50.9	53.9	56.9	59.9	62.9	65.9	68.9	71.9											
150	46.8	49.9	53.0	56.2	59.3	62.4	65.5	68.6	71.8												
160	48.7	51.9	55.2	58.4	61.7	64.9	68.1	71.4													
170	50.5	53.9	57.3	60.7	64.0	67.4	70.8						Exceeds maximum possible moisture content								
180	52.4	55.9	59.4	62.9	66.4	69.9															
190	54.3	57.9	61.5	65.1	68.8																
200	56.2	59.9	63.6	67.4																	
Max *M*	268	248	229	213	198	185	173	162	152	143	135	127	120	114	107	102	96	91	87	82	78
Max *D*	69.0	69.4	69.8	70.3	70.7	71.1	71.6	72.0	72.4	72.9	73.3	73.8	74.2	74.6	75.1	75.5	75.9	76.4	76.8	77.3	77.7

[a]For M < 30 percent, $D = 62.4G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$; for M > 30 percent, $D = 62.4G_b(1 + M/100)$.

Table 4—Results of Equation (9) in SI units

M	Density (kg/m^3) at various levels of specific gravity (ovendry weight/green volume)[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	326	350	374	398	423	447	473	498	524	550	576	603	630	658	685	713	742	771	800	829	859
4	335	359	384	408	433	458	483	509	535	561	587	614	641	668	696	724	752	780	809	838	867
8	344	369	393	418	443	468	494	520	546	572	598	625	652	679	706	734	761	789	818	846	875
12	353	378	403	428	453	478	504	530	556	582	608	635	662	689	716	743	770	798	826	854	882
16	361	386	412	437	463	488	514	540	566	592	618	645	671	698	725	752	779	806	834	861	889
20	370	395	421	446	472	498	523	549	575	602	628	654	680	707	734	760	787	814	841	868	895
24	378	404	429	455	481	507	533	559	585	611	637	663	689	716	742	768	795	821	848	875	901
28	386	412	438	464	490	516	542	568	594	620	646	672	698	724	750	776	802	829	855	881	907
32	396	422	449	475	502	528	554	581	607	634	660	686	713	739	766	792	818	845	871	898	924
36	408	435	462	490	517	544	571	598	626	653	680	707	734	762	789	816	843	870	898	925	952
40	420	448	476	504	532	560	588	616	644	672	700	728	756	784	812	840	868	896	924	952	980
44	432	461	490	518	547	576	605	634	662	691	720	749	778	806	835	864	893	922	950	979	1008
48	444	474	503	533	562	592	622	651	681	710	740	770	799	829	858	888	918	947	977	1006	1036
52	456	486	517	547	578	608	638	669	699	730	760	790	821	851	882	912	942	973	1003	1034	1064
56	468	499	530	562	593	624	655	686	718	749	780	811	842	874	905	936	967	998	1030	1061	1092
60	480	512	544	576	608	640	672	704	736	768	800	832	864	896	928	960	992	1024	1056	1088	1120
64	492	525	558	590	623	656	689	722	754	787	820	853	886	918	951	984	1017	1050	1082	1115	1148
68	504	538	571	605	638	672	706	739	773	806	840	874	907	941	974	1008	1042	1075	1109	1142	1176
72	516	550	585	619	654	688	722	757	791	826	860	894	929	963	998	1032	1066	1101	1135	1170	1204
76	528	563	598	634	669	704	739	774	810	845	880	915	950	986	1021	1056	1091	1126	1162	1197	1232
80	540	576	612	648	684	720	756	792	828	864	900	936	972	1008	1044	1080	1116	1152	1188	1224	
84	552	589	626	662	699	736	773	810	846	883	920	957	994	1030	1067	1104	1141	1178	1214		
88	564	602	639	677	714	752	790	827	865	902	940	978	1015	1053	1090	1128	1166	1203			
92	576	614	653	691	730	768	806	845	883	922	960	998	1037	1075	1114	1152	1190				
96	588	627	666	706	745	784	823	862	902	941	980	1019	1058	1098	1137	1176	1215				
100	600	640	680	720	760	800	840	880	920	960	1000	1040	1080	1120	1160	1200					
110	630	672	714	756	798	840	882	924	966	1008	1050	1092	1134	1176							
120	660	704	748	792	836	880	924	968	1012	1056	1100	1144	1188								
130	690	736	782	828	874	920	966	1012	1058	1104	1150										
140	720	768	816	864	912	960	1008	1056	1104	1152											
150	750	800	850	900	950	1000	1050	1100	1150												
160	780	832	884	936	988	1040	1092	1144													
170	810	864	918	972	1026	1080	1134														
180	840	896	952	1008	1064	1120															
190	870	928	986	1044	1102																
200	900	960	1020	1080																	
Max *M*	268	248	229	213	198	185	173	162	152	143	135	127	120	114	107	102	96	91	87	82	78
Max *D*	1105	1112	1119	1126	1133	1140	1147	1154	1161	1168	1175	1182	1189	1196	1203	1210	1217	1224	1231	1238	1245

Exceeds maximum possible moisture content

[a]For $M < 30$ percent, $D = 1000G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$; for $M > 30$ percent, $D = 1000G_b(1 + M/100)$.

Table 5—Wood density based on volume at 12 percent moisture content

M	Density (lb/ft^3) at various levels of specific gravity[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	19.3	20.7	22.0	23.4	24.7	26.1	27.4	28.8	30.2	31.6	32.9	34.3	35.7	37.1	38.6	40.0	41.4	42.8	44.3	45.7	47.2
4	19.9	21.2	22.6	24.0	25.3	26.7	28.1	29.5	30.9	32.2	33.6	35.0	36.4	37.8	39.2	40.7	42.1	43.5	44.9	46.4	47.8
8	20.4	21.8	23.2	24.6	26.0	27.3	28.7	30.1	31.5	32.9	34.3	35.7	37.1	38.5	39.9	41.3	42.7	44.1	45.5	47.0	48.4
12	21.0	22.4	23.8	25.2	26.6	28.0	29.4	30.8	32.1	33.5	34.9	36.3	37.7	39.1	40.5	41.9	43.3	44.7	46.1	47.5	48.9
16	21.5	22.9	24.3	25.7	27.1	28.6	30.0	31.4	32.8	34.2	35.6	37.0	38.4	39.7	41.1	42.5	43.9	45.3	46.7	48.1	49.4
20	22.0	23.4	24.9	26.3	27.7	29.1	30.5	32.0	33.4	34.8	36.2	37.6	38.9	40.3	41.7	43.1	44.5	45.8	47.2	48.6	49.9
24	22.5	23.9	25.4	26.8	28.3	29.7	31.1	32.5	33.9	35.3	36.7	38.1	39.5	40.9	42.3	43.6	45.0	46.4	47.7	49.1	50.4
28	23.0	24.5	25.9	27.4	28.8	30.2	31.7	33.1	34.5	35.9	37.3	38.7	40.1	41.4	42.8	44.2	45.5	46.9	48.2	49.6	50.9
32	23.6	25.1	26.6	28.0	29.5	31.0	32.4	33.9	35.3	36.7	38.2	39.6	41.0	42.4	43.7	45.1	46.5	47.8	49.2	50.5	51.9
36	24.3	25.8	27.4	28.9	30.4	31.9	33.4	34.9	36.4	37.8	39.3	40.8	42.2	43.6	45.1	46.5	47.9	49.3	50.7	52.1	53.5
40	25.0	26.6	28.2	29.7	31.3	32.9	34.4	35.9	37.4	39.0	40.5	42.0	43.4	44.9	46.4	47.9	49.3	50.7	52.2	53.6	55.0
44	25.7	27.4	29.0	30.6	32.2	33.8	35.4	37.0	38.5	40.1	41.6	43.2	44.7	46.2	47.7	49.2	50.7	52.2	53.7	55.1	56.6
48	26.4	28.1	29.8	31.4	33.1	34.7	36.4	38.0	39.6	41.2	42.8	44.4	45.9	47.5	49.0	50.6	52.1	53.6	55.2	56.7	58.2
52	27.2	28.9	30.6	32.3	34.0	35.7	37.3	39.0	40.7	42.3	43.9	45.6	47.2	48.8	50.4	52.0	53.5	55.1	56.7	58.2	59.7
56	27.9	29.6	31.4	33.1	34.9	36.6	38.3	40.0	41.7	43.4	45.1	46.8	48.4	50.1	51.7	53.3	54.9	56.5	58.1	59.7	61.3
60	28.6	30.4	32.2	34.0	35.8	37.5	39.3	41.1	42.8	44.5	46.2	48.0	49.7	51.3	53.0	54.7	56.3	58.0	59.6	61.3	62.9
64	29.3	31.2	33.0	34.8	36.7	38.5	40.3	42.1	43.9	45.6	47.4	49.2	50.9	52.6	54.3	56.1	57.8	59.4	61.1	62.8	64.5
68	30.0	31.9	33.8	35.7	37.6	39.4	41.3	43.1	44.9	46.8	48.6	50.3	52.1	53.9	55.7	57.4	59.2	60.9	62.6	64.3	66.0
72	30.7	32.7	34.6	36.5	38.5	40.4	42.3	44.1	46.0	47.9	49.7	51.5	53.4	55.2	57.0	58.8	60.6	62.3	64.1	65.9	67.6
76	31.4	33.4	35.4	37.4	39.4	41.3	43.2	45.2	47.1	49.0	50.9	52.7	54.6	56.5	58.3	60.2	62.0	63.8	65.6	67.4	69.2
80	32.2	34.2	36.2	38.2	40.2	42.2	44.2	46.2	48.1	50.1	52.0	53.9	55.9	57.8	59.6	61.5	63.4	65.2	67.1	68.9	70.7
84	32.9	35.0	37.0	39.1	41.1	43.2	45.2	47.2	49.2	51.2	53.2	55.1	57.1	59.0	61.0	62.9	64.8	66.7	68.6	70.5	72.3
88	33.6	35.7	37.8	39.9	42.0	44.1	46.2	48.2	50.3	52.3	54.3	56.3	58.3	60.3	62.3	64.3	66.2	68.1	70.1	72.0	73.9
92	34.3	36.5	38.6	40.8	42.9	45.1	47.2	49.3	51.4	53.4	55.5	57.5	59.6	61.6	63.6	65.6	67.6	69.6	71.6	73.5	75.5
96	35.0	37.2	39.5	41.6	43.8	46.0	48.2	50.3	52.4	54.5	56.6	58.7	60.8	62.9	64.9	67.0	69.0	71.0	73.1	75.1	
100	35.7	38.0	40.3	42.5	44.7	46.9	49.1	51.3	53.5	55.7	57.8	59.9	62.1	64.2	66.3	68.4	70.4	72.5	74.5		
110	37.5	39.9	42.3	44.6	47.0	49.3	51.6	53.9	56.2	58.4	60.7	62.9	65.2	67.4	69.6	71.8	74.0				
120	39.3	41.8	44.3	46.7	49.2	51.6	54.0	56.5	58.8	61.2	63.6	65.9	68.3	70.6	72.9						
130	41.1	43.7	46.3	48.9	51.4	54.0	56.5	59.0	61.5	64.0	66.5	68.9	71.4								
140	42.9	45.6	48.3	51.0	53.7	56.3	59.0	61.6	64.2	66.8	69.4	71.9									
150	44.7	47.5	50.3	53.1	55.9	58.7	61.4	64.2	66.9	69.6	72.3										
160	46.5	49.4	52.3	55.2	58.1	61.0	63.9	66.7	69.5				Excess maximum possible moisture content								
170	48.2	51.3	54.3	57.4	60.4	63.4	66.3	69.3													
180	50.0	53.2	56.4	59.5	62.6	65.7	68.8														
190	51.8	55.1	58.4	61.6	64.8	68.1															
200	53.6	57.0	60.4	63.7	67.1	70.4															
Max *M*	284	263	245	229	214	201	189	178	168	159	151	143	136	129	123	118	112	107	102	98	94
Max *D*	68.7	69.1	69.4	69.8	70.2	70.6	71.0	71.4	71.8	72.1	72.5	72.9	73.3	73.6	74.0	74.4	74.7	75.1	75.4	75.8	76.2

[a]For $M < 30$ percent, $D = 62.4G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$ and $G_b = G_{12}(1 - 0.265aG_{12}/(1 + 0.265aG_{12}))$; for $M > 30$ percent, $D = 62.4G_b(1 + M/100)$.

Table 6—SI values for data in Table 5

M	Density (kg/m^3) at various levels of specific gravity[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	310	331	353	374	396	418	440	462	484	506	528	550	573	595	618	641	664	687	710	733	756
4	319	340	362	384	406	428	450	472	494	517	539	561	584	606	629	652	674	697	720	743	766
8	327	350	372	394	416	438	460	483	505	527	550	572	595	617	640	662	685	707	730	752	775
12	336	358	381	403	426	448	470	493	515	538	560	582	605	627	650	672	694	717	739	762	784
16	344	367	390	412	435	458	480	503	525	548	570	592	615	637	659	682	704	726	748	770	792
20	353	376	398	421	444	467	489	512	535	557	580	602	624	646	669	691	713	735	757	779	800
24	361	384	407	430	453	476	499	521	544	566	589	611	633	655	678	700	721	743	765	787	808
28	368	392	415	438	462	485	507	530	553	575	598	620	642	664	686	708	730	751	773	794	815
32	378	402	426	449	473	496	520	543	566	589	611	634	656	679	701	723	745	767	788	810	831
36	389	414	439	463	487	511	535	559	583	607	630	653	676	699	722	745	768	790	812	835	857
40	401	426	452	477	502	527	551	576	600	624	648	672	696	720	743	767	790	813	836	859	882
44	412	438	464	490	516	542	567	592	617	642	667	692	716	740	765	789	813	836	860	884	907
48	424	451	477	504	530	557	583	609	634	660	686	711	736	761	786	811	835	860	884	908	932
52	435	463	490	518	545	572	598	625	652	678	704	730	756	782	807	833	858	883	908	933	957
56	447	475	503	531	559	587	614	642	669	696	723	749	776	802	828	854	880	906	932	957	983
60	458	487	516	545	573	602	630	658	686	714	741	768	796	823	850	876	903	929	956	982	1008
64	470	499	529	558	588	617	646	674	703	731	760	788	816	843	871	898	926	953	980	1006	1033
68	481	512	542	572	602	632	661	691	720	749	778	807	835	864	892	920	948	976	1003	1031	1058
72	493	524	555	586	616	647	677	707	737	767	797	826	855	884	913	942	971	999	1027	1055	1083
76	504	536	568	599	631	662	693	724	754	785	815	845	875	905	935	964	993	1022	1051	1080	1109
80	515	548	581	613	645	677	709	740	772	803	834	865	895	926	956	986	1016	1046	1075	1105	1134
84	527	560	594	627	659	692	724	757	789	821	852	884	915	946	977	1008	1038	1069	1099	1129	1159
88	538	572	606	640	674	707	740	773	806	838	871	903	935	967	998	1030	1061	1092	1123	1154	1184
92	550	585	619	654	688	722	756	790	823	856	889	922	955	987	1020	1052	1084	1115	1147	1178	1209
96	561	597	632	667	702	737	772	806	840	874	908	941	975	1008	1041	1074	1106	1139	1171	1203	
100	573	609	645	681	717	752	787	822	857	892	926	961	995	1028	1062	1095	1129	1162	1195		
110	601	639	677	715	753	790	827	864	900	937	973	1009	1044	1080	1115	1150	1185				
120	630	670	710	749	788	827	866	905	943	981	1019	1057	1094	1131	1168						
130	659	700	742	783	824	865	906	946	986	1026	1065	1105	1144								
140	687	731	774	817	860	903	945	987	1029	1070	1112	1153									
150	716	761	806	851	896	940	984	1028	1072	1115	1158										
160	744	792	839	885	932	978	1024	1069	1114												
170	773	822	871	919	968	1015	1063	1110													
180	802	853	903	953	1003	1053	1102	Excess maximum possible moisture content													
190	830	883	935	987	1039	1091															
200	859	914	968	1022	1075	1128															
Max *M*	284	263	245	229	214	201	189	178	168	159	151	143	136	129	123	118	112	107	102	98	94
Max *D*	1100	1107	1113	1119	1125	1132	1138	1144	1150	1156	1162	1168	1174	1180	1186	1192	1198	1203	1209	1215	1220

[a]For $M < 30$ percent, $D = 1000G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$ and $G_b = G_{12}(1 + 0.265aG_{12})$; for $M > 30$ percent, $D = 1000G_b(1 + M/100)$.

Table 7—Wood density based on ovendry volume

M	Density (lb/ft^3) at various levels of specific gravity[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	18.7	20.0	21.2	22.5	23.7	25.0	26.2	27.5	28.7	30.0	31.2	32.4	33.7	34.9	36.2	37.4	38.7	39.9	41.2	42.4	43.7
4	19.3	20.5	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.6	31.9	33.1	34.4	35.6	36.9	38.1	39.4	40.6	41.9	43.1	44.3
8	19.8	21.1	22.4	23.7	24.9	26.2	27.5	28.8	30.0	31.3	32.5	33.8	35.1	36.3	37.5	38.8	40.0	41.3	42.5	43.7	45.0
12	20.3	21.6	22.9	24.2	25.5	26.8	28.1	29.4	30.7	31.9	33.2	34.4	35.7	36.9	38.2	39.4	40.7	41.9	43.1	44.3	45.5
16	20.8	22.2	23.5	24.8	26.1	27.4	28.7	30.0	31.3	32.5	33.8	35.1	36.3	37.6	38.8	40.0	41.3	42.5	43.7	44.9	46.1
20	21.3	22.7	24.0	25.3	26.7	28.0	29.3	30.6	31.9	33.1	34.4	35.7	36.9	38.2	39.4	40.6	41.8	43.1	44.3	45.5	46.6
24	21.8	23.2	24.5	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.2	37.5	38.7	40.0	41.2	42.4	43.6	44.8	46.0	47.2
28	22.3	23.7	25.0	26.4	27.7	29.1	30.4	31.7	33.0	34.3	35.5	36.8	38.0	39.3	40.5	41.7	42.9	44.1	45.3	46.5	47.7
32	22.9	24.3	25.7	27.1	28.4	29.8	31.1	32.5	33.8	35.1	36.4	37.6	38.9	40.2	41.4	42.6	43.9	45.1	46.3	47.5	48.6
36	23.6	25.0	26.5	27.9	29.3	30.7	32.1	33.4	34.8	36.1	37.5	38.8	40.1	41.4	42.7	43.9	45.2	46.4	47.7	48.9	50.1
40	24.3	25.8	27.2	28.7	30.2	31.6	33.0	34.4	35.8	37.2	38.6	39.9	41.3	42.6	43.9	45.2	46.5	47.8	49.1	50.3	51.6
44	25.0	26.5	28.0	29.5	31.0	32.5	34.0	35.4	36.8	38.3	39.7	41.1	42.4	43.8	45.2	46.5	47.8	49.2	50.5	51.8	53.1
48	25.7	27.2	28.8	30.4	31.9	33.4	34.9	36.4	37.9	39.3	40.8	42.2	43.6	45.0	46.4	47.8	49.2	50.5	51.9	53.2	54.5
52	26.4	28.0	29.6	31.2	32.7	34.3	35.8	37.4	38.9	40.4	41.9	43.3	44.8	46.3	47.7	49.1	50.5	51.9	53.3	54.6	56.0
56	27.1	28.7	30.4	32.0	33.6	35.2	36.8	38.4	39.9	41.5	43.0	44.5	46.0	47.5	48.9	50.4	51.8	53.3	54.7	56.1	57.5
60	27.7	29.5	31.1	32.8	34.5	36.1	37.7	39.3	40.9	42.5	44.1	45.6	47.2	48.7	50.2	51.7	53.2	54.6	56.1	57.5	59.0
64	28.4	30.2	31.9	33.6	35.3	37.0	38.7	40.3	42.0	43.6	45.2	46.8	48.3	49.9	51.4	53.0	54.5	56.0	57.5	59.0	60.4
68	29.1	30.9	32.7	34.5	36.2	37.9	39.6	41.3	43.0	44.6	46.3	47.9	49.5	51.1	52.7	54.3	55.8	57.4	58.9	60.4	61.9
72	29.8	31.7	33.5	35.3	37.1	38.8	40.6	42.3	44.0	45.7	47.4	49.1	50.7	52.3	54.0	55.6	57.2	58.7	60.3	61.8	63.4
76	30.5	32:4	34.3	36.1	37.9	39.7	41.5	43.3	45.0	46.8	48.5	50.2	51.9	53.6	55.2	56.9	58.5	60.1	61.7	63.3	64.8
80	31.2	33.1	35.0	36.9	38.8	40.6	42.4	44.3	46.1	47.8	49.6	51.3	53.1	54.8	56.5	58.1	59.8	61.5	63.1	64.7	66.3
84	31.9	33.9	35.8	37.7	39.6	41.5	43.4	45.2	47.1	48.9	50.7	52.5	54.2	56.0	57.7	59.4	61.1	62.8	64.5	66.2	67.8
88	32.6	34.6	36.6	38.6	40.5	42.4	44.3	46.2	48.1	50.0	51.8	53.6	55.4	57.2	59.0	60.7	62.5	64.2	65.9	67.6	69.3
92	33.3	35.3	37.4	39.4	41.4	43.3	45.3	47.2	49.1	51.0	52.9	54.8	56.6	58.4	60.2	62.0	63.8	65.6	67.3	69.0	70.7
96	34.0	36.1	38.1	40.2	42.2	44.2	46.2	48.2	50.1	52.1	54.0	55.9	57.8	59.6	61.5	63.3	65.1	66.9	68.7	70.5	72.2
100	34.7	36.8	38.9	41.0	43.1	45.1	47.2	49.2	51.2	53.1	55.1	57.0	59.0	60.9	62.7	64.6	66.5	68.3	70.1	71.9	73.7
110	36.4	38.7	40.9	43.1	45.2	47.4	49.5	51.6	53.7	55.8	57.9	59.9	61.9	63.9	65.9	67.8	69.8	71.7	73.6		
120	38.2	40.5	42.8	45.1	47.4	49.6	51.9	54.1	56.3	58.5	60.6	62.7	64.9	66.9	69.0	71.1	73.1				
130	39.9	42.3	44.8	47.2	49.5	51.9	54.2	56.6	58.8	61.1	63.4	65.6	67.8	70.0	72.2						
140	41.6	44.2	46.7	49.2	51.7	54.2	56.6	59.0	61.4	63.8	66.1	68.4	70.7	73.0							
150	43.4	46.0	48.7	51.3	53.9	56.4	59.0	61.5	64.0	66.4	68.9	71.3									
160	45.1	47.9	50.6	53.3	56.0	58.7	61.3	63.9	66.5	69.1	71.6										
170	46.8	49.7	52.5	55.4	58.2	60.9	63.7	66.4	69.1	71.7											
180	48.6	51.5	54.5	57.4	60.3	63.2	66.0	68.8													
190	50.3	53.4	56.4	59.5	62.5	65.4	68.4														
200	52.0	55.2	58.4	61.5	64.6	67.7	70.7														
Max *M*	295	274	256	239	225	211	200	189	179	170	162	154	147	140	134	128	123	118	113	109	104
Max *D*	68.5	68.8	69.2	69.6	69.9	70.3	70.7	71.0	71.4	71.7	72.0	72.4	72.7	73.0	73.4	73.7	74.0	74.4	74.7	75.0	75.3

Excess maximum possible moisture content

[a]For $M < 30$ percent, $D = 62.4G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$ and $G_b = G_0(1 + 0.265aG_0)$; for $M > 30$ percent, $D = 62.4G_b(1 + M/100)$.

Table 8—SI values for data in Table 7

M	Density (kg/m^3) at various levels of specific gravity[a]																				
(%)	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
0	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700
4	309	329	349	370	390	410	430	451	471	491	511	531	551	571	591	611	631	651	671	691	710
8	317	338	359	379	400	420	441	461	481	501	522	542	562	582	602	622	641	661	681	701	720
12	326	347	368	388	409	430	450	471	491	512	532	552	572	592	612	632	652	671	691	710	730
16	334	355	376	397	418	439	460	481	501	521	542	562	582	602	622	642	661	681	700	720	739
20	342	363	385	406	427	448	469	490	511	531	551	571	592	612	631	651	671	690	709	728	748
24	350	372	393	415	436	457	478	499	520	540	561	581	601	621	640	660	679	699	718	737	756
28	357	380	401	423	445	466	487	508	529	549	570	590	610	630	649	669	688	707	726	745	764
32	367	389	412	434	456	477	499	520	541	562	583	603	624	644	664	683	703	722	742	761	779
36	378	401	424	447	470	492	514	536	558	579	600	622	642	663	684	704	724	744	764	784	803
40	389	413	437	460	483	506	529	552	574	596	618	640	661	683	704	725	746	766	786	807	827
44	400	425	449	473	497	521	544	567	590	613	636	658	680	702	724	745	767	788	809	830	850
48	411	437	462	486	511	535	559	583	607	630	653	676	699	722	744	766	788	810	831	853	874
52	422	448	474	500	525	550	574	599	623	647	671	695	718	741	764	787	809	832	854	876	898
56	434	460	487	513	539	564	590	615	640	664	689	713	737	761	784	808	831	854	876	899	921
60	445	472	499	526	552	579	605	630	656	681	706	731	756	780	804	828	852	876	899	922	945
64	456	484	512	539	566	593	620	646	672	698	724	750	775	800	824	849	873	897	921	945	968
68	467	496	524	552	580	608	635	662	689	715	742	768	794	819	845	870	895	919	944	968	992
72	478	507	536	565	594	622	650	678	705	732	759	786	813	839	865	890	916	941	966	991	1016
76	489	519	549	578	608	637	665	694	722	749	777	804	831	858	885	911	937	963	989	1014	1039
80	500	531	561	592	621	651	680	709	738	767	795	823	850	878	905	932	959	985	1011	1037	1063
84	511	543	574	605	635	665	695	725	754	784	812	841	869	897	925	953	980	1007	1034	1060	1086
88	522	555	586	618	649	680	711	741	771	801	830	859	888	917	945	973	1001	1029	1056	1083	1110
92	534	566	599	631	663	694	726	757	787	818	848	877	907	936	965	994	1022	1051	1079	1106	1134
96	545	578	611	644	677	709	741	772	804	835	865	896	926	956	985	1015	1044	1073	1101	1129	1157
100	556	590	624	657	690	723	756	788	820	852	883	914	945	975	1005	1035	1065	1094	1123	1152	1181
110	584	619	655	690	725	759	794	828	861	894	927	960	992	1024	1056	1087	1118	1149	1180		
120	611	649	686	723	760	796	831	867	902	937	971	1005	1039	1073	1106	1139	1172				
130	639	678	717	756	794	832	869	906	943	979	1015	1051	1087	1122	1156						
140	667	708	749	789	829	868	907	946	984	1022	1060	1097	1134	1170							
150	695	737	780	822	863	904	945	985	1025	1065	1104	1143									
160	723	767	811	854	898	940	983	1025	1066	1107	1148										
170	750	796	842	887	932	976	1020	1064	1107												
180	778	826	873	920	967	1013	1058	1103													
190	806	855	905	953	1001	1049	1096														
200	834	885	936	986	1036	1085															
Max *M*	295	274	256	239	225	211	200	189	179	170	162	154	147	140	134	128	123	118	113	109	104
Max *D*	1097	1103	1109	1115	1121	1127	1132	1138	1144	1149	1155	1160	1165	1171	1176	1181	1186	1192	1197	1202	1207

Excess maximum possible moisture content

[a]For $M < 30$ percent, $D = 1000G_b(1 + M/100)/(1 - 0.265aG_b)$, where $a = (30 - M)/30$ and $G_b = G_0((1 + 0.265aG_0)$; for $M > 30$ percent, $D = 1000G_b(1 + M/100)$.

Appendix. Relationship of Specific Gravity Values

In this appendix, we describe the general relationship between basic specific gravity and specific gravity values baaed on volume at other moisture content levels.

Basic specific gravity is defined as

$$G_b = (W_d/V_d)/p_w \qquad (1a)$$

where W_d is oven-dry weight of wood, V_d is volume of dry wood, and p_{w_w} is density of water.

Specific gravity baaed on volume at any other moisture content M is defined as

$$G_M = (W_d/V_M)/p_w \qquad (2a)$$

Equating Equations (1a) and (2a) through W_d

$$G_M = G_b V_g/V_M \qquad (3a)$$

where V_g is volume of green wood.

Volumetric shrinkage S from ≥30 percent to <30 percent moisture content is

$$S = (V_g - V_M)/V_M$$

or

$$V_M = V_g(1 - S) \qquad (4a)$$

Substituting Equation (4a) into Equation (3a)

$$G_b = G_M(1 - S) \qquad (5a)$$

Assuming the linear shrinkage of Equation (6) in the text ($S = aS_t$)

$$G_b = G_M(1 - aS_t) \qquad (6a)$$

where a is (30 - M)/30.

The next step is to express S_t in Equation (6a) in terms of G_M. Substituting Equation (6a) into Equation (8) ($S_t = 0.265\ G_b$) in the text

$$S_t = 0.265G_M(1 - aS_t) \qquad (7a)$$

Solving for S_t

$$S_t = \frac{0.265G_M}{1 + 0.265aG_M} \qquad (8a)$$

and substituting Equation (8a) into Equation (6a)

$$G_b = \frac{G_M}{1 + 0.265aG_M} \qquad (9a)$$

which can be substituted into Equation (9) in the text to calculate density based on the volume at any moisture content. Equation (9a) can also be used to calculate the graphical relationship between moisture content, basic specific gravity, and specific gravity based on volume at any moisture content, as shown in Figure 1 of the text.

The value of M in the term a ((30 - M)/30) in Equation (9a) is the moisture content for the volume base of the specific gravity. The value of M in the term a in Equation (9) in the text is the moisture content at which the density is calculated (that is, 0 to 200 percent in Tables 5 and 7). If this latter value of M is taken as the moisture content of the specific gravity volume base, the resulting density values will be baaed on the specific gravity at the volume of the tabulated moisture content, that is, the same as that in the tables in the *Wood Handbook.* Note also in Equation (9a) that when M = 30, a = 0, and $G_M = G_b$, text Equation (9) reverts to text Equations (3) and (4).

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