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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
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Letter
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STANDARD THICKNESSES OF SHEET METAL

CONTENTS

I. INTRODUCTION

Common or stock sizes of metal sheets are sometimes based on definite thicknesses of the sheet, and frequently on definite weights per unit area. In some cases the same kind and grade of sheet metal is made to more than one list of stock sizes or sheet metal gages. In this country the same gage is seldom used for a variety of metals however. This circular is intended to furnish information as to the usual practice of American manufacturers with regard to stock thicknesses of sheets of common metals or alloys. This information has hitherto been scattered, and similar compilations previously made are largely collections of series of gage sizes only, those applying to wires being given the most attention. This circular also contains all available information with regard to manufacturing tolerances adopted by technical societies, manufacturers associations, or used by leading manufacturers. There is apparently considerable need for unification of practice in standard sizes of metal sheets.

The principal gages for sheet metal in use in the United States are: The United States Standard Gage for Sheet and Plate Iron and Steel, the Galvanized Sheet Gage, the American Wire Gage (Brown and Sharpe), the Tin Plate Gage, and the Sheet Zinc Gage. The information and data included in this circular pertain to the application of these gages to various metals. There are also included herein the principal foreign gages for sheet metal, namely the Birmingham Gage, B.G., and the Paris or French Gage.

In the base of thickness gages, the weights per square foot given in the tables are based on specific gravities most widely accepted as being correct for rolled sheets at 20°C or 68°F.

II. IRON AND STEEL SHEET AND PLATE

1. The United States Standard Gage for Sheet and Plate Iron and Steel

The United States Standard Gage for Sheet and Plate Iron and Steel is the legal standard used in determining duties and taxes levied by the United States, and is the recognized commercial standard for all uncoated sheet and plate iron and steel. It is a weight gage, having been based upon weights per square foot in ounces. The provisions of the Act of Congress, approved March 3, 1893, (27 Stat. L., 746), establishing this gage are as follows:

A. AN ACT ESTABLISHING A STANDARD GAGE FOR SHEET AND PLATE IRON AND STEEL

Be it enacted by the Senate and House of Representative of the United States of America in Congress assembled, That for the purpose of securing uniformity, the following is established as the only standard gage for sheet and plate iron and steel in the United States of America, namely:-

Number of gage	Approximate thickness in fractions of an inch	Approximate thickness in decimal parts of an inch	Approximate thickness in millimeters	Weight per square foot in ounces avoirdupois	Weight per square foot in pounds avoirdupois	Weight per square foot in kilograms	Weight per square meter in kilograms	Weight per square meter in pounds avoirdupois
0000000	1-2	0.5	12.7	320	20.00	9.072	97.65	215.28
000000	15-32	.46875	11.90625	300	18.75	8.505	91.55	201.82
00000	7-16	.4375	11.1125	280	17.50	7.983	85.44	188.37
0000	13-32	.40625	10.31875	260	16.25	7.371	79.33	174.91
000	3-8	.375	9.525	240	15	6.804	73.24	161.46
00	11-32	.34375	8.73125	220	13.75	6.237	67.13	148.00
0	5-16	,3125	7.9375	200	12.50	5.67	61.03	134.55
1	9-32	.28125	7.14375	180	11.25	5.103	54.93	121.09
2	17-64	.265625	6.746875	170	10.625	4.819	51.88	114.37
3	1-4	.25	6.35	160	10	4.536	48.82	107.64
4	15-64	.234375	5.953125	150	9.375	4.252	45.77	100.91
5	7-32	.21875	5.55625	140	8.75	3.969	42.72	94.18
6	13-64	.203125	5.159375	130	8.125	3.685	39.67	87.45
7	3-16	.1875	4.7625	120	7.5	3.402	36.62	80.72
8	11-64	.171875	4.365625	110	6.875	3.118	33.57	74.00
9	5-32	.15625	3.96875	100	6.25	2.835	30.52	67.27
10	9-64	.140625	3.571875	90	5.625	2.552	27.46	60.55
11	1-8	.125	3.175	80	5	2.268	24.41	53.82
12	7-64	.109375	2.778125	70	4.375	1.984	21.36	47.09
13	3-32	.09375	2.38125	60	3.75	1.701	18.31	40.36
14	5-64	.078125	1.984375	50	3.125	1.417	15.26	33.64
15	9-128	.0703125	1.7859375	45	2.8125	1.276	13.73	30.27
16	1-16	.0625	1.5875	40	2.5	1.134	12.21	26.91
17	9-160	.05625	1.42875	36	2.25	1.021	10.99	24.22
18	1-20	.05	1.27	32	2.	.9072	9.765	21.53
19	7-160	.04375	1.11125	28	1.75	.7988	8.544	18.84
20	3-80	.0375	.9525	24	1.50	.6804	7.324	16.15
21	11-320	.034375	.873125	22	1.375	.6237	6.713	14.80
22	1-32	.03125	.793750	20	1.25	.567	6.103	13.46
23	9-320	.028125	.714375	18	1.125	.5103	5.493	12.11
24	1-40	.025	.635	16	1.	.4536	4.882	10.76
25	7-320	.021875	.555625	14	.875	.3969	4.272	9.42
26	3-160	.01875	.47625	12	.75	.3402	3.662	8.07
27	11-640	.0171875	.4365625	11	.6875	.3119	3.357	7.40
28	1-64	.015625	.396875	10	.625	.2835	3.052	6.73
29	9-640	.0140625	.3571875	9	.5625	.2551	2.746	6.05
30	1-80	.0125	.3175	8	.5	.2268	2.441	5.38
31	7-640	.0109375	.2778125	7	.4375	.1984	2.136	4.71
32	13-1280	.01015625	.25796875	6-1/2	.40625	.1843	1.983	4.37
33	3-320	.009375	.238125	6	.375	.1701	1.831	4.04
34	11-1280	.00859375	.21828125	5-1/2	.34375	.1559	1.678	3.70
35	5-640	.0078125	.1984375	5	.3125	.1417	1.526	3.36
36	9-1280	.00703125	.17859375	4-1/2	.28125	.1276	1.373	3.03
37	17-2560	.006640625	.168671875	4-1/4	.265625	.1205	1.297	2.87
38	1-160	.00625	.15875	4	.25	.1134	1.221	2.69

And on and after July first, eighteen hundred and ninety-three, the same and no other shall shall be used in determining duties and taxes levied by the United States of America on sheet and plate iron and steel. But this act shall not be construed to increase duties upon any articles which may be imported.

Sec. 2. That the Secretary of the Treasury is authorized and required to prepare suitable standards in accordance herewith.

Sec. 3. That in the practical use and application of the standard gage hereby established a variation of two and one-half per cent either way may be allowed.

Approved, March 3, 1893.

B. Approximate Thicknesses of Steel Plates and Sheets

The thicknesses given in the law as appropriate equivalents were based upon the density of wrought iron of 0.2778 pounds per cubic inch, or 480 pounds per cubic foot. Since the U.S. Standard Gage was established, wrought iron has been almost entirely superseded by steel, for sheets. The density of steel is generally agreed by various authorities to be 0.2833 pounds per cubic inch or 489.6 pounds per cubic foot. The approximate thicknesses of both wrought iron and steel sheets are given in Table 1, and are based upon the above values, but attention is directed to the fact that the density of commercial hot-rolled steel varies considerably and is usually less than 0.2833 pounds per cubic inch, the density of forged steel. Cold rolled steel sheets are said to have a greater density than 0.2833; however, two samples of full pickled full cold-rolled sheets showed an average density of 0.2833 pounds per cubic inch. Until a more representative value for hot-rolled sheets can be agreed upon, it is thought advisable to continue the use of the value 0.2833 pounds per cubic inch.

The action of the rolls on hot metal tends to decrease the density of the material, and of two sheets of different thicknesses rolled from the same material, the thicker sheet is always the denser. This effect is not easily explained. A similar reduction in density has been noted in hard drawn steel wire. In this case the reduction has been shown to be smaller, the greater the carbon content of the sample. (Ref. Über den Einfluss der Mechanischen Formgebung auf die Eigenshaften von Eisen and Stahl, by P. Goerens, Stahl und Eisen, March 13, 1913, Vol. 33, No. 11, pages 438-444). Reductions in density as follows were found by Goerens:

0.0012	lbs.	per	cu.	in.	for	steel	having	0.07% C.
.0009	"	"	"	"	"	"	"	.55% C.
.0002	"	"	"	"	"	"	"	.78% C.

In Table 1 the approximate thicknesses and weights are given, for practical use, only to the number of decimal places warranted by the precision of measurement ordinarily attainable, and the usual variation in density. Also, the sizes above No.38 are included, which have become standardized by custom, but were not included in the Congressional enactment.

Table 1. - United States Standard Gage for Sheet and Plate Iron and Steel, and Extension

Number of gage	Approximate thickness in fractions of an inch	Wrought Iron: Approximate thickness in decimal parts of an inch	Wrought Iron: Approximate thickness in Millimeters	Steel: Approximate thickness in decimal parts of an inch	Steel: Approximate thickness in millimeters	Iron and Steel: Weight per square foot in ounces avoirdupois	Iron and Steel: Weight per square foot in pounds avoirdupois	Iron and Steel: Weight per square foot in kilograms	Iron and Steel: Weight per square meter in kilograms	Weight per square meter in pounds avoirdupois
0000000	1/2	0.500	12.70	0.490	12.45	320	20.00	9.072	97.65	215.3
000000	15/32	.469	11.91	.460	11.67	300	18.75	8.505	91.55	201.8
00000	7/16	.438	11.11	.429	10.90	280	17.50	7.983	85.44	188.4
0000	13/32	.406	10.32	.390	10.12	260	16.25	7.371	79.33	174.9
000	3/8	.375	9.52	.368	9.34	240	15.00	6.804	73.24	161.5
00	11/32	.344	8.73	.337	8.56	220	13.75	6.237	67.13	148.0
0	5/16	.312	7.94	.306	7.78	200	12.50	5.670	61.03	134.6
1	9/32	.2812	7.14	.2758	7.00	180	11.25	5.103	54.93	121.1
2	17/64	.2656	6.75	.2604	6.62	170	10.62	4.819	51.88	114.4
3	1/4	.2500	6.35	.2451	6.23	160	10.00	4.536	48.82	107.6
4	15/64	.2344	5.95	.2298	5.84	150	9.375	4.252	45.77	100.9
5	7/32	.2188	5.56	.2145	5.45	140	8.750	3.969	42.72	94.18
6	13/64	.2031	5.16	.1992	5.06	130	8.125	3.685	39.67	87.45
7	3/16	.1875	4.76	.1838	4.67	120	7.500	3.402	36.62	80.72
8	11/64	.1719	4.37	.1685	4.28	110	6.875	3.118	33.57	74.00
9	5/32	.1562	3.97	.1532	3.89	100	6.250	2.835	30.52	67.27
10	9/64	.1406	3.57	.1379	3.50	90	5.625	2.552	27.46	60.55
11	1/8	.1250	3.18	.1226	3.11	80	5.000	2.268	24.41	53.82
12	7/64	.1094	2.778	.1072	2.724	70	4.375	1.984	21.36	47.09
13	3/32	.0938	2.381	.0919	2.335	60	3.750	1.701	18.31	40.36
14	5/64	.0781	1.984	.0766	1.946	50	3.125	1.417	15.26	33.64
15	9/128	.0703	1.786	.0689	1.751	45	2.812	1.276	13.73	30.27
16	1/16	.0625	1.588	.0613	1.557	40	2.500	1.134	12.21	26.91
17	9/160	.0562	1.429	.0552	1.401	36	2.250	1.021	10.99	24.22
18	1/20	.0500	1.270	.0490	1.245	32	2.000	0.9072	9.765	21.53
19	7/160	.0438	1.111	.0429	1.090	28	1.750	.7938	8.544	18.84
20	3/80	.0375	0.953	.0368	0.934	24	1.500	.6804	7.324	16.15
21	11/320	.0344	.873	.0337	.856	22	1.375	.6237	6.713	14.80
22	1/32	.0312	.794	.0306	.778	20	1.250	.5670	6.103	13.46
23	9/320	.0281	.714	.0276	.700	18	1.125	.5103	5.493	12.11
24	1/40	.0250	.635	.0245	.622	16	1.000	.4536	4.882	10.76
25	7/320	.0219	.556	.0214	.545	14	0.8750	.3969	4.272	9.42
26	3/160	.0188	.476	.0184	.467	12	.7500	.3402	3.662	8.07
27	11/640	.0172	.437	.0169	.428	11	.6875	.3119	3.357	7.40
28	1/64	.0156	.397	.0153	.389	10	.6250	.2835	3.052	6.73
29	9/640	.0141	.357	.0138	.350	9	.5625	.2551	2.746	6.05
30	1/80	.0125	.318	.0123	.311	8	.5000	.2268	2.441	5.38
31	7/640	.0109	.278	.0107	.272	7	.4375	.1984	2.136	4.71
32	13/1280	.0102	.258	.0100	.253	6-1/2	.4062	.1843	1.983	4.37
33	3/320	.0094	.238	.0092	.233	6	.3750	.1701	1.831	4.04
34	11/1280	.0086	.218	.0084	.214	5-1/2	.3438	.1559	1.678	3.70
35	5/640	.0078	.198	.0077	.194	5	.3125	.1417	1.526	3.36
36	9/1280	.0070	.179	.0069	.175	4-1/2	.2812	.1276	1.373	3.03
37	17/2560	.0066	.169	.0065	.165	4-1/4	.2656	.1205	1.297	2.87
38	1/160	.0062	.159	.0061	.156	4	.2500	.1134	1.221	2.69
39	15/2560	.0059	.149	.0057	.146	3-3/4	.2344	.1063	1.144	2.52
40	7/1280	.0055	.139	.0054	.136	3-1/2	.2188	.0992	1.068	2.35
41	27/5120	.0053	.134	.0052	.131	3-3/8	.2109	.0957	1.030	2.27
42	13/2560	.0051	.129	.0050	.126	3-1/4	.2031	.0921	0.9917	2.19
43	25/5120	.0049	.124	.0048	.122	3-1/8	.1953	.0886	.9536	2.10
44	3/640	.0047	.119	.0046	.117	3	.1875	.0850	.9155	2.02

C. Permissible Variations in Weight and Thickness

Manufacturers have found considerable difficulty in keeping within the tolerance of plus or minus 2-1/2 per cent specified in the law establishing the U.S. Standard Gage for Sheet and Plate Iron and Steel, particularly on the heavier sheets. As the law does not make this tolerance mandatory for commercial purposes the Association of American Steel Manufacturers have adopted the following specifications regarding permissible variations in weight and gage:

(a) The sectional area or weight of each structural shape, and of each rolled-edge plate up to and including 36 in. in width, shall not vary more than 2.5 per cent from theoretical or specified amounts.

(b) The thickness or weight of each universal plate over 36 in. in width, and of each sheared plate, shall conform to the schedules of permissible variations for sheared plates, Manufacturers' Standard Practice, given in Tables 2 and 3. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

(c) When ordered to WEIGHT per square foot, the weight of each lot in each shipment shall not very from the weight ordered more than the amount given in Table 2.

(d) When ordered to THICKNESS, the thickness of each plate shall not vary more than 0.01 in. under that ordered. The overweight of each lot in each shipment shall not exceed the amount given in Table 3.

Tables of permissible rolling variations in weight and thickness of sheared plates were adopted by the Association of American Steel Manufadturers in 1896. These tables were revised from time to time the latest revision as to percentages of over-weight being made in 1916. The 1916 revision was adopted by the American Society for Testing Materials, and the tables appear in the following of its specifications:

Standard Specifications for Structural Steel for Bridges, 1916;
" " " " Nickel Steel, 1916;
" " " " Steel for Buildings, 1916;
" " " " " " Locomotives, 1916;
" " " " " " Cars, 1916;
" " " " " " Ships, 1916;
" " " " Boiler and Firebox Steel for Locomotives (Table 3 only), 1918;
Tentative " " Steel Plates for Forge Welding, 1921;
" " " Boiler and Firebox Steel for Stationary Service (Table 3 only), 1918.

In 1921 and 1922, the Association of American Steel Manufacturers adopted the following modifications and additions to the tables, which have not been adopted by the American Society for Testing Materials, although some of them are under consideration:

(Turn to page 8).

Table 2. Permissible Variations of Plates Ordered to Weight

Ordered weight, pounds per square foot	Permissible Variations in Average Weights Per Square Foot of Plates for Widths Given Expressed in Percentages of Ordered Weights																	
	Under 48 in.		48 to 60 in. excl.		60 to 72 in. excl.		72 to 84 in. excl.		84 to 96 in. excl.		96 to 108 in. excl.		108 to 120 in. excl.		120 to 132 in. excl.		132 in. or over	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Under 5	5	3	5.5	3	6	3	7	3	..	..	..	..	..	..	..	..	..	..
5 to 7.5 Excl	4.5	3	5	3	5.5	3	6	3	..	..	..	..	..	..	..	..	..	..
7.5 to 10 "	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	..	..	..	..
10 to 12.5 "	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3
12.5 to 15 "	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3
15 to 17.5 "	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3
17.5 to 20 "	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3
20 to 25 "	2	2	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3
25 to 30 "	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	5	3
30 to 40 "	2	2	2	2	3	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3
40 or over	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3

The weight per square foot of individual plates shall not vary from the ordered **weight** by more than 1-1/3 times the amount given in this table.

The term "lot" applied to this table means all of the plates of each group width and group weight.

Table 3. Permissible Overweights of Steel Plates Ordered to Thickness.

Ordered Thickness, Inches		Permissible excess in average weights per square foot of plates for widths given, expressed in percentages of nominal weights								
		Under 48 in.	48 to 60 in. excl.	60 to 72 in. excl.	72 to 84 in. excl.	84 to 96 in. excl.	96 to 108 in. excl.	108 to 120 in. excl.	120 to 132 in. excl.	132 in. or over
Under 1/8		9	10	12	14	..	..	..	..	..
1/8 to 3/16	excl.	8	9	10	12	..	..	..	..	..
3/16 to 1/4	"	7	8	9	10	12	..	..	..	..
1/4 to 5/16	"	6	7	8	9	10	12	14	16	19
5/16 to 3/8	"	5	6	7	8	9	10	12	14	17
3/8 to 7/16	"	4.5	5	6	7	8	9	10	13	15
7/16 to 1/2	"	4	4.5	5	6	7	8	9	10	13
1/2 to 5/8	"	3.5	4	4.5	5	6	7	8	9	11
5/8 to 3/4	"	3	3.5	4	4.5	5	6	7	8	9
3/4 to 1	"	2.5	3	3.5	4	4.5	5	6	7	8
1 or over		2.5	2.5	3	3.5	4	4.5	5	6	7

The term "lot" applied to this table means all of the plates of each group width and group thickness.

(e) The heading for the last width group of tables 2 and 3 is changed to read - "132 inches to 144 inches exclusive".

(f) Tables 2 and 3 are to apply to rectangular plates only.

(g) Tables 2 is not to be used when a minimum thickness at edges is required.

(h) The following note is to be added to Table 3: "The width of individual plates ordered to gage shall not vary from the nominal weight more than 1-1/3 times the amount given in this table".

2. Galvanized Sheet Gage

The Galvanized Sheet Gage, given in Table 4, is based upon the United States Standard Gage for Sheet and Plate Iron and Steel; 2.5 ounces per square foot being added to the weight per square foot of a given gage number of the United States Standard Gage, to determine the weight per square foot of the corresponding gage number of the Galvanized Sheet Gage. This gage is considered standard in the United States, having been established by custom. The resistance of the galvanized sheet to corrosion depends on the purity, evenness and weight of coating. The weight of coating is seldom as great as 2-1/2 ounces per square foot; the specification of a minimum weight of 2 ounces is quite common. Navy Department specifications for minimum weight of coating are given in Column 4 of the table.

Table 4 - Galvanized Sheet Gage

1	2	3	4
Number of Gage	Weight per Square foot	Weight per square foot	Minimum weight * of zinc coating per square foot
	Pounds	Ounces	Ounces
8	7.031	112.5	
9	6.406	102.5	
10	5.781	92.5	1.65
11	5.156	82.5	1.65
12	4.531	72.5	1.65
13	3.906	62.5	1.65
14	3.281	52.5	1.65
15	2.969	47.5	1.65
16	2.656	42.5	1.65
17	2.406	38.5	1.65
18	2.156	34.5	1.65
19	1.906	30.5	1.65
20	1.656	26.5	1.65
21	1.531	24.5	1.50
22	1.406	22.5	1.50
23	1.281	20.5	1.50
24	1.156	18.5	1.50
25	1.031	16.5	1.40
26	0.906	14.5	1.40
27	.844	13.5	1.35
28	.781	12.5	1.35
29	.719	11.5	1.35
30	.656	10.5	1.35
31	.594	9.5	
32	.563	9.0	
33	.531	8.5	
34	.500	8.0	

*U.S.Navy Department Specification 47S10C, July 1, 1928

III. COPPER, BRASS, AND ALUMINUM SHEETS

1. American Wire Gage

The American Wire Gage is extensively used in the United States for nearly all non-ferrous sheets, particularly copper, brass, aluminum and nickel-silver (German silver) sheets, as well as for wire of the same materials. It was devised by J. R. Brown and Lucian Sharpe, founders of the Brown and Sharpe Manufacturing Company, in 1856 and was adopted by the Association of Brass Manufacturers in February 1857, eight of the leading brass manufacturers signing the resolutions. Its gage numbers, like those of the United States Standard Gage and many other gages are retrogressive, a larger number denoting a smaller size. The gage is based on a simple mathematical law of geometrical progression, which may be expressed in either of three following manners:-

(a) The ratio of any size to the next smaller is a constant number, namely the 39th root of $\frac{.460}{.005}$ = 1.1229322.

(b) The difference between any two successive sizes is a constant percentage of the smaller of the two sizes, namely .1229322.

(c) The difference between any two successive sizes is a constant ratio times the next smaller difference between two successive sizes, namely 1.1229322.

When the gage was developed the size No. 0000 was defined as 0.4600, and of No. 36 as 0.005 inch, and it was specified that there should be 38 sizes between the two which should advance by geometrical progression. The sixth power of the ratio 1.1229322 is 2.0050, so that the thickness and consequently the weight per unit area of a sheet six times heavier, is approximately twice as great.

A. Approximate Weights per Square Foot

In Table 5, the size numbers and thickness of the American Wire Gage are given, together with the approximate weights per square foot of rolled copper, brass and aluminum sheets. The weights of copper sheets given in this table are based on the specific gravity 8.89 grams per cubic centimeter, or 555 pounds per cubic foot, since that is the value adopted as standard by the American Institute of Electrical Engineers and by the International Electro- Technical Commission; also adoptee by the American Society for Testing Materials for hard drawn copper wire and annealed copper. The weights given in the table are, therefore, for cold rolled and annealed copper sheets. Hot rolled copper plates having a thickness of 5/16 inch, and over are about 1/2 per cent heavier, the specific gravity being 8.94 g. per cc. or 558 lbs. per cubic foot, according to A.S.T.M. Standard Specifications for Locomotive Fireboxes, 1918.

The weights of brass sheets are based on the specific gravity 8.56 grams per cubic centimeter, or 534 pounds per cubic foot, which is the value for rolled yellow brass given in the Smithsonian Tables, 1920. The weights of aluminum sheets are based on the specific gravity 2.70 grams per cubic centimeter, or 168.6 pounds per cubic foot.

Copper sheets are frequently made in definite weights per square foot. This practice is quite common in the heavier flat sheets. Table 6 shows the corresponding approximate thicknesses, which are based on a density of 8.89 grams per cubic centimeter or 555 lbs. per cubic foot.

Copper sheets can also be obtained in fractional inch sizes varying by sixteenths of an inch from 1/16 to 2 inches. Also the Birmingham or Stubs wire gage has been used in designating sizes of copper sheets.

B. Permissible Variations in Thickness and Weight

The available data as to tolerancesapplied to copper, brass, and aluminum sheets are given in Tables 7, 8 and 9. These tables were taken from specifications of the American Society for Testing Material, and of the Aluminum Company of America.

Table 5. - American Wire Gage, - Weights of Copper, Brass and Aluminum Sheets and Plates

1	2	3	4	5	6
Number of gage	Thickness in decimal parts of an inch	Thickness in millimeters	Approximate weight per square foot in pounds avoirdupois		
			Copper	Brass	Aluminum
0000	0.4600	11.68	21.27	20.48	6.461
000	.4096	10.40	18.95	18.24	5.754
00	.3648	9.266	16.87	16.25	5.124
0	.3249	8.252	15.02	14.47	4.563
1	.2893	7.348	13.38	12.88	4.064
2	.2576	6.544	11.92	11.47	3.619
3	.2294	5.827	10.61	10.22	3.223
4	.2043	5.189	9.449	9.098	2.870
5	.1819	4.621	8.415	8.102	2.556
6	.1620	4.115	7.493	7.215	2.276
7	.1443	3.665	6.673	6.425	2.027
8	.1285	3.264	5.943	5.722	1.805
9	.1144	2.906	5.292	5.096	1.607
10	.1019	2.588	4.712	4.537	1.431
11	.0907	2.305	4.197	4.041	1.275
12	.0808	2.053	3.737	3.599	1.135
13	.0720	1.828	3.328	3.205	1.011
14	.0641	1.628	2.964	2.854	0.9001
15	.0571	1.450	2.639	2.541	.8016
16	.0508	1.291	2.350	2.263	.7138
17	.0453	1.150	2.093	2.015	.6357
18	.0403	1.024	1.864	1.795	.5661
19	.0359	0.9116	1.660	1.598	.5041
20	.0320	.8118	1.478	1.423	.4489
21	.0285	.7230	1.316	1.267	.3998
22	.0253	.6438	1.172	1.129	.3560
23	.0226	.5733	1.044	1.005	.3170
24	.0201	.5106	0.9296	0.8951	.2823
25	.0179	.4547	.8279	.7971	.2514
26	.0159	.4049	.7372	.7098	.2239
27	.0142	.3606	.6565	.6321	.1994
28	.0126	.3211	.5846	.5629	.1776
29	.0113	.2859	.5206	.5013	.1581
30	.0100	.2546	.4636	.4464	.1408
31	.00893	.2268	.4129	.3976	.1254
32	.00795	.2019	.3677	.3540	.1117
33	.00708	.1798	.3274	.3153	.09945
34	.00630	.1601	.2916	.2807	.08855
35	.00561	.1426	.2596	.2500	.07886
36	.00500	.1270	.2312	.2227	.07023
37	.00445	.1131	.2059	.1983	.06255
38	.00396	.1007	.1834	.1766	.05569
39	.00353	.0897	.1633	.1572	.04960
40	.00314	.0799	.1454	.1400	.04416

Table 6. - Copper Sheets Furnished in Weights per Square Foot.

1	2	1	2
Weight per square foot	Approximate thickness	Weight per square foot	Approximate thickness
Ounces	Inch	Pounds	Inch
2	0.0027	5	0.1081
4	.0054	5 1/2	.1189
6	.0081	6	.1297
7	.0095	6 1/2	.1405
8	.0108	7	.1514
9	.0122	7 1/2	.1622
10	.0135	8	.1730
11	.0149	8 1/2	.1838
12	.0162	9	.1946
13	.0176	9 1/2	.2054
14	.0189	10	.2162
15	.0203	11	.2378
16	.0216	12	.2595
18	.0243	13	.2811
20	.0270	14	.3027
24	.0324	15	.3243
26	.0351	16	.3460
28	.0378		
32	.0432		
36	.0486		
40	.0541		
44	.0595		
46	.0622		
48	.0649		
52	.0703		
56	.0757		
64	.0865		
72	.0973		
76	.1027		

Table 7. - Permissible Overweights of Copper Plates for Locomotive Fireboxes, Ordered to Thickness. Standard Specifications, American Society for Testing Materials, 1918

Ordered Thickness, in.	Weight, lb. per sq. ft.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given Expressed in Percentages of Nominal Weights			
		Under 75 in.	75 to 100 in., excl.	100 to 115 in., excl.	115 in. or over
Inches					
5/16.....	14.53	8	12	16	..
3/8......	17.44	7	10	13	17
7/16.....	20.34	6	8	10	13
1/2......	23.25	5	7	9	12
9/16.....	26.16	5	6.5	8.5	11
5/8......	29.06	5	6	8	10
Over 5/8......	.....	5	5	6.5	9

The thickness of each plate shall not vary more than 0.04 in. under that ordered.

Table 8. - Permissible Variations in Thickness, High Sheet Brass. Tentative Specifications, American Society for Testing Materials, 1920

Thickness, American Wire Gage No.	Thickness, in.	Width, in.			
		Up to 5 incl.	Over 5 to 8 incl.	Over 8 to 11, incl.	Over 11 to 14, incl.
0000 to 0, incl.	0.4600 to 0.3248	±0.0044	±0.0048	±0.0051	±0.0055
Below 0 to 4, incl.	0.3248 " 0.2043	±0.0039	±0.0043	±0.0046	±0.0050
" 4 " 8, "	0.2043 " 0.1284	±0.0034	±0.0038	±0.0041	±0.0045
" 8 "14, "	0.1284 " 0.0640	±0.0029	±0.0033	±0.0036	±0.0040
" 14 "18, "	0.0640 " 0.0403	±0.0025	±0.0029	±0.0033	±0.0037
" 18 "24, "	0.0403 " 0.0201	±0.0020	±0.0024	±0.0028	±0.0032
" 24 "28, "	0.0201 " 0.0126	±0.0016	±0.0020	±0.0024	±0.0028
" 28 "32, "	0.0126 " 0.0079	±0.0013	±0.0017	±0.0020	±0.0024
" 32 "35, "	0.0079 " 0.0056	±0.0010	±0.0014	±0.0017	±0.0022
" 35 "38, "	0.0056 " 0.0039	±0.0008	±0.0012	±0.0015	±0.0019

The standard method of specifying thickness shall be in terms of the American Wire Gage (Brown and Sharpe). When the thickness is specified in either common or decimal fractions of an inch, the tolerances shall be those of the corresponding group of American Wire Gage sizes in this table.

Table 9. - Permissible Variations in Thickness of Aluminum Sheet

1	2	3	4	5
		Flat sheet		Coiled sheet
Gage No.	Thickness	A.S.T.M. Tentative Specifications, 1919	Aluminum Co. of America, 1922	Aluminum Co. of America, 1922
	Inches	Inches	Inches	Inches
1/4 in. to 4	0.25 to 0.2043		±0.010	
5 " 9	.1819" .1144		± .006	
10 " 13	.1019" .0720	±0.003	± .003	±0.003
14 " 17	.0641" .0453	± .003	± .0025	± .003
18 " 21	.0403" .0285	± .002	± .0025	± .002
22 " 24	.0253" .0201	± .002	± .002	± .002
25 & 26	.0179" .0159	± .002	± .0015	± .002
27 & 28	.0142" .0126		± .0015	± .0015
29 & thinner	.0113 & less		± .0015	± .001

IV. TIN AND TERNE PLATE

1. Tin Plate Gage

Tin plates, which consist of soft sheet steel coated with tin and Terne plates in which the coating is approximately 25% tin and 75% lead, are measured in a unit of area known as the base box. This is an old English unit amounting to 31.360 square inches and is independent of thickness (which is always shown on the packing box). Tin plates are customarily made in sizes of 10 x 14 inches and multiples thereof, the most commonly used sizes being 14 x 20 and 20 x 28 inches. The base box corresponds to 112 plates, 14 x 20 inches.

In Table 10 are given the essential dimensions and trade symbols of the Tin Plate Gage as published in the Reference Book of the American Sheet and Tin Plate Company. This gage is established by long custom and the symbols noted in the table are inherited from the British industry. It should be borne in mind that the corrosion resisting qualities of both tin and terne plates depend on the thickness of the coating rather than on the total thickness of the plate. Tin plate comes in a number of grades usually designated by "A", "AAA", "AAAA" and so forth, the greater the number of A's in the symbol, the greater the coating. AAA tin plate has approximately 3 lbs of tin coating per box. Terne plate used extensively as roofing tin comes in coats of from 8 to 40 pounds per box.

Table 10. - Tin Plate Gage

Trade Symbol	Pounds per base box	Pounds per square foot	*Approximate thickness
			Inches
55-pounds	55	0.253	0.0063
60- "	60	.276	.0069
65- "	65	.298	.0075
70- "	70	.321	.0080
75- "	75	.344	.0086
80- "	80	.367	.0092
85- "	85	.390	.0098
90- "	90	.413	.0103
95- "	95	.436	.0109
I C L	100	.459	.0115
I C	107	.491	.0123
112-pounds	112	.514	.0129
118- "	118	.542	.0135
I X L	128	.588	.0147
I X	135	.620	.0155
D C	139	.638	.0160
2 X L	148	.680	.0170
2 X	155	.712	.0178
3 X L	168	.771	.0193
3 X	175	.804	.0201
D X	180	.827	.0207
4 X L	188	.863	.0216
4 X	195	.895	.0224
5 X L	208	.955	.0239
D 2 X	210	.964	.0241
5 X	215	.987	.0247
6 X L	228	1.047	.0262
6 X	235	1.079	.0270
D 3 X	240	1.102	.0275
7 X L	248	1.139	.0285
7 X	255	1.171	.0293
8 X L	268	1.231	.0308
D 4 X	270	1.240	.0310
8 X	275	1.263	.0316

*Assuming that tin plate weighs 480 lbs. per cu. ft.

V. ZINC

1. Sheet Zinc Gage

The Sheet Zinc Gage, commonly used by manufacturers of zinc sheet in the United States, is given in Table 11. The weights per square foot for the thicknesses given are based on a specific gravity of 7.19 grams per cubic centimeter of 448.9 pounds per cubic foot.

Table 11. - Sheet Zinc Gage

1	2	3
Gage No.	Thickness Inches	Weight pounds per sq.ft.
1	0.002	0.07
2	.004	.15
3	.006	.22
4	.008	.30
5	.010	.37
6	.012	.45
7	.014	.52
8	.016	.60
9	.018	.67
10	.020	.75
11	.024	.90
12	.028	1.05
13	.032	1.20
14	.036	1.35
15	.040	1.50
16	.045	1.68
17	.050	1.87
18	.055	2.06
19	.060	2.24
20	.070	2.62
21	.080	2.99
22	.090	3.37
23	.100	3.74
24	.125	4.68
25	.250	9.35
26	.375	14.03
27	.500	18.70
28	1.000	37.40

VI. - MONEL METAL

Monel metal is a non-corrodible, natural alloy, comparable with the better grades of steel in strength, toughness and ductility. Its composition is approximately 67% nickel, 28% copper and 5% of other elements. Monel metal sheets are rolled in thicknesses corresponding to the thickness sizes of the U.S. Standard Gage for Sheet and Plate Iron and Steel. The corresponding weights per unit area are given in Table 12. Inasmuch as the U.S. sheet metal gage is strictly a weight gage, this practice with regard to sizes of monel metal sheets represents a deviation from the standard practice. Monel metal sheets are usually used to replace sheet metal, or steel sheets coated with zinc, which come in sheet metal gage sizes. If monel metal sheets were rolled to the same weight per unit area as the sheet metal gage, the resulting thicknesses would be quite different from standard steel sheet thicknesses, because of the large difference in density of the two metals. This is the reason given for the practice.

The tolerances on thickness given in Table 12 are the practice of the International Nickel Company. When rolled to weight, their tolerances correspond to sheet steel practice.

Table 12. - Monel Metal Sheets

1	2	3	4	5	6
	Thickness			*Weight per square foot	
Number of gage	In fractions of an inch	In decimal parts of an inch	Tolerances	In ounces	In pounds
2	17-64	0.2656		194-1/2	12.211
3	1-4	.25	±0.008	183	11.493
4	15-64	.2344	± .008	171-3/4	10.774
5	7-32	.2188	± .007	160-1/4	10.056
6	13-64	.2031	± .007	148-3/4	9.338
7	3-16	.1875	± .005	137-1/2	8.619
8	11-64	.1719	± .004	126	7.901
9	5-32	.1562	± .004	114-1/2	7.183
10	9-64	.1406	± .004	103	6.465
11	1-8	.125	± .003	91-1/2	5.746
12	7-64	.1094	± .003	80-1/4	5.028
13	3-32	.0938	± .003	68-3/4	4.310
14	5-64	.0781	± .003	57-1/4	3.591
15	9-128	.0703	± .003	51-1/2	3.232
16	1-16	.0625	± .002	45-3/4	2.873
17	9-160	.0562	± .002	41	2.586
18	1-20	.05	± .002	36-1/2	2.300
19	7-160	.0438	± .002	32	2.011
20	3-80	.0375	± .001	27-1/2	1.724
21	11-320	.0344	± .001	25	1.580
22	1-32	.0313	± .001	22-3/4	1.437
23	9-320	.0281	± .001	20-1/2	1.293
24	1-40	.025	± .001	18-1/4	1.149
25	7-320	.0219	± .001	16	1.005
26	3-160	.0188	± .001	13-3/4	0.862
27	11-640	.0172		12-1/2	.7901
28	1-64	.0156		11-1/4	.7183

*Based on a density of 8.85 grams per cubic centimeter or approximately 552 lbs. per cubic foot.

VI. FOREIGN SHEET AND PLATE GAGES

1. Birmingham Gage, B.G. (British Legal Standard)

The Board of Trade, Standards Department, England, passed an Order in Council, on July 16, 1914, giving legal sanction to the Birmingham Gage, B.G., for iron and steel sheets, hoops, etc. The enumeration and sizes of the B.G. gage was first issued by the South Staffordshire Ironmaster's Association March 1, 1884, and came into more or less general use in the British sheet steel and hoop iron trade. By 1914 the B.G. series of sizes was recognized by most of the sheet steel rollers and galvanizers, and tin plate and hoop iron manufacturers in England; and upon petition of various Chambers of Commerce in the United Kingdom, the Board of Trade proceeded to have the gage legalized. See Table 13.

2. Paris or French Gage.

The "Jauge de Paris", given in Table 8, is a gage for sheet metal and wire, which has been in use in France since 1857. It is a thickness gage established by custom. The weights of sheet iron given in Table 8 are computed on the basis of 480 pounds per cu. ft.

Table 13. - British Sheet and Hoop Iron Standard Gage (Birmingham Gage, B.G.)

1	2	1	2	1	2
Descriptive Number	Equivalents in decimal parts of an inch	Descriptive Number	Equivalents in decimal parts of an inch	Descriptive Number	Equivalents in decimal parts of an inch
No.	Inches	No.	Inches	No.	Inches
15/0 B.G.	1.000	8 B.G.	0.1570	30 B.G.	0.0123
14/0 B.G.	0.9583	9 B.G.	.1398	31 B.G.	.0110
13/0 B.G.	.9167	10 B.G.	.1250	32 B.G.	.0098
12/0 B.G.	.8750	11 B.G.	.1113	33 B.G.	.0087
11/0 B.G.	.8333	12 B.G.	.0991	34 B.G.	.0077
10/0 B.G.	.7917	13 B.G.	.0882	35 B.G.	.0069
9/0 B.G.	.7500	14 B.G.	.0785	36 B.G.	.0061
8/0 B.G.	.7083	15 B.G.	.0699	37 B.G.	.0054
7/0 B.G.	.6666	16 B.G.	.0625	38 B.G.	.0048
6/0 B.G.	.6250	17 B.G.	.0556	39 B.G.	.0043
5/0 B.G.	.5883	18 B.G.	.0495	40 B.G.	.00386
4/0 B.G.	.5416	19 B.G.	.0440	41 B.G.	.00343
3/0 B.G.	.5000	20 B.G.	.0392	42 B.G.	.00306
2/0 B.G.	.4452	21 B.G.	.0349	43 B.G.	.00272
1/0 B.G.	.3964	22 B.G.	.03125	44 B.G.	.00242
1 B.G.	.3532	23 B.G.	.02782	45 B.G.	.00215
2 B.G.	.3147	24 B.G.	.02476	46 B.G.	.00192
3 B.G.	.2804	25 B.G.	.02204	47 B.G.	.00170
4 B.G.	.2500	26 B.G.	.01961	48 B.G.	.00152
5 B.G.	.2225	27 B.G.	.01745	49 B.G.	.00135
6 B.G.	.1981	28 B.G.	.015625	50 B.G.	.00120
7 B.G.	.1764	29 B.G.	.0139	51 B.G.	.00107
				52 B.G.	.00095

N.B. It is important that in all transactions in sheet and hoop iron the initial letters B.G. should appear to distinguish the Sheet and Hoop Iron Standard Gage from other gages.

Table 14.- Paris or French Gage for Sheets and Wires.

1	2	3	4	5
Number of gage	Thickness in millimeters	Approximate thickness in inches	Weight per square meter in kilograms, sheet iron	Weight per square meter in pounds avoirdupois, sheet iron
P15	0.15	0.0059	1.1533	2.5426
P14	.16	.0063	1.2302	2.7122
P13	.17	.0067	1.3071	2.8817
P12	.18	.0071	1.3840	3.0512
P11	.20	.0079	1.5378	3.3902
P10	.22	.0087	1.6915	3.7292
P 9	.23	.0091	1.8453	3.8987
P 8	.25	.0098	1.9222	4.2377
P 7	.27	.0106	2.0760	4.5768
P 6	.28	.0110	2.1529	4.7463
P 5	.30	.0118	2.3066	5.0853
P 4	.34	.0134	2.6142	5.7633
P 3	.37	.0146	2.8449	6.2718
P 2	.42	.0165	3.2293	7.1194
P 1	.46	.0181	3.5369	7.7974
P 0	.50	.0197	3.8444	8.4755
1	.6	.0236	4.6133	10.1706
2	.7	.0276	5.3822	11.8657
3	.8	.0315	6.1511	13.5608
4	.9	.0354	6.9199	15.2558
5	1.0	.0394	7.6888	16.9509
6	1.1	.0433	8.4577	18.6460
7	1.2	.0472	9.2266	20.3411
8	1.3	0.0512	9.9955	22.0362
9	1.4	.0551	10.7643	23.7313
10	1.5	.0591	11.5332	25.4264
11	1.6	.0630	12.3021	27.1215
12	1.8	.0709	13.8399	30.5117
13	2.0	.0787	15.3776	33.9019
14	2.2	.0866	16.9154	37.2921
15	2.4	.0945	18.4532	40.6823
16	2.7	.1063	20.7598	45.7675
17	3.0	.1181	23.0664	50.8528
18	3.4	.1339	26.1420	57.6332
19	3.9	.1535	29.9864	66.1087
20	4.4	.1732	33.8308	74.5841
21	4.9	.1929	37.6752	83.0596
22	5.4	.2126	41.5196	91.5351
23	5.9	.2323	45.3634	100.0106
24	6.4	.2520	49.2084	108.4860
25	7.0	.2756	53.8217	118.6566
26	7.6	.2992	58.4350	128.8272
27	8.2	.3228	63.0483	138.9977
28	8.8	.3465	67.6616	149.1683
29	9.4	.3701	72.2749	159.3388
30	10.0	.3937	76.8882	169.5094