U. S. DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

STANDARD THICKNESSES WEIGHTS, AND TOLERANCES OF SHEET METAL (CUSTOMARY PRACTICE)

CIRCULAR OF THE BUREAU OF STANDARDS, No. 391

U. S. DEPARTMENT OF COMMERCE
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BUREAU OF STANDARDS
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STANDARD THICKNESSES, WEIGHTS, AND TOLERANCES OF SHEET METAL (CUSTOMARY PRACTICE) [1]

ABSTRACT

This circular is intended to furnish information as to the usual practice of American manufacturers with regard to stock thicknesses or weights of sheets and plates of common metals and alloys, but it does not promulgate these data as standards. The stock list of thicknesses or weights to which plates and sheets of a given metal are rolled, constitutes what is known as a gage. There are various gages for sheet metal in use in the United States. The information and data included in this circular pertain to the specific applications of these gages to various metals and alloys. There are also included herein gages or stock lists for sheet metal widely used in Europe, particularly England, France, and Germany, and in Japan.

The circular also contains information with regard to manufacturing tolerances adopted by American technical societies, manufacturers' associations, and standardizing bodies, or used by leading manufacturers.

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[1] Compiled by I. H. Fullmer and D. R. Miller.

I. INTRODUCTION

Common or stock sizes of metal plates and sheets are based either on definite thicknesses or on definite weights per unit area. In some cases the same kind and grade of sheet metal is made to conform to more than one list of stock sizes or sheet metal gage. This circular is intended to furnish information as to the usual practice of American manufacturers with regard to stock thicknesses or weights of sheets and plates of common metals and alloys; also information with regard to manufacturing tolerances on thickness or weight adopted by American technical societies, manufacturers' associations, and standardizing bodies, or used by leading manufacturers. The Sectional Committee B32 on "Wire and Sheet Metal Gages," organized under the procedure of the American Standards Association, is working on this subject, and this publication (superseding Letter Circular No. 24, September 21, 1925) *is issued for information only as to current practice, and is not intended to promulgate standards.*

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 tin plate gage, the Birmingham wire or Stubs' iron wire gage, the American wire gage, and the American zinc gage. The information and data included in this circular pertain to the application of these gages to various metals; that is, this circular lists the usual stock thicknesses or weights for various kinds of sheet metal. There are also included herein the principal foreign gages or stock lists for sheet metal, namely, the Birmingham gage, B. G., the Imperial (British) standard wire gage, the Paris or French gage, the Continental zinc gage, the German (N. D. I.) standards for steel, brass, copper, and aluminum, and the Japanese standard thicknesses of sheet metal.

For thickness gages the weights per square foot, and for weight gages the equivalent thicknesses given in the tables, are based on densities most widely accepted as being representative for rolled sheets at 20° C. or 68° F., or, in a few instances, on densities determined at this bureau by tests of the rolled material.

The various standard specifications referred to herein are also sources of information as to standard widths and lengths of sheets and plates, tolerances on width and length, standard compositions of alloys used for sheets, etc., which it has not been considered expedient to include herein.

Because of the confusion that may arise on account of the large number of sheet metal gages in use, it is always advisable to specify in addition to the gage or stock size number, the equivalent decimal thickness, or weight per unit area in the case of weight gages. Care should be taken that the thickness or weight per unit area specified corresponds to a stock size to which the material ordered is regularly made and stocked.

The manufacturing tolerance on sheet metal is bilateral; that is, variations from the stock sizes are expected to be either plus or minus. The specification of a stock size with a unilateral tolerance—that is, wording the specification so that sheets shall not exceed, or shall not be less than the stock size, with a tolerance specified or implied in one direction only—is a departure from standard practice, and the manufacturer may not be able to fill the order from stock except by selection.

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 formerly 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 in ounces per square foot. 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 Representatives 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	.7983	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	6½	.40625	.1843	1.983	4.37
33	3–320	.009375	.238125	6	.375	.1701	1.831	4.04
34	11–1280	.00859375	.21828125	5½	.34375	.1559	1.678	3.70
35	5–640	.0078125	.1984375	5	.3125	.1417	1.526	3.36
36	9–1280	.00703125	.17859375	4½	.28125	.1276	1.373	3.03
37	17–2560	.006640625	.168671875	4¼	.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 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 approximate equivalents were based upon the density of wrought iron of 480 pounds per cubic foot, or 0.2778 pound per cubic inch. Since the United States standard gage was established, steel and commercially pure open-hearth iron have come into general use for plates and sheets. For most commercial purposes the density of steel is taken as 489.6 pounds per cubic foot, 0.2833 pound per cubic inch, or in terms more familiar to the sheet maker and user, steel weighs 40.80 pounds per square foot per inch thick, 2 per cent more than wrought iron, which weighs 40.00 pounds per square foot per inch thick.

The density of steel varies, depending upon a number of factors, such as carbon content, presence of alloying elements, heat treatment, tempering temperature, amount and manner of cold working, etc.[2] The total variation for carbon steel, due to these factors, may be of the order of 1 per cent. In the case of hot-rolled steel, it has been found that the mechanical working of the metal during hot-rolling 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. Cold-rolled steel sheets have been said to have a greater density than 0.2833 pound per cubic inch; however, two samples of full pickled, full cold-rolled sheets showed an average density of 0.2833 pound per cubic inch. Tests also have shown this value to be representative of commercially pure open-hearth iron.

In Table 1 the weights, and approximate thicknesses based upon 40.00 pounds per square foot per inch thick for wrought iron, and 40.80 for steel and open-hearth iron, are given for practical use.[3] Also, the gage numbers above No. 38 are included, which have become standardized by custom, but were not included in the congressional enactment. The numbers of decimal places given for weights in pounds and for equivalent thicknesses have been limited, but the values have been carried out further than they should be used practically.

Attention is directed to United States Department of Commerce Simplified Practice Recommendations R28—29, Sheet Steel, which covers simplified sizes and weights of galvanized flat sheets, one pass cold-rolled box annealed sheets, and blue annealed sheets; and R78—28, Iron and Steel Roofing.

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[2] See Density of Hot-Rolled and Heat-Treated Carbon Steels, by H. C. Cross and E. E. Hill, B. S. Sci. Paper No. 562.

[3] According to an opinion rendered by the Attorney General of the United States, Apr. 22, 1929, the commercial use of the data presented in Table 1, or of tolerances as presented in Sections II (*c*) and II (*d*) herein, does not violate the act of Mar. 3, 1893, establishing the United States standard gage. An excerpt of the opinion is as follows:

"Compliance with the standard gage established by the above act is not made mandatory either upon American manufacturers or upon the Government departments in preparing their specifications for sheet and plate iron and steel. The only mandatory provision in the act is that the standard gage therein established 'shall be used in determining duties and taxes levied by the United States of America on sheet and plate iron and steel.' There is no prohibition against the importation of sheet and plate iron or steel not complying with the standard gage, but it is provided merely that the standard shall be followed in determining the duties and taxes levied thereon."

TABLE 1.—*United States standard gage for sheet and plate iron and steel, and extension*

Gage No.	Weight per square foot		Weight per square meter	Approximate thickness			
				Wrought iron		Steel and open-hearth iron	
	Ounces	*Pounds*	*kg*	*Inch*	*mm*	*Inch*	*mm*
0000000	320	20.00	97.65	0.500	12.70	0.490	12.45
000000	300	18.75	91.55	.469	11.91	.460	11.67
00000	280	17.50	85.44	.438	11.11	.429	10.90
0000	260	16.25	79.34	.406	10.32	.398	10.12
000	240	15.00	73.24	.375	9.52	.368	9.34
00	220	13.75	67.13	.344	8.73	.337	8.56
0	200	12.50	61.03	.312	7.94	.306	7.78
1	180	11.25	54.93	.2812	7.14	.2757	7.00
2	170	10.62	51.88	.2656	6.75	.2604	6.62
3	160	10.00	48.82	.2500	6.35	.2451	6.23
4	150	9.375	45.77	.2344	5.95	.2298	5.84
5	140	8.750	42.72	.2188	5.56	.2145	5.45
6	130	8.125	39.67	.2031	5.16	.1991	5.06
7	120	7.500	36.62	.1875	4.76	.1838	4.67
8	110	6.875	33.57	.1719	4.37	.1685	4.28
9	100	6.250	30.52	.1562	3.97	.1532	3.89
10	90	5.625	27.46	.1406	3.57	.1379	3.50
11	80	5.000	24.41	.1250	3.18	.1225	3.11
12	70	4.375	21.36	.1094	2.778	.1072	2.724
13	60	3.750	18.31	.0938	2.381	.0919	2.335
14	50	3.125	15.26	.0781	1.984	.0766	1.946
15	45	2.812	13.73	.0703	1.786	.0689	1.751
16	40	2.500	12.21	.0625	1.588	.0613	1.557
17	36	2.250	10.99	.0562	1.429	.0551	1.400
18	32	2.000	9.765	.0500	1.270	.0490	1.245
19	28	1.750	8.544	.0438	1.111	.0429	1.090
20	24	1.500	7.324	.0375	.952	.0368	.934
21	22	1.375	6.713	.0344	.873	.0337	.856
22	20	1.250	6.103	.0312	.794	.0306	.778
23	18	1.125	5.493	.0281	.714	.0276	.700
24	16	1.000	4.882	.0250	.635	.0245	.623
25	14	.8750	4.272	.0219	.556	.0214	.545
26	12	.7500	3.662	.0188	.476	.0184	.467
27	11	.6875	3.357	.0172	.437	.0169	.428
28	10	.6250	3.052	.0156	.397	.0153	.389
29	9	.5625	2.746	.0141	.357	.0138	.350
30	8	.5000	2.441	.0125	.318	.0123	.311
31	7	.4375	2.136	.0109	.278	.0107	.272
32	6½	.4062	1.983	.0102	.258	.0100	.253
33	6	.3750	1.831	.0094	.238	.0092	.233
34	5½	.3438	1.678	.0086	.218	.0084	.214
35	5	.3125	1.526	.0078	.198	.0077	.195
36	4½	.2812	1.373	.0070	.179	.0069	.175
37	4¼	.2656	1.297	.0066	.169	.0065	.165
38	4	.2500	1.221	.0062	.159	.0061	.156
39	3¾	.2344	1.144	.0059	.149	.0057	.146
40	3½	.2188	1.068	.0055	.139	.0054	.136
41	3⅜	.2109	1.030	.0053	.134	.0052	.131
42	3¼	.2031	.9917	.0051	.129	.0050	.126
43	3⅛	.1953	.9536	.0049	.124	.0048	.122
44	3	.1875	.9155	.0047	.119	.0046	.117

(c) PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS OF PLATES

Manufacturers have had considerable difficulty in keeping within the tolerance of plus or minus 2½ per cent specified in the law establishing the United States standard gage for sheet and plate iron and steel. As the law does not make this tolerance mandatory for commercial purposes, the Association of American Steel Manufacturers has adopted the following specifications regarding permissible

variations in weight and thickness, which have been applied to plate mill products regularly, but not to sheet and tin mill products. (See Manufacturers' Standard Specifications for Structural and Boiler Steel. The Assocation of American Steel Manufacturers, revised November 24, 1922.)

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

(*b*) The thickness or weight of sheared mill plates, and of universal mill plates over 36 inches in width, shall conform to the manufacturers' standard practice governing the permissible variations for sheared mill plates, as given in Tables 2 and 3 herein.

(*c*) *Sheared plates, when ordered to weight per square foot.*—The weight of each lot[4] in each shipment shall not vary from the weight ordered more than the amount given in Table 2. This table shall not be used when a minimum edge thickness is required. In such cases the table of permissible variations for plates ordered to thickness shall apply.

(*d*) *Sheared plates, when ordered to thickness.*—The thickness of each plate shall not vary more than 0.01 inch under the thickness ordered, and the overweight of each lot[4] 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 Manufacturers in 1896. These tables were revised from time to time, the latest revision as to percentages of overweight 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:

(A 7–29) for structural steel for bridges.
(A 8–29) for structural nickel steel.
(A 9–29) for structural steel for buildings.
(A12–21) for structural steel for ships.
(A30–24) for structural boiler and firebox steel for locomotives (Table 3 only).
(A70–27) for boiler and firebox steel for stationary service (Table 3 only).
(A78–30) for steel plates of structural quality for forge welding.
(A89–30) for steel plates of flange quality for forge welding (Table 3 only).
(A94–29) for structural silicon steel.
(A113–29) for structural steel for locomotives and cars.

Tentative Specifications:

(A114–29T) for marine boiler steel plates (Table 3 only).
(A129–30T) for open-hearth iron plates of flange quality (Table 3 only).

Table 2 is applied to wrought iron in United States Army metal specifications No. 57–110, June 6, 1923, Wrought-Iron Bars and Plates.

Table 3 is applied to marine boiler steel plates in United States Government master specification No. 549, March 5, 1928.

[4] The term "lot" applied to these tables means all of the plates of each group width and each group thickness or weight.

TABLE 2.—*Permissible variations in weight of rectangular sheared plates ordered to weight*

Ordered weight (pounds per square foot)	Permissible variations in average weight per square foot of plates for widths given (expressed in percentage of ordered weights)																	
	Under 48 inches		48 inches, inclusive, to 60 inches, exclusive		60 inches, inclusive, to 72 inches, exclusive		72 inches, inclusive, to 84 inches, exclusive		84 inches, inclusive, to 96 inches, exclusive		96 inches, inclusive, to 108 inches, exclusive		108 inches, inclusive, to 120 inches, exclusive		120 inches, inclusive,to 132 inches, exclusive		132 inches, inclusive, to 144 inches, exclusive[1]	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Over	Under	Under
Under 5	5	3	5.5	3	6	3	7	3										
5, inclusive, to 7.5, exclusive	4.5	3	5	3	5.5	3	6	3										
7.5, inclusive, to 10, exclusive	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3				
10, inclusive, to 12.5, exclusive	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3
12.5, inclusive, to 15, exclusive	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3
15, inclusive, to 17.5, exclusive	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, inclusive, to 20, exclusive	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, inclusive, to 25, exclusive	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, inclusive, to 30, exclusive	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, inclusive, to 40, exclusive	2	2	2	2	2	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

NOTE.—The weight per square foot of individual plates shall not vary from the ordered weight by more than one and one-third times the amount given in this table.

TABLE 3.—*Permissible overweights of rectangular steel plates ordered to thickness*

Ordered thickness (inch)	Permissible excess in average weight per square foot of plates for widths given (expressed in percentage of nominal weight)								
	Under 48 inches	48 inches, inclusive, to 60 inches, exclusive	60 inches, inclusive, to 72 inches, exclusive	72 inches, inclusive, to 84 inches, exclusive	84 inches, inclusive, to 96 inches, exclusive	96 inches, inclusive, to 108 inches, exclusive	108 inches, inclusive, to 120 inches, exclusive	120 inches, inclusive, to 132 inches, exclusive	132 inches, inclusive, to 144 inches, exclusive[1]
Under 1/8	9	10	12	14					
1/8, inclusive, to 3/16, exclusive	8	9	10	12					
3/16, inclusive, to 1/4, exclusive	7	8	9	10	12				
1/4, inclusive, to 5/16, exclusive	6	7	8	9	10	12	14	16	19
5/16, inclusive, to 3/8, exclusive	5	6	7	8	9	10	12	14	17
3/8, inclusive, to 7/16, exclusive	4.5	5	6	7	8	9	10	12	15
7/16, inclusive, to 1/2, exclusive	4	4.5	5	6	7	8	9	10	13
1/2, inclusive, to 5/8, exclusive	3.5	4	4.5	5	6	7	8	9	11
5/8, inclusive, to 3/4, exclusive	3	3.5	4	4.5	5	6	7	8	9
3/4, inclusive, to 1, exclusive	2.5	3	3.5	4	4.5	5	6	7	8
1, to over	2.5	2.5	3	3.5	4	4.5	5	6	7

[1] In American Society for Testing Materials specifications, the last column in the above tables is headed: "132 inches or over."

NOTE.—The weight of individual plates ordered to thickness shall not exceed the nominal weight by more than one and one-third times the amount given in the above table.

(d) PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS OF SHEETS

Standard permissible variations of steel sheets in gage weight, gage thickness, size, and flatness were adopted by the Association of American Steel Manufacturers March 28, 1929. The tolerances then adopted had been in general use for about 10 years. The permissible variations in weight and thickness are as follows:

Sheets ordered by weight.—When ordered by weight per unit area, sheets shall conform to Table 4. If ordered by gage number, the gage weights shall be those of the United States standard gage table for uncoated sheets and for long ternes, and of the galvanized sheet gage tables for zinc-coated (galvanized) sheets.

Sheets ordered by thickness.—When ordered by thickness, sheets shall conform to Table 5. While sheets ordered by thickness are not subject to weight gage tolerances, weights of sheets are affected by the following considerations:

1. Weight of sheets ordered by thickness should be computed on the basis of the ordered size and ordered thickness at 40.80 pounds per square foot per inch thick, to which should be added 2 per cent for greater cross section of the sheet than is represented by the mean of thickest and thinnest points.

2. When resquared, no adjustment should be made to the weight so computed (41.62 pounds per square foot per inch thick; $40.80 \times 1.02 = 41.616$).

3. When neither resquared nor cold-rolled after annealing (blue annealed, black, one pass, hot-rolled pickled), 1.5 per cent should be added to account for excess width and length within standard tolerance limits (42.24 pounds per square foot per inch thick; $41.616 \times 1.015 = 42.240$).

4. When not resquared, but cold-rolled after annealing (full cold-rolled, pickled, and cold-rolled), 3 per cent should be added to account for excess width and length within standard tolerance limits (42.86 pounds per square foot per inch thick; $41.616 \times 1.03 = 42.864$).

5. Estimated weights on orders and in records and correspondence should be calculated as shown above.

6. The weight computed on the proper basis with proper adjustments as explained, is, of course, affected by the usual permissible variation of 5.0 per cent for not lighter than No. 16 gage, of 3.5 per cent for lighter than No. 16 but not lighter than No. 22 gage, and of 2.5 per cent for lighter than No. 22 gage, as applied to all of one gage and size in a shipment. (See Table 4.) (In computing weight the permissible variations in thickness given in Table 5 are not taken into account.)

7. These considerations are expressed in tabular form in Table 6 (which is a simplified form of Table A of the original specifications).

TABLE 4.—*Permissible variations in weight of steel sheets ordered by weight or gage number*

Ordered gage weight				Permissible variation from ordered gage weight, in percentage of estimated weight		
Less than		Not less than				
Ounces per square foot	Pounds per square foot	Ounces per square foot	Pounds per square foot	All of one gage and size in shipment	Single package	Single sheet
		40 (No. 16)	2.5	±5.0	±7.0	±10.0
40 (No. 16)	2.5	20 (No. 22)	1.25	±3.5	±5.5	±10.0
20 (No. 22)	1.25			±2.5	±4.0	±10.0

NOTE.—"All of one gage and size in shipment" shall apply to lots of not less than 6,000 pounds.

References are to gross weights of bundled material and to net weights of crated and boxed material.

Ordering by minimum or maximum weight per unit area is objectionable, as it is liable to cause error in manufacture and gage classification, but when sheets are so ordered the total permissible plus and minus weight variation, otherwise applicable to the mean gage weight of all of one gage and size in a shipment, shall, in the absence of other instructions, be applied on the permissible side to the weight ordered.

Sheets are not weighed singly at mill and 10 per cent limit can not be assured, but any sheets found by purchaser that are outside this limit may be rejected.

Sheets ordered by weight per unit area are subject to weight gage tolerances only—not to thickness gage tolerances.

Should weight variations be considered more important, yet sheets be so used that uniform thickness is desirable, sheets should be ordered by weight gage, and order should stipulate: "Make of as nearly uniform thickness as practicable." Sheets so ordered will be of less average thickness than those ordered by the equivalent thickness.

Both resquared and nonresquared sheets, by custom of long standing, are subject to these weight-gage tolerances, based upon the ordered area; though, logically, nonresquared sheets should have smaller minus and greater plus tolerances.

TABLE 5.—*Permissible variations in thickness of steel sheets ordered by thickness*

Ordered thickness, range, inch	Permissible variation from ordered thickness	Ordered thickness, range, inch	Permissible variation from ordered thickness
	Inch		*Inch*
0.250 and over	0.016	0.099 to 0.080	0.009
.249 to .220	.015	.079 to .070	.008
.219 to .190	.014	.069 to .060	.007
.189 to .160	.013	.059 to .050	.006
.159 to .140	.012	.049 to .040	.005
.139 to .120	.011	.039 to .030	.004
.119 to .100	.010	.029 to	.003

NOTE.—The thickness variation range in any one sheet shall not exceed (to the nearest thousandth) one and one-fifth times the tabular limit for the ordered thickness.

Ordering minimum or maximum thickness is objectionable, as it is likely to cause error in manufacture and gage classification, but when sheets are so ordered the total permissible plus and minus thickness variation, otherwise applicable to the mean thickness, shall be applied on the permissible side to the thickness ordered.

Sheets are not all gaged at mill and the limits shown can not be assured, but any sheets found by purchaser that are outside the limits may be rejected, except in extreme widths.

Sheets ordered by thickness are subject to thickness gage tolerances only, and not to weight gage tolerances.

Should weight variations be more important than thickness variations, and sheets be ordered by thickness by preference or custom, order should stipulate: "Make of equivalent weight per unit area." In such case, sheets shall be subject to weight gage tolerances only, based on 40.80 pounds per square foot per inch thick.

TABLE 6.—*Steel sheets ordered to thickness, expected average and maximum weights of shipment when all of one gage and size and not less than 6,000 pounds*

Weight in pounds $= L \times W \times T \times N \times F$

Where L = ordered length of sheet in feet,
W = ordered width of sheet in feet,
T = ordered thickness of sheet in inches,
N = number of sheets, and
F = factor based on weight per square foot per inch thick and excess metal.

RESQUARED SHEETS, 2 PER CENT FOR EXCESS CROSS SECTION

Percentage tolerance	F
0	40.80 ×1.02 =41.616 average.
5	41.616×1.05 =43.70
3½	41.616×1.035=43.07
2½	41.616×1.025=42.66

NOT RESQUARED, NOT COLD-ROLLED AFTER ANNEALING, 1.5 PER CENT FOR EXCESS WIDTH AND LENGTH

0	41.616×1.015=42.240 average.
5	42.240×1.05 =44.35
3½	42.240×1.035=43.72
2½	42.240×1.025=43.30

NOT RESQUARED, COLD-ROLLED AFTER ANNEALING, 3 PER CENT FOR EXCESS WIDTH AND LENGTH

0	41.616×1.03 =42.864 average.
5	42.864×1.05 =45.00
3½	42.864×1.035=44.36
2½	42.864×1.025=43.94

2. GALVANIZED SHEET GAGE

The galvanized sheet gage given in Table 7 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 corresponding to 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 a weight gage for finished sheet regardless of the weight of coating and has been established by custom in the United States. It appears, accordingly, that the sheet prior to coating must be rolled to such weight, depending upon the weight of coating to be applied, as to produce a sheet of the proper weight when coated. This is contrary to the principles of simplified practice, as it multiplies the number of gages to be rolled, a commercial practice which does not appear to be economically justified.

Tolerances for the weights per square foot of galvanized sheets, adopted March 28, 1929, by the Association of American Steel Manufacturers are given on page 9, and those of the American Society for Testing Materials as given in standard specifications A 93–27, Zinc-Coated (Galvanized) Sheets, are given in Table 8.

The resistance of galvanized sheet to corrosion depends upon the evenness and weight of coating. The weight of coating is also a factor in determining the degree of deformation which a sheet can undergo without breaking the coating. The American Society for

Testing Materials adopted in 1927 standard specifications No. A 93–27, Zinc-Coated (Galvanized) Sheets, covering sheets of Bessemer steel, open-hearth steel, and open-hearth iron, with five classes of zinc coatings, applied by the hot-dip process, as given in Table 9. The American Society for Testing Materials specifications also include tolerances for the various coating weights, together with methods of test.

TABLE 7.—*Galvanized sheet gage, weights for all classes*

Gage No.[1]	Weight per square foot		Gage No.[1]	Weight per square foot	
	Pounds	*Ounces*		*Pounds*	*Ounces*
8	7.031	112.5	22	1.406	22.5
9	6.406	102.5	*23*	1.281	20.5
10	5.781	92.5	24	1.156	18.5
11	5.156	82.5	*25*	1.031	16.5
12	4.531	72.5	26	0.906	14.5
13	3.906	62.5	27	.844	13.5
14	3.281	52.5	28	.781	12.5
15	2.969	47.5	29	.719	11.5
16	2.656	42.5	30	.656	10.5
17	2.406	38.5	*31*	.594	9.5
18	2.156	34.5	*32*	.562	9.0
19	1.906	30.5	*33*	.531	8.5
20	1.656	26.5	*34*	.500	8.0
21	1.531	24.5			

[1] Gage numbers in italics are not included in the simplified list of sizes promulgated by the Department of Commerce, Bureau of Standards, in Simplified Practice Recommendation R28-29, Sheet Steel. Weights of coatings are specified, however, by the American Society for Testing Materials for Nos. 8, 9, 10, 11, and 13. (See Table 9.)

NOTE.—The weight per square foot in each case is 2.5 ounces more than that corresponding to the same gage number of the United States standard gage as applied to black sheets.

TABLE 8.—*Tolerances on weights per square foot of galvanized sheets (A. S. T. M. standard specifications A93–27)*

Range				Permissible tolerances in weights of sheets in percentage of theoretical weight[1]		
Galvanized sheet gage No.		Weight of sheets		All of one gage and size in shipment[2]	Single package	Single sheets
Lighter than—	Not lighter than—	Less than—	Not less than—			
		Oz./ft.²	*Oz./ft.²*			
	16		42.5	±5.0	±7.0	±10.0
16	22	42.5	22.5	±3.5	±5.5	±10.0
22		22.5		±2.5	±4.0	±10.0

[1] References are to gross weights of bundled material and to net weights of crated and boxed material. If the minimum or maximum only be ordered, double tolerance is to be taken on permissible side.

[2] All of one gage and size in shipment shall apply to lots of not less than 6,000 pounds.

TABLE 9.—*Weights of coatings, galvanized sheets (A. S. T. M. standard specifications A93–27)*

Galvanized sheet gage No.	Weights of coatings [1]				
	Class A	Class B	Class C	Class D	Class E
	Oz./ft.²	*Oz./ft.²*	*Oz./ft.²*	*Oz./ft.²*	*Oz./ft.²*
8	2.75	2.50	2.00		
9	2.75	2.50	2.00		
10	2.75	2.50	2.00		
11	2.75	2.50	2.00		
12	2.75	2.50	2.00		
13	2.75	2.50	2.00		
14	2.75	2.50	2.00		
16	2.75	2.50	2.00	No specified coatings. See note.	No specified coatings. See note.
18	2.75	2.50	1.75		
20	2.75	2.50	1.75		
22	2.75	2.50	1.75		
24		2.50	1.50		
26		2.25	1.25		
27		2.00	1.25		
28		1.75	1.25		
29		1.50	1.25		
30		1.25	1.25		

[1] Class A, extra heavily coated sheets that are not intended to be formed other than by corrugating.
Class B, heavily coated sheets that are not intended to be formed other than by corrugating and curving to large radii.
Class C, moderately heavily coated sheets for moderate bending.
Class D, ordinary coated sheets for general utility. These coatings approximate those of class C except in medium gages in which coatings of class D are appreciably lighter. Class D represents material generally available in warehouse stocks, which is not intended for use where relatively long life, represented by classes A, B, and C, or severe forming, represented by class E, is required.
Class E, sheets having lighter, more tightly adhering coatings to reduce liability of flaking in severe forming. The sheet maker should be made acquainted with the requirements of fabrication.

3. TIN-PLATE GAGE

Tin plates, which consist of soft sheet steel coated with tin, and roofing terneplates in which the coating is approximately 25 per cent tin and 75 per cent lead, are measured in a unit of area known as the base box. This is an old British unit amounting to 31,360 square inches, or 217.78 square feet, is independent of weight, and corresponds to the area covered by 112 plates, each 14 by 20 inches.

The tin-plate gage is based on pounds per base box. 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 & Tin Plate Co. 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 terneplate depend on the thickness of the coating rather than on the total thickness of the plate. The term "coke tin plates" is used to designate tin plates of the lighter coating weights. "Charcoal tin plates" designates higher grades of finish, the amount of coating and the degree of finish being distinguished by letters A to 5A, the greater number of A's in the symbol, the heavier the coating. "AAA" tin plate, for example, has approximately 4 pounds of tin coating per base box. The designation "taggers tin" is usually applied to either "coke" or "charcoal plates," 65 pounds per base box or lighter.

Terneplate, used extensively as roofing, is manufactured in standard weights of coating of 8, 15, 20, 25, 30, 32, and 40 pounds per double base box. For roofing it is accepted practice to manufacture terneplates not lighter than IC weight (107 pounds per base box). (See U. S. Department of Commerce Simplified Practice Recommendation No. 30–28, Roofing Ternes.) The United States standard gage is also used for long ternes.

Long terne, roofing terne, and tin plate are regarded by the industry as subject to the weight-gage tolerances given in Table 4, page 9. Weights and permissible variations in weights, of resquared terneplates (roofing tin) as specified in Federal specification No. QQT–201, are given in Table 11.

TABLE 10.—*Tin-plate gage*

Trade symbol	Weights			Approximate equivalent (inch) thickness [1]	Trade symbol	Weights			Approximate equivalent (inch) thickness [1]
	Pounds per base box	Pounds per square foot, approximate	Ounces per square foot, approximate			Pounds per base box	Pounds per square foot, approximate	Ounces per square foot, approximate	
55-pound	55	0.253	4.04	0.0062	142-pound	143	0.657	10.51	0.0161
60-pound	60	.276	4.41	.0068	2XL	148	.680	10.87	.0167
65-pound	65	.298	4.78	.0073	2X	155	.712	11.39	.0174
70-pound	70	.321	5.14	.0079	163-pound	163	.748	11.98	.0183
75-pound	75	.344	5.51	.0084	3XL	168	.771	12.34	.0189
80-pound	80	.367	5.88	.0090	3X	175	.804	12.86	.0197
85-pound	85	.390	6.24	.0096	DX	180	.827	13.22	.0203
90-pound	90	.413	6.61	.0101	4XL	188	.863	13.81	.0212
95-pound	95	.436	6.98	.0107	4X	195	.895	14.33	.0219
ICL	100	.459	7.35	.0113	5XL	208	.955	15.28	.0234
IC	107	.491	7.86	.0120	D2X	210	.964	15.43	.0236
108-pound	108	.496	7.93	.0122	5X	215	.987	15.80	.0242
110-pound	110	.505	8.08	.0124	6XL	228	1.047	16.75	.0257
112-pound	112	.514	8.23	.0126	6X	235	1.079	17.27	.0264
118-pound	118	.542	8.67	.0133	D3X	240	1.102	17.63	.0270
123-pound	123	.565	9.04	.0138	7XL	248	1.139	18.22	.0279
125-pound	125	.574	9.18	.0141	7X	255	1.171	18.73	.0287
IXL	128	.588	9.40	.0144	8XL	268	1.231	19.69	.0302
IX	135	.620	9.92	.0152	D4X	270	1.240	19.84	.0304
DC	139	.638	10.21	.0156	8X	275	1.263	20.20	.0309

[1] Assuming that tin plate weighs 40.80 pounds per square foot per inch thick.

TABLE 11.—*Weights of resquared terneplates (roofing tin) and permissible variations, Federal specification No. QQT–201*

Trade symbol		Weight of black sheets after pickling		Weight of coating (in pounds per double base box)											
				8		15		20		25		30		40	
				Weight of coating (in ounces per square foot of sheet)											
				0.2939		0.5510		0.7347		0.9184		1.1020		1.4694	
				Weight of finished sheets											
		Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box	Ounces per square foot	Pounds per double base box
IC	Minimum	7.00	191	7.29	199	7.55	206	7.73	211	7.92	216	8.10	220	8.47	231
	Nominal	8.00	218	8.29	226	8.55	233	8.73	238	8.92	243	9.10	248	9.47	258
	Maximum	9.00	245	9.29	253	9.55	260	9.73	265	9.92	270	10.10	275	10.47	285
IX	Minimum	9.00	245	9.29	253	9.55	260	9.73	265	9.92	270	10.10	275	10.47	285
	Nominal	10.00	272	10.29	280	10.55	287	10.73	292	10.92	297	11.10	302	11.47	312
	Maximum	11.00	299	11.29	307	11.55	314	11.73	319	11.92	324	12.10	329	12.47	339

NOTE.—A tolerance of ±2.5 per cent on net weight of finished sheets on all of one base weight and size in shipment or individual package is allowed. Single sheets may vary within the limits given above.

4. BIRMINGHAM WIRE GAGE

The Birmingham wire gage, or Stubs' iron wire gage, is an empirical thickness gage consisting of 40 sizes ranging from No. 0000 = 0.454 inch to No. 36 = 0.004 inch. The application of this gage to wall thicknesses of boiler and condenser tubes, and *seamless* brass, bronze, and copper tubes is established by custom, but for most other purposes the gage is becoming obsolete, being superseded by the American wire gage. However, this gage is applied by some manufacturers to flat rolled steel, and it is regularly applied to saws, harrow disks, and other similar articles. In Table 12 is given the Birmingham wire gage, together with the equivalent weights per square foot of steel based on the density 40.80 pounds per square foot per inch thick.

TABLE 12.—*Birmingham wire gage, weights of flat-rolled steel*

Gage No.	Thickness		Approximate weight per square foot	Gage No.	Thickness		Approximate weight per square foot
	Inch	*mm*	*Pounds*		*Inch*	*mm*	*Pounds*
0000	0.454	11.532	18.52	17	0.058	1.473	2.366
000	.425	10.795	17.34	18	.049	1.245	1.999
00	.380	9.652	15.50	19	.042	1.067	1.714
0	.340	8.636	13.87	20	.035	.889	1.428
1	.300	7.620	12.24	21	.032	.813	1.306
2	.284	7.214	11.59	22	.028	.711	1.142
3	.259	6.579	10.57	23	.025	.635	1.020
4	.238	6.045	9.710	24	.022	.559	.8976
5	.220	5.588	8.976	25	.020	.508	.8160
6	.203	5.156	8.282	26	.018	.457	.7344
7	.180	4.572	7.344	27	.016	.406	.6528
8	.165	4.191	6.732	28	.014	.356	.5712
9	.148	3.759	6.038	29	.013	.330	.5304
10	.134	3.404	5.467	30	.012	.305	.4896
11	.120	3.048	4.896	31	.010	.254	.4080
12	.109	2.769	4.447	32	.009	.229	.3672
13	.095	2.413	3.876	33	.008	.203	.3264
14	.083	2.108	3.386	34	.007	.178	.2856
15	.072	1.829	2.938	35	.005	.127	.2040
16	.065	1.651	2.652	36	.004	.102	.1632

III. NONFERROUS PLATE, SHEET, AND STRIP

1. AMERICAN WIRE GAGE (FOR COPPER, ALUMINUM, AND NONFERROUS ALLOYS)

The American wire gage, also commonly known as the Brown & Sharpe gage, is extensively used in the United States for nearly all nonferrous sheets, particularly copper, aluminum, and nonferrous alloy sheets, as well as for wire of the same materials. It was devised by J. R. Brown and Lucian Sharpe, founders of the Brown & Sharpe Manufacturing Co., 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, $\sqrt[39]{\frac{0.460}{0.005}}$, which is 1.1229322; (*b*) the difference between any two successive sizes is a constant percentage of the smaller of the two sizes, namely, 0.1229322; and (*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 1.229322 is 2.0050, so that the thickness and, consequently, the weight per unit area of a sheet six sizes heavier than a given size, is approximately twice as great as for the given size.

(a) APPROXIMATE WEIGHTS PER SQUARE FOOT

In Table 13 the gage numbers and thicknesses of the American wire gage are given, together with the approximate weights per square foot of rolled copper and aluminum sheets.

Copper.—The weights of copper sheets given in Table 13 are based on the density of 8.89 grams per cubic centimeter, which is the value adopted by the International Electrotechnical Commission and the American Institute of Electrical Engineers in their "definition of the annealed copper standard"; and is used in some specifications of the American Society for Testing Materials. This value for density is equivalent to 0.321 pounds per cubic inch, or 46.25 pounds per square foot per inch thick. The weights given in the table are, therefore, for cold-rolled and annealed copper sheets. Hot-rolled copper plates having a thickness of five-sixteenths inch and over, are about one-half per cent heavier, the density being 8.94 grams per cubic centimeter, 0.323 pound per cubic inch, or 46.51 pounds per square foot per inch thick, according to A. S. T. M. standard specifications for Copper Plates for Locomotive Fireboxes, B11–18. The International Critical Tables give 8.94 grams per cubic centimeter as also the value for pure copper.

Aluminum.—The weights of aluminum sheets, given in Table 13, are based on the density 2.71 grams per cubic centimeter, 169.2 pounds per cubic foot, or 14.10 pounds per square foot per inch thick, this value being commonly accepted as the average density of commercially pure (99.0 to 99.4 per cent) aluminum (2S) rolled commercial sheets. The National Metals Handbook gives the value 2.706 grams per cubic centimeter for 99.4 per cent aluminum.

Copper alloys.—The weights of brass and some other copper alloy sheets and plates rolled to the American wire gage are given in Table 14. These are alloys covered by certain United States Government or United States Army specifications, as noted herein on page 18. The weights of gilding metal and cupro-nickel are based on determinations of density of samples of sheet made to such specifications, whereas those for commercial brass, naval brass, and nickel silver are

those generally accepted as representative of rolled sheets of these materials. The densities are as follows:

Alloy	Grams per cubic centimeter	Pounds per cubic inch	Pounds per square foot per inch thick
Commercial brass	8.47	0.306	44.06
Naval brass	8.41	.304	43.75
Gilding metal	8.79	.318	45.73
Cupro-nickel, (Benedict nickel)	8.92	.322	46.41
Nickel silver	8.75	.316	45.52

Tests of samples showed that, in general, the density of nonferrous sheets is somewhat higher than that of bars. Also a variation averaging about one-half per cent among different thicknesses of sheet samples of brass of the same nominal composition was noted, but a sufficient number of samples was not tested and chemically analyzed to determine a consistent relationship.

Aluminum alloys.—The weights of certain aluminum alloy sheets and plates rolled to the American wire gage are given in Table 15. These weights are based on densities obtained from Aluminum Co. of America data sheet No. 389, November 15, 1929, as follows:

Alloy	Grams per cubic centimeter	Pounds per cubic inch	Pounds per square foot per inch thick
Aluminum manganese alloy (3S)	2.74	0.099	14.25
Aluminum alloy 17S and duralumin	2.79	.101	14.51
Aluminum alloy 25S	2.79	.101	14.51
Aluminum alloy 51S	2.68	.097	13.94

TABLE 13.—*American wire gage, weights of copper and aluminum sheets and plates*

Gage No.	Thickness		Approximate weight per square foot [1]		Gage No.	Thickness		Approximate weight per square foot [1]	
			Copper	Aluminum				Copper	Aluminum
1	2	3	4	5	1	2	3	4	5
	Inch	*mm*	*Pounds*	*Pounds*		*Inch*	*mm*	*Pounds*	*Pounds*
0000	0.4600	11.68	21.27	6.49	19	0.0359	0.9116	1.660	0.506
000	.4096	10.40	18.94	5.78	20	.0320	.8118	1.480	.451
00	.3648	9.266	16.87	5.14	21	.0285	.7230	1.318	.402
0	.3249	8.252	15.03	4.58	22	.0253	.6438	1.170	.3567
1	.2893	7.348	13.38	4.08	23	.0226	.5733	1.045	.3186
2	.2576	6.544	11.91	3.632	24	.0201	.5106	.930	.2834
3	.2294	5.827	10.61	3.234	25	.0179	.4547	.828	.2524
4	.2043	5.189	9.45	2.880	26	.0159	.4049	.735	.2242
5	.1819	4.621	8.41	2.565	27	.0142	.3606	.657	.2002
6	.1620	4.115	7.49	2.284	28	.0126	.3211	.583	.1775
7	.1443	3.665	6.67	2.034	29	.0113	.2859	.523	.1593
8	.1285	3.264	5.94	1.812	30	.0100	.2546	.4625	.1410
9	.1144	2.906	5.29	1.613	31	.00893	.2268	.4130	.1259
10	.1019	2.588	4.713	1.437	32	.00795	.2019	.3677	.1121
11	.0907	2.305	4.195	1.279	33	.00708	.1798	.3274	.0998
12	.0808	2.053	3.737	1.139	34	.00630	.1601	.2914	.0888
13	.0720	1.828	3.330	1.015	35	.00561	.1426	.2595	.0791
14	.0641	1.628	2.965	.904	36	.00500	.1270	.2312	.0705
15	.0571	1.450	2.641	.805	37	.00445	.1131	.2058	.0627
16	.0508	1.291	2.349	.716	38	.00397	.1007	.1836	.0560
17	.0453	1.150	2.095	.639	39	.00353	.0897	.1633	.0498
18	.0403	1.024	1.864	.568	40	.00314	.0799	.1452	.0443

[1] The equivalent weights correspond to the gage thicknesses as rounded off in column 2, and are carried out further than they should be used practically.

TABLE 14.—*American wire gage, weights of copper alloy sheets and plates*

Gage No.	Thickness		Approximate weight per square foot[1]				
			Commercial (high) brass	Naval brass	Red brass or gilding metal	Cupro-nickel	Nickel silver
1	2	3	4	5	6	7	8
	Inch	*mm*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0000	0.4600	11.68	20.27	20.13	21.04	21.35	20.94
000	.4096	10.40	18.05	17.92	18.73	19.01	18.64
00	.3648	9.266	16.07	15.96	16.68	16.93	16.61
0	.3249	8.252	14.32	14.21	14.86	15.08	14.79
1	.2893	7.348	12.75	12.66	13.23	13.42	13.17
2	.2576	6.544	11.35	11.27	11.78	11.95	11.73
3	.2294	5.827	10.11	10.04	10.49	10.65	10.44
4	.2043	5.189	9.00	8.94	9.34	9.48	9.30
5	.1819	4.621	8.01	7.96	8.32	8.44	8.28
6	.1620	4.115	7.14	7.09	7.41	7.52	7.37
7	.1443	3.665	6.36	6.31	6.60	6.70	6.57
8	.1285	3.264	5.66	5.62	5.88	5.96	5.85
9	.1144	2.906	5.04	5.01	5.23	5.31	5.21
10	.1019	2.588	4.490	4.458	4.660	4.729	4.633
11	.0907	2.305	3.996	3.968	4.148	4.209	4.129
12	.0808	2.053	3.560	3.535	3.695	3.750	3.678
13	.0720	1.828	3.172	----------	3.292	3.341	3.277
14	.0641	1.628	2.824	----------	2.931	2.975	2.918
15	.0571	1.450	2.516	----------	2.611	2.650	2.599
16	.0508	1.291	2.238	----------	2.323	2.357	2.312
17	.0453	1.150	1.996	----------	2.072	2.102	2.062
18	.0403	1.024	1.776	----------	1.843	1.870	1.834
19	.0359	.9116	1.582	----------	1.642	1.666	1.634
20	.0320	.8118	1.410	----------	1.463	1.485	1.457
21	.0285	.7230	1.256	----------	1.303	1.323	1.297
22	.0253	.6438	1.115	----------	1.157	1.174	1.152
23	.0226	.5733	.996	----------	1.033	1.049	1.029
24	.0201	.5106	.886	----------	.919	.933	.915
25	.0179	.4547	.789	----------	.819	.831	.815
26	.0159	.4049	.701	----------	.727	.738	.724
27	.0142	.3606	.626	----------	.649	.659	.646
28	.0126	.3211	.555	----------	.576	.585	.574
29	.0113	.2859	.498	----------	.517	.524	.514
30	.0100	.2546	.4406	----------	.4573	.4641	.4552
31	.00893	.2268	.3935	----------	.4084	.4144	.4065
32	.00795	.2019	.3503	----------	.3635	.3689	.3619
33	.00708	.1798	.3119	----------	.3238	.3286	.3223
34	.00630	.1601	.2776	----------	.2881	.2924	.2868
35	.00561	.1426	.2472	----------	.2565	.2604	.2554
36	.00500	.1270	.2203	----------	.2286	.2320	.2276
37	.00445	.1131	.1961	----------	.2035	.2065	.2026
38	.00397	.1007	.1749	----------	.1815	.1842	.1807
39	.00353	.0897	.1555	----------	.1614	.1638	.1607
40	.00314	.0799	.1383	----------	.1436	.1457	.1429

[1] The equivalent weights correspond to the gage thicknesses as rounded off in column 2, and are carried out further than they should be used practically.

TABLE 15.—*American wire gage, weights of aluminum alloy sheets and plates*

Gage No.	Thickness		Approximate weight per square foot [1]			Gage No.	Thickness		Approximate weight per square foot [1]		
			Aluminum manganese alloy 3S	Aluminum alloys 17S, 25S and duralumin	Aluminum alloy 51S				Aluminum manganese alloy 3S	Aluminum alloys 17S, 25S and duralumin	Aluminum alloy 51S
1	2	3	4	5	6	1	2	3	4	5	6
	Inch	*mm*	*Pounds*	*Pounds*	*Pounds*		*Inch*	*mm*	*Pounds*	*Pounds*	*Pounds*
0000	0.4600	11.68	6.56	6.68	6.41	19	0.0359	0.9116	0.512	0.521	0.501
000	.4096	10.40	5.84	5.95	5.71	20	.0320	.8118	.456	.464	.446
00	.3648	9.266	5.20	5.29	5.09	21	.0285	.7230	.406	.414	.397
0	.3249	8.252	4.63	4.72	4.53	22	.0253	.6438	.3605	.3671	.3527
1	.2893	7.348	4.12	4.20	4.03	23	.0226	.5733	.3221	.3280	.3150
2	.2576	6.544	3.671	3.738	3.591	24	.0201	.5106	.2864	.2917	.2802
3	.2294	5.827	3.269	3.329	3.198	25	.0179	.4547	.2551	.2597	.2495
4	.2043	5.189	2.911	2.964	2.848	26	.0159	.4049	.2266	.2307	.2216
5	.1819	4.621	2.592	2.640	2.536	27	.0142	.3606	.2024	.2060	.1980
6	.1620	4.115	2.308	2.351	2.258	28	.0126	.3211	.1796	.1828	.1756
7	.1443	3.665	2.056	2.094	2.012	29	.0113	.2859	.1610	.1640	.1575
8	.1285	3.264	1.831	1.865	1.792	30	.0100	.2546	.1425	.1451	.1394
9	.1144	2.906	1.630	1.660	1.595	31	.00893	.2268	.1273	.1296	.1245
10	.1019	2.588	1.452	1.479	1.420	32	.00795	.2019	.1133	.1154	.1108
11	.0907	2.305	1.292	1.316	1.264	33	.00708	.1798	.1009	.1027	.0987
12	.0808	2.053	1.151	1.172	1.126	34	.00630	.1601	.0898	.0914	.0878
13	.0720	1.828	1.026	1.045	1.004	35	.00561	.1426	.0800	.0814	.0782
14	.0641	1.628	.913	.930	.894	36	.00500	.1270	.0713	.0726	.0697
15	.0571	1.450	.814	.829	.796	37	.00445	.1131	.0634	.0646	.0620
16	.0508	1.291	.724	.737	.708	38	.00397	.1007	.0566	.0576	.0553
17	.0453	1.150	.645	.657	.631	39	.00353	.0897	.0503	.0512	.0492
18	.0403	1.024	.574	.585	.562	40	.00314	.0799	.0447	.0456	.0438

[1] The equivalent weights correspond to the gage thicknesses as rounded off in column 2, and are carried out further than they should be used practically.

(b) PERMISSIBLE VARIATIONS IN THICKNESS AND WEIGHT

The available data as to tolerances applied to thicknesses of copper, aluminum, brass, and other nonferrous alloy plates, sheets, and strips are given in Tables 16 and 17. These tables are included in various specifications as follows:

Table No.	Metal or alloy	References
16	Naval brass	United States Army metal specification No. 57–162, Apr. 30, 1923 (gage Nos. 0000 to 12, inclusive, only).
16	Wrought aluminum bronze	United States Army metal specification No. 57–165, Apr. 30, 1923. Society of Automotive Engineers specification No. 69, February, 1929.
16	Phosphor bronze	United States Army metal specification No. 57–167, May 3, 1923. Society of Automotive Engineers specification No. 77, February, 1929.
16	Cupro-nickel	United States Army metal specification No. 57–169, May 3, 1923.
16	Nickel silver (German silver)	United States Government master specification No. 468, Jan. 25, 1927.
16	Manganese bronze	United States Government master specification No. 552, Apr. 30, 1928 (gage Nos. 0000 to 12, inclusive, only).
17	Copper	United States Government master specification No. 467, Jan. 25, 1927. Society of Automotive Engineers specification No. 71, February, 1929.
17	Low and rich low brass	United States Army metal specification No. 57–160, Dec. 20, 1923.
17	Commercial brass, or high brass	United States Government master specification No. 392, Mar. 1, 1926. Society of Automotive Engineers specification No. 70, February, 1929. American Society for Testing Materials standard specification No. B 36–27.
17	Gilding metal	United States Army metal specification No. 57–171, May 3, 1923.
18, 19	Aluminum [1] Aluminum manganese alloy	See references under Tables 18 and 19.

[1] Data relative to densities for aluminum alloys are given in Aluminum Co. of America data sheet No. 389. Compositions and properties are discussed in the American Institute of Mining and Metallurgical Engineers Technical Publication No. 33, Commercial Forms and Applications of Aluminum and Aluminum Alloys, by P. V. Faragher.

TABLE 16.—*Permissible variations in thickness of wrought nonferrous sheets and strips of naval brass, wrought aluminum bronze, phosphor bronze, cupro-nickel, nickel silver, and manganese bronze*

American wire gage No.	Thickness	Permissible variations in thickness for widths—			
		Up to 6 inches, inclusive	Up to 9 inches, inclusive	Up to 14 inches, inclusive	Up to 20 inches, inclusive
	Inch	*Inch*	*Inch*	*Inch*	*Inch*
0000	0.4600	±0.0054	±0.0056	±0.0059	±0.0061
000	.4096	±.0053	±.0055	±.0058	±.0060
00	.3648	±.0051	±.0054	±.0056	±.0059
0	.3249	±.0050	±.0053	±.0055	±.0058
1	.2893	±.0049	±.0051	±.0054	±.0056
2	.2576	±.0048	±.0050	±.0053	±.0055
3	.2294	±.0046	±.0049	±.0051	±.0054
4	.2043	±.0045	±.0048	±.0050	±.0053
5	.1819	±.0044	±.0046	±.0049	±.0051
6	.1620	±.0043	±.0045	±.0048	±.0050
7	.1443	±.0041	±.0044	±.0046	±.0049
8	.1285	±.0040	±.0043	±.0045	±.0048
9	.1144	±.0039	±.0041	±.0044	±.0046
10	.1019	±.0038	±.0040	±.0043	±.0045
11	.0907	±.0036	±.0039	±.0041	±.0044
12	.0808	±.0035	±.0038	±.0040	±.0043
13	.0720	±.0034	±.0036	±.0039	±.0041
14	.0641	±.0033	±.0035	±.0038	±.0040
15	.0571	±.0031	±.0034	±.0036	±.0039
16	.0508	±.0030	±.0033	±.0035	±.0038
17	.0453	±.0029	±.0031	±.0034	±.0036
18	.0403	±.0028	±.0030	±.0033	±.0035
19	.0359	±.0026	±.0029	±.0031	±.0033
20	.0320	±.0025	±.0026	±.0029	±.0030
21	.0285	±.0024	±.0025	±.0026	±.0028
22	.0253	±.0023	±.0024	±.0025	±.0026
23	.0226	±.0021	±.0023	±.0024	±.0025
24	.0201	±.0020	±.0021	±.0023	±.0024
25	.0179	±.0019	±.0020	±.0021	±.0023
26	.0159	±.0018	±.0019	±.0020	±.0021
27	.0142	±.0016	±.0018	±.0019	±.0020
28	.0126	±.0015	±.0016	±.0018	±.0019
29	.0113	±.0014	±.0015	±.0016	±.0018
30	.0100	±.0014	±.0015	±.0016	±.0018
31	.00893	±.0013	±.0014	±.0015	±.0016
32	.00795	±.0013	±.0014	±.0015	±.0016
33	.00708	±.0011	±.0013	±.0014	±.0015
34	.00630	±.0011	±.0013	±.0014	±.0015
35	.00561	±.0010	±.0011	±.0013	±.0014
36	.00500	±.0010	±.0011	±.0013	±.0014

TABLE 17.—*Permissible variations in thickness of wrought nonferrous sheets and strips of copper, low and rich low brass, commercial brass, and gilding metal*

American wire gage No.	Thickness	Permissible variations in thickness for widths—			
		Up to 6 inches, inclusive	Up to 9 inches, inclusive	Up to 14 inches, inclusive	Up to 20 inches, inclusive
	Inch	*Inch*	*Inch*	*Inch*	*Inch*
0000	0.4600	±0.0043	±0.0045	±0.0047	±0.0049
000	.4096	±.0042	±.0044	±.0046	±.0048
00	.3648	±.0041	±.0043	±.0045	±.0047
0	.3249	±.0040	±.0042	±.0044	±.0046
1	.2893	±.0039	±.0041	±.0043	±.0045
2	.2576	±.0038	±.0040	±.0042	±.0044
3	.2294	±.0037	±.0039	±.0041	±.0043
4	.2043	±.0036	±.0038	±.0040	±.0042
5	.1819	±.0035	±.0037	±.0039	±.0041
6	.1620	±.0034	±.0036	±.0038	±.0040
7	.1443	±.0033	±.0035	±.0037	±.0039
8	.1285	±.0032	±.0034	±.0036	±.0038
9	.1144	±.0031	±.0033	±.0035	±.0037
10	.1019	±.0030	±.0032	±.0034	±.0036
11	.0907	±.0029	±.0031	±.0033	±.0035
12	.0808	±.0028	±.0030	±.0032	±.0034
13	.0720	±.0027	±.0029	±.0031	±.0033
14	.0641	±.0026	±.0028	±.0030	±.0032
15	.0571	±.0025	±.0027	±.0029	±.0031
16	.0508	±.0024	±.0026	±.0028	±.0030
17	.0453	±.0023	±.0025	±.0027	±.0029
18	.0403	±.0022	±.0024	±.0026	±.0028
19	.0359	±.0021	±.0023	±.0025	±.0026
20	.0320	±.0020	±.0021	±.0023	±.0024
21	.0285	±.0019	±.0020	±.0021	±.0022
22	.0253	±.0018	±.0019	±.0020	±.0021
23	.0226	±.0017	±.0018	±.0019	±.0020
24	.0201	±.0016	±.0017	±.0018	±.0019
25	.0179	±.0015	±.0016	±.0017	±.0018
26	.0159	±.0014	±.0015	±.0016	±.0017
27	.0142	±.0013	±.0014	±.0015	±.0016
28	.0126	±.0012	±.0013	±.0014	±.0015
29	.0113	±.0011	±.0012	±.0013	±.0014
30	.0100	±.0011	±.0012	±.0013	±.0014
31	.00893	±.0010	±.0011	±.0012	±.0013
32	.00795	±.0010	±.0011	±.0012	±.0013
33	.00708	±.0009	±.0010	±.0011	±.0012
34	.00630	±.0009	±.0010	±.0011	±.0012
35	.00561	±.0008	±.0009	±.0010	±.0011
36	.00500	±.0008	±.0009	±.0010	±.0011

TABLE 18.—*Permissible variations in thickness of flat aluminum sheets, plates, and strips, (commercially pure aluminum (2S) and aluminum manganese (1.25 per cent) alloy (3S))*

American wire gage No.		Thickness		Permissible variations in thickness for widths—				
				Sheets only [1]			Sheets, plates, and strips [2]	
From—	To and including—	From—	To and including—	20 inches and under	Over 20 to 36 inches, inclusive	Over 36 to 60 inches, inclusive	30 inches and under	Over 30 inches
1	2	3	4	5	6	7	8	9
		Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
2	3	0.2576	0.2294	±0.0070	±0.0080	±0.0090	±0.0100	±0.0100
4		.2043		±.0050	±.0060	±.0070	±.0100	±.0100
5	9	.1819	.1144	±.0050	±.0060	±.0070	±.0090	±.0095
10	13	.1019	.0720	±.0030	±.0035	±.0040	±.0030	±.0035
14	17	.0641	.0453	±.0025	±.0025	±.0030	±.0030	±.0035
18	21	.0403	.0285	±.0025	±.0025	±.0030	±.0025	±.0030
22	24	.0253	.0201	±.0020	±.0020	±.0030	±.0020	±.0025
25	26	.0179	.0159	±.0020	±.0020	±.0020	±.0020	±.0025
27		.0142		±.0020	±.0020	±.0020	±.0015	±.0020
28	36	.0126	.0050	±.0015	±.0015	±.0015	±.0015	±.0020

[1] Presented in American Society for Testing Materials standard specification B25–29, and Aluminum Co. of American data sheet No. 669.742, June 1, 1929. Material having thickness greater than 0.250 inch is considered plate, and is covered by plate tolerances.

[2] Presented in—

1. United States Army metal specifications No. 57–151, May 9, 1923. The tolerances given in column 8 also apply to aluminum-alloy plates, sheets, and strips, United States Army metal specifications No. 57–152, May 25, 1923.
2. Society of Automotive Engineers specification No. 78, February, 1924.

TABLE 19.—*Permissible variations in thickness of coiled aluminum sheet, commercial practice*

American wire gage No.		Thickness		Permissible variations in thickness for widths—	
From—	To and including—	From—	To and including—	¼ to 12 inches, inclusive	Over 12 to 24 inches, inclusive
		Inch	*Inch*	*Inch*	*Inch*
10	18	0.1019	0.0403	±0.0030	±0.0030
19	20	.0359	.0320	±.0020	±.0025
21	25	.0285	.0179	±.0020	±.0025
26	29	.0159	.0113	±.0015	
30	36	.0100	.0050	±.0010	

NOTE.—The above tolerances are taken from Aluminum Co. of America data sheet No. 669.742, June 1, 1929.

2. OTHER GAGES FOR COPPER SHEETS

Copper sheets are frequently made in definite weights per square foot. This practice is customary in the heavier flat sheets. Table 20 shows the corresponding approximate thicknesses, which are based on a density of 8.89 grams per cubic centimeter, 555 pounds per cubic foot, or 46.25 pounds per square foot per inch thick.

Copper sheets can also be obtained in fractional-inch thicknesses varying by sixteenths of an inch from one-sixteenth to 2 inches. Also the Birmingham wire gage has been used in designating thick-

nesses of copper sheets. Table 21 gives permissible variations in weight and thickness of certain fractional-inch sizes.

TABLE 20.—*Copper sheets furnished in weights per square foot*

Weight per square foot (ounces)	Approximate thickness	Weight per square foot (ounces)	Approximate thickness	Weight per square foot (pounds)	Approximate thickness
	Inch		*Inch*		*Inch*
2	0.0027	24	0.0324	5	0.1081
4	.0054	28	.0351	5½	.1189
6	.0081	28	.0378	6	.1297
7	.0095	32	.0432	6½	.1405
8	.0108	36	.0486	7	.1514
9	.0122	40	.0541	7½	.1622
10	.0135	44	.0595	8	.1730
11	.0149	46	.0622	8½	.1838
12	.0162	48	.0649	9	.1946
13	.0176	52	.0703	9½	.2054
14	.0189	56	.0757	10	.2162
15	.0203	64	.0865	11	.2378
16	.0216	72	.0973	12	.2595
18	.0243	76	.1027	13	.2811
20	.0270			14	.3027
				15	.3243
				16	.3460

TABLE 21.—*Permissible overweights of copper plates for locomotive fire boxes, ordered to thickness, A. S. T. M. standard specifications B11—18*

Ordered thickness	Weight	Permissible excess in average weights per square foot of plates for widths given, expressed in percentages of nominal weights			
		Under 75 inches	75 to 100 inches, exclusive	100 to 115 inches, exclusive	115 inches or over
	Lbs./ft.²				
5/16 inch	14.53	8	12	16	
3/8 inch	17.44	7	10	13	17
7/16 inch	20.34	6	8	10	13
½ inch	23.25	5	7	9	12
9/16 inch	26.16	5	6.5	8.5	11
5/8 inch	29.06	5	6	8	10
Over 5/8 inch		5	5	6.5	9

NOTE.—The thickness of each plate shall not vary more than 0.04 inch under that ordered.

3. MONEL METAL (NICKEL-COPPER ALLOY)

Monel metal sheets (approximately 67 per cent nickel, 28 per cent copper, and 5 per cent of other elements) are rolled in thicknesses corresponding to the wrought iron thicknesses of the United States standard gage for sheet and plate iron and steel. The corresponding weights per unit area are given in Table 22. The weights per square foot are based on a density of 8.850 grams per cubic centimeter, 552.5 pounds per cubic foot, or 46.04 pounds per square foot per inch thick.

Inasmuch as the United States standard gage is strictly a weight gage this practice with regard to thicknesses of Monel metal sheets represents a deviation from the standard practice. Monel metal sheets are usually used to replace sheet steel, or steel sheets coated with zinc, both of which come in United States standard gage weights. If Monel metal sheets were rolled to the same weight per unit area as

steel sheets, according to the United States standard gage, the resulting thicknesses would be quite different from those of standard steel sheets of corresponding gage number, because of the large difference in density of the two metals.

The tolerances on thickness of Monel metal, as given in Table 22, are the practice of the International Nickel Co. When rolled to weight, the tolerances correspond to sheet-steel practice. Permissible variations in thickness given in United States Government master specification No. 585, December 8, 1928, are shown in Table 23.

TABLE 22.—*Monel metal sheets*

Gage No.	Thickness			Weight per square foot	
	In fractions of an inch	In decimal parts of an inch	Tolerances	In ounces [1]	In pounds
			Inch		
2	17/64	0.2656		194½	12.211
3	¼	.2500	±0.008	183	11.493
4	15/64	.2344	±.008	171¾	10.774
5	7/32	.2188	±.007	160¼	10.056
6	13/64	.2031	±.007	148¾	9.338
7	3/16	.1875	±.005	137½	8.619
8	11/64	.1719	±.004	126	7.901
9	5/32	.1562	±.004	114½	7.183
10	9/64	.1406	±.004	103	6.465
11	⅛	.1250	±.003	91½	5.746
12	7/64	.1094	±.003	80¼	5.028
13	3/32	.0938	±.003	68¾	4.310
14	5/64	.0781	±.003	57¼	3.591
15	9/128	.0703	±.003	51½	3.232
16	1/16	.0625	±.002	45¾	2.873
17	9/160	.0562	±.002	41	2.586
18	1/20	.0500	±.002	36½	2.300
19	7/160	.0438	±.002	32	2.011
20	3/80	.0375	±.001	27½	1.724
21	11/320	.0344	±.001	25	1.580
22	1/32	.0312	±.001	22¾	1.437
23	9/320	.0281	±.001	20½	1.293
24	1/40	.0250	±.001	18¼	1.149
25	7/320	.0219	±.001	16	1.005
26	3/160	.0188	±.001	13¾	.862

[1] To the nearest ¼ ounce.

TABLE 23.—*Permissible variations in thickness of Monel metal plates, sheets, and strips. (U. S. Government master specification No. 585, Dec. 8, 1928)*

Thickness (in inches)	Widths (in inches)	Permissible variation in thickness
0.02 and less	All widths	±0.002 inch.
Over 0.02 to 0.04, inclusive	do	±0.003 inch.
Over 0.04 to 0.065, inclusive	do	±0.004 inch.
Over 0.065 to 0.08, inclusive	do	±0.005 inch.
Over 0.08 to 0.10, inclusive	do	±0.006 inch.
Over 0.10 to 0.12, inclusive	do	±0.007 inch.
Over 0.12 to 0.25, inclusive	do	±0.008 inch.
Over 0.25	48 and less	±5 per cent.
	Over 48 to 60, inclusive	Plus 5 per cent; minus 7 per cent.
	Over 60	Plus 5 per cent; minus 8 per cent.

4. AMERICAN ZINC GAGE

The American zinc gage, commonly used by manufacturers of zinc sheet in the United States, is given in Table 24. The weights per square foot for the thicknesses given are based on a density of 0.2596 pounds per cubic inch, 37.38 pounds per square foot per inch thick, or 7.186 grams per cubic centimeter, the value given in the specifications cited below.

Permissible variations in thicknesses of sheet zinc are presented in United States Government master specification No. 531, November 23, 1917, and in the American Society for Testing Materials standard specifications for rolled zinc, B 69–29, wherein rolled zinc is classified as follows:

Type A, ribbon zinc and sheets or strips cut from ribbon zinc.—Type A rolled zinc shall be rolled from a single bar in one continuous direction. The permissible variations in thickness of type A rolled zinc shall be as given in Table 25. Thicknesses of metals falling between the gages shown shall take the tolerances of the nearest gage. (Table 25 corresponds approximately to Table 17.)

Type B, sheet zinc or strips cut from sheet zinc.—Type B rolled zinc shall be rolled by the pack-rolling method. The permissible variations in thickness of type B rolled zinc shall be as given in Table 26, wherein such tolerances are expressed as percentages, plus or minus, of the equivalent weights as given in Table 24, and apply only to units or lots of 500 pounds or more.

No individual sheet shall weigh more than the theoretical weight of a sheet of the gage next above, nor less than a sheet of the next gage below.

Type C, boiler plate, name plates, tags, etc.—Type C rolled zinc may be rolled either from a single bar or by the pack-rolling method. The permissible variations in thickness of type C rolled zinc shall be the same as those for either type A or type B rolled zinc, depending upon whether the material is cut from a ribbon or a sheet.

TABLE 24.—*American zinc gage*

American zinc gage No.	Thickness	Weight per square foot, approximate	American zinc gage No.	Thickness	Weight per square foot, approximate	American zinc gage No.	Thickness	Weight per square foot, approximate
	Inch	*Pounds*		*Inch*	*Pounds*		*Inch*	*Pounds*
1	0.002	0.075	11	0.024	0.897	21	0.080	2.99
2	.004	.150	12	.028	1.05	22	.090	3.36
3	.006	.224	13	.032	1.20	23	.100	3.74
4	.008	.299	14	.036	1.35	24	.125	4.67
5	.010	.374	15	.040	1.50	25	.250	9.35
6	.012	.449	16	.045	1.68	26	.375	14.02
7	.014	.523	17	.050	1.87	27	.500	18.69
8	.016	.598	18	.055	2.05	28	1.000	37.38
9	.018	.673	19	.060	2.24			
10	.020	.748	20	.070	2.62			

NOTE.—Manufacturers' catalogues usually omit Nos. 1 and 2.

TABLE 25.—*Permissible variations in thickness of type A rolled zinc*

American zinc gage No.	Thickness	Permissible variations in thickness for widths—			
		0 to 6 inches, inclusive	Over 6 to 9 inches, inclusive	Over 9 to 14 inches, inclusive	Over 14 to 20 inches, inclusive
	Inch	*Inch*	*Inch*	*Inch*	*Inch*
3	0.006	±0.0009	±0.0010	±0.0011	±0.0012
4	.008	±.0010	±.0011	±.0012	±.0013
5	.010	±.0011	±.0012	±.0013	±.0014
6	.012	±.0011	±.0012	±.0013	±.0014
7	.014	±.0013	±.0014	±.0015	±.0016
8	.016	±.0014	±.0015	±.0016	±.0017
9	.018	±.0015	±.0015	±.0017	±.0018
10	.020	±.0016	±.0017	±.0018	±.0019
11	.024	±.0018	±.0019	±.0020	±.0021
12	.028	±.0019	±.0020	±.0021	±.0022
13	.032	±.0020	±.0021	±.0023	±.0024
14	.036	±.0021	±.0023	±.0025	±.0026
15	.040	±.0022	±.0024	±.0026	±.0028
16	.045	±.0023	±.0025	±.0027	±.0029
17	.050	±.0024	±.0026	±.0028	±.0030
18	.055	±.0025	±.0027	±.0029	±.0031
19	.060	±.0026	±.0028	±.0030	±.0032
20	.070	±.0027	±.0029	±.0031	±.0033
21	.080	±.0028	±.0030	±.0032	±.0034
22	.090	±.0029	±.0031	±.0033	±.0035
23	.100	±.0030	±.0032	±.0034	±.0036
24	.125	±.0032	±.0033	±.0035	±.0037

TABLE 26.—*Permissible variations in thickness of type B rolled zinc*

American zinc gage No.	Thickness	Permissible variation by weight	American zinc gage No.	Thickness	Permissible variation by weight	American zinc gage No.	Thickness	Permissible variation by weight
	Inch	*Per cent*		*Inch*	*Per cent*		*Inch*	*Per cent*
3	0.006	±16	10	0.020	±6	17	0.050	±6
4	.008	±13	11	.024	±6	18	.055	±6
5	.010	±10	12	.028	±6	19	.060	±6
6	.012	±9	13	.032	±6	20	.070	±6
7	.014	±8	14	.036	±6	21	.080	±6
8	.016	±6	15	.040	±6	22	.090	±6
9	.018	±6	16	.045	±6	23	.100	±6

5. SHEET LEAD

Sheet lead is commonly ordered on the basis of weight per square foot in units as given in column 1 of Table 27. The average weight per cubic foot of sheet lead is about 707.6 pounds, which corresponds to 59.0 pounds per square foot per inch thick. (The value 59.5 is commonly used.) The decimal thicknesses given in column 2, Table 27, are computed on the basis 59.0. The fractional thicknesses in column 3 are those commonly listed in catalogues and handbooks.

United States Government master specification No. 308, July 6, 1925, specifies the permissible variation in weight of any sheet as ± 5 per cent. Grade A lead sheet contains no reclaimed lead and the thickness of any sheet of grade A sheet lead, corresponding to the weight per square foot specified, may vary within ± 0.003 inch.

TABLE 27.—*Lead sheets furnished by weight*

Weight per square foot (in pounds)	Approximate thickness		Weight per square foot (in pounds)	Approximate thickness		Weight per square foot (in pounds)	Approximate thickness	
	Decimal	Binary fraction [1]		Decimal	Binary fraction [1]		Decimal	Binary fraction [1]
1	2	3	1	2	3	1	2	3
	Inch	*Inch*		*Inch*	*Inch*		*Inches*	*Inch*
1	0.0169	1/64	5	0.0847	5/64	16	0.2712	9/32
1½	.0254	3/128	6	.1017	3/32	20	.3390	11/32
2	.0339	1/32	8	.1356	1/8	24	.4068	13/32
2½	.0424	5/128	10	.1695	5/32	30	.5085	1/2
3	.0508	3/64	12	.2034	3/16	40	.6780	11/16
3½	.0593	7/128	14	.2373	7/32	60	1.0169	1
4	.0678	1/16	15	.2542	1/4			

[1] As commonly listed in catalogues.

IV. FOREIGN SHEET AND PLATE GAGES

1. BIRMINGHAM GAGE, B. G. (BRITISH LEGAL STANDARD FOR IRON AND STEEL SHEETS)

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 Canada; and upon petition of various chambers of commerce in the United Kingdom, the board of trade proceeded to have the gage legalized. The gage is given in Table 28.

2. IMPERIAL STANDARD WIRE GAGE (BRITISH LEGAL STANDARD FOR WIRES)

The Imperial standard wire gage (S. W. G.) was adopted by the British Board of Trade January 15, 1884, and is the legal standard in Great Britain and Canada for all wires. It is the customary standard for nonferrous sheets and is also used to some extent for iron and steel sheets. Tolerances on thicknesses of steel sheets corresponding to S. W. G. Nos. 3 to 22, inclusive, are given in the following British Engineering Standards Association Reports: No. 113–1920, British Standard Schedule of Sheet Steels for Aircraft, and No. 5007–1924, British Standard Schedule of Sheet Steels for Automobiles.

This gage has a mathematical basis, the thickness, or diameter of successive sizes diminishing by 10.557 per cent, and the cross-sectional area of wires diminishing by 20 per cent, beginning with the No. 7/0 which is 0.50 inch, and ending with the No. 50 which is 0.001 inch. In sizes larger than 0.018 inch the Imperial standard wire gage approximately parallels the steel wire gage of this country. The gage is presented in Table 29.

3. PARIS OR FRENCH GAGE

The "Jauge de Paris," given in Table 30, is a gage for sheet metal and wire, which has been in general use in France since 1857. It is a thickness gage established by custom. The weights of sheet steel given in Table 30 are computed on the basis of 0.2833 pounds per cubic inch, or 40.80 pounds per square foot per inch thick.

4. GERMAN STANDARDS FOR FERROUS SHEETS

Standard thicknesses, and tolerances on thickness and weight of steel sheets, were adopted by the Normenausschuss der Deutschen Industrie and published in Dinormen 1542 and 1543. For the calculation of the weights from the thicknesses specified, taking into account the differing thicknesses of the sheets in the center and at the edge, a cross-sectional weight of 8 kilograms per square meter of 1 millimeter thickness (41.62 pounds per square foot per inch thick) is taken. (See Tables 31 and 32.)

5. GERMAN STANDARDS FOR NONFERROUS SHEETS

Standard thicknesses, tolerances on thickness, and weights of brass, copper, and aluminum sheets adopted by the Normenausschuss der Deutschen Industrie and published in Dinormen 1751, 1752, and 1753, respectively, are given herein in Tables 33, 34, and 35. The weights given are based on the following densities: Brass, 8.5 grams per cubic centimeter, 530.6 pounds per cubic foot, or 44.22 pounds per square foot per inch thick; copper, 8.9 grams per cubic centimeter, 555.6 pounds per cubic foot, or 46.30 pounds per square foot per inch thick; and aluminum, 2.73 grams per cubic centimeter, 170.4 pounds per cubic foot, or 14.20 pounds per square foot per inch thick.

6. CONTINENTAL ZINC GAGE

The continental zinc gage, given in Table 36, is used throughout Belgium, France, and Germany for zinc sheets. The metric sizes and weights given in Table 36 are taken from Fascicule A33–2, January 27, 1923, of the Commission Permanente de Standardization, France, entitled "Cahier des Charges pour la Fourniture du Zinc Industriel."

7. JAPANESE STANDARD THICKNESSES OF SHEET METAL

According to Japanese engineering standard No. 2–B2, "Diameter of Wire, Thickness of Sheet Metal, and Their Designation," approved by the Japanese Engineering Standards Committee, October 19, 1922, the thicknesses of sheet metals (as well as the diameters of wires), shall be of 42 classes each, and each class shall be designated by its diameter or thickness, but not by gage number. These classes are listed in Table 37.

TABLE 28.—*British sheet and hoop iron standard gage (Birmingham gage, B.G.)*

Descriptive No.	Equivalents in decimal parts of an inch	Descriptive No.	Equivalents in decimal parts of an inch	Descriptive No.	Equivalents in decimal parts of an inch	Descriptive No.	Equivalents in decimal parts of an inch
	Inch		*Inch*		*Inch*		*Inch*
15/0 B. G.	1.000	3 B. G.	0.2804	20 B. G.	0.0392	37 B. G.	0.0054
14/0 B. G.	.9583	4 B. G.	.2500	21 B. G.	.0349	38 B. G.	.0048
13/0 B. G.	.9167	5 B. G.	.2225	22 B. G.	.03125	39 B. G.	.0043
12/0 B. G.	.8750	6 B. G.	.1981	23 B. G.	.02782	40 B. G.	.00386
11/0 B. G.	.8333	7 B. G.	.1764	24 B. G.	.02476	41 B. G.	.00343
10/0 B. G.	.7917	8 B. G.	.1570	25 B. G.	.02204	42 B. G.	.00306
9/0 B. G.	.7500	9 B. G.	.1398	26 B. G.	.01961	43 B. G.	.00272
8/0 B. G.	.7083	10 B. G.	.1250	27 B. G.	.01745	44 B. G.	.00242
7/0 B. G.	.6666	11 B. G.	.1113	28 B. G.	.015625	45 B. G.	.00215
6/0 B. G.	.6250	12 B. G.	.0991	29 B. G.	.0139	46 B. G.	.00192
5/0 B. G.	.5883	13 B. G.	.0882	30 B. G.	.0123	47 B. G.	.00170
4/0 B. G.	.5416	14 B. G.	.0785	31 B. G.	.0110	48 B. G.	.00152
3/0 B. G.	.5000	15 B. G.	.0699	32 B. G.	.0098	49 B. G.	.00135
2/0 B. G.	.4452	16 B. G.	.0625	33 B. G.	.0087	50 B. G.	.00120
1/0 B. G.	.3964	17 B. G.	.0556	34 B. G.	.0077	51 B. G.	.00107
1 B. G.	.3532	18 B. G.	.0495	35 B. G.	.0069	52 B. G.	.00095
2 B. G.	.3147	19 B. G.	.0440	36 B. G.	.0061		

NOTE.—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 29.—*Imperial standard wire gage (British)*

Gage No.	Thickness		Gage No.	Thickness		Gage No.	Thickness		Gage No.	Thickness	
	Inch	*mm*		*Inch*	*mm*		*Inch*	*mm*		*Inch*	*mm*
7/0	0.500	12.700	9	0.144	3.658	24	0.022	0.559	39	0.0052	0.1321
6/0	.464	11.785	10	.128	3.251	25	.020	.508	40	.0048	.1219
5/0	.432	10.973	11	.116	2.946	26	.018	.457	41	.0044	.1118
4/0	.400	10.160	12	.104	2.642	27	.0164	.4166	42	.0040	.1016
3/0	.372	9.449	13	.092	2.337	28	.0148	.3759	43	.0036	.0914
2/0	.348	8.839	14	.080	2.032	29	.0136	.3454	44	.0032	.0813
1/0	.324	8.229	15	.072	1.829	30	.0124	.3150	45	.0028	.0711
1	.300	7.620	16	.064	1.626	31	.0116	.2946	46	.0024	.0610
2	.276	7.010	17	.056	1.422	32	.0108	.2743	47	.0020	.0508
3	.252	6.401	18	.048	1.219	33	.0100	.2540	48	.0016	.0406
4	.232	5.893	19	.040	1.016	34	.0092	.2337	49	.0012	.0305
5	.212	5.385	20	.036	.914	35	.0084	.2134	50	.0010	.0254
6	.192	4.877	21	.032	.813	36	.0076	.1930			
7	.176	4.470	22	.028	.711	37	.0068	.1727			
8	.160	4.064	23	.024	.610	38	.0060	.1524			

TABLE 30.—*Paris or French gage*

Gage No.	Thickness	Approximate thickness	Approximate weight per square meter,[1] sheet steel	Approximate weight per square foot, sheet steel	Gage No.	Thickness	Approximate thickness	Approximate weight per square meter,[1] sheet steel	Approximate weight per square foot sheet steel
	mm	*Inch*	*kg*	*Pounds*		*mm*	*Inch*	*kg*	*Pounds*
P15	0.15	0.0059	1.176	0.2409	P5	0.30	0.0118	2.353	0.4818
P14	.16	.0063	1.255	.2570	P4	.34	.0134	2.666	.5461
P13	.17	.0067	1.333	.2730	P3	.37	.0146	2.901	.5943
P12	.18	.0071	1.412	.2891	P2	.42	.0165	3.294	.6746
P11	.20	.0079	1.568	.3212	P1	.46	.0181	3.607	.7388
P10	.22	.0087	1.725	.3533	P0	.50	.0197	3.921	.8031
P9	.23	.0091	1.804	.3694	1	.6	.0236	4.705	.9637
P8	.25	.0098	1.960	.4015	2	.7	.0276	5.489	1.124
P7	.27	.0106	2.117	.4336	3	.8	.0315	6.273	1.285
P6	.28	.0110	2.196	.4497	4	.9	.0354	7.058	1.445

[1] The weights for sheet steel in columns 4 and 5 are based on a density of 0.2833 pounds per cubic inch, 489.6 pounds per cubic foot, 40.80 pounds per square foot per inch thick, or 7841.7 kg per cubic meter.

TABLE 30.—*Paris or French gage*—Continued

Gage No.	Thickness	Approximate thickness	Approximate weight per square meter,[1] sheet steel	Approximate weight per square foot, sheet steel	Gage No.	Thickness	Approximate thickness	Approximate weight per square meter,[1] sheet steel	Approximate weight per square foot, sheet steel
	mm	*Inch*	*kg*	*Pounds*		*mm*	*Inch*	*kg*	*Pounds*
5	1.0	0.0394	7.842	1.606	18	03.4	.1339	26.66	5.461
6	1.1	.0433	8.626	1.767	19	3.9	.1535	30.58	6.264
7	1.2	.0472	9.410	1.927	20	4.4	.1732	34.50	7.067
8	1.3	.0512	10.19	2.088	21	4.9	.1929	38.42	7.870
9	1.4	.0551	10.98	2.249	22	5.4	.2126	42.35	8.675
10	1.5	.0591	11.76	2.409	23	5.9	.2323	46.27	9.476
11	1.6	.0630	12.55	2.570	24	6.4	.2520	50.19	10.28
12	1.8	.0709	14.12	2.891	25	7.0	.2756	54.89	11.24
13	2.0	.0787	15.68	3.212	26	7.6	.2992	59.60	12.21
14	2.2	.0866	17.25	3.533	27	8.2	.3228	64.30	13.17
15	2.4	.0945	18.82	3.855	28	8.8	.3465	69.01	14.13
16	2.7	.1063	21.17	4.336	29	9.4	.3701	73.71	15.10
17	3.0	.1181	23.53	4.818	30	10.0	.3937	78.42	16.06

TABLE 31.—*Thin and medium rolled ingot-steel sheets under 5 mm thickness (German thin-sheet gage) and tolerances on thickness and weight, German industry standard (DIN 1542, September, 1924)*

Gage No.	Thickness, nominal		Weight per square meter	Weight per square foot	Stock sizes,[1] tolerances		All special sizes up to oversize sheets, tolerances			Oversize sheets, tolerances on thickness[3]
					Thickness	Weight[2]	Thickness		Weight	
	mm	*Inch*[4]	*kg*	*Pounds*		*Per cent*		*mm*	*Per cent*	*mm*
3	4.500	0.1772	36.000	7.373		±5		±0.25	±7	±0.50
4	4.250	.1673	34.000	6.964		±5		±.25	±7	±.50
5	4.000	.1575	32.000	6.554		±5		±.25	±7	±.50
6	3.750	.1476	30.000	6.145		±5		±.25	±7	±.50
7	3.500	.1378	28.000	5.735		±5		±.25	±7	±.50
8	3.250	.1280	26.000	5.325		±5		±.25	±7	±.50
9	3.000	.1181	24.000	4.916		±5		±.25	±7	±.50
10	2.750	.1083	22.000	4.506		±6		±.25	±8	±.50
11	2.500	.0984	20.000	4.096		±6		±.25	±8	±.50
12	2.250	.0886	18.000	3.687		±6		±.25	±8	±.50
13	2.000	.0787	16.000	3.277		±6		±.25	±8	±.50
14	1.750	.0689	14.000	2.867		±6		±.15	±8	±.30
15	1.500	.0591	12.000	2.458	(5)	±6	(5)	±.15	±8	±.30
16	1.375	.0541	11.000	2.253		±7		±.15	±9	±.30
17	1.250	.0492	10.000	2.048		±7		±.15	±9	±.30
18	1.125	.0443	9.000	1.843		±7		±.15	±9	±.30
19	1.000	.0394	8.000	1.639		±7		±.15	±9	±.30
20	.875	.0344	7.000	1.434		±8		±.12	±10	±.24
21	.750	.0295	6.000	1.229		±8		±.12	±10	±.24
22	.625	.0246	5.000	1.024		±8		±.08	±10	±.16
23	.562	.0221	4.496	.921		±8		±.08	±10	±.16
24	.500	.0197	4.000	.819		±8		±.08	±10	±.16
25	.438	.0172	3.504	.718		±9		±.06	±11	±.12
26	.375	.0148	3.000	.614		±9		±.06	±11	±.12
27	.300	.0118	2.400	.492		±9		±.06	±11	±.12

[1] 800 mm wide by 1,600 mm long, gage numbers 3 to 27, inclusive; 1,000 mm wide by 2,000 mm long, gage numbers 3 to 24, inclusive; 1,250 mm wide by 2,500 mm long, gage numbers 3 to 15, inclusive.

[2] If sheets in numbers smaller than 10 pieces of the same size are ordered, the variations in weight may be 50 per cent larger. The tolerance on weight covers the total amount of sheets of the same size.

[3] As to weight the sheets are to be taken as they come so far as no special agreement exists.

[4] Approximate.

[5] Up to ¾ of the difference between the nominal thickness of the ordered thickness and the nominal thickness of the next thicker or thinner.

[6] Up to the entire difference between the nominal thickness of the ordered thickness and the nominal thickness of the next thicker or thinner.

TABLE 32.—*Thick rolled ingot-steel plates, 5 mm and over, tolerances on thickness and weight, German industry standard (DIN 1543, September, 1924)*

Thickness range		Permissible difference between smallest and greatest thickness of the same plate, and permissible excesses over calculated weights[1] in width ranges—									
		To 1,500 mm		Over 1,500 to 1,700 mm		Over 1,700 to 2,000 mm		Over 2,000 to 2,300 mm		Over 2,300 to 2,600 mm	
Over—	To—	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight	Thickness	Weight
mm	*mm*	*mm*	*Per cent*	*mm*	*Per cent*	*mm*	*Per cent*	*mm*	*Per cent*	*mm*	*Per cent*
5	6	1.1	7	1.4	11	1.8	14				
6	7	1.1	6	1.3	9	1.7	12	2.1	14		
7	10	1.0	5	1.2	7	1.6	9	2.0	11	2.4	14
10	15	.9	4.5	1.1	6	1.5	7	1.8	9	2.2	11
15	20	.9	4	1.0	5	1.4	6	1.7	8	2.1	10
20	------	.8	3	.9	4	1.3	5	1.6	6	2.0	8

Thickness range		Permissible difference between smallest and greatest thickness of the same plate, and permissible excesses over calculated weights[1] in width ranges—							Permissible minus tolerance[2]		
		Over 2,600 to 3,000 mm		Over 3,000 to 3,300 mm		Over 3,300 to 3,600 mm		Over 3,600 mm	In thickness	For lengths to—	For surfaces to—
Over—	To—	Thickness	Weight	Thickness	Weight	Thickness	Weight				
mm	*mm*	*mm*	*Per cent*	*mm*	*Per cent*	*mm*	*Per cent*		*mm*	*m*	*m²*
5	6	The sheets are to be taken as they come, so far as no special agreement exists							0.3	6	9
6	7								.3	7	10
7	10								.3	8	12
10	15	2.7	13						.5	9	14
15	20	2.6	13	3.1	14				.5	10	16
20	------	2.5	11	2.8	13	3.1	14		.5	10	18

[1] If it is agreed that the cross-sectional weight at 8 kg per square meter of surface of 1 mm ordered thickness may not be exceeded, then the entire weight tolerance is applied minus, whereby, however, guarantee for holding within definite minimum and maximum thicknesses can not be undertaken.

[2] For greater lengths or surfaces (oversize sheets) this tolerance is doubled. The established minus tolerances hold for all sheet widths to 3,600 mm. For boiler plates, which come under the steam-boiler code, the stated tolerances hold only as plus tolerances.

TABLE 33.—*Thicknesses of cold-rolled brass sheets, German industry standard (DIN 1751, July, 1925)*

Thickness		Permissible variations in thickness for widths of—								Approximate weight per square meter	Approximate weight per square foot
		350 to 500 mm (13.78 to 19.68 inches)		350 to 600 mm (13.78 to 23.62 inches)		Over 600 to 750 mm (over 23.62 to 29.53 inches)		Over 750 to 1,000 mm (over 29.53 to 39.37 inches)			
mm	*Inch*[1]	*mm*	*Inch*[1]	*mm*	*Inch*[1]	*mm*	*Inch*[1]	*mm*	*Inch*[1]	*kg*	*Pounds*
0.10	0.0039	±0.015	±0.0006	------	------	------	------	------	------	0.85	0.174
.15	.0059	±.015	±.0006	------	------	------	------	------	------	1.27	.261
.20	.0079	±.015	±.0006	------	------	------	------	------	------	1.70	.348
.25	.0098	±.020	±.0008	------	------	------	------	------	------	2.12	.435
.30	.0118	±.020	±.0008	------	------	------	------	------	------	2.55	.522
.35	.0138	±.030	±.0012	------	------	------	------	------	------	2.97	.609
.40	.0157	±.030	±.0012	------	------	------	------	------	------	3.40	.696
.45	.0177	------	------	±0.035	±0.0014	------	------	------	------	3.82	.783
.50	.0197	------	------	±.035	±.0014	±0.060	±0.0024	------	------	4.25	.870
.60	.0236	------	------	±.035	±.0014	±.060	±.0024	------	------	5.10	1.045
.70	.0276	------	------	±.035	±.0014	±.060	±.0024	------	------	5.95	1.219
.80	.0315	------	------	±.040	±.0016	±.060	±.0024	------	------	6.80	1.393
.90	.0354	------	------	±.040	±.0016	±.070	±.0028	------	------	7.65	1.567
1.00	.0394	------	------	±.040	±.0016	±.070	±.0028	±0.090	±0.0035	8.50	1.741
1.20	.0472	------	------	±.040	±.0016	±.080	±.0031	±.110	±.0043	10.20	2.089
1.50	.0591	------	------	±.050	±.0020	±.080	±.0031	±.110	±.0043	12.75	2.611
1.80	.0709	------	------	±.060	±.0024	±.100	±.0039	±.130	±.0051	15.30	3.134
2.00	.0787	------	------	±.060	±.0024	±.100	±.0039	±.130	±.0051	17.00	3.482
2.50	.0984	------	------	±.080	±.0031	±.120	±.0047	±.150	±.0059	21.25	4.352
3.00	.1181	------	------	±.080	±.0031	±.120	±.0047	±.150	±.0059	25.50	5.223
3.50	.1378	------	------	±.100	±.0039	±.150	±.0059	±.170	±.0067	29.75	6.093
4.00	.1575	------	------	±.100	±.0039	±.150	±.0059	±.170	±.0067	34.00	6.964

[1] Approximate.

NOTE.—The points of measurement for thickness shall be at least 100 mm from the corners and 40 mm from the edges of the sheet.

TABLE 34.—*Thicknesses of cold-rolled copper sheets, German industry standard (DIN 1752, July, 1925)*

Thickness		Permissible variation in thickness		Approximate weight per square meter	Approximate weight per square foot	Thickness		Permissible variation in thickness		Approximate weight per square meter	Approximate weight per square foot
mm	*Inch* [1]	*mm*	*Inch* [1]	*kg*	*Pound*	*mm*	*Inch* [1]	*mm*	*Inch* [1]	*kg*	*Pounds*
0.10	0.0039	±0.015	±0.0006	0.89	0.182	0.50	0.0197	±0.040	±0.0016	4.45	0.911
.15	.0059	±.015	±.0006	1.33	.273	.60	.0236	±.050	±.0020	5.34	1.094
.20	.0079	±.015	±.0006	1.78	.365	.70	.0276	±.060	±.0024	6.23	1.276
.22	.0087	±.015	±.0006	1.96	.401	.80	.0315	±.070	±.0028	7.12	1.458
.25	.0098	±.020	±.0003	2.22	.456	.90	.0354	±.070	±.0028	8.01	1.641
.28	.0110	±.020	±.0008	2.49	.510	1.00	.0394	±.080	±.0031	8.90	1.823
.30	.0118	±.020	±.0008	2.67	.547	1.20	.0472	±.100	±.0039	10.68	2.187
.35	.0138	±.030	±.0012	3.11	.638	1.50	.0591	±.110	±.0043	13.35	2.734
.40	.0157	±.040	±.0016	3.56	.729	1.80	.0709	±.130	±.0051	16.02	3.281
.45	.0177	±.040	±.0016	4.00	.820	2.00	.0787	±.130	±.0051	17.80	3.646

[1] Approximate.

NOTE.—The points of measurement for thickness shall be at least 100 mm from the corners and 40 mm from the edges of the sheet.

TABLE 35.—*Thicknesses of cold-rolled aluminum sheets, German industry standard (DIN 1753, July, 1925)*

Thickness		Permissible variations in thickness for widths of—								Approximate weight per square meter	Approximate weight per square foot
		350 to 500 mm (13.78 to 19.68 inches)		350 to 600 mm (13.78 to 23.62 inches)		Over 600 to 750 mm (over 23.62 to 29.53 inches)		Over 750 to 1,000 mm (over 29.53 to 39.37 inches)			
mm	*Inch* [1]	*mm*	*Inch* [1]	*mm*	*Inch* [1]	*mm*	*Inch* [1]	*mm*	*Inch* [1]	*kg*	*Pounds*
0.20	0.0079	±0.015	±0.0006	------	------	------	------	------	------	0.55	0.112
.25	.0098	±.020	±.0008	------	------	------	------	------	------	.68	.140
.30	.0118	±.020	±.0008	------	------	------	------	------	------	.82	.168
.35	.0138	±.030	±.0012	------	------	------	------	------	------	.96	.196
.40	.0157	±.030	±.0012	------	------	------	------	------	------	1.09	.224
.45	.0177	------	------	±0.035	±0.0014	------	------	------	------	1.23	.252
.50	.0197	------	------	±.035	±.0014	±0.050	±0.0020	------	------	1.37	.280
.60	.0236	------	------	±.035	±.0014	±.050	±.0020	------	------	1.64	.335
.70	.0276	------	------	±.035	±.0014	±.050	±.0020	------	------	1.91	.391
.80	.0315	------	------	±.040	±.0016	±.050	±.0020	------	------	2.18	.447
.90	.0354	------	------	±.040	±.0016	±.060	±.0024	------	------	2.46	.503
1.00	.0394	------	------	±.040	±.0016	±.060	±.0024	±0.080	±0.0031	2.73	.559
1.10	.0433	------	------	±.040	±.0016	±.070	±.0028	±.090	±.0035	3.00	.615
1.20	.0472	------	------	±.040	±.0016	±.070	±.0028	±.090	±.0035	3.28	.671
1.30	.0512	------	------	±.050	±.0020	±.070	±.0028	±.090	±.0035	3.55	.727
1.40	.0551	------	------	±.050	±.0020	±.070	±.0028	±.090	±.0035	3.82	.783
1.50	.0591	------	------	±.050	±.0020	±.070	±.0028	±.090	±.0035	4.09	.839
1.80	.0709	------	------	±.060	±.0024	±.090	±.0035	±.110	±.0043	4.91	1.006
2.00	.0787	------	------	±.060	±.0024	±.090	±.0035	±.110	±.0043	5.46	1.118
2.20	.0866	------	------	±.060	±.0024	±.090	±.0035	±.110	±.0043	6.01	1.230
2.50	.0984	------	------	±.080	±.0031	±.110	±.0043	±.130	±.0051	6.83	1.398
3.00	.1181	------	------	±.080	±.0031	±.110	±.0043	±.130	±.0051	8.19	1.677
3.50	.1378	------	------	±.100	±.0039	±.130	±.0051	±.150	±.0059	9.55	1.957
4.00	.1575	------	------	±.100	±.0039	±.130	±.0051	±.150	±.0059	10.92	2.236
4.50	.1772	------	------	±.120	±.0047	±.150	±.0059	±.170	±.0067	12.28	2.516
5.00	.1968	------	------	±.120	±.0047	±.150	±.0059	±.170	±.0067	13.65	2.795

[1] Approximate.

NOTE.—The points of measurement for thickness shall be at least 100 mm from the corners and 40 mm from the edges of the sheet.

TABLE 36.—*Continental zinc gage*

Gage No.	Thickness		Weight per square meter	Weight per square foot	Gage No.	Thickness		Weight per square meter	Weight per square foot
	mm	*Inch*	*kg*	*Pounds*		*mm*	*Inch*	*kg*	*Pounds*
1	0.100	0.0039	0.709	0.14	14	0.82	0.0323	5.740	1.18
2	.143	.0056	1.001	.20	15	.95	.0374	6.650	1.36
3	.186	.0073	1.302	.27	16	1.08	.0425	7.560	1.55
4	.228	.0090	1.596	.33	17	1.21	.0476	8.470	1.73
5	.250	.0098	1.750	.36	18	1.34	.0528	9.380	1.92
6	.30	.0118	2.100	.43	19	1.47	.0579	10.290	2.11
7	.35	.0138	2.450	.50	20	1.60	.0630	11.200	2.29
8	.40	.0157	2.800	.57	21	1.78	.0701	12.460	2.55
9	.45	.0177	3.150	.65	22	1.96	.0772	13.720	2.81
10	.50	.0197	3.500	.72	23	2.14	.0843	14.980	3.07
11	.58	.0228	4.060	.83	24	2.32	.0913	16.240	3.33
12	.66	.0260	4.620	.95	25	2.50	.0984	17.500	3.58
13	.74	.0291	5.180	1.06	26	2.68	.1055	18.760	3.84

TABLE 37.—*Japanese engineering standard thicknesses of sheet metal*

Millimeters	Inch [1]	Millimeters	Inch [1]	Millimeters	Inch [1]
12.00	0.4724	1.20	0.0472	0.12	0.0047
10.00	.3937	1.00	.0394	.10	.0039
9.00	.3543	.90	.0354		
8.00	.3150	.80	.0315		
7.00	.2756	.70	.0276		
6.50	.2559	.65	.0256		
6.00	.2362	.60	.0236		
5.50	.2165	.55	.0217		
5.00	.1968	.50	.0197		
4.50	.1772	.45	.0177		
4.00	.1575	.40	.0157		
3.50	.1378	.35	.0138		
3.20	.1260	.32	.0126		
2.90	.1142	.29	.0114		
2.60	.1024	.26	.0102		
2.30	.0906	.23	.0091		
2.00	.0787	.20	.0079		
1.80	.0709	.18	.0071		
1.60	.0630	.16	.0063		
1.40	.0551	.14	.0055		

[1] Approximate.

V. APPENDIX—CONVERSION FACTORS

Given	Multiply by—	To obtain
Grams per cubic centimeter	62.423	Pounds per cubic foot.
	.036127	Pounds per cubic inch.
	5.2024	Pounds per square foot per inch thick.
Pounds per cubic inch	27.680	Grams per cubic centimeter.
	1728.0	Pounds per cubic foot.
	144.00	Pounds per square foot per inch thick.
	276.80	Kilograms per square meter per centimeter thick.
Pounds per square foot	4.8824	Kilograms per square meter.
	16.000	Ounces per square foot.
	217.78	Pounds per base box.
	3484.4	Ounces per base box.
Ounces per square foot	.062500	Pounds per square foot.
	13.611	Pounds per base box.
	217.78	Ounces per base box.
Pounds per base box	.0045918	Pounds per square foot.
	.073469	Ounces per square foot.
	.022419	Kilograms per square meter.

WASHINGTON, JULY 14, 1930.

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