

USEFUL INFORMATION

- To find circumference of a circle multiply diameter by 3.1416.
To find diameter of a circle multiply circumference by .31831.
To find area of a circle multiply square of diameter by .7854.
To find area of rectangle multiply length by breadth.
Doubling the diameter of a circle increases its area four times.
To find area of a triangle multiply base by 1/2 perpendicular height.
To find area of a trapezoid add the lengths of the two parallel sides, divide by two, and multiply by the height.
To find surface of a ball multiply square of diameter by 3.1416.
To find volume of a ball multiply cube of diameter by .5236.
To find side of an inscribed square multiply diameter by 0.7071 or multiply circumference by 0.2251 or divide circumference by 4.4428.
To find side of a square of equal area multiply diameter by .8862.
Square. A side multiplied by 1.4142 equals diameter of its circumscribing circle.
Aside multiplied by 4.443 equals circumference of its circumscribing circle.
A side multiplied by 1.128 equals diameter of an equal circle.
A side multiplied by 3.547 equals circumference of an equal circle.
The area of a circle times 1.273 equals the area of a circumscribing square.
To find cubic inches in a ball multiply cube of diameter by .5236.
To find cubic contents of a cone, multiply area of base by 1/3 the altitude.
To find surface of a cone not including the base multiply 3.1416 by radius of base by slant height.
Doubling the diameter of a pipe increases its capacity four times.
A gallon of water (U.S. standard) weighs 8-1/3 lbs. and contains 231 cubic inches.
A cubic foot of water contains 7-1/2 gallons, 1728 cubic inches, and weighs 62-1/2 lbs.
To find the pressure in pounds per square inch of a column of water multiply the height of the column in feet by .434.
Steam rising from water at its boiling point (212 degrees) has a pressure equal to the atmosphere (14.7 lbs. to the square inch.)
A standard horse power: The evaporation of 30 lbs. of water per hour from a feed water temperature of 100 degrees F. into steam of 70 lbs. gauge pressure.
To find capacity of tanks any size: given dimensions of a cylinder in inches, to find its capacity in U.S. gallons: Square the diameter, multiply by the length and by .0034.
To ascertain heating surface in tubular boilers multiply 2/3 the circumference of boiler by length of boiler in inches and add to it the area of all the tubes.
One-sixth of tensile strength of plate multiplied by thickness of plate and divided by one half the diameter of boiler gives safe working pressure for tubular boilers. For marine boilers add 20 per cent for drilled holes.
To find the capacity of an air compressor in cubic feet of free air per minute: Multiply the area of low pressure cylinder (on compound compressor), by the stroke in inches, and divide by 1728; and multiply this result –
(a) In single acting, simple or compound, by the R.P.M.
(b) Double acting, simple or compound, by 2 x R.P.M.
(c) Duplex double acting, by 4 x R.P.M.



FRACTION AND DECIMAL EQUIVALENTS

GENERAL AND TECHNICAL INFORMATION

$1/64$	—	.015625	$33/64$	—	.515625
$1/32$	—	.03125	$17/32$	—	.53125
$3/64$	—	.046875	$35/64$	—	.546875
$1/16$	—	.0625	$9/16$	—	.5625
$5/64$	—	.078125	$37/64$	—	.578125
$3/32$	—	.09375	$19/32$	—	.59375
$7/64$	—	.109375	$39/64$	—	.609375
$1/8$	—	.125	$5/8$	—	.625
$9/64$	—	.140625	$41/64$	—	.640625
$5/32$	—	.15625	$21/32$	—	.65625
$11/64$	—	.171875	$43/64$	—	.671875
$3/16$	—	.1875	$11/16$	—	.6875
$13/64$	—	.203125	$45/64$	—	.703125
$7/32$	—	.21875	$23/32$	—	.71875
$15/64$	—	.234375	$47/64$	—	.734375
$1/4$	—	.25	$3/4$	—	.75
$17/64$	—	.265625	$49/64$	—	.765625
$9/32$	—	.28125	$25/32$	—	.78125
$19/64$	—	.296875	$51/64$	—	.796875
$5/16$	—	.3125	$13/16$	—	.8125
$21/64$	—	.328125	$53/64$	—	.828125
$11/32$	—	.34375	$27/32$	—	.84375
$23/64$	—	.359375	$55/64$	—	.859375
$3/8$	—	.375	$7/8$	—	.875
$25/64$	—	.390625	$57/64$	—	.890625
$13/32$	—	.40625	$29/32$	—	.90625
$27/64$	—	.421875	$59/64$	—	.921875
$7/16$	—	.4375	$15/16$	—	.9375
$29/64$	—	.453125	$61/64$	—	.953125
$15/32$	—	.46875	$31/32$	—	.96875
$31/64$	—	.484375	$63/64$	—	.984375
$1/2$	—	.500000	1		1.00000



CONVERTING INCHES INTO DECIMALS OF A FOOT

Inches	Decimal of a Ft.	Inches	Decimal of a Ft.	Inches	Decimal of a Ft.
0"	1/16 .005208	4" .33333	1/16 .338542	8" .66666	1/16 .671875
	1/8 .010416		1/8 .343750		1/8 .677083
	3/16 .015625		3/16 .348958		3/16 .682292
	1/4 .020833		1/4 .354166		1/4 .687500
	5/16 .026042		5/16 .359375		5/16 .692708
	3/8 .031250		3/8 .364583		3/8 .697916
	7/16 .036458		7/16 .369792		7/16 .703125
	1/2 .041666		1/2 .375000		1/2 .708323
	9/16 .046875		9/16 .380208		9/16 .713542
	5/8 .052083		5/8 .385416		5/8 .718750
	11/16 .057292		11/16 .390625		11/16 .723958
	3/4 .062500		3/4 .395833		3/4 .729166
	13/16 .067708		13/16 .401042		13/16 .734375
	7/8 .072916		7/8 .406250		7/8 .739583
	15/16 .078125		15/16 .411458		15/16 .744792
1" .083333	1/16 .088542	5" .416666	1/16 .421875	9" .750	1/16 .755208
	1/8 .093750		1/8 .427083		1/8 .760416
	3/16 .098958		3/16 .432292		3/16 .765625
	1/4 .104166		1/4 .437500		1/4 .770833
	5/16 .109375		5/16 .442708		5/16 .776042
	3/8 .114583		3/8 .447916		3/8 .781250
	7/16 .119792		7/16 .453125		7/16 .786458
	1/2 .125000		1/2 .458333		1/2 .791666
	9/16 .130208		9/16 .463542		9/16 .796875
	5/8 .135416		5/8 .468750		5/8 .802083
	11/16 .140625		11/16 .473958		11/16 .807292
	3/4 .145833		3/4 .479166		3/4 .812500
	13/16 .151042		13/16 .484375		13/16 .817708
	7/8 .156250		7/8 .489583		7/8 .822916
	15/16 .161458		15/16 .494792		15/16 .828125
2" .166666	1/16 .171875	6" .50	1/16 .505208	10" .833333	1/16 .838542
	1/8 .177083		1/8 .510416		1/8 .843750
	3/16 .182292		3/16 .515625		3/16 .848958
	1/4 .187500		1/4 .520833		1/4 .854166
	5/16 .192708		5/16 .526042		5/16 .859375
	3/8 .197906		3/8 .531250		3/8 .864583
	7/16 .203175		7/16 .536458		7/16 .869792
	1/2 .208333		1/2 .541666		1/2 .875000
	9/16 .213542		9/16 .546875		9/16 .880208
	5/8 .218750		5/8 .552083		5/8 .885416
	11/16 .223958		11/16 .557292		11/16 .890625
	3/4 .229166		3/4 .562500		3/4 .895833
	13/16 .234375		13/16 .567708		13/16 .901042
	7/8 .239583		7/8 .572916		7/8 .906250
	15/16 .244792		15/16 .578125		15/16 .911458
3" .250	1/16 .255208	7" .583333	1/16 .588542	11" .916666	1/16 .921875
	1/8 .260416		1/8 .593750		1/8 .927083
	3/16 .265625		3/16 .598958		3/16 .932292
	1/4 .270833		1/4 .604166		1/4 .937500
	5/16 .276042		5/16 .609375		5/16 .942708
	3/8 .281250		3/8 .614583		3/8 .947916
	7/16 .286458		7/16 .619792		7/16 .953125
	1/2 .291666		1/2 .625000		1/2 .958333
	9/16 .296875		9/16 .630208		9/16 .963542
	5/8 .302083		5/8 .635416		5/8 .968750
	11/16 .307292		11/16 .640625		11/16 .973958
	3/4 .312500		3/4 .645833		3/4 .979166
	13/16 .317708		13/16 .651042		13/16 .984375
	7/8 .322916		7/8 .656250		7/8 .989583
	15/16 .328125		15/16 .661458		15/16 .994792

GENERAL AND TECHNICAL INFORMATION



STANDARD GAUGE

When ordering, specify decimal as well as name of gauge

Gauge	Amerian Or Brown & Sharpe	Birmingham Or Stubs	U.S. Standard	Mfgs. Standard	Steel Wire Or Washburn & Moen	Galvanized Sheet	Gauge
	Non-Ferrous Sheet-Wire & Rod	Tube Ferrous Strip, Flat Wire, Spring Steel	Stainless	Ferrous Sheet	Ferrous Wire (Except Music Wire)		
6-0	.5800		.469		.4615		6-0
5-0	.5165		.438		.4305		5-0
4-0	.4600	.454	.406		.3938		4-0
3-0	.4096	.425	.375		.3626		3-0
2-0	.3648	.380	.344		.3310		2-0
1-0	.3249	.340	.312		.3065		1-0
1	.2893	.300	.281		.2830		1
2	.2576	.284	.266		.2625		2
3	.2294	.259	.250	.2391	.2437		3
4	.2043	.238	.234	.2242	.2253		4
5	.1819	.220	.219	.2092	.2070		5
6	.1620	.203	.203	.1943	.1920		6
7	.1443	.188	.188	.1793	.1770		7
8	.1285	.172	.172	.1644	.1620	.1681	8
9	.1144	.156	.156	.1495	.1483	.1532	9
10	.1019	.141	.141	.1345	.1350	.1382	10
11	.0907	.125	.125	.1196	.1205	.1233	11
12	.0808	.109	.109	.1046	.1055	.1084	12
13	.0720	.0938	.0938	.0897	.0915	.0934	13
14	.0641	.0781	.0781	.0747	.0800	.0785	14
15	.0571	.0703	.0703	.0673	.0720	.0710	15
16	.0508	.0625	.0625	.0598	.0625	.0635	16
17	.0453	.0562	.0562	.0538	.0540	.0575	17
18	.0403	.0500	.0500	.0478	.0475	.0516	18
19	.0359	.0438	.0438	.0418	.0410	.0456	19
20	.0320	.0375	.0375	.0359	.0348	.0396	20
21	.0285	.0375	.0375	.0359	.0348	.0396	21
22	.0253	.0312	.0312	.0299	.0286	.0336	22
23	.0226	.0281	.0281	.0269	.0288	.0306	23
24	.0201	.0250	.0250	.0239	.0230	.0276	24
25	.0179	.0219	.0219	.0209	.0204	.0247	25
26	.0159	.0188	.0188	.0179	.0181	.0127	26
27	.0142	.0172	.0172	.0164	.0473	.0202	27
28	.0126	.0156	.0156	.0149	.0162	.0187	28
29	.0113	.0141	.0141	.0135	.0150	.0172	29
30	.0100	.0125	.0125	.0120	.0140	.0157	30
31	.0089	.0109	.0109	.0105	.0132	.0142	31
32	.0080	.0103	.0102	.0097	.0128	.0134	32
33	.0071	.00938	.00938	.0090	.0118		33
34	.0063	.00859	.00859	.0082	.0104		34
35	.0056	.00781	.00781	.0075	.0095		35
36	.0050	.00703	.00703	.0067	.0090		36
37	.0045	.00664	.00664	.0064	.0085		37
38	.0040	.00625	.00625	.0060	.0080		38

ALUMINUM-BRASS-STAINLESS
COPPER-ALLOY-CARBON



CIRCUMFERENCES AND AREAS OF CIRCLES

OF INCHES OR FEET

Dia.	Circ.	Area	Dia.	Circ.	Area
1	3.1416	.7854	48	150.80	1809.56
2	6.2832	3.1416	49	153.94	1885.74
3	9.4248	7.0686	50	157.08	1963.50
4	12.5664	12.5664	51	160.22	2042.82
5	15.7080	19.6350	52	163.36	2123.72
6	18.8500	28.2740	53	166.50	2206.18
7	21.9910	38.4850	54	169.65	2290.22
8	25.1330	50.2660	55	172.79	2375.83
9	28.2740	63.6170	56	175.93	2463.01
10	31.4160	78.5400	57	179.07	2551.76
11	34.5580	95.0330	58	182.21	2642.08
12	37.6990	113.1000	59	185.35	2733.97
13	40.8410	132.7300	60	188.50	2827.43
14	43.9820	153.9400	61	191.64	2922.47
15	47.1240	176.7100	62	194.78	3019.07
16	50.2650	201.0600	63	197.92	3117.25
17	53.4070	226.9800	64	201.06	3216.99
18	56.5490	254.4700	65	204.20	3318.31
19	59.6900	283.5300	66	207.34	3421.19
20	62.8320	314.1600	67	210.49	3525.65
21	65.9730	346.3600	68	213.63	3631.68
22	69.1150	380.1300	69	216.77	3739.28
23	72.2570	415.4800	70	219.91	3848.45
24	75.3980	452.3900	71	223.05	3959.19
25	78.5400	490.8700	72	226.19	4071.50
26	81.6810	530.9300	73	229.34	4185.39
27	84.8230	572.5600	74	232.48	4300.84
28	87.9650	615.7500	75	235.62	4417.86
29	91.1060	660.5200	76	238.76	4536.46
30	94.2480	706.8600	77	241.90	4656.63
31	97.3890	754.7700	78	245.04	4778.36
32	100.5300	804.2500	79	248.19	4901.67
33	103.6700	855.3000	80	251.33	5026.55
34	106.8100	907.9200	81	254.47	5153.00
35	109.9600	962.1100	82	257.61	5281.02
36	113.1000	1017.8800	83	260.75	5410.61
37	116.2400	1075.2100	84	263.89	5541.77
38	119.3800	1134.1100	85	267.04	5674.50
39	122.5200	1194.5900	86	270.18	5808.80
40	125.6600	1256.6400	87	273.32	5944.68
41	128.8100	1320.2500	88	276.46	6082.12
42	131.9500	1385.4400	89	279.60	6221.14
43	135.0900	1452.2000	90	282.74	6361.73
44	138.2300	1520.5300	91	285.88	6503.88
45	141.3700	1590.4300	92	289.03	6647.61
46	144.5100	1661.9000	93	292.17	6792.91
47	147.6500	1734.9400	94	295.31	6939.78

CONTINUED

GENERAL AND TECHNICAL INFORMATION



CIRCUMFERENCES AND AREAS OF CIRCLES

OF INCHES OR FEET

Dia.	Circ.	Area	Dia.	Circ.	Area
95	298.45	7088.22	111	348.72	9676.89
96	301.59	7238.23	112	351.86	9852.03
97	304.73	7339.81	113	355.00	10028.75
98	307.88	7542.96	114	358.14	10207.03
99	311.02	7697.69	115	361.28	10386.89
100	314.16	7853.98	116	364.42	10568.32
101	317.30	8011.85	117	367.57	10751.32
102	320.44	8171.28	118	370.71	10935.88
103	323.58	8332.29	119	373.85	11122.02
104	326.73	8494.87	120	376.99	11309.73
105	329.87	8659.01	121	380.13	11499.01
106	333.01	8824.73	122	383.27	11689.87
107	336.15	8992.02	123	386.42	11882.29
108	339.29	9160.88	124	389.56	12076.28
109	342.43	9331.32	125	392.70	12271.85
110	345.58	9503.32	126	395.84	12468.98

Weight Formula

To find the weight (pounds) of one foot of steel:

- ROUNDS:** Multiply the square of the diameter in inches by 2.67
- SQUARES:** Multiply the square of the diameter of inches by 3.4
- HEXAGONS:** Multiply the square of the diameter in inches by 2.94
- FLATS:** Multiply the width by the thickness by 3.4



PRODUCT COLOR CODES

ALUMINUM

CAST PLATE	GOLD / GREEN
2011	BROWN
2024-T3	RED
3003	GREEN
3003 -H14	GREEN / RED
3003 -H22	GREEN / RED
5005	YELLOW / RED
5052	PURPLE
5052-H34	PURPLE / ORANGE
5052-H112	PURPLE / GREEN
5083	RED / GRAY
5086	RED / ORANGE
5454	GRAY / PINK
6061	BLUE
6061-T651	BLUE / YELLOW
6063	YELLOW / GREEN
6068	WHITE / YELLOW
6082	RED / BLUE
6082-T6 ABS CERTIFIED	RED / BLUE / WHITE
6082-T6 GL CERTIFIED	RED / BLUE / BLACK
6101	RED / BLACK
7075	BLACK

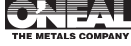
EXPANDED METAL

1 / 4" x #20	BLACK / YELLOW
1 / 4" x #18	BLACK / BLUE
1 / 2" x #20	RED / YELLOW
1 / 2" x #18	RED / BLUE
1 / 2" x #16	RED / ORANGE
1 / 2" x #13	RED / GREEN
3 / 4" x #16	GREEN / ORANGE
3 / 4" x #13	GREEN / GREEN
3 / 4" x #10	GREEN / GOLD
3 / 4" x #9	GREEN / RED
1" x #16	WHITE / ORANGE
1-1 / 2" x #16	BLUE / ORANGE
1-1 / 2" x #13	BLUE / GREEN
1-1 / 2" x #9	BLUE / RED
1-1 / 2" x #6	BLUE / BLACK

X-METAL GRATING

3#	WHITE
3.14#	ORANGE
4#	YELLOW

GENERAL AND TECHNICAL INFORMATION



PRODUCT COLOR CODES CONTINUED

X-METAL GRATING CONTINUED

4.27#	GREEN
5#	BLUE
6.25#	GOLD
7#	RED

GRIP STRUT

10GA	YELLOW
12GA	RED
14GA	GREEN

PIPE

RA 400 (HEIL)	RED / PURPLE
A500 PIPE	ORANGE
HANDRAIL	ORANGE
REJECT	YELLOW
TESTED-ASTM A-53 TYPE F	BLUE
TESTED-ASTM A-53 TYPE E GRADE A	GOLD
AST, A53 SCHEDULE 80	RED
UNTESTED	PURPLE

TUBING

HFSM A519 GR 1026	DARK GREEN
HFSM A519 GR 8620	FLUORESCENT ORANGE
COLD DRAWN BUTTWELDED	YELLOW
COLD DRAWN SEAMLESS	GREEN
SEAMLESS 1045	GREEN / PURPLE
SEAMLESS 10B45	GREEN / PURPLE / PINK
SEAMLESS 4140	GREEN / BLUE
DOM	WHITE
HIGH YIELD	FLUORESCENT RED
HOT FINISHED SEAMLESS	PINK
WELDED	SEE SHEETS BELOW

SHEETS & WELDED TUBING

6GA	ALUMINUM / BLACK
7GA	ALUMINUM
8GA	BLACK / RED
10GA	RED
11GA	WHITE
12GA	BLUE
13GA	FLUORESCENT GREEN
14GA	YELLOW
15GA	PURPLE
16GA	GREEN



PRODUCT COLOR CODES CONTINUED

SHEETS & WELDED TUBING CONTINUED

17GA	YELLOW / WHITE
18GA	ORANGE
20GA	BLACK
22GA	RED / WHITE
24GA	BLUE / WHITE
26GA	GREEN / WHITE
28GA	BLACK / WHITE
ASTM A1011SS GRADE 30	BEIGE / FLUORESCENT GREEN
ASTM A1011SS GRADE 36	BEIGE / BLACK
ASTM A1011SS GRADE 40	BEIGE / YELLOW
ASTM A1011SS GRADE 50	BEIGE / FLUORESCENT RED
ASTM A1011SS GRADE 55	FLUORESCENT GREEN / YELLOW
ASTM A606 TYPE 4 CORTEN	BLUE / YELLOW
ASTM A1011 HSLAS GRADE 50	ALUMINUM / RED
ASTM A1011 HSLAS GRADE 60	ALUMINUM / GREEN
ASTM A1011 HSLAS-F GRADE 50	LIGHT BLUE / YELLOW
ASTM A1011 HSLAS-F GRADE 60	LIGHT BLUE / GREEN
ASTM A1011 HSLAS-F GRADE 80	LIGHT BLUE / WHITE
1E2819 ROPS	ALUMINUM / GREEN / YELLOW

COLD FINISHED BARS

AISI 1018	YELLOW / ORANGE
AISI 1042 / 1045	PURPLE
AISI 1045 CHROME PLATED ONLY	LIGHT BLUE
AISI 1045 IND HARD CHROME PLT	PINK
1045 ANNEALED	PURPLE / BLACK
1050	BLUE / PINK
AISI 1117	ALUMINUM
AISI 1141	GREEN / PINK
AISI 1144	PURPLE / GREEN
AISI 11L17	ORANGE
AISI 11L41	BLACK
AISI 11L44	LIGHT BEIGE
AISI 1215	GREEN
AISI 12L14 & 12L15	WHITE
AISI 12L14 MAG TESTED	DK. MACHINE GRAY / WHITE
AISI 4130	FLUORESCENT GREEN
AISI 4140 / 4142 ANNEALED	FLUORESCENT ORANGE / BLUE
AISI 4140 / 4145 HEAT TREATED	RED / BLACK
AISI 4150	PURPLE / PINK



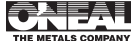
PRODUCT COLOR CODES CONTINUED

COLD FINISHED BARS CONTINUED

AISI 4150RS (Resulfurized)	LIGHT GREEN
4820H	YELLOW / PURPLE
6150	BLACK / GREEN
AISI 8620	FLUORESCENT ORANGE
AISI 86L20	WHITE / GREEN
ETD150	BROWN
MAC+ AISI 1018	WHITE / YELLOW
MAG TESTED AISI 1018	DARK MACHINE GREY
NEALOY	RED
STRESSPROOF	GOLD
FATIGUE PROOF	BLACK / WHITE
NITRALLOY	LIGHT BLUE / RED
SUPER 1200	PINK

HOT ROLLED STRUCTURALS & BARS

AISI M1010	PURPLE / YELLOW
AISI M1015	BLUE / WHITE
1018	YELLOW / ORANGE
AISI 1020	ORANGE / BLACK
AISI 1040	RED / YELLOW
AISI M1044	PURPLE / ORANGE
AISI 1045	PURPLE
AISI 1060 ASTM A-576	WHITE
AISI 1065	LIGHT BLUE
AISI 1080	RED / WHITE
AISI 1117	ALUMINUM
AISI 1141	BLUE
AISI 1144	PURPLE / GREEN
Wearally As Rolled Alloy Bar	BLUE / BLACK
Wearally 400 HR HT Alloy Bar	BLUE / WHITE
AISI 4140 HR-HT SR-MS	RED / BLACK
AISI 4140 / 4142 ANNEALED	FLUORESCENT ORANGE / BLUE
AISI 4145 ANNEALED	ALUMINUM / BLUE
AISI 4150	PURPLE / PINK
AISI 4150RS	LIGHT GREEN
AISI 4340	PINK / GREEN
4820H	PINK / WHITE
A-36	YELLOW
A-36 / A-572 GRADE 50	BLACK FLUORESCENT / ORANGE
AISI 5140	BLACK
AISI 5160	GREEN
AISI 8620	FLUORESCENT ORANGE
ASTM A-36 RIBBED BAR	GREEN



PRODUCT COLOR CODES CONTINUED

HOT ROLLED STRUCTURALS & BARS CONTINUED

9310	RED / BLUE
ASTM A-514	YELLOW / FLUORESCENT RED
ASTM A-529 GRADE 50	PURPLE / YELLOW
ASTM A-572 GRADE 50	GREEN / YELLOW
A-572 GRADE 50 COPPER STEEL	GREEN / YELLOW / GOLD
CASE MS314	GREEN / YELLOW / BLACK
ASTM A-572 GRADE 65	GREEN / BLUE
A-572 GRADE 70	BLACK / GREEN
ASTM A-588 GRADE A (CORTEN)	BLUE / YELLOW
ASTM A-615 GRADE 40 RE-BAR	LIGHT BEIGE
ASTM A-615 GRADE 60 RE-BAR	PINK
A-996 GRADE 40 RE-BAR	ORANGE / BEIGE
COMMERCIAL QUALITY FLATS	WHITE
CSA 44W	PINK
NEALOY	RED
ABS SECTION 43 GR A	FLUORESCENT GREEN
A992 (W SHAPES ONLY)	BLACK / YELLOW

PLATE (HOT ROLLED)

AISI 1008	FLUORESCENT RED
AISI 1015	LIGHT BEIGE
B4A72A (GE SPEC)	BEIGE / RED
AISI 1018	BEIGE / ORANGE
AISI 1020	ORANGE / BLACK
AISI 1025	LIGHT BLUE / PINK
AISI 1040	RED / YELLOW
AISI 1045	PURPLE
AISI 1119	PURPLE / BLACK
CAT 1E0650	GREEN / RED
CAT 1E0682	RED / YELLOW
CAT 1E0860	GREEN / RED / YELLOW
A-36 (0.8-1.2 MN)	YELLOW / BROWN
ASTM A-283 GRADE C	WHITE
ASTM A-283 GRADE D	ORANGE
ASTM A-285 GRADE C	YELLOW / ALUMINUM
ASTM A-36 (DOMESTIC)	RED / WHITE / BLUE
ASTM A-36 (FOREIGN)	YELLOW
ASTM A-387 GRADE 11 CLASS 1	GOLD / GREEN
ASTM A-387 GRADE 11 CLASS 2	GOLD / BROWN
ASTM A-387 GRADE 22 CLASS 1	GOLD / BLUE
ASTM A-387 GRADE 22 CLASS 2	GOLD / PINK
IPSCO 100XF	RED / BLACK

GENERAL AND TECHNICAL INFORMATION



PRODUCT COLOR CODES CONTINUED

PLATE (HOT ROLLED) CONTINUED

ASTM A-514	RED
ASTM A-515 / 516 GRADE 70 DUAL	
CERTIFIED	BLACK / WHITE / BLACK
ASTM A-516 GRADE 60	PURPLE / YELLOW
ASTM A-516 GRADE 70	BLACK
ASTM A-516 GRADE 70 NORMALIZED	BLACK / WHITE
A455	BLACK / ORANGE
A-529 GRADE 50	PURPLE / YELLOW
A-529 GRADE 55	BLACK / YELLOW
ASTM A-572 GRADE 50	GREEN / YELLOW
A-572 GR 50 (CVN TESTED TO11F / UT)	GREEN / RED / PURPLE
A-572 GR 55	GREEN / WHITE
MEC-850 (W / CHARPIES)	GOLD / WHITE / BLACK
ASTM A-572 GRADE 60	GREEN / GRAY
ASTM A-572 GRADE 65	GREEN / BLUE
ASTM A-588 GRADE A (CORTEN)	BLUE / YELLOW
ASTM A-588 GRADE B	BLUE / PINK
A-633 GRADE C (NORMALIZED)	BLACK / GOLD
A-633 GRADE E (NORMALIZED)	FLOURESCENT ORANGE / FLOURESCENT GREEN
ASTM A-656 GRADE 50 (HI-FORM 50)	PURPLE / WHITE
A656 GRADE 70	GOLD / WHITE
ASTM A-656 GRADE 80	ORANGE / WHITE
A710	BLACK / WHITE / GREEN
EN 10025 GR S355J2G3 NORMANLIZED	BLUE / ORANGE
A1018 HSLAS GR 50	ALUMINUM / RED
A1018 HSLAS GR 55	ALUMINUM / YELLOW
A1018 HSLAS GR 60	ALUMINUM / GREEN
A1018 HSLAS GR 70	ALUMINUM / ORANGE
A1018 HSLAS GR 80	LIGHT BLUE / WHITE
COMMERCIAL QUALITY (CS)	WHITE / RED
CSA 44W	PINK
AR225 / 235	GREEN
O'NEAL STAR	BLUE
AR 400	BLUE / WHITE
O'NEAL STAR 450	ALUMINUM
T-1, T-1A, T-1B, T-1C (321 BHN MIN)	GOLD
HARDOX 400	BLUE / WHITE
UHSS GR 130	RED / GOLD
HARDOX 500	GREEN / LIGHT BLUE
WELDOX 130	GOLD / FLUORESCENT GREEN
33 MAX	LIGHT BLUE
ABS SECTION 43 GR A	FLUORESCENT GREEN



PRODUCT COLOR CODES CONTINUED

PLATE (HOT ROLLED) CONTINUED

A572-50 / ABS AHDH GR36	FLUORESCENT GREEN / YELLOW
ABS A LLOYDS	FLUORESCENT GREEN / GOLD
ABS AH LLOYDS	FLUORESCENT RED / GOLD
API 2W GR 50	FLUORESCENT RED / YELLOW / GREEN
API 2H50 / ABS DH / EH36	FLOURESCENT RED / BLUE
MANGANESE PLATE	PURPLE / PINK
US SHIELD 400	PURPLE / RED
ISG HARWEAR 400	PURPLE / GREEN

TOOL STEEL

AL 29-4C	GREEN / RED
01	FLUORESCENT RED
06	ALUMINUM / BLACK
A2	WHITE / RED
D2	WHITE
H13	YELLOW / BLACK
M2	GOLD / BLACK
S5	PINK
S7	YELLOW / BLUE
W1	BLACK
BRAKEDIE	PINK / WHITE
DRILL ROD-COMMERCIAL	BLACK
DRILL ROD-OIL HARDENING	FLUORESCENT RED

STAINLESS STEEL

201	FLOURESCENT GREEN
201L	GREEN / WHITE
201LN	GREEN / BLUE
201HP	GREEN / RED
203	WHITE
301	PURPLE / BEIGE
303 T G & P	ORANGE
T303	ORANGE / BLUE
304	BLUE
304L	BLACK
304 / 304L DUAL CERTIFIED	GOLD
T304 (KOOL LINE)	GRAY
309H	PURPLE
309S	BLUE / WHITE
310S	PINK
316	YELLOW
316L	GREEN
316 / 316L DUAL CERTIFIED	FLUORESCENT RED



PRODUCT COLOR CODES CONTINUED

STAINLESS STEEL CONTINUED

317L.....	YELLOW / RED
321 / 321H	PURPLE / PINK
3CR12.....	GOLD / BLACK
409.....	PINK / GOLD
410.....	LIGHT BEIGE
416.....	RED
416 (PUMP SHAFT QUALITY)	GOLD / RED
430.....	BEIGE / YELLOW
440.....	PINK / BLACK
JS-700.....	BROWN
17-4 PH COND H1150	PINK / YELLOW
17-4 PH COND A.....	PINK / WHITE

BRASS & BRONZE

660 BRONZE.....	BROWN
AMPCO 8	GOLD
AMPCO 18	YELLOW
AMPCO 21	BLUE
AMPCO 45	ORANGE
BRASS STRIP.....	GREEN
FC BRASS.....	BLACK



CONVERSION OF MILES TO KILOMETERS AND KILOMETERS TO MILES

Miles	Kilometers	Kilometers	Miles
1	1.6	1	0.6
2	3.2	2	1.2
3	4.8	3	1.8
4	6.4	4	2.4
5	8.0	5	3.1
6	9.6	6	3.7
7	11.2	7	4.3
8	12.8	8	4.9
9	14.4	9	5.5
10	16.0	10	6.2
20	32.1	20	12.4
30	48.2	30	18.6
40	64.3	40	24.8
50	80.4	50	31.0
60	96.5	60	37.2
70	112.6	70	43.4
80	128.7	80	49.7
90	144.8	90	55.9
100	160.9	100	62.1
1000	1609	1000	621

CONVERSION TABLES

LENGTH

Metric

1 kilometer	.6214 mile (approximately 5/8's of a mile)
1 meter	1.094 yards (approximately 39 + inches)
1 meter	3.281 feet
1 centimeter	.3937 inch
1 millimeter	.039 inch

Customary

1 mile	1.6093 kilometers (approximately 1-3/5's kilometers)
1 yard	.9144 meter
1 foot	.3048 meter
1 inch	2.54 centimeters
1 inch	25.4 millimeters

AREA

Metric

1 sq. kilometer	.386 sq. mile
1 sq. kilometer	247.10 acres
1 hectare	2.471 acres
1 sq. meter	1.196 sq. yards
1 sq. meter	10.7646 sq. feet
1 sq. centimeter	.155 sq. inch



CONVERSION TABLES CONTINUED

Customary

1 sq. mile	2.59 sq. kilometers
1 acre	.405 hectare
1 sq. yard	.8361 sq. meter
1 sq. inch	6.45 sq. centimeters

VOLUME

Metric

1 cu. meter	1.308 cu. yards
1 liter	1.0567 liquid quarts (U.S.)
1 liter	.9081 dry quart (U.S.)
1 liter	.88 quart (imperial)
1 milliliter	.06 cu. inch (or 1 cu. centimeter)

Customary

1 cu. meter	.7646 cu. meter
1 liquid quart (U.S.)	.9463 liter
1 dry quart (U.S.)	1.10 liters
1 quart (Imperial)	1.1365 liters
1 gallon (U.S.)	3.785 liters
1 gallon (Imperial)	4.546 liters
1 cu. inch	16.39 milliliters (or cu. centimeter)

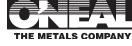
WEIGHT

Metric

1 metric ton	2205 pounds
1 metric ton	1.1023 short tons
1 metric ton	.9842 long ton
1 kilogram	2.205 pounds (avoirdupois)
1 kilogram	2.679 pounds (Troy)
1 gram	.0353 ounce (avoirdupois)
1 gram	.0322 ounce (Troy)
1 diamond carat	(1000 milligrams = 1 gram)

Customary

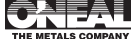
1 short (American) ton	2000 pounds
1 long (British) ton	2240 pounds
1 short ton	.9072 metric ton
1 long ton	1.016 metric tons
1 pound (avoir.)	.4536 kilogram
1 pound (avoir.)	453.6 grams
1 pound (Troy)	.3732 kilogram
1 pound (Troy)	373.2 grams
1 ounce (avoir.)	28.35 grams
1 ounce (Troy)	31.103 grams



METRIC CONVERSION TABLE

MILLIMETERS TO DECIMALS OF AN INCH

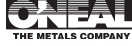
Millimeters	Inches	Millimeters	Inch-
1	0.03937	51	2.00787
2	0.07874	52	2.04721
3	0.11811	53	2.08661
4	0.15748	54	2.12598
5	0.19685	55	2.16535
6	0.23622	56	2.20472
7	0.27559	57	2.24400
8	0.31496	58	2.28346
9	0.35433	59	2.32283
10	0.39370	60	2.36220
11	0.43307	61	2.40157
12	0.47244	62	2.44094
13	0.51181	63	2.48031
14	0.55118	64	2.51968
15	0.59055	65	2.55905
16	0.62992	66	2.59842
17	0.66929	67	2.63779
18	0.70866	68	2.67716
19	0.74803	69	2.71653
20	0.78740	70	2.75590
21	0.82677	71	2.79527
22	0.86614	72	2.83464
23	0.90551	73	2.87401
24	0.94488	74	2.91338
25	0.98425	75	2.95275
26	1.02362	76	2.99212
27	1.06299	77	3.03449
28	1.10236	78	3.07086
29	1.14173	79	3.11023
30	1.18110	80	3.14960
31	1.22047	81	3.18897
32	1.25984	82	3.22834
33	1.29921	83	3.26771
34	1.33858	84	3.30708
35	1.37795	85	3.34645
36	1.41732	86	3.38582
37	1.45669	87	3.42519
38	1.49606	88	3.46456
39	1.53543	89	3.50393
40	1.57480	90	3.54330
41	1.61417	91	3.58267
42	1.65354	92	3.62204
43	1.69291	93	3.66141
44	1.73228	94	3.70078
45	1.77165	95	3.74015
46	1.81102	96	3.77952
47	1.85039	97	3.81889
48	1.88976	98	3.85826
49	1.92913	99	3.89763
50	1.96850	100	3.93700



METRIC CONVERSION TABLE

INCH (HUNDREDTHS) TO MILLIMETERS

Inch	Millimeters	Inch	Millimeters
.01	0.254	.51	12.954
.02	0.508	.52	13.208
.03	0.762	.53	13.462
.04	1.016	.54	13.716
.05	1.270	.55	13.970
.06	1.524	.56	14.224
.07	1.778	.57	14.478
.08	2.032	.58	14.732
.09	2.286	.59	14.986
.10	2.540	.60	15.240
.11	2.794	.61	15.494
.12	3.048	.62	15.748
.13	3.302	.63	16.002
.14	3.556	.64	16.256
.15	3.810	.65	16.510
.16	4.064	.66	16.764
.17	4.318	.67	17.018
.18	4.572	.68	17.272
.19	4.826	.69	17.526
.20	5.080	.70	17.780
.21	5.334	.71	18.034
.22	5.588	.72	18.288
.23	5.842	.73	18.542
.24	6.096	.74	18.796
.25	6.350	.75	19.050
.26	6.604	.76	19.304
.27	6.858	.77	19.558
.28	7.112	.78	19.812
.29	7.366	.79	20.066
.30	7.620	.80	20.320
.31	7.874	.81	20.574
.32	8.128	.82	20.828
.33	8.382	.83	21.082
.34	8.636	.84	21.336
.35	8.890	.85	21.590
.36	9.144	.86	21.844
.37	9.398	.87	22.098
.38	9.652	.88	22.352
.39	9.906	.89	22.606
.40	10.160	.90	22.860
.41	10.414	.91	23.114
.42	10.668	.92	23.368
.43	10.922	.93	23.622
.44	11.176	.94	23.876
.45	11.430	.95	24.130
.46	11.684	.96	24.384
.47	11.938	.97	24.638
.48	12.192	.98	24.892
.49	12.446	.99	25.146
.50	12.700	1.00	25.400



METRIC CONVERSION TABLE

INCHES TO MILLIMETERS

Inch	Millimeters	Inch	Millimeters
1	1,422	51	72,539
2	2,845	52	73,962
3	4,267	53	75,384
4	5,689	54	76,806
5	7,112	55	78,229
6	8,534	56	79,651
7	9,956	57	81,073
8	11,379	58	82,496
9	12,801	59	83,918
10	14,223	60	85,340
11	15,646	61	86,763
12	17,068	62	88,185
13	18,490	63	89,607
14	19,913	64	91,030
15	21,335	65	92,452
16	22,757	66	93,874
17	24,180	67	95,297
18	25,602	68	96,719
19	27,024	69	98,141
20	24,447	70	99,564
21	29,869	71	100,986
22	31,291	72	102,408
23	32,714	73	103,831
24	34,136	74	105,253
25	35,558	75	106,675
26	36,981	76	108,098
27	38,403	77	109,520
28	39,826	78	110,943
29	41,248	79	112,365
30	42,670	80	113,787
31	44,093	81	115,210
32	45,515	82	116,632
33	46,937	83	118,054
34	48,360	84	119,477
35	49,782	85	120,899
36	51,204	86	122,321
37	52,627	87	123,744
38	54,049	88	125,166
39	55,471	89	126,588
40	56,894	90	128,011
41	58,316	91	129,433
42	59,738	92	130,855
43	61,161	93	132,278
44	62,583	94	133,700
45	64,005	95	135,122
46	65,428	96	136,545
47	66,850	97	137,969
48	68,272	98	139,389
49	69,695	99	140,812
50	71,117	100	142,234

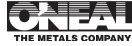


METRIC CONVERSION TABLE

POUNDS PER SQUARE INCH TO KILOGRAMS PER SQUARE MILLIMETER

Lbs. per sq. in.	Kilograms per sq. mm.	Lbs. per sq. in.	Kilograms per sq. mm.	Lbs. per sq. in.	Kilograms per sq. mm.
100	0.0703	29,000	20.3889	65,000	45.6993
200	0.1406	30,000	21.0920	66,000	46.4024
300	0.2109	31,000	21.7951	67,000	47.1055
400	0.2812	32,000	22.4981	68,000	47.8085
500	0.3515	33,000	23.2012	69,000	48.5116
600	0.4218	34,000	23.9043	70,000	49.2147
700	0.4921	35,000	24.6073	71,000	49.9177
800	0.5625	36,000	25.3104	72,000	50.6208
900	0.6328	37,000	26.0135	73,000	51.3239
1,000	0.7031	38,000	26.7165	74,000	52.0269
2,000	1.4061	39,000	27.4196	75,000	52.7300
3,000	2.1092	40,000	28.1227	76,000	53.4331
4,000	2.8123	41,000	28.8257	77,000	54.1361
5,000	3.5153	42,000	29.5288	78,000	54.8392
6,000	4.2184	43,000	30.2319	79,000	55.5423
7,000	4.9215	44,000	30.9349	80,000	56.2453
8,000	5.6246	45,000	31.6380	81,000	56.9484
9,000	6.3276	46,000	32.3411	82,000	57.6515
10,000	7.0307	47,000	33.0441	83,000	58.3545
11,000	7.7338	48,000	33.7472	84,000	59.0576
12,000	8.4368	49,000	34.4503	85,000	59.7607
13,000	9.1399	50,000	35.1533	86,000	60.4637
14,000	9.8429	51,000	35.8564	87,000	61.1668
15,000	10.5460	52,000	36.5595	88,000	61.8699
16,000	11.2491	53,000	37.2625	89,000	62.5729
17,000	11.9521	54,000	37.9656	90,000	63.2760
18,000	12.6552	55,000	38.6687	91,000	63.9791
19,000	13.3583	56,000	39.3717	92,000	64.6822
20,000	14.0631	57,000	40.0748	93,000	65.3852
21,000	14.7644	58,000	40.7779	94,000	66.0883
22,000	15.4675	59,000	41.4809	95,000	66.7914
23,000	16.1705	60,000	42.1840	96,000	67.4944
24,000	16.8736	61,000	42.8871	97,000	68.1975
25,000	17.5767	62,000	43.5901	98,000	68.9006
26,000	18.2797	63,000	44.2932	99,000	69.6036
27,000	18.9828	64,000	44.9963	100,000	70.3067
28,000	19.6859				

GENERAL AND TECHNICAL INFORMATION



METRIC CONVERSION TABLE

POUNDS TO KILOGRAMS

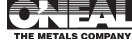
Pounds	Kilograms	Pounds	Kilograms
1	0.436	51	23.1332
2	0.9072	52	23.5868
3	1.3608	53	24.0404
4	1.8144	54	24.4940
5	2.2680	55	24.9876
6	2.7216	56	25.4012
7	3.1751	57	25.8549
8	3.6287	58	26.3084
9	4.0823	59	26.7620
10	4.5459	60	27.2156
11	1.9095	61	27.6691
12	5.4431	62	28.1227
13	5.8967	63	28.5763
14	6.3503	64	29.0299
15	6.8039	65	29.4835
16	7.2575	66	29.9371
17	7.7111	67	20.3907
18	8.1647	68	30.8413
19	8.1647	69	31.2979
20	9.0718	70	31.7515
21	9.5254	71	32.2051
22	9.9790	72	32.6587
23	10.4326	73	33.1122
24	10.8862	74	33.5658
25	11.3398	75	34.0194
26	11.7934	76	34.4730
27	12.2470	77	34.9266
28	12.7006	78	35.3802
29	13.1542	79	35.8338
30	13.6078	80	36.2874
31	14.0614	81	36.7410
32	14.5150	82	37.1946
33	14.9686	83	37.6482
34	15.4221	84	38.1018
35	15.8757	85	38.5554
36	16.3293	86	39.0089
37	16.7920	87	39.4625
38	17.2365	88	39.9161
39	17.6001	89	40.3697
40	18.1437	90	40.8233
41	18.5973	91	41.2769
42	19.0509	92	41.7305
43	19.5045	93	42.1841
44	19.9581	94	42.6377
45	20.1117	95	43.0913
46	20.8653	96	43.5449
47	21.3188	97	43.9985
48	21.7724	98	44.4521
49	22.2260	99	44.9057
50	22.6796	100	45.3592



METRIC CONVERSION TABLE

KILOGRAMS TO POUNDS

Kilograms	Pounds	Kilograms	Pounds
1	2.2046	51	112.436
2	4.4092	52	114.640
3	6.6139	53	116.845
4	8.8185	54	119.050
5	11.0231	55	121.254
6	13.2277	56	123.459
7	15.4324	57	125.663
8	17.6370	58	127.868
9	19.8416	59	130.073
10	22.0462	60	132.277
11	24.2508	61	134.482
12	26.4555	62	136.687
13	28.6601	63	138.891
14	30.8647	64	141.096
15	33.0693	65	143.300
16	35.2740	66	145.505
17	37.4786	67	147.710
18	39.6832	68	149.914
19	41.8878	69	152.119
20	44.0924	70	154.324
21	46.2971	71	156.528
22	48.5017	72	158.733
23	50.7063	73	160.937
24	52.9109	74	163.142
25	55.1156	75	165.347
26	57.3202	76	167.551
27	59.5248	77	169.756
28	61.7294	78	171.961
29	63.9340	79	174.165
30	66.1387	80	176.370
31	68.3433	81	178.574
32	70.5479	82	180.745
33	72.7525	83	182.984
34	74.9572	84	185.188
35	77.1618	85	187.393
36	79.3664	86	189.598
37	81.5710	87	191.802
38	83.7756	88	194.007
39	85.9803	89	196.211
40	88.1849	90	198.416
41	90.3900	91	200.621
42	92.5940	92	202.825
43	94.7990	93	205.030
44	97.0030	94	207.234
45	99.2080	95	209.439
46	101.413	96	211.644
47	103.617	97	213.848
48	105.822	98	216.053
49	108.026	99	218.258
50	110.231	100	220.462



HARDNESS CONVERSION TABLE

Relationship Between Brinell Hardness Number
and Tensile Strength for Steel

BHN Indentation Dia. mm	BHN No. 3000-Kg Load 10mm Tungsten Carbide Ball	Rockwell Hardness Number					Tensile Strength (approx.) in 1000 psi
		A-Scale 60-Kg Load Brale Penetrator	B-Scale 100-KG Kiad 1/16 in. Dia. Ball	C-Scale 150-KG Load Brale Penetrator	Vickers Diamond Pyramid Hardness No.		
2.25	745	84.1	—	65.3	840	—	
2.35	682	82.2	—	61.7	737	—	
2.40	653	81.2	—	60.0	697	—	
2.45	627	80.5	—	58.7	667	—	
2.50	601	79.8	—	57.3	640	—	
2.55	578	79.1	—	56.0	615	—	
2.60	555	78.4	—	54.7	591	298	
2.65	534	77.8	—	53.5	569	288	
2.70	514	76.9	—	52.1	547	274	
2.75	495	76.3	—	51.0	528	264	
2.80	477	75.6	—	49.6	508	252	
2.85	461	74.9	—	48.5	491	242	
2.90	444	74.2	—	47.1	472	230	
2.95	429	73.4	—	45.7	455	219	
3.00	415	72.8	—	44.5	440	212	
3.05	401	72.0	—	43.1	425	202	
3.10	388	71.4	—	41.8	410	193	
3.15	375	70.6	—	40.4	396	184	
3.20	363	70.0	—	39.1	383	177	
3.25	352	69.3	(110.0)	37.9	372	171	
3.30	341	68.7	(109.0)	36.6	360	164	
3.35	331	68.1	(108.5)	35.5	350	159	
3.40	321	67.5	(108.0)	34.3	339	154	
3.45	311	66.9	(107.5)	33.1	328	149	
3.50	302	66.3	(107.0)	32.1	319	146	
3.55	293	65.7	(106.0)	30.9	309	141	
3.60	285	65.3	(105.5)	29.9	301	138	

GENERAL AND TECHNICAL INFORMATION



HARDNESS CONVERSION TABLE

Relationship Between Brinell Hardness Number
and Tensile Strength for Steel

BHN Indentation Dia. mm	BHN No. 3000-Kg Load 10mm Tungsten Carbide Ball	Rockwell Hardness Number					Tensile Strength (approx.) in 1000 psi
		A-Scale 60-Kg Load Brale Penetrator	B-Scale 100-KG Kiad 1/16 in. Dia. Ball	C-Scale 150-KG Load Brale Penetrator	Vickers Diamond Pyramid Hardness No.		
3.65	277	64.6	(104.5)	28.8	292	134	
3.70	269	64.1	(104.0)	27.6	284	130	
3.75	262	63.6	(103.0)	26.6	276	127	
3.80	255	63.0	(102.0)	25.4	269	123	
3.85	248	62.5	(101.0)	24.2	261	120	
3.90	241	61.8	101.00	22.8	253	116	
3.95	235	61.4	99.0	21.7	147	114	
4.00	229	60.8	98.2	20.5	241	111	
4.05	223	—	97.3	(18.8)	234	—	
4.10	217	—	96.4	(17.5)	228	105	
4.15	212	—	95.5	(16.0)	222	102	
4.20	207	—	94.6	(15.2)	218	100	
4.25	201	—	93.8	(13.8)	212	98	
4.30	197	—	92.8	(12.7)	207	95	
4.35	192	—	91.9	(11.5)	202	93	
4.40	187	—	90.7	(10.0)	196	90	
4.45	183	—	90.0	(9.0)	192	89	
4.50	179	—	89.0	(8.0)	188	87	
4.55	174	—	87.8	(6.4)	182	85	
4.60	170	—	86.8	(5.4)	178	83	
4.65	167	—	86.0	(4.4)	175	81	
4.70	163	—	85.0	(3.3)	171	79	
4.80	156	—	82.9	(0.9)	163	76	
4.90	149	—	80.8	—	156	73	
5.00	143	—	78.7	—	150	71	
5.10	137	—	76.4	—	143	67	
5.20	131	—	74.0	—	137	65	
5.30	126	—	72.0	—	132	63	

GENERAL AND TECHNICAL INFORMATION



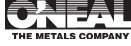
HARDNESS CONVERSION TABLE

Relationship Between Brinell Hardness Number
and Tensile Strength for Steel

BHN Indentation Dia. mm	BHN No. 3000-Kg Load 10mm Tungsten Carbide Ball	Rockwell Hardness Number				
		A-Scale 60-Kg Load Brale Pene- trator	B-Scale 100-KG Kiad 1/16 in. Dia. Ball	C-Scale 150-KG Load Brale Pene- trator	Vickers Diamond Pyramid Hardness No.	Tensile Strength (approx.) in 1000 psi
5.40	121	—	69.8	—	127	60
5.50	116	—	67.6	—	122	58
5.60	111	—	65.7	—	117	56

The values in the foregoing table are taken from Table 2, Approximate Equivalent Hardness Numbers for Brinell Hardness Numbers, for Steel, SAE J417, SAE Handbook, Society of Automotive Engineers, Inc.

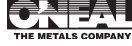
The hardness values shown in parentheses are beyond the normal range of the test scale and are given for information only.



NONRESULPHURIZED CARBON STEELS

CHEMICAL RANGES AND LIMITS

Grade No.	C	Mn	P Max.	S Max.
1005	0.06 max.	0.35 max.	0.040	0.050
1006	0.08 max.	0.25 / 0.40	0.040	0.050
1008	0.10 max.	0.25 / 0.50	0.040	0.050
1010	0.08 / 0.13	0.30 / 0.60	0.040	0.050
1011	0.08 / 0.13	0.60 / 0.90	0.040	0.050
1012	0.10 / 0.15	0.30 / 0.60	0.040	0.050
1015	0.13 / 0.18	0.30 / 0.60	0.040	0.050
1016	0.13 / 0.18	0.60 / 0.90	0.040	0.050
1017	0.15 / 0.20	0.30 / 0.60	0.040	0.050
1018	0.15 / 0.20	0.60 / 0.90	0.040	0.050
1019	0.15 / 0.20	0.70 / 1.00	0.040	0.050
1020	0.18 / 0.23	0.30 / 0.60	0.040	0.050
1021	0.18 / 0.23	0.60 / 0.90	0.040	0.050
1022	0.18 / 0.23	0.70 / 1.00	0.040	0.050
1023	0.20 / 0.25	0.30 / 0.60	0.040	0.050
1025	0.22 / 0.28	0.30 / 0.60	0.040	0.050
1026	0.22 / 0.28	0.60 / 0.90	0.040	0.050
1029	0.25 / 0.31	0.60 / 0.90	0.040	0.050
1030	0.28 / 0.34	0.60 / 0.90	0.040	0.050
1031	0.28 / 0.34	0.30 / 0.60	0.040	0.050
1035	0.32 / 0.38	0.60 / 0.90	0.040	0.050

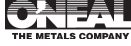


NONRESULPHURIZED CARBON STEELS

CHEMICAL RANGES AND LIMITS

Grade No.	C	Mn	P Max.	S Max.
1037	0.32 / 0.38	0.70 / 1.00	0.040	0.050
1038	0.35 / 0.42	0.60 / 0.90	0.040	0.050
1039	0.37 / 0.44	0.70 / 1.00	0.040	0.050
1040	0.37 / 0.44	0.60 / 0.90	0.040	0.050
1042	0.40 / 0.47	0.60 / 0.90	0.040	0.050
1044	0.43 / 0.50	0.30 / 0.60	0.040	0.050
1045	0.43 / 0.50	0.60 / 0.90	0.040	0.050
1046	0.43 / 0.50	0.70 / 1.00	0.040	0.050
1049	0.46 / 0.53	0.60 / 0.90	0.040	0.050
1050	0.48 / 0.55	0.60 / 0.90	0.040	0.050
1053	0.48 / 0.55	0.70 / 1.00	0.040	0.050
1055	0.50 / 0.60	0.60 / 0.90	0.040	0.050
1060	0.55 / 0.65	0.60 / 0.90	0.040	0.050
1062	0.54 / 0.65	0.85 / 1.15	0.040	0.050
1070	0.65 / 0.75	0.60 / 0.90	0.040	0.050
1078	0.72 / 0.85	0.30 / 0.60	0.040	0.050
1080	0.75 / 0.88	0.60 / 0.90	0.040	0.050
1084	0.80 / 0.93	0.60 / 0.90	0.040	0.050
1085	0.80 / 0.93	0.70 / 1.00	0.040	0.050
1086	0.80 / 0.93	0.30 / 0.50	0.040	0.050
1090	0.85 / 0.98	0.60 / 0.90	0.040	0.050
1095	0.90 / 1.03	0.30 / 0.50	0.040	0.050

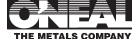
GENERAL AND TECHNICAL INFORMATION



NONRESULPHURIZED CARBON STEELS
MANGANESE MAXIMUM OVER 1.00 PER CENT
CHEMICAL RANGES AND LIMITS

Grade No.	C	Mn	P Max.	S Max.
1513	0.10 / 0.16	1.10 / 1.40	0.040	0.050
1518	0.15 / 0.21	1.10 / 1.40	0.040	0.050
1522	0.18 / 0.24	1.10 / 1.40	0.040	0.050
1524	0.19 / 0.25	1.35 / 1.65	0.040	0.050
1525	0.23 / 0.29	0.80 / 1.10	0.040	0.050
1526	0.22 / 0.29	1.10 / 1.40	0.040	0.050
1527	0.22 / 0.29	1.20 / 1.50	0.040	0.050
1536	0.30 / 0.37	1.20 / 1.50	0.040	0.050
1541	0.36 / 0.44	1.35 / 1.65	0.040	0.050
1547	0.43 / 0.51	1.35 / 1.65	0.040	0.050
1548	0.44 / 0.52	1.10 / 1.40	0.040	0.050
1551	0.45 / 0.56	0.85 / 1.15	0.040	0.050
1552	0.47 / 0.55	1.20 / 1.50	0.040	0.050
1561	0.55 / 0.65	0.75 / 1.05	0.040	0.050
1566	0.60 / 0.71	0.85 / 1.15	0.040	0.050
1572	0.65 / 0.76	1.00 / 1.30	0.040	0.050

GENERAL AND TECHNICAL INFORMATION



RESULPHURIZED CARBON STEELS

CHEMICAL RANGES AND LIMITS

Grade No.	C	Mn	P Max.	S
1108	0.08 / 0.13	0.50 / 0.80	0.040	0.08 / 0.13
1109	0.08 / 0.13	0.60 / 0.90	0.040	0.08 / 0.13
1110	0.08 / 0.13	0.30 / 0.60	0.040	0.08 / 0.13
1117	0.14 / 0.20	1.00 / 1.30	0.040	0.08 / 0.13
1118	0.14 / 0.20	1.30 / 1.60	0.040	0.08 / 0.13
1119	0.14 / 0.20	1.00 / 1.30	0.040	0.24 / 0.33
1126	0.23 / 0.29	0.70 / 1.00	0.040	0.08 / 0.13
1132	0.27 / 0.34	1.35 / 1.65	0.040	0.08 / 0.13
1137	0.32 / 0.39	1.35 / 1.65	0.040	0.08 / 0.13
1138	0.34 / 0.40	1.70 / 1.00	0.040	0.08 / 0.13
1139	0.35 / 0.43	1.35 / 1.65	0.040	0.13 / 0.20
1140	0.37 / 0.44	0.70 / 1.00	0.040	0.08 / 0.13
1141	0.37 / 0.45	1.35 / 1.65	0.040	0.08 / 0.13
1144	0.40 / 0.48	1.35 / 1.65	0.040	0.24 / 0.33
1145	0.42 / 0.49	0.70 / 1.00	0.040	0.04 / 0.07
1146	0.42 / 0.49	0.70 / 1.00	0.040	0.08 / 0.13
1151	0.48 / 0.55	0.70 / 1.00	0.040	0.08 / 0.13

RESULPHURIZED CARBON STEELS

CHEMICAL RANGES AND LIMITS

Grade No.	Ca	Mn	P	S	Pb
1211	0.13 Max.	1.10 / 1.40	1.10 / 1.40	1.10 / 1.40	
1212	0.13 Max.	1.10 / 1.40	1.10 / 1.40	1.10 / 1.40	
1213	0.13 Max.	1.10 / 1.40	1.10 / 1.40	1.10 / 1.40	
12L14	0.15 Max.	1.35 / 1.65	1.35 / 1.65	1.35 / 1.65	1.15 / 0.35
1215	0.09 Max.	0.80 / 1.10	0.80 / 1.10	1.20 / 1.50	



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS - HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elongation in 2 In., %	Reduction In Area %	BHN	Avg. Machinability Rating (C.D. 1212 -100%)
1006	H.R.	43,000	24,000	30	55	86	50
	C.D.	48,000	41,000	20	45	95	
1008	H.R.	44,000	24,500	30	55	86	55
	C.D.	49,000	41,500	20	45	95	
1010	H.R.	47,000	26,000	28	50	95	55
	C.D.	53,000	44,000	20	40	105	
1012	H.R.	48,000	26,500	28	50	95	55
	C.D.	54,000	45,000	19	40	105	
1015	H.R.	50,000	27,500	28	50	101	60
	C.D.	56,000	47,000	18	40	111	
1016	H.R.	55,000	30,000	25	50	111	70
	C.D.	61,000	51,000	18	40	121	
1017	H.R.	53,000	29,000	26	50	105	65
	C.D.	59,000	49,000	18	40	116	
1018	H.R.	58,000	32,000	25	50	116	70
	C.D.	64,000	54,000	15	40	126	
1019	H.R.	59,000	32,500	25	50	116	70
	C.D.	66,000	55,000	15	40	131	
1020	H.R.	55,000	30,000	25	50	111	65
	C.D.	61,000	51,000	15	40	121	
1021	H.R.	61,000	33,000	24	48	116	70
	C.D.	68,000	57,000	15	40	131	
1022	H.R.	62,000	34,000	23	47	121	70
	C.D.	69,000	58,000	15	40	137	

ACD - annealed, cold drawn

NCD - normalized, cold drawn

SACD - spheroidized annealed, cold drawn

The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS – HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elongation in 2 In., %	Reduction In Area %	BHaN	Avg. Machinability Rating (C.D. 1212 -100%)
1023	H.R.	56,000	31,000	25	50	111	65
	C.D.	62,000	52,500	15	40	121	
1524	H.R.	74,000	41,000	20	42	149	60
	C.D.	82,000	69,000	12	35	163	
1025	H.R.	58,000	32,000	25	50	116	65
	C.D.	64,000	54,000	15	40	126	
1026	H.R.	64,000	35,000	24	49	126	75
	C.D.	71,000	60,000	15	40	143	
1527	H.R.	75,000	41,000	18	40	149	65
	C.D.	83,000	70,000	12	35	163	
1030	H.R.	68,000	37,500	20	42	137	70
	C.D.	76,000	64,000	12	35	149	
1035	H.R.	72,000	39,500	18	40	143	65
	C.D.	80,000	67,000	12	35	163	
1536	H.R.	83,000	45,500	16	40	163	55
	C.D.	92,000	77,500	12	35	187	
1037	H.R.	74,000	40,500	18	40	143	65
	C.D.	82,000	69,000	12	35	167	
1038	H.R.	75,000	41,000	18	40	149	65
	C.D.	83,000	70,000	12	35	163	
1039	H.R.	79,000	43,500	16	40	156	60
	C.D.	88,000	74,000	12	35	179	
1040	H.R.	76,000	42,000	18	40	149	60
	C.D.	85,000	71,000	12	35	170	

ACD - annealed, cold drawn

NCD - normalized, cold drawn

SACD - spheroidized annealed, cold drawn

The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30

GENERAL AND TECHNICAL INFORMATION



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS – HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elongation in 2 In., %	Reduction In Area %	BHN	Avg. Machinability Rating (C.D. 1212 -100%)
1541	H.R.	92,000	51,000	15	40	187	
	C.D.	102,500	87,000	10	30	207	45
	ACD	94,000	80,000	10	45	184	60
1042	H.R.	80,000	44,000	16	40	163	
	C.D.	89,000	75,000	12	35	179	60
	NCD	85,000	73,000	12	45	179	70
1043	H.R.	82,000	45,000	16	40	163	
	C.D.	91,000	77,000	12	35	179	60
	NCD	87,000	75,000	12	45	179	70
1044	H.R.	80,000	44,000	16	40	163	
1045	H.R.	82,000	45,000	16	40	163	
	C.D.	91,000	77,000	12	35	179	55
	ACD	85,000	73,000	12	45	170	65
1046	H.R.	85,000	47,000	15	40	170	
	C.D.	94,000	79,000	12	35	187	55
	ACD	90,000	75,000	12	45	179	65
1547	H.R.	94,000	52,000	15	30	192	
	C.D.	103,000	88,000	10	28	207	40
	ACD	95,000	85,000	10	35	187	45
1548	H.R.	96,000	53,000	14	33	197	
	C.D.	106,500	89,500	10	28	217	45
	ACD	93,500	78,500	10	35	192	50
1049	H.R.	87,000	48,000	15	33	179	
	C.D.	97,000	81,500	10	28	197	45
	ACD	92,000	77,000	10	35	187	55
1050	H.R.	90,000	49,500	15	35	179	
	C.D.	100,000	84,000	10	30	197	45
	ACD	95,000	80,000	10	40	189	55

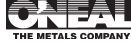
ACD - annealed, cold drawn

NCD - normalized, cold drawn

SACD - spheroidized annealed, cold drawn

The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS – HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elongation in 2 In., %	Reduction In Area %	BHN	Avg. Machinability Rating (C.D. 1212 -100%)
1552	H.R.	108,000	59,500	12	30	217	50
	ACD	98,000	83,000	10	40	193	
1055	H.R.	94,000	51,500	12	30	192	55
	ACD	96,000	81,000	10	40	197	
1060	H.R.	98,000	54,000	12	30	201	60
	SACD	90,000	70,000	10	45	183	
1064	H.R.	97,000	53,500	12	30	201	60
	SACD	89,000	69,000	10	45	183	
1065	H.R.	100,000	55,000	12	30	207	60
	SACD	92,000	71,000	10	45	187	
1070	H.R.	102,000	56,000	12	30	212	55
	SACD	93,000	72,000	10	45	192	
1074	H.R.	105,000	58,000	12	30	217	55
	SACD	94,500	73,000	10	40	192	
1078	H.R.	100,000	55,000	12	30	207	55
	SACD	94,000	72,500	10	40	192	
1080	H.R.	112,000	61,500	10	25	229	45
	SACD	98,000	75,000	10	40	192	
1084	H.R.	119,000	65,500	10	25	241	45
	SACD	100,000	77,000	10	40	192	
1085	H.R.	121,000	66,500	10	25	248	45
	SACD	100,500	78,000	10	40	192	
1086	H.R.	112,000	61,500	10	25	229	45
	SACD	97,000	74,000	10	40	192	

ACD - annealed, cold drawn

NCD - normalized, cold drawn

SACD - spheroidized annealed, cold drawn

The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30

GENERAL AND TECHNICAL INFORMATION



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS – HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elongation in 2 In., %	Reduction In Area %	BHN	Avg. Machinability Rating (C.D. 1212 -100%)
1090	H.R.	122,000	67,000	10	25	248	45
	SACD	101,000	78,000	10	40	197	
1095	H.R.	120,000	66,000	10	25	248	45
	SACD	99,000	76,000	10	40	197	
1211	H.R.	55,000	33,000	25	45	121	95
	C.D.	75,000	58,000	10	35	163	
1212	H.R.	56,000	33,500	25	45	121	100
	C.D.	78,000	60,000	10	35	167	
1213	H.R.	56,000	33,500	25	45	121	135
	C.D.	78,000	60,000	10	35	167	
12L14	H.R.	57,000	34,000	22	45	121	160
	C.D.	78,000	60,000	10	35	163	
1108	H.R.	50,000	27,500	30	50	101	80
	C.D.	56,000	47,000	20	40	121	
1109	H.R.	50,000	27,500	30	50	101	80
	C.D.	56,000	47,000	20	40	121	
1117	H.R.	62,000	34,000	23	47	121	90
	C.D.	69,000	58,000	15	40	137	
1118	H.R.	65,000	36,000	23	47	131	85
	C.D.	2,000	61,000	15	40	143	
1119	H.R.	62,000	34,000	23	47	121	100
	C.D.	69,000	58,000	15	40	137	
1132	H.R.	83,000	45,500	16	40	167	75
	C.D.	92,000	77,000	12	35	183	

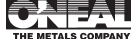
ACD - annealed, cold drawn

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The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30



ESTIMATED MECHANICAL PROPERTIES AND MACHINABILITY OF CARBON STEEL BARS - HOT ROLLED AND COLD DRAWN

ESTIMATED MINIMUM VALUES

Grade	Type of Processing	Tensile psi	Yield psi	Elonga- tion in 2 In., %	Reduc- tion In Area %	BHN	Avg. Machin- ability Rating (C.D. 1212 -100%)
1137	H.R.	88,000	48,000	15	35	179	70
	C.D.	98,000	82,000	10	30	197	
1140	H.R.	79,000	43,500	16	40	156	70
	C.D.	88,000	74,000	12	35	170	
1141	H.R.	94,000	51,500	15	35	187	70
	C.D.	105,100	88,000	10	30	212	
1144	H.R.	97,000	53,000	15	35	197	80
	C.D.	108,000	90,000	10	30	217	
1145	H.R.	85,000	47,000	15	40	170	65
	C.D.	94,000	80,000	12	35	187	
1146	H.R.	85,000	47,000	15	40	170	70
	C.D.	94,000	80,000	12	35	187	
1151	H.R.	92,000	50,500	15	35	187	65
	C.D.	102,000	86,000	10	30	207	

ACD - annealed, cold drawn

NCD - normalized, cold drawn

SACD - spheroidized annealed, cold drawn

The mechanical properties shown are expected minimums for the sizes ranging from 3/4" to 1-1/4".

REF: SAE J414, Handbook Supplement HS30

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

COLD FINISHED BARS

MECHANICAL PROPERTIES

(Average for 1" round)

	TENSILE STRENGTH PSI	YIELD POINT PSI	ELONGATION IN 2" %	REDUCTION OF AREA %	BRINELL HARDNESS	MACHINEABILITY RATING %
1018	64,000	54,000	15	40	126	78
1018 T&P and TG&P	58,000	32,000	25	50	116	55
1045	91,000	77,000	12	35	170	57
1045 T&P and TG&P	82,000	45,000	16	40	163	55
1141	105,000	88,000	10	30	212	70
Stressproof (C-1144)	132,000 (Mean)	100,000	12 (Mean)	34 (Mean)	255/269	83
Fatigue-Proof	140,000* (Min)	120,000 (Mean)	8 (Mean)	26 (Mean)	280 Min*	80
1117	69,000	58,000	15	40	137	91
11L17	69,000	58,000	15	40	137	104
1215	78,000	60,000	10	35	167	136
12L14	78,000	60,000	10	35	167	170

*In the event of disagreement between hardness and tensile strength, the tensile strength shall govern.

COLD FINISHED BARS CHEMISTRY

	CARBON	MANGANESE	PHOSPHORUS	SULPHUR	LEAD	SILICON	CHROMIUM	MOLYBDENUM
1018	.15/.20	.60/.90	.04 max	.05 max				
1045	.43/.50	.60/.90	.04 max	.05 max			Nitrogen .006/.009	
1141	.37/.45	1.35/1.65	.04 max	.08/.13		.15/.30	Nitrogen .006/.009	
Stressproof (1144)	.40/.48	1.35/1.65	.04 max	.24/.33		.15/.30	Nitrogen .006/.009	
Fatigue-proof	.40/.48	1.35/1.65	.04 max	.24/.33		.15/.30		
1117	.14/.20	1.00/1.30	.04 max	.08/.13				
11L17	.14/.20	1.00/1.30	.04 max	.08/.13	.15/.35			
1215	.09max	.75/1.05	.04/09	.26/.35				
12L14	.15 max	.85/1.15	.04/09	.26/.35	.15/.25	.20/.35	.80/1.10	

GENERAL AND TECHNICAL INFORMATION

ALLOY STEELS

Typical Chemical Ranges and Limits

Grade	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo
1330	0.28/0.33	1.60/1.90	0.035	0.040	0.20/0.35	—	—	—
1335	0.33/0.38	1.60/1.90	0.035	0.040	0.20/0.35	—	—	—
1340	0.38/0.43	1.60/1.90	0.035	0.040	0.20/0.35	—	—	—
1345	0.43/0.48	1.60/1.90	0.035	0.040	0.20/0.35	—	—	—
4012	0.09/0.14	0.75/1.00	0.035	0.040	0.20/0.35	—	—	0.15/0.25
4023	0.20/0.25	0.70/0.90	0.035	0.040	0.20/0.35	—	—	0.20/0.30
4024	0.20/0.25	0.70/0.90	0.035	0.035/0.050	0.20/0.35	—	—	0.20/0.30
4027	0.25/0.30	0.70/0.90	0.035	0.040	0.20/0.35	—	—	0.20/0.30
4028	0.25/0.30	0.70/0.90	0.035	0.035/0.050	0.20/0.35	—	—	0.20/0.30
4037	0.35/0.40	0.70/0.90	0.035	0.040	0.20/0.35	—	—	0.20/0.30
4047	0.45/0.50	0.70/0.90	0.035	0.040	0.20/0.35	—	—	0.20/0.30
4118	0.18/0.23	0.70/0.90	0.035	0.040	0.20/0.35	—	0.40/0.60	0.08/0.15
4130	0.28/0.33	0.40/0.60	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4137	0.35/0.40	0.70/0.90	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4140	0.38/0.43	0.75/1.00	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4140/42	0.38/0.45	0.75/1.00	0.035	0.035	0.15/0.35	—	0.80/1.10	0.15/0.25

ALLOY STEELS

Typical Chemical Ranges and Limits

Grade	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo
ETD150	0.40 min.	0.70/1.10	0.035	0.060	0.20/0.35	—	0.80/1.20	0.15/0.25
4142	0.40/0.45	0.75/1.00	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4145	0.43/0.48	0.75/1.00	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4147	0.45/0.50	0.75/1.00	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4150	0.48/0.53	0.75/1.00	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15/0.25
4150 MOD. (NEALOY)	0.45/0.54	0.70/1.00	0.040	0.06/0.10	0.20/0.35	—	0.80/1.15	0.15/0.25
4161	0.56/0.64	0.75/1.00	0.035	0.040	0.20/0.35	—	0.70/0.90	0.25/0.35
4320	0.17/0.22	0.45/0.65	0.035	0.040	0.20/0.35	1.65/2.00	0.40/0.60	0.20/0.30
4340	0.38/0.43	0.60/0.80	0.035	0.040	0.15/0.35	1.65/2.00	0.70/0.90	0.20/0.30
E4340	0.38/0.43	0.65/0.85	0.025	0.025	0.20/0.35	1.65/2.00	0.70/0.90	0.20/0.30
4419	0.18/0.23	0.45/0.65	0.035	0.040	0.20/0.35	—	—	0.45/0.60
4615	0.13/0.18	0.45/0.65	0.035	0.040	0.20/0.35	1.65/2.00	—	0.20/0.30
4620	0.17/0.22	0.45/0.65	0.035	0.040	0.20/0.35	1.65/2.00	—	0.20/0.30
4621	0.18/0.23	0.70/0.90	0.035	0.040	0.20/0.35	1.65/2.00	—	0.20/0.30
4626	0.24/0.29	0.45/0.65	0.035	0.040	0.20/0.35	0.70/1.00	—	0.15/0.25
4718	0.16/0.21	0.70/0.90	0.035	0.040	0.20/0.35	0.90/1.20	0.35/0.55	0.30/0.40
4720	0.17/0.22	0.50/0.70	0.035	0.040	0.20/0.35	0.90/1.20	0.35/0.55	0.15/0.25

4 GENERAL AND TECHNICAL INFORMATION

6 ALLOY STEELS

Typical Chemical Ranges and Limits

Grade	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo
4815	0.13/0.18	0.40/0.60	0.035	0.040	0.20/0.35	3.25/3.75	—	0.20/0.30
4817	0.15/0.20	0.40/0.60	0.035	0.040	0.20/0.35	3.25/3.75	—	0.20/0.30
4820	0.18/0.23	0.50/0.70	0.035	0.040	0.20/0.35	3.25/3.75	—	0.20/0.30
5015	0.12/0.17	0.30/0.50	0.035	0.040	0.20/0.35	—	0.30/0.50	—
5120	0.17/0.22	0.70/0.90	0.035	0.040	0.20/0.35	—	0.70/0.90	—
5130	0.28/0.33	0.70/0.90	0.035	0.040	0.20/0.35	—	0.80/1.10	—
5132	0.30/0.35	0.60/0.80	0.035	0.040	0.20/0.35	—	0.75/1.00	—
5135	0.33/0.38	0.60/0.80	0.035	0.040	0.20/0.35	—	0.80/1.05	—
5140	0.38/0.43	0.70/0.90	0.035	0.040	0.20/0.35	—	0.70/0.90	—
5145	0.43/0.48	0.70/0.90	0.035	0.040	0.20/0.35	—	0.70/0.90	—
5147	0.46/0.51	0.70/0.95	0.035	0.040	0.20/0.35	—	0.85/1.15	—
5150	0.48/0.53	0.70/0.90	0.035	0.040	0.20/0.35	—	0.70/0.90	—
5155	0.51/0.59	0.70/0.90	0.035	0.040	0.20/0.35	—	0.70/0.90	—
5160	0.56/0.64	0.75/1.00	0.035	0.040	0.20/0.35	—	0.70/0.90	—
E51100	0.98/1.10	0.25/0.45	0.025	0.025	0.20/0.35	—	0.90/1.15	—
E52100	0.98/1.10	0.25/0.45	0.025	0.025	0.20/0.35	—	1.30/1.60	—



ALLOY STEELS

Typical Chemical Ranges and Limits

Grade	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo
6118	0.16/0.21	0.50/0.70	0.035	0.040	0.20/0.35	—	0.50/0.70	0.10/0.15
6150	0.48/0.53	0.70/0.90	0.035	0.040	0.20/0.35	—	0.80/1.10	0.15 min.
8615	0.13/0.18	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8617	0.15/0.20	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8620	0.18/0.23	0.70/0.90	0.035	0.040	0.15/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8622	0.20/0.25	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8625	0.23/0.28	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8627	0.25/0.30	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8630	0.28/0.33	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8637	0.35/0.40	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8640	0.38/0.43	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8642	0.40/0.45	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8645	0.43/0.48	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8655	0.51/0.59	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25
8720	0.18/0.23	0.70/0.90	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30
8740	0.38/0.43	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30

GENERAL AND TECHNICAL INFORMATION

ALLOY STEELS

Typical Chemical Ranges and Limits

Grade	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo
8822	0.20/0.25	0.75/1.00	0.035	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.30/0.40
9254	0.51/0.59	0.60/0.80	0.035	0.040	1.20/1.60	—	0.60/0.80	—
9255	0.51/0.59	0.70/0.95	0.035	0.040	1.80/2.20	—	—	—
9260	0.56/0.64	0.75/1.00	0.035	0.040	1.80/2.20	—	—	—

HOT ROLLED SHEET GRADES - CARBON / SS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1011 CS Type A	ASTM A1011 CS Type B	ASTM A1011 CS Type C	ASTM A1011 CS Type D	ASTM A1011 DS Type A	ASTM A1011 DS Type B	ASTM A1011 SS GR 30	ASTM A1011 SS GR 33	ASTM A1011 SS GR 36 Ty 1	ASTM A1011 SS GR 36 Ty 2
Yield Point KSI										
Tensile Strength KSI										
% Elongation 2"										
Carbon	0.10 max	0.02 - 0.15	0.08 max	0.10 max	0.08 max	0.02 - 0.08	0.25 max	0.25 max	0.25 max	0.25 max
Manganese	0.60 max	0.60 max	0.60 max	0.70 max	0.50 max	0.50 max	0.90 max	0.90 max	0.90 max	1.35 max
Phosphorus	0.030 max	0.030 max	0.10 max	0.030 max	0.020 max	0.020 max	0.035 max	0.035 max	0.035 max	0.035 max
Sulfur	0.035 max	0.035 max	0.035 max	0.035 max	0.030 max	0.030 max	0.04 max	0.04 max	0.04 max	0.04 max
Aluminum					0.01 min	0.01 min				
Silicon										
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Nickel	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Chromium	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Molybdenum	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Columbium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Titanium	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max

GENERAL AND TECHNICAL INFORMATION

4 GENERAL AND TECHNICAL INFORMATION

HOT ROLLED SHEET GRADES - SS / HSLAS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A 1011 SS GR 40	ASTM A 1011 SS GR 45	ASTM A 1011 SS GR 50	ASTM A 1011 SS GR 55	ASTM A 1011 SS GR 60	ASTM A 1011 SS GR 70	ASTM A 1011 SS GR 80	ASTM A 1011 HSLAS GR 45 CL 1	ASTM A 1011 HSLAS GR 45 CL 2	ASTM A 1011 HSLAS GR 50 CL 1
Yield Point KSI	40 min	45 min	50 min	55 min	60 min	70 min	80 min	45 min	45 min	50 min
Tensile Strength KSI	55 min	60 min	65 min	70 min	75 min	85 min	95 min	60 min	55 min	65 min
% Elongation 2"	21 min	19 min	17 min	15 min	14 min	13 min	12 min	25 min	25 min	22 min
Carbon	0.25 max	0.25 max	0.25 max	0.25 max	0.25 max	0.25 max	0.25 max	0.22 max	0.15 max	0.23 max
Manganese	0.90 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max
Phosphorus	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.04 max	0.04 max	0.04 max
Sulfur	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max
Aluminum										
Silicon	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Nickel	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Chromium	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Molybdenum	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.005 min	0.005 min	0.005 min
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.005 min	0.005 min	0.005 min
Columbium	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.005 min	0.005 min	0.005 min
Titanium								0.005 min	0.005 min	0.005 min

HOT ROLLED SHEET GRADES - HSLAS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1011 HSLAS GR 50 CL 2	ASTM A1011 HSLAS GR 55 CL 1	ASTM A1011 HSLAS GR 55 CL 2	ASTM A1011 HSLAS GR 60 CL 1	ASTM A1011 HSLAS GR 60 CL 2	ASTM A1011 HSLAS GR 65 CL 1	ASTM A1011 HSLAS GR 65 CL 2	ASTM A1011 HSLAS GR 70 CL 1	ASTM A1011 HSLAS GR 70 CL 2	ASTM A606 TYPE 4
Yield Point KSI	50 min 60 min 22 min	55 min 70 min 20 min	55 min 65 min 20 min	60 min 75 min 18 min	60 min 70 min 18 min	65 min 80 min 16 min	65 min 75 min 16 min	70 min 85 min 14 min	70 min 80 min 14 min	50 min 70 min 22 min
Tensile Strength KSI	0.15 max 1.35 max 0.04 max 0.04 max	0.25 max 1.35 max 0.04 max 0.04 max	0.15 max 1.35 max 0.04 max 0.04 max	0.26 max 1.50 max 0.04 max 0.04 max	0.15 max 1.50 max 0.04 max 0.04 max	0.26 max 1.50 max 0.04 max 0.04 max	0.26 max 1.50 max 0.04 max 0.04 max	0.26 max 1.65 max 0.04 max 0.04 max	0.15 max 1.65 max 0.04 max 0.04 max	0.22 max 1.25 max 0.050 max
% Elongation 2"										
Carbon										
Manganese										
Phosphorus										
Sulfur										
Aluminum										
Silicon										
Copper										
Nickel										
Chromium										
Molybdenum										
Vanadium										
Columbium										
Titanium										

GENERAL AND TECHNICAL INFORMATION

HOT ROLLED SHEET GRADES - HSLAS-F / PRESSURE VESSEL QUALITY

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1011 HSLAS-F GR 50	ASTM A1011 HSLAS-F GR 60	ASTM A1011 HSLAS-F GR 70	ASTM A1011 HSLAS-F GR 80	ASTM A414 PVQ GR A	ASTM A414 PVQ GR B	ASTM A414 PVQ GR C	ASTM A414 PVQ GR D	ASTM A414 PVQ GR E	ASTM A414 PVQ GR F	ASTM A414 PVQ GR G
Yield Point KSI	50 min	60 min	70 min	80 min	25 min	30 min	33 min	35 min	38 min	42 min	45 min
Tensile Strength KSI	60 min	70 min	80 min	90 min	45-60	50-65	55-70	60-75	65-85	70-90	75-95
% Elongation 2"	24 min	22 min	20 min	18 min	23 min	21 min	19 min	17 min	15 min	13 min	13 min
Carbon	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.22 max	0.25 max	0.25 max	0.27 max	0.31 max	0.31 max
Manganese	1.65 max	1.65 max	1.65 max	1.65 max	0.90 max	0.90 max	0.90 max	1.20 max	1.20 max	1.20 max	1.35 max
Phosphorus	0.020 max	0.020 max	0.020 max	0.020 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max
Sulfur	0.025 max	0.025 max	0.025 max	0.025 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max
Aluminum											
Silicon											
Copper	0.20 max	0.20 max	0.20 max	0.20 max							
Nickel	0.20 max	0.20 max	0.20 max	0.20 max							
Chromium	0.15 max	0.15 max	0.15 max	0.15 max							
Molybdenum	0.06 max	0.06 max	0.06 max	0.06 max							
Vanadium	0.005 min	0.005 min	0.005 min	0.005 min							
Columbium	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min
Titanium	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min

COLD ROLLED SHEET GRADES - CARBON / SS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A794 CS Hi Carbon	ASTM A1008 CS Type A	ASTM A1008 CS Type B	ASTM A1008 CS Type C	ASTM A1008 DS Type A	ASTM A1008 DS Type B	ASTM A1008 DDS	ASTM A1008 EDDS	ASTM A1008 SS GR 25	ASTM A1008 SS GR 30	ASTM A1008 SS GR 33 Ty 1
Yield Point KSI	50 min								25 min	30 min	33 min
Tensile Strength KSI	60 min								42 min	45 min	48 min
% Elongation 2"	24 min								26 min	24 min	22 min
Carbon	0.30-0.90	0.10 max	0.02 - 0.15	0.08 max	0.08 max	0.02 - 0.08	0.06 max	0.02 max	0.20 max	0.20 max	0.20 max
Manganese		0.60 max	0.60 max	0.60 max	0.50 max	0.50 max	0.50 max	0.40 max	0.60 max	0.60 max	0.60 max
Phosphorus	0.04 max	0.030 max	0.030 max	0.10 max	0.020 max	0.020 max	0.020 max	0.020 max	0.035 max	0.035 max	0.035 max
Sulfur	0.04 max	0.035 max	0.035 max	0.035 max	0.030 max	0.030 max	0.025 max	0.025 max	0.035 max	0.035 max	0.035 max
Aluminum					0.01 min	0.02 min	0.01 min	0.01 min			
Silicon											
Copper		0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.10 max	0.20 max	0.20 max	0.20 max
Nickel		0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.10 max	0.20 max	0.20 max	0.20 max
Chromium		0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Molybdenum		0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.03 max	0.06 max	0.06 max	0.06 max
Vanadium		0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.008 max	0.008 max	0.008 max
Columbium		0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.008 max	0.008 max	0.008 max
Titanium		0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.15 max	0.025 max	0.025 max	0.025 max

GENERAL AND TECHNICAL INFORMATION

COLD ROLLED SHEET GRADES - SS / HSLAS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1008 SS GR 33 Ty 2	ASTM A1008 SS GR 40 Ty 1	ASTM A1008 SS GR 40 Ty 2	ASTM A1008 SS GR 50	ASTM A1008 SS GR 60	ASTM A1008 SS GR 70	ASTM A1008 SS GR 80	ASTM A1008 HSLAS GR 45 CL 1	ASTM A1008 HSLAS GR 45 CL 2	ASTM A1008 HSLAS GR 50 CL 1
Yield Point KSI	33 min	40 min	40 min	50 min	60 min	70 min	80 min	45 min	45 min	50 min
Tensile Strength KSI	48 min	52 min	52 min	65 min	75 min	85 min	82 min	60 min	55 min	65 min
% Elongation 2"	22 min	20 min	20 min	18 min	12 min	6 min	None	25 min	25 min	22 min
Carbon	0.15 max	0.20 max	0.15 max	0.20 max	0.20 max	0.20 max	0.20 max	0.22 max	0.15 max	0.23 max
Manganese	0.60 max	0.90 max	0.60 max	0.70 max	0.70 max	0.70 max	0.60 max	1.65 max	1.65 max	1.65 max
Phosphorus	0.02 max	0.035 max	0.02 max	0.035 max	0.035 max	0.035 max	0.035 max	0.04 max	0.04 max	0.04 max
Sulfur	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max
Aluminum										
Silicon	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Nickel	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Chromium	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Molybdenum	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.005 min	0.005 min	0.005 min
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.005 min	0.005 min	0.005 min
Columbium	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.005 min	0.005 min	0.005 min
Titanium								0.005 min	0.005 min	0.005 min

COLD ROLLED SHEET GRADES - HSLAS

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1008 HSLAS GR 50 CL 2	ASTM A1008 HSLAS GR 55 CL 1	ASTM A1008 HSLAS GR 55 CL 2	ASTM A1008 HSLAS GR 60 CL 1	ASTM A1008 HSLAS GR 60 CL 2	ASTM A1008 HSLAS GR 65 CL 1	ASTM A1008 HSLAS GR 65 CL 2	ASTM A1008 HSLAS GR 70 CL 1	ASTM A1008 HSLAS GR 70 CL 2	ASTM A606 TYPE 4
Yield Point KSI	50 min 60 min 20 min	55 min 70 min 18 min	55 min 65 min 18 min	60 min 75 min 16 min	60 min 70 min 16 min	65 min 80 min 15 min	65 min 75 min 15 min	70 min 85 min 14 min	70 min 80 min 14 min	50 min 70 min 22 min
Tensile Strength KSI	0.15 max 1.65 max 0.04 max	0.25 max 1.65 max 0.04 max	0.15 max 1.65 max 0.04 max	0.26 max 1.65 max 0.04 max	0.15 max 1.65 max 0.04 max	0.26 max 1.65 max 0.04 max	0.15 max 1.65 max 0.04 max	0.26 max 1.65 max 0.04 max	0.15 max 1.65 max 0.04 max	0.22 max 1.25 max 0.050 max
% Elongation 2"										
Carbon										
Manganese										
Phosphorus										
Sulfur										
Aluminum										
Silicon										
Copper	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	0.20 max 0.20 max	
Nickel	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	0.15 max 0.06 max	
Chromium	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	0.06 max 0.005 min	
Molybdenum	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	0.005 min 0.005 min	
Vanadium										
Columbium										
Titanium										

GENERAL AND TECHNICAL INFORMATION

COLD ROLLED SHEET GRADES - HSLAS-F

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1008 HSLAS-F GR 50	ASTM A1008 HSLAS-F GR 60	ASTM A1008 HSLAS-F GR 70	ASTM A1008 HSLAS-F GR 80	ASTM A1008 HSLAS-F SHS-GR 26	ASTM A1008 HSLAS-F SHS GR 31	ASTM A1008 HSLAS-F SHS GR 35	ASTM A1008 HSLAS-F SHS GR 41	ASTM A1008 HSLAS-F SHS GR 44
Yield Point KSI	50 min 60 min 22 min	60 min 70 min 18 min	70 min 80 min 16 min	80 min 90 min 14 min	26 min 43 min 32 min	31 min 46 min 30 min	35 min 50 min 26 min	41 min 53 min 24 min	44 min 57 min 22 min
Tensile Strength KSI	0.15 max 1.65 max	0.15 max 1.65 max	0.15 max 1.65 max	0.15 max 1.65 max	0.12 max 1.50 max	0.12 max 1.50 max	0.12 max 1.50 max	0.12 max 1.50 max	0.12 max 1.50 max
% Elongation 2"	0.020 max 0.025 max	0.020 max 0.025 max	0.020 max 0.025 max	0.020 max 0.025 max	0.12 max 0.03 max	0.12 max 0.03 max	0.12 max 0.03 max	0.12 max 0.03 max	0.12 max 0.03 max
Carbon	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Manganese	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Phosphorus	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Sulfur	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Aluminum	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Silicon	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Copper	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Nickel	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Chromium	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Molybdenum	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Vanadium	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Columbium	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Titanium	0.005 min	0.005 min	0.005 min	0.005 min	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max

COLD ROLLED SHEET GRADES - HSLAS-F

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A1008 HSLAS-F BHS GR 26	ASTM A1008 HSLAS-F BHS GR 31	ASTM A1008 HSLAS-F BHS GR 35	ASTM A1008 HSLAS-F BHS GR 41	ASTM A1008 HSLAS-F BHS GR 44
Yield Point KSI	26 min 43 min 30 min	31 min 46 min 28 min	35 min 50 min 24 min	41 min 53 min 22 min	44 min 57 min 20 min
Tensile Strength KSI	0.12 max 1.50 max 0.12 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.12 max 0.030 max
% Elongation 2"					
Carbon					
Manganese					
Phosphorus					
Sulfur					
Aluminum					
Silicon					
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Nickel	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Chromium	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Molybdenum	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Columbium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Titanium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

COATED SHEET GRADES

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A653 CS Type A	ASTM A653 CS Type B	ASTM A653 CS Type C	ASTM A653 FS Type A	ASTM A653 FS Type B	ASTM A653 DDS Type A	ASTM A653 DDS Type C	ASTM A653 EDDS	ASTM A653 SS GR 33	ASTM A653 SS GR 37	ASTM A653 SS GR 40
Yield Point KSI									33 min 45 min 20 min	37 min 52 min 18 min	40 min 55 min 16 min
Tensile Strength KSI									0.20 max 0.20 max 0.20 max	0.20 max 0.20 max 0.20 max	0.25 max 1.35 max 0.10 max
% Elongation 2"									0.04 max 0.04 max 0.04 max	0.10 max 0.10 max 0.04 max	0.25 max 1.35 max 0.10 max
Carbon	0.10 max	0.02 - 0.15	0.08 max	0.10 max	0.02-0.10	0.06 max	0.02 max	0.02 max	0.20 max	0.20 max	0.25 max
Manganese	0.60 max	0.60 max	0.60 max	0.50 max	0.50 max	0.50 max	0.50 max	0.40 max	1.35 max	1.35 max	1.35 max
Phosphorus	0.030 max	0.030 max	0.10 max	0.020 max	0.020 max	0.020 max	0.020-0.10	0.020 max	0.04 max	0.10 max	0.10 max
Sulfur	0.035 max	0.035 max	0.035 max	0.035 max	0.030 max	0.025 max	0.025 max	0.020 max	0.04 max	0.04 max	0.04 max
Aluminum						0.01 min	0.01 min	0.01 min			
Silicon											
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.10 max	0.10 max	0.20 max	0.20 max	0.20 max
Nickel	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.10 max	0.10 max	0.20 max	0.20 max	0.20 max
Chromium	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Molybdenum	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.10 max	0.008 max	0.008 max	0.008 max
Columbium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.10 max	0.008 max	0.008 max	0.008 max
Titanium	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.15 max	0.15 max	0.025 max	0.025 max	0.025 max

COATED SHEET GRADES

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A653 SS GR 50 CL 1	ASTM A653 SS GR 50 CL 2	ASTM A653 SS GR 50 CL 3	ASTM A653 SS GR 50 CL 4	ASTM A653 SS GR 80 CL 1	ASTM A653 SS GR 80 CL 2	ASTM A653 HSLAS GR 40	ASTM A653 HSLAS GR 50	ASTM A653 HSLAS GR 60	ASTM A653 HSLAS GR 70	ASTM A653 HSLAS GR 80
Yield Point KSI	50 min	50 min	50 min	50 min	80 min	80 min	40 min	50 min	60 min	70 min	80 min
Tensile Strength KSI	65 min	70 min	70 min	60 min	82 min	82 min	50 min	60 min	70 min	80 min	90 min
% Elongation 2"	12 min	12 min	12 min	12 min	None	None	22 max	20 max	16 max	12 max	10 max
Carbon	0.25 max	0.25 max	0.25 max	0.25 max	0.20 max	0.02 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Manganese	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.35 max	1.20 max	1.20 max	1.35 max	1.65 max	1.65 max
Phosphorus	0.20 max	0.20 max	0.04 max	0.20 max	0.04 max	0.05 max	0.035 max	1.20 max	1.35 max	1.65 max	1.65 max
Sulfur	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.02 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max
Aluminum											
Silicon	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max					
Copper	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max					
Nickel	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max	0.20 max	0.20 max	0.20 max	0.20 max	0.20 max
Chromium	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max	0.15 max	0.15 max	0.15 max	0.15 max	0.15 max
Molybdenum	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.16 max	0.16 max	0.16 max	0.16 max	0.16 max
Vanadium	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.10 max	0.01 min	0.01 min	0.01 min	0.01 min	0.01 min
Columbium	0.008 max	0.008 max	0.008 max	0.008 max	0.015 max	0.10 max	0.005 min	0.005 min	0.005 min	0.005 min	0.005 min
Titanium	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.15 max	0.01 min	0.01 min	0.01 min	0.01 min	0.01 min

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

COATED SHEET GRADES

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A653 HSLAS-F GR 40	ASTM A653 HSLAS-F GR 50	ASTM A653 HSLAS-F GR 60	ASTM A653 HSLAS-F GR 70	ASTM A653 HSLAS-F GR 80	ASTM A653 HSLAS-F SHS GR 26	ASTM A653 HSLAS-F SHS GR 31	ASTM A653 HSLAS-F SHS GR 35	ASTM A653 HSLAS-F SHS GR 41	ASTM A653 HSLAS-F SHS GR 44
Yield Point KSI	40 min 50 min 24 min	50 min 60 min 22 min	60 min 70 min 18 min	70 min 80 min 14 min	80 min 90 min 12 min	26 min 43 min 32 min	31 min 46 min 30 min	35 min 50 min 26 min	41 min 53 min 24 min	44 min 57 min 22 min
Tensile Strength KSI										
% Elongation 2"										
Carbon	0.15 max 1.20 max	0.15 max 1.20 max	0.15 max 1.20 max	0.15 max 1.65 max	0.15 max 1.65 max	0.12 max 1.50 max 0.12 max	0.12 max 1.50 max 0.12 max	0.12 max 1.50 max 0.12 max	0.12 max 1.50 max 0.12 max	0.12 max 1.50 max 0.12 max
Manganese										
Phosphorus										
Sulfur	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.030 max	0.030 max	0.030 max	0.030 max	0.030 max
Aluminum										
Silicon										
Copper										
Nickel	0.20 max 0.15 max	0.20 max 0.15 max	0.20 max 0.15 max	0.20 max 0.15 max	0.20 max 0.15 max	0.20 max 0.20 max 0.15 max	0.20 max 0.20 max 0.15 max	0.20 max 0.20 max 0.15 max	0.20 max 0.20 max 0.15 max	0.20 max 0.20 max 0.15 max
Chromium										
Molybdenum	0.16 max 0.01 min	0.16 max 0.01 min	0.16 max 0.01 min	0.16 max 0.01 min	0.16 max 0.01 min	0.06 max 0.008 max	0.06 max 0.008 max	0.06 max 0.008 max	0.06 max 0.008 max	0.06 max 0.008 max
Vanadium	0.005 min 0.01 min	0.005 min 0.01 min	0.005 min 0.01 min	0.005 min 0.01 min	0.005 min 0.01 min	0.008 max 0.008 max	0.008 max 0.008 max	0.008 max 0.008 max	0.008 max 0.008 max	0.008 max 0.008 max
Columbium										
Titanium	0.01 min	0.01 min	0.01 min	0.01 min	0.01 min	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max

COATED SHEET GRADES

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A653 HSLAS-F BHS GR 26	ASTM A653 HSLAS-F BHS GR 31	ASTM A653 HSLAS-F BHS GR 35	ASTM A653 HSLAS-F BHS GR 41	ASTM A653 HSLAS-F BHS GR 44	ASTM A653 Coating Zinc	ASTM A653 Coating Zn - Fe
Yield Point KSI	26 min 43 min 30 min	31 min 46 min 28 min	35 min 50 min 24 min	41 min 53 min 22 min	44 min 57 min 20 min	G360 G300 G235 G210 G185 G165 G140 G115 G100 G90 G60 G40 G30 G01	A60 A40 A25 A01
Tensile Strength KSI	0.12 max 1.50 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.030 max	0.12 max 1.50 max 0.12 max 0.030 max		
% Elongation 2"	0.20 max 0.20 max 0.15 max 0.06 max 0.008 max 0.008 max 0.025 max	0.20 max 0.20 max 0.15 max 0.06 max 0.008 max 0.008 max 0.025 max	0.20 max 0.20 max 0.15 max 0.06 max 0.008 max 0.008 max 0.025 max	0.20 max 0.20 max 0.15 max 0.06 max 0.008 max 0.008 max 0.025 max	0.20 max 0.20 max 0.15 max 0.06 max 0.008 max 0.008 max 0.025 max		
Carbon							
Manganese							
Phosphorus							
Sulfur							
Aluminum							
Silicon							
Copper							
Nickel							
Chromium							
Molybdenum							
Vanadium							
Columbium							
Titanium							

GENERAL AND TECHNICAL INFORMATION

HOT ROLLED PLATE – CARBON STRUCTURAL QUALITY

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A-36	ASTM A131 Grade B	ASTM A283 Grade A	ASTM A283 Grade B	ASTM A283 Grade C	ASTM A283 Grade D	ASTM A573 Grade 58	ASTM A573 Grade 65	ASTM A573 Grade 70
Yield Point ksi	36 min	34 min	24 min	27 min	30 min	33 min	32 min	35 min	42 min
Tensile Strength ksi	58-80	58-71	45-60	50-65	55-70	60-75	58-71	65-77	70-90
% Elong. 2"	23	24	30	28	25	23	24	32	21
Bend									
Carbon	0.27 max	0.21	0.14	0.17	0.24	0.27	0.23	0.24-0.26	0.27-0.28
Manganese	1.20 max	0.80-1.10	0.90	0.90	0.90	0.90	0.60-0.90	0.85-1.20	0.85-1.20
Phosphorus	0.04 max	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Sulfur	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Silicon	0.15-0.40	0.35 max	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40	0.10-0.35	0.15-0.40	0.15-0.40
Copper	0.20		0.20	0.20	0.20	0.20			
Nickel									
Chromium									
Columbium									
Vanadium									
Aluminum									
Molybdenum									

HOT ROLLED PLATE – HSLA STRUCTURAL QUALITY

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A572 Grade 42	ASTM A572 Grade 50	ASTM A572 Grade 60	ASTM A572 Grade 65	ASTM A588 Grade A	ASTM A656 Grade 50	ASTM A656 Grade 60	ASTM A656 Grade 70	ASTM A656 Grade 80
Yield Point ksi	42 min 60 min	50 min 65 min	60 min 75 min	65 min 80 min	50 min 70 min	50 min 60 min	60 min 70 min	70 min 80 min	80 min
Tensile Strength ksi	24	21	18	17	21	23	20	17	15
% Elong. 2"									
Bend									
Carbon	0.21 max	0.23 max	0.26 max	0.23 max	0.19 max	0.18 max	0.18 max	0.18 max	0.18 max
Manganese	1.35 max	1.35 max	1.35 max	1.65 max	0.80-1.25	1.65 max	1.65 max	1.65 max	1.65 max
Phosphorus	0.04 max	0.04 max	0.04 max	0.04 max	0.04 max	0.025 max	0.025 max	0.025 max	0.025 max
Sulfur	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max	0.035 max	0.035 max	0.035 max	0.035 max
Silicon					0.30-0.65	0.60	0.60	0.60	0.60
Copper					0.25-0.40				
Nickel					0.40 max				
Chromium					0.40-0.65				
Columbium						0.005-0.15	0.005-0.15	0.005-0.15	0.005-0.15
Vanadium						0.08 max	0.08 max	0.08 max	0.08 max
Aluminum									
Molybdenum									

GENERAL AND TECHNICAL INFORMATION

HOT ROLLED PLATE – CARBON PRESSURE VESSEL QUALITY

Typical Mechanical Properties and Chemical Ranges and Limits

	ASTM A285 Grade A	ASTM A285 Grade B	ASTM A285 Grade C	ASTM A516 Grade 55	ASTM A516 Grade 60	ASTM A516 Grade 65	ASTM A516 Grade 70
Yield Point ksi	24 min 45-65	27 min 50-70	30 min 55-75	30 min 55-75	32 min 60-80	35 min 65-85	38 min 70-90
Tensile Strength ksi	30	28	27	27	25	23	21
% Elong. 2"							
Bend							
Carbon	0.17 max	0.22 max	0.28	0.26 max	0.27 max	0.29 max	0.31 max
Manganese	0.90-0.98	0.90-0.98	0.90-0.98	0.60-1.20	0.85-1.20	0.85-1.20	0.85-1.20
Phosphorus	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max
Sulfur	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max	0.035 max
Silicon				0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40
Copper							
Nickel							
Chromium							
Columbium							
Vanadium							
Aluminum							
Molybdenum							

PLATE

Typical Mechanical Properties and Chemical Ranges and Limits

Grade or Type	Condition of Steel	Tensile Strength PSI	Yield Strength PSI	Elongation in 2" (%)	Approx. Brinell Hardness
Alloy-Structural Quality ASTM A514 B ASTM A514 H ASTM A514 F ASTM A514 Q	Quench and Tempered	110,000 / 130,000	100,000 min.	16	235 / 293
	Quench and Tempered	110,000 / 130,000	100,000 min.	16	235 / 293
	Quench and Tempered	110,000 / 130,000	100,000 min.	16	235 / 293
	Quench and Tempered	100,000 / 130,000	90,000 min.	14	235 / 293
High Strength-Low Alloy ASTM A588 A / Cor-Ten B	As Rolled	70,000 min.	50,000 min.	19	143
	As Rolled				200 / 250
Abrasion Resisting – Carbon AR 225	Quench and Tempered				321 min.

6

GENERAL AND TECHNICAL INFORMATION

PLATE

Typical Mechanical Properties and Chemical Ranges and Limits

Grade or Type	Condition of Steel	Tensile Strength PSI	Yield Strength PSI	Elongation in 2" (%)	Approx. Brinell Hardness
Abrasion Resisting – Alloy – con't T-1, Type B / A514 H (Chemistry) 321 Min. BHN T-1 / A514 F (Chemistry) 321 Min. BHN T-1, Type C / A514 Q (Chemistry) 321 Min. BHN S.T.A.R. 360 Min. BHN	Quench and Tempered				321 min.
	Quench and Tempered				321 min.
	Quench and Tempered				321 min.
	Quench and Tempered				360 min.
Abrasion Resisting – Work Hardening Manganese 12% - 14%	Quench-Annealed (Fully Austenitic)				210 / 255



PLATE

Typical Chemical Analysis and Chemical Ranges and Limits

ASTM Grade Trade Name	A514 B T-1 Type A	A514 H T-1 Type B	A514 F T-1	A514 Q T-1 Type C	S.T.A.R.	AR225	A588 A Cor-Ten B	Manganese 12% - 14%
Carbon	0.12 / 0.21	0.12 / 0.21	0.10 / 0.20	0.14 / 0.21	0.12 / 0.21	0.35 / 0.50	0.19 max.	1.05 / 1.20
Manganese	0.70 / 1.00	0.95 / 1.30	0.60 / 1.00	0.95 / 1.30	0.70 / 1.00	1.50 / 2.00	0.80 / 1.25	11.50 / 14.00
Phosphorus	0.035 max.	0.035 max.	0.035 max.	0.035 max.	0.035 max.	0.04 max.	0.04 max.	0.07 max.
Sulphur 0.04 max.	0.04 max.	0.04 max.	0.04 max.	0.04 max.	0.05 max.	0.05 max.		
Silicon	0.20 / 0.35	0.20 / 0.35	0.15 / 0.35	0.15 / 0.35	0.20 / 0.35	0.15 / 0.35	0.30 / 0.65	1.00 max.
Chromium	0.40 / 0.65	0.40 / 0.65	0.40 / 0.65	1.00 / 1.50	0.40 / 0.65	0.40 max.	0.40 / 0.65	
Nickel	0.30 / 0.70	0.70 / 1.00	1.20 / 1.50					
Molybdenum	0.15 / 0.25	0.20 / 0.30	0.40 / 0.60	0.40 / 0.60	0.15 / 0.25			
Vanadium	0.03 / 0.08	0.03 / 0.08	0.03 / 0.08	0.03 / 0.08	0.03 / 0.08		0.02 / 0.10	
Titanium	0.01 / 0.03				0.01 / 0.03			
Copper		0.15 / 0.50						
Boron	0.0005 / 0.005	0.0005 / 0.005	0.0005 / 0.006		0.0005 / 0.005	0.25 / 0.40		

GENERAL AND TECHNICAL INFORMATION

RADIUS FOR COLD BENDING

Suggested minimum inside bend radius for cold forming, based on ASTM Standards where t = material thickness.

Specification	Grade	Up to 3/4 in. Thick	Over 3/4 in to 1 in incl.	Over 1 in to 2 in incl.	Over 2 in. Thick
A36	A, B, D, C, S, and E AH32, DH32, EH32, and FH32 AH36, DH36, EH36, and FH36 AH40, DH40, EH40, and FH40	1.5t	1.5t	1.5t	2.0t
A131		1.5t	1.5t	1.5t	2.0t
		1.5t	1.5t	2.0t	2.5t
A242	A and B C and D All Grades 50 and 55 42 50 55	1.5t	1.5t	2.0t	2.5t
A283		1.5t	1.5t	1.5t	1.5t
		1.5t	1.5t	1.5t	2.0t
A514	All Grades 50 and 55 42 50 55	1.75t	2.25t	4.5t	5.5t
A529		1.5t	1.5t	2.0t	2.5t
A572		1.5t	1.5t	1.5t	2.0t
	60 and 65 58 and 65 70 All Grades All Grades	1.5t	1.5t	2.0t	2.5t
A573		1.5t	1.5t	3.0t	3.0t
		1.5t	1.5t	1.5t	3.5t
A588	All Grades All Grades	1.5t	1.5t	2.0t	2.5t
A633		1.5t	1.5t	2.0t	2.5t
		1.5t	1.5t	1.5t	2.0t

NOTE: When bend lines are parallel to the direction of final rolling, multiply values by 1.5.

* The width across the female die should be at least 8 times the plate thickness. The male die radius should be as large as is possible.

** Shear burrs and gas cut edges should be removed by grinding.

RADIUS FOR COLD BENDING

Suggested minimum inside bend radius for cold forming, based on ASTM Standards where t = material thickness.

Specification	Grade	Up to 3/4 in. Thick	Over 3/4 in to 1 in incl.	Over 1 in to 2 in incl.	Over 2 in. Thick
A656	50	1.5t	1.5t	1.5t	2.0t
	60	1.5t	1.5t	2.5t	3.0t
	70	1.5t	1.5t	3.0t	3.5t
	80	1.75t	2.25t	4.5t	5.5t
A678	A and B	1.5t	1.5t	2.0t	2.5t
	C and D	1.5t	1.5t	2.5t	3.0t
A709	36	1.5t	1.5t	1.5t	2.0t
	50, 50W, and HPS 50W	1.5t	1.5t	2.0t	2.5t
A710	HPS70W	1.5t	1.5t	2.5t	3.0t
	100 and 100W	1.75t	2.25t	4.5t	5.5t
A808	A	1.75t	2.25t	4.5t	5.5t
A852		1.5t	1.5t	2.0t	2.5t
A871	60 and 65	1.5t	1.5t	2.5t	3.0t
A945	50 and 65	1.5t	1.5t	3.0t	3.5t
A1008	SS25, SHS26, and BHS26	1/2t	1.5t	1.5t	2.0t
	SS30, HSLAS-F50, SHS31, and BHS31	1t	1.5t	2.0t	2.5t
A1008	SS33, HSLAS45, HSLAS-F60, SHS35, BHS35	1 1/2t	1.5t	3.0t	3.5t
	HSLAS50 CL2	1 1/2t	1.5t	1.5t	2.0t

NOTE: When bend lines are parallel to the direction of final rolling, multiply values by 1.5.

GENERAL AND TECHNICAL INFORMATION

RADIUS FOR COLD BENDING

Suggested minimum inside bend radius for cold forming, based on ASTM Standards where t =material thickness.

Specification	Grade	Up to 3/4 in. Thick	Over 3/4 in to 1 in incl.	Over 1 in to 2 in incl.	Over 2 in. Thick
A1008	SS40, HSLAS 50 CL1, 55, 60 CL2, HSLAS-F 70, 80 SHS 41, 44, BHS 41, 44 SS50, HSLAS 60 CL1, 65 CL2, SS60, HSLAS 65 CL1, 70 CL2 HSLAS 70 CL1 SS70 SS80	2t 2t 2 1/2t 3t 3 1/2t 4t N/A			
A1011	SS30, SS33, HSLAS-F 50 SS36 Ty1, HSLAS 45, 50 CL2, HSLAS-F 60 SS36 Ty2, 40, 45, HSLAS 50 CL1, 55, 60 CL2 HSLAS-F 70, 80	1t 1 1/2t 2t 2t 2t			
A1018	SS50, HSLAS 60 CL1, 65 CL2 SS55, HSLAS 65 CL1, 70 CL2 SS60, HSLAS CL1 SS70, 80 SS30, 33, HSLAS-F 50 SS30 Ty1, HSLAS 45, 50 CL2, HSLAS-F 60 SS36 Ty2, 40, 45, HSLAS 50 CL1, 60, HSLAS-F 70, 80 SS50, HSLAS 60 CL1, 65 CL2 SS55, HSLAS 65 CL1, 70 CL2 HSLAS 70 CL1	2 1/2t 3t 3 1/2t 4t 1t 1 1/2t 2t 2 1/2t 3t 3 1/2t 4t 1t 1 1/2t 2t 2 1/2t 3t 3 1/2t	1t 1 1/2t 2t 2 1/2t 3t 3 1/2t		

NOTE: When bend lines are parallel to the direction of final rolling, multiply values by 1.5.

MACHINABILITY RATINGS FOR ALLOY STEEL

SAE No.	Machinability Rating	Condition	Range of Typical Hardnesses (Brinell)
1330	55	Annealed and Cold Drawn	179-235
1335	55	Annealed and Cold Drawn	179-235
1340	50	Annealed and Cold Drawn	183-241
1345	45	Annealed and Cold Drawn	183-241
4012	70	Hot Rolled and Cold Drawn	149-196
4023	70	Hot Rolled and Cold Drawn	156-207
4024	75	Hot Rolled and Cold Drawn	156-207
4027	70	Annealed and Cold Drawn	167-212
4028	75	Annealed and Cold Drawn	167-212
4032	70	Annealed and Cold Drawn	174-217
4037	70	Annealed and Cold Drawn	174-217
4042	65	Annealed and Cold Drawn	179-229
4047	65	Annealed and Cold Drawn	179-229
4118	60	Hot Rolled and Cold Drawn	170-207
4130	70	Annealed and Cold Drawn	187-229
4135	70	Annealed and Cold Drawn	187-229
4137	70	Annealed and Cold Drawn	187-229
4140	65	Annealed and Cold Drawn	187-229
4142	65	Annealed and Cold Drawn	187-229
4145	60	Annealed and Cold Drawn	187-229
4147	60	Annealed and Cold Drawn	187-235
4150	55	Annealed and Cold Drawn	187-241
4161	50	Spheroidized and Cold Drawn	187-241
4320	60	Annealed and Cold Drawn	187-229
4340	50	Annealed and Cold Drawn	187-241
E4340	50	Annealed and Cold Drawn	187-241
4419	65	Annealed and Cold Drawn	170-212
4422	65	Hot Rolled and Cold Drawn	170-212
4427	65	Annealed and Cold Drawn	170-212
4615	65	Hot Rolled and Cold Drawn	174-223
4617	65	Hot Rolled and Cold Drawn	174-223
4620	65	Hot Rolled and Cold Drawn	183-229
4621	60	Hot Rolled and Cold Drawn	183-229
4626	70	Hot Rolled and Cold Drawn	170-212
4718	60	Hot Rolled and Cold Drawn	187-229
4720	65	Hot Rolled and Cold Drawn	187-229
4815	50	Annealed and Cold Drawn	187-229
4817	50	Annealed and Cold Drawn	187-229
4820	50	Annealed and Cold Drawn	187-229



MACHINABILITY RATINGS FOR ALLOY STEEL

SAE No.	Machinability Rating	Condition	Range of Typical Hardnesses (Brinell)
5015	65	Hot Rolled and Cold Drawn	156-196
50B40	65	Annealed and Cold Drawn	174-223
50B44	65	Annealed and Cold Drawn	174-223
5046	60	Annealed and Cold Drawn	174-223
50B46	60	Annealed and Cold Drawn	174-223
50B50	55	Annealed and Cold Drawn	183-235
5060	55	Spheroidized Annealed and Cold Drawn	170-212
50B60	55	Spheroidized Annealed and Cold Drawn	170-212
5115	65	Hot Rolled and Cold Drawn	163-201
5120	70	Hot Rolled and Cold Drawn	163-201
5130	70	Annealed and Cold Drawn	174-212
5132	70	Annealed and Cold Drawn	174-212
5135	70	Annealed and Cold Drawn	179-217
5140	65	Annealed and Cold Drawn	179-217
5145	65	Annealed and Cold Drawn	179-229
5147	65	Annealed and Cold Drawn	179-229
5150	60	Annealed and Cold Drawn	183-235
5155	55	Annealed and Cold Drawn	183-235
5160	55	Spheroidized Annealed and Cold Drawn	179-217
51B60	55	Spheroidized Annealed and Cold Drawn	179-217
50100	40	Spheroidized Annealed and Cold Drawn	183-241
51100	40	Spheroidized Annealed and Cold Drawn	183-241
52100	40	Spheroidized Annealed and Cold Drawn	183-241
6118	60	Hot Rolled and Cold Drawn	179-217
6150	55	Annealed and Cold Drawn	183-241
8115	65	Hot Rolled and Cold Drawn	163-202
81B45	65	Annealed and Cold Drawn	179-223
8615	70	Hot Rolled and Cold Drawn	179-235
8617	70	Hot Rolled and Cold Drawn	179-235
8620	65	Hot Rolled and Cold Drawn	179-235
8622	65	Hot Rolled and Cold Drawn	179-235
8625	60	Annealed and Cold Drawn	179-233
8627	60	Annealed and Cold Drawn	179-223
8630	70	Annealed and Cold Drawn	179-229
8637	65	Annealed and Cold Drawn	179-229
8640	65	Annealed and Cold Drawn	184-229



MACHINABILITY RATINGS FOR ALLOY STEEL

SAE No.	Machinability Rating	Condition	Range of Typical Hardnesses (Brinell)
8642	65	Annealed and Cold Drawn	184-229
8645	65	Annealed and Cold Drawn	184-235
86B45	65	Annealed and Cold Drawn	184-235
8650	60	Annealed and Cold Drawn	187-248
8655	55	Annealed and Cold Drawn	187-248
8660	55	Spheroidized Annealed and Cold Drawn	179-217
8720	65	Hot Rolled and Cold Drawn	179-235
8740	65	Annealed and Cold Drawn	184-235
8822	55	Hot Rolled and Cold Drawn	179-223
9254	45	Spheroidized Annealed and Cold Drawn	187-241
9255	40	Spheroidized Annealed and Cold Drawn	179-229
9260	40	Spheroidized Annealed and Cold Drawn	184-235
9310	50	Annealed and Cold Drawn	184-229
94B15	70	Hot Rolled and Cold Drawn	163-202
94B17	70	Hot Rolled and Cold Drawn	163-202
94B30	70	Annealed and Cold Drawn	170-223



ALLOY BARS

TYPICAL MECHANICAL PROPERTIES

(Based on 1" Diameter Bar)

Grade	Tensile Strength psi	Yield Strength psi	% Elongation	Brinell Hardness
4140-HT	130,000	110,000	16	269/321
4140-Annealed	91,000	60,000	26	192-229
E.T.D. 150	150,000 min	130,000 min	10	302 min.
4340-HT	143,000	137,000	14	280-340
8620-As Rolled	97,000	57,000	25	201

ALLOY BARS

4340 Forged and Rough Turned
(12", 14", 16" Diameter - Heat Treated)

Tensile Strength psi	Yield Strength psi	% Elongation	Brinell Hardness
115,000	90,000	12	269-321

*Properties are typical and represent measurement at mid-radius

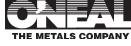


HOT ROLLED ALLOY BARS ROUNDS AND SQUARES

TOLERANCES

Specified Size In Inches	Variation from Size in Inches		Out of Round* or Square In Inches
	Over	Under	
Up to 5/16, incl.	.005	.005	.008
Over 5/16 to 7/16, incl.	.006	.006	.009
Over 7/16 to 5/8, incl.	.007	.007	.010
Over 5/8 to 7/8, incl.	.008	.008	.012
Over 7/8 to 1, incl.	.009	.009	.013
Over 1 to 1-1/8, incl.	.010	.010	.015
Over 1-1/8 to 1-1/4, incl.	.011	.011	.016
Over 1-1/4 to 1-3/8, incl.	.012	.012	.018
Over 1-3/8 to 1-1/2, incl.	.014	.014	.021
Over 1-1/2 to 2, incl.	1/64	1/64	.023
Over 2 to 2-1/2, incl.	1/32		.023
Over 2-1/2 to 3-1/2, incl.	3/64		.035
Over 3-1/2 to 4-1/2, incl.	1/16		.046
Over 4-1/2 to 5-1/2, incl.	5/64		.058
Over 5-1/2 to 6-1/2, incl.	1/8		.070
Over 6-1/2 to 8-1/4, incl.	5/32		.085
Over 8-1/4 to 9-1/2, incl.	3/16		.100
Over 9-1/2 to 10, incl.	1/4		.120

* Out-of-round is the difference between the maximum and minimum diameters of a round bar measured at the same cross section. Out-of-square is the difference in the two dimensions at the same cross section of a square bar - each dimension being the distance between opposite faces.



COLD FINISHED ALLOY BARS
Cold Drawn or Turned and Polished

TOLERANCES

GENERAL AND TECHNICAL INFORMATION

Specified Size In Inches	Undersize Variations in Inches			
	Max. Carbon Range .28% or less	Max. Carbon Range Over .28 to .55% incl.	Annl'd. or Stress Relieved after C.F. Max. carb. to .55%	Max. Carbon range over 0.55% with or without stress relieving or annealing after cold finishing. Also, all carbons Heat Tr. or Norm. & Temp. before cold finishing
To 1 incl. (in coils)	.002	.003	.004	.005
To 1-1/2, incl.	.003	.004	.005	.006
Over 1-1/2 to 2-1/2	.004	.005	.006	.007
Over 2-1/2 to 4	.005	.006	.007	.008
Over 4 to 6	.006	.007	.008	.009
Over 6 to 8	.007	.008	.009	.010
Over 8 to 9	.008	.009	.010	.011
Over 9	.008	.010	.011	.012



COLD FINISHED ALLOY BARS

Cold Drawn, Ground and Polished Rounds Turned, Ground and Polished Rounds

TOLERANCES

Diameter in Inches	Cold Drawn, Ground & Polished	Turned, Ground & Polished	
	All Carbons with or without thermal treatment before Cold Drawing	Not Heat Treated All Carb.	Heat* Treated All Carb.
To 1-1/2, incl.	.001	.001	.001
Over 1-1/2 to 2-1/2, excl.	.0015	.0015	.0015
2-1/2 to 3, incl.	.002	.002	.002
Over 3 to 4, incl.	.003	.003	.003
Over 4 to 6, incl.	---	.004	.005
Over 6	---	.005	.006

*Applies to quenched and tempered (heat treated), normalized and tempered, or any similar double treatment prior to turning.

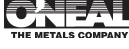
GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

Hot Rolled Alloy Flats TOLERANCES

Tolerances apply to thickness in inches

Specified width in Inches	0.23-.230 excl.	Variations from Thickness in Inches (Tolerances are over or under)						Variations from Width in Inches	
		Under 1/4	1/4 - 1/2	Over 1/2 - 1	Over 1 - 2	Over 2 - 3	Over 3	Over	Under
Up to 1	0.007	.007	.008	.010	—	—	—	1/64	1/64
Over 1 - 2	0.007	.007	.012	.015	1/32	—	—	1/32	1/32
Over 2 - 4	0.008	.008	.015	.020	1/32	3/64	3/64	1/16	1/32
Over 4 - 6	0.009	.009	.015	.020	1/32	3/64	3/64	3/32	1/16



HOT ROLLED ALLOY STRAIGHTNESS Rounds and Squares

Standard Straightness – 1/4" in any feet, or 1/4 x number of feet in length inches
5

Standard Straightness – 1/8" in any 5 feet, of 1/8 x number of feet in length inches
5



COLD FINISHED ALLOY BARS Machining Recommendations

Recommended Minimum Machining Allowance Per Side Percent of Specified Size

Regular Quality Alloy and Special Quality Carbon Steel Bars

	Non- Resulturized		Resulturized	
	2" & Under	Over 2"	2" & Under	Over 2"
Centerless Turned or Ground	2.6%	1.6%	3.4%	2.4%

Note 1: Based on bars with special straightness tolerance.

Note 2: Bars turned on centers. Since this operation is dependent upon length and straightness considerations, each item should be negotiated between consumer and supplier.



COLD FINISHED CARBON STEEL BARS

Standard Manufacturing Tolerances

All Tolerances are Minus

COLD FINISHED OR TURNED & POLISHED ROUNDS

Undersize Variations in Inches

Size Range in inches	Max. Carbon Range .28% or less	Max. Carbon Range Over .28% to .55% Inc.	Max. Carbon Range to .55% incl. stress Relieved or Annealed After Cold Finishing	Max. Carbon Range Over .55% or All Grades Quenched and Tempered or Normalized and Tempered Before Cold Finishing
1-1/2 or under	.002	.003	.004	.005
Over 1-1/2 to 2-1/2, incl.	.003	.004	.005	.006
Over 2-1/2 to 4, incl	.004	.005	.006	.007
Over 4 to 6, incl	.005	.006	.007	.008
Over 6 to 8, incl	.006	.007	.008	.009
Over 8 to 9, incl	.007	.008	.009	.010
Over 9	.008	.009	.010	.011

Cold Finished Hexagons

3/4 or under	.002	.003	.004	.005
Over 3/4 to 1-1/2 incl.	.003	.004	.005	.006
Over 1-1/2 to 2-1/2, incl	.004	.005	.006	.007
Over 2-1/2 to 3-1/8, incl	.005	.006	.007	.008

Cold Finished Squares

3/4 or under	.002	.004	.005	.007
Over 3/4 to 1-1/2 incl.	.003	.005	.006	.008
Over 1-1/2 to 2-1/2, incl	.004	.006	.007	.009
Over 2-1/2 to 4, incl	.006	.008	.009	.011

Cold Finished Flats

Tolerances for flats apply to thickness as well as width

Width in Inches				
To 3/4 incl.	.003	.004	.006	.008
Over 3/4 to 1-1/2, incl.	.004	.005	.008	.010
Over 1-1/2 to 3, incl	.005	.006	.010	.012
Over 3 to 4, incl	.006	.008	.011	.016
Over 4 to 6, incl	.008	.010	.012	.020
Over 6	.013	.015		



COLD FINISHED CARBON STEEL BARS

Standard Manufacturing Tolerances

CONTINUED

Turned, Ground and Polished Rounds Cold Finished, Ground and Polished Rounds

Underside Variations in Inches

Size Range in Inches	Turned, Ground and Polished Round	Cold Drawn, Ground and Polished Rounds
1-1/2 and under..	.001	.001
Over 1-1/2 to less than 2-1/20015	.0015
2-1/2 to 3, incl....	.002	.002
Over 3 to 4, incl.	.003	.003
Over 4 to 6, incl.	.004*	
Over 6005*	

* For non-resulphurized steels (steels specified to maximum sulphur limits under 0.08%) or for steels thermally treated, the tolerance is increased by .001".

Specific straightness imitations are sometimes required. Arrangement for furnishing bars to restricted straightness limits are established as well as the methods for checking the straightness.

Straightness is a very perishable quality influenced by all handling after production. Each product has its own problems and limitations. To preserve straightness in cold finished bars requires the utmost care in subsequent handling.

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

TOOL STEEL TYPICAL ANALYSIS

AISI Grade or Trade Name	% Carbon	% Manganese	% (Max) Phosphorus	%(Max) Sulphur	% Silicon	% Chromium	% Vanadium	% Tungsten	% Molybdenum	ASTM
01	0.85	1.00	0.030	0.030	0.10	0.40	0.30 max	0.40		A681
	1.00	1.40			0.50	0.60		0.60		
06	1.25	0.30	0.030	0.030	0.55	0.30 max			0.20	A681
	1.55	1.10			1.50				0.30	
A2	0.95	0.40	0.030	0.030	0.10	4.75	0.15	0.90	0.90	A681
	1.05	1.00			0.50	5.50	0.50	1.40	1.40	
A6	0.65	1.80	0.030	0.030	0.10	0.90		0.90	0.90	A681
	0.75	2.50			0.50	1.20		1.40		
D2	1.40	0.20	0.030	0.030	0.10	11.00	0.50	0.70	0.70	A681
	1.60	0.60			0.60	13.00	1.10	1.20		
S5	0.50	0.60	0.030	0.030	1.75	0.10	0.15	0.20	0.20	A681
	0.65	1.00			2.25	0.50	0.35	1.35		

TOOL STEEL

TYPICAL ANALYSIS

AISI Grade or Trade Name	% Carbon	% Manganese	% (Max) Phosphorus	%(Max) Sulphur	% Silicon	% Chromium	% Vanadium	% Tungsten	% Molybdenum	ASTM
S7	<u>0.45</u>	<u>0.20</u>	0.030	0.030	<u>0.20</u>	<u>3.00</u>	0.35 max		<u>1.30</u>	A681
	0.55	0.90			1.00	3.50			1.80	
M2	<u>0.78</u>	<u>0.15</u>	0.030	0.030	<u>0.20</u>	<u>3.75</u>	<u>1.75</u>	<u>5.50</u>	<u>4.50</u>	A600
	0.88	0.40			0.45	4.50	2.20	6.75	5.50	
T1	<u>0.65</u>	<u>0.10</u>	0.030	0.030	<u>0.20</u>	<u>3.75</u>	<u>0.90</u>	<u>17.25</u>		A600
	0.80	0.40			0.40	4.50	1.30	18.75		
H13	<u>0.32</u>	<u>0.20</u>	0.030	0.030	<u>0.80</u>	<u>4.75</u>	<u>0.80</u>		<u>1.10</u>	A681
	0.45	0.50			1.20	5.50	1.20		1.75	
Viscount 44	0.40	0.80			1.00	5.25	1.00		1.35	
Brake Die 4150	<u>0.40</u>	<u>0.75</u>				<u>0.65</u>			<u>0.15</u>	
	0.50	1.25				1.10			0.25	



TOOL STEELS

Maximum Brinell Hardness
(IN ANNEALED CONDITION)

AISI Grade	Brinell Hardness (BHN)
01	212
06	229
A2	248
A6	248
D2	255
S5	229
S7	229
M2	248
T1	255
H13	235



TOOL STEEL TOLERANCES

ROUGH-TURNED ROUND BARS (ASTM A681 SIZE TOLERANCE A

Specified Sizes B In Inches	Size Tolerance	
	Under	Over
Over 3/4 to 1-1/2, inc.	0.00	0.10
Over 1-1/2 to 3-1/16, incl.	0.00	0.15
Over 3-1/16 to 4-1/16, incl.	0.00	0.31
Over 4-1/16 to 6-1/16, incl.	0.00	0.62
Over 6-1/16 to 10-1/16, incl.	0.00	0.94
Over 10-1/16 - Consult	0.00	

A Out-of-round tolerances to be one half of the total tolerance.

B Consult producer for oversize allowance and decarburization limits for all sizes.



TOOL STEELS TOLERANCES

DRILL ROD, ROUNDS, POLISHED OR GROUND (ASTM A681)

Size (Inches)	Standard Manufacturing Tolerance Plus and Minus	Precision Tolerance Plus and Minus
Up to 0.124, incl.	0.0003	0.0002
0.125 to 0.499, incl.	0.0005	
0.500 to 1.500, inc.	0.001	

NOTE: Out-of-round tolerances to be one-half of the total tolerance.

TOOL STEEL TOLERANCES

PRECISION GROUND SQUARE AND FLAT BARS (ASTM A681)
THICKNESS AND WIDTH TOLERANCE

Thickness (Inches)	Tolerance (Inches)	
	Under	Over
	<u>Thickness</u>	
Up to 1-1/4, inc.	0.001	0.001
Over 1-1/4 to 2, incl.	0.0002	0.002
1/2 to 14, incl.	0.000	0.005

COMPARATIVE TRADE NAMES FOR TOOL STEEL

AISI Type	Grade	Latrobe	AL Tech	Crucible	Jessop	Vasco	
<i>Cold Work Steels</i>	01	Badger	Saratoga	Ketos	Truform	Colonial No. 6	
	02	Mangano	Deward		Spici Oil-Hard		
	06	Graph-Mo	Oilgraph	Halgraph	Trulidge		
	A2	Select 8	Sagamore	Airkool	Windsor	Air Hard	
	A4	Tempair					
	A6	Lesco A6	Apache		Jess-Air		
	A10	Graph-Air	Ontario		CNS-1	Ohio Die	
	D2	Olympic					
	<i>Shock Steels</i>	S1	XL Chisel	Seminole	Atha Pneu	Top Notch	Par-Exu
		S5	Lanark	Chicasaw	LaBelle Silicon 2	No. 259	Mosil
S7		Bearcat	Arapacho		Supershock	Simoch	
<i>Hot Work Steels</i>	H11	Dycast No. 1	Creek	Halcomb 218	Dica B Mod	Hotform No. 2	
	H12	LPD	Choctaw	Cro-Mow	DicaB	Hotform No. 1	
	H13	VDC-Visc 20, 24	Potomac M	Nu Die V	Dica B	Hotform V	

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

BRASS / BRONZE

TYPICAL ANALYSIS

UNS Number	% Copper	% Lead	% Iron	% Zinc	% Tin	% Antimony	% Sulphur	% Silicon	% Phosphorus	% Manganese	% Aluminum	% Nickel (incl. Cobalt)	% Other
C26000	<u>68.5</u>	<u>0.07</u>	<u>0.05</u>	REM									<u>0.15</u>
	71.5	max	max										max
C36000	<u>60.0</u>	<u>2.5</u>	<u>0.35</u>	REM									<u>0.50</u>
	63.0	3.7	max										max
C93200	<u>81.0</u>	<u>6.0</u>	<u>0.20</u>	<u>1.0</u>	<u>6.3</u>	<u>0.35</u>	<u>0.005</u>	<u>0.15</u>		<u>0.005</u>	<u>1.0</u>		
	85.0	8.0	max	4.0	7.5	max	max	max	max		max	max	
C95400	<u>83.0</u>		<u>3.0</u>							<u>0.50</u>	<u>10.0</u>	<u>1.50</u>	
	Min		5.0							max	11.5	max	

BRASS / BRONZE

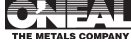
TYPICAL MECHANICAL PROPERTIES

UNS Number	Tensile (PSI)	Yield (PSI)	Rockwell "B" Hardness
<u>Rod (Based on 1" Diameter)</u>			
C36000	58,000	45,000	78
C93200	44,000	24,000	70*
C95400	90,000	36,000	179**
<u>Sheet</u>			
C26000 (Half Hard)	62,000	52,000	70

* Brinell 500 KG

** Brinell 3000 KG





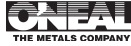
**C.D. SEAMLESS
MECHANICAL TUBING**
STANDARD MFG. TOLERANCES

ASTM A-519

GENERAL AND TECHNICAL INFORMATION

Group	Size O.D. Inches	Permissible Variations from:					
		Outside Diameter in Inches		Inside Diameter in Inches		Wall Thickness per cent	
		Over	Under	Over	Under	Over	Under
1	3/16 to 1/2 excl.	0.004	0	a,b	a,b	a,b	a,b
2	1/2 to 1-1/2 excl.	0.005c	0c	0a,b	0.005a,b	10a,b	10a,b
3	1-1/2 to 3-1/2 excl.	0.010c	0c	0.a	0.010a	10a	10a
4	3-1/2 to 5-1/2 excl.	0.015	0c	0.005a	0.015a	10a	10a
5	5-1/2 to 8 excl. when wall is less than 5% of O.D.	0.030c	0.030c	0.035c	0.035c	10	10
6	5-1/2 to 8 excl. when wall is 5 to 7.5% of O.D.	0.020	0.020	0.025	0.025	10	10
7	5-1/2 to 8 excl. when wall is over 7.5% of O.D.	0.030	0	0.015a	0.030a	10a	10a
8	8 to 10-3/4 incl. when wall is less than 5% of O.D.	0.045c	0.045c	0.050c	0.050c	10	10
9	8 to 10-3/4 incl. when wall is 5 to 7.5% of O.D.	0.035	0.035	0.040	0.040	10	10
10	8 to 10-3/4 incl. when wall is over 7.5% of O.D.	0.045	0	0.15a	0.040a	10a	10a

- (a) For tubes with inside diameter less than 50% of outside diameter or with wall thickness more than 25% of outside diameter or with wall thickness over 1-1/4", or weighing more than 90 lb per ft., which cannot be successfully drawn over a mandrel, the inside diameter may vary over or under by 10% of the wall thickness. The wall thickness may vary 12-1/2% over or under that specified.
- (b) For the tubes with inside diameter less than 1/2" (or less than 5/8" when the wall thickness is more than 20% of the outside diameter). which cannot be successfully drawn over a mandrel, the wall thickness may vary 15% over or under that specified and the inside diameter will be governed by the outside diameter and wall thickness variations.



**C.D. SEAMLESS
MECHANICAL TUBING**
STANDARD MFG. TOLERANCES

ASTM A-519

- (c) Tubing having a wall thickness less than 3% of the outside diameter cannot be straightened properly without a certain amount of distortion. Consequently such tubes, while having an average outside diameter and inside diameter within the tolerances shown in the table, will require an ovality of tolerance of 1/2% over or under the nominal outside diameter and inside diameter in addition to the tolerances indicated in the table.

WAREHOUSE TOLERANCES LIMITED TO O.D.-AND WALL (except for Cylinder Tubing specially drawn to O.D.-I.D. dimensions.)

**HOT FINISHED SEAMLESS
MECHANICAL TUBING**
DIAMETER TOLERANCES-INCHES/MILLIMETERS

ASTM A-519

OD Size Range Inches Inclusive	As Rolled or Annealed OD, ± Inches	Quenched & Tempered OD & ID ± OD
2.000-2.499	.017	.027
2.500-2.999	.019	.029
3.000-3.499	.021	.032
3.500-3.999	.023	.035
4.000-4.499	.025	.038
4.500-4.999	.027	.041
5.000-5.499	.029	.044
5.500-5.999	.031	.047
6.000-6.499	.033	.050
6.500-6.999	.035	.053
7.000-7.499	.037	.056

OD Size Range Millimeters, Inclusive	As Rolled or Annealed OD, ± Millimeters	Quenched & Tempered OD & ID ± Millimeters
50.80-63.48	0.43	0.686
63.49-76.17	0.48	0.737
76.18-88.87	0.53	0.813
88.88-101.57	0.58	0.889
101.58-114.28	0.64	0.985
114.29-126.97	0.69	1.041
126.98-139.67	0.74	1.118
139.68-152.38	0.79	1.194
152.39-165.08	0.84	1.270
165.09-177.78	0.89	1.346
177.79-190.48	0.94	1.422

Tolerances do not apply to heat treated material or bearing quality tubing.

CONTINUED

GENERAL AND TECHNICAL INFORMATION



**HOT FINISHED SEAMLESS
MECHANICAL TUBING**

ASTM A-519

WALL THICKNESS TOLERANCES-
INCHES/MILLIMETERS

Wall Thickness % of OD	Maximum Percent Over & Under Nominal	Wall Thickness % of OD	Maximum Percent Over & Under Nominal
	OD 2" and Over		OD 2" and Over
Under 10	10.0	Under 10	10.0
10 to 25	7.5	10 to 25	7.5

**HOT FINISHED SEAMLESS
MECHANICAL TUBING**

ASTM A-519

STRAIGHTNESS TOLERANCES-INCHES/MILLIMETERS

OD Size Range Inches Inclusive	Wall Percent of OD	Maximum Deviation from Straight Total Inches in any 3 Feet
Up to 5.000	3% OD & Over	.030
5.001-7.500	4% OD & Over	.045

OD Size Range Inches Inclusive	Wall Percent of OD	Maximum Deviation from Straight Total Millimeters in any 3 Feet
Up to 127.00	3% OD & Over	0.83
127.01-190.50	4% OD & Over	1.14

Straightness, or camber, is measured for any 3 ft. or meter of length with a 3 ft. or meter straight edge and a feeler gauge.

GENERAL AND TECHNICAL INFORMATION



ERW DRAWN OVER MANDREL ROUND MECHANICAL STEEL TUBING • A-513

OD AND ID TOLERANCES
INCHES (MM)

OD Size Range	% of OD	OD, Inches		OD, Inches	
		Over	Under	Over	Under
0.625-1.699 (15.82-43.16)	All	.005(.13)	.000	.000	.005(.13)
1.700-2.099 (43.17-53.32)	All	.006(.15)	.000	.000	.006(.15)
2.100-2.499 (53.33-63.48)	All	.007(.18)	.000	.000	.007(.18)
2.500-2.899 (63.49-73.64)	All	.008(.20)	.000	.000	.008(.20)
2.900-3.299 (73.65-83.80)	All	.009(.23)	.000	.000	.009(.23)
3.300-3.699 (83.81-93.96)	All	.010(.25)	.000	.000	.010(.25)
3.700-4.099 (93.97-104.12)	All	.011(.28)	.000	.000	.011(.28)
4.100-4.499 (104.13-114.28)	All	.012(.30)	.000	.000	.012(.30)
4.500-4.899 (114.29-124.44)	All	.013(.33)	.000	.000	.013(.33)
4.900-5.299 (124.45-134.60)	All	.014(.36)	.000	.000	.014(.36)
5.300-5.549 (134.61-140.95)	All	.015(.38)	.000	.000	.015(.38)
5.550-5.999 (140.96-152.38)	Under 6 7 to 7-1/2 Over 7-1/2	.010(.25) .009(.23) .018(.46)	.010(.25) .009(.23) .000	.010(.25) .009(.23) .009(.23)	.010(.25) .009(.23) .009(.23)
6.000-6.499 (152.39-165.08)	Under 6 6 to 7-1/2 Over 7-1/2	.013(.33) .010(.25) .020(.51)	.013(.33) .010(.25) .000	.013(.33) .010(.25) .010(.25)	.013(.33) .010(.25) .010(.25)
6.555-6.999 (165.09-177.78)	Under 6 6 to 7-1/2 Over 7-1/2	.015(.38) .012(.30) .023(.58)	.015(.38) .012(.30) .000	.015(.38) .012(.30) .012(.30)	.015(.38) .012(.30) .012(.30)
7.000-7.499 (177.79-190.48)	Under 6 6 to 7-1/2 Over 7-1/2	.018(.46) .013(.33) .026(.66)	.018(.46) .013(.33) .000	.018(.46) .013(.33) .013(.33)	.018(.46) .013(.33) .013(.33)
7.500-7.999 (190.49-203.18)	Under 6 6 to 7-1/2 Over 7-1/2	.020(.51) .015(.38) .029(.74)	.020(.51) .015(.38) .000	.020(.51) .015(.38) .015(.38)	.020(.51) .015(.38) .015(.38)
8.000-8.499 (203.19-215.88)	Under 6 6 to 7-1/2 6 to 7-1/2 Over 7-1/2	.023(.58) .016(.41) .016(.41) .031(.79)	.023(.58) .016(.41) .016(.41) .000	.023(.58) .016(.41) .016(.41) .015(.38)	.023(.58) .016(.41) .016(.41) .016(.41)
8.500-8.999 (215.89-228.58)	Under 6 6 to 7-1/2 Over 7-1/2	.025(.64) .017(.43) .034(.86)	.025(.64) .017(.43) .000	.025(.64) .017(.43) .015(.38)	.025(.64) .017(.43) .019(.48)
9.000-9.499 (228.59-241.28)	Under 6 6 to 7-1/2 Over 7-1/2	.028(.71) .019(.48) .037(.94)	.028(.71) .019(.48) .000	.028(.71) .019(.48) .015(.38)	.028(.71) .019(.48) .022(.56)
9.500-9.999 (241.29-253.98)	Under 6 6 to 7-1/2 Over 7-1/2	.030(.76) .020(.51) .040(1.02)	.030(.76) .020(.51) .000	.030(.76) .020(.51) .015(.38)	.030(.76) .020(.51) .025(.64)
10.000-10.999 (253.99-279.38)	Under 6 6 to 7-1/2 Over 7-1/2	.034(.86) .022(.56) .044(1.12)	.034(.86) .022(.56) .000	.034(.86) .022(.56) .015(.38)	.034(.86) .022(.56) .029(.74)
11.000-11.999 (279.39-304.78)	Under 6 6 to 7-1/2 Over 7-1/2	.035(.89) .025(.64) .045(1.14)	.035(.89) .025(.64) .000	.035(.89) .025(.64) .015(.38)	.035(.89) .025(.64) .035(.89)
12.000-12.999 (304.79-330.18)	Under 6 7 to 7-1/2 Over 7-1/2	.036(.91) 7 to 7-1/2 Over 7-1/2	.036(.91) .027(.69) .000	.036(.91) .027(.69) .015(.38)	.036(.91) .027(.69) .037(.94)
13.000-13.999 (330.19-355.58)	Under 6 6 to 7-1/2 Over 7-1/2	Under 6 6 to 7-1/2 Over 7-1/2	.037(.94) .029(.74) .000	.037(.94) .029(.74) .015(.38)	.037(.94) .029(.74) .040(1.02)
14.000-15.000 (355.59-381.00)	Under 6 6 to 7-1/2 Over 7-1/2	Under 6 6 to 7-1/2 Over 7-1/2	.038(.97) .030(.76) .000	.038(.97) .030(.76) .015(.38)	.038(.97) .030(.76) .042(1.07)

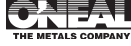
GENERAL AND TECHNICAL INFORMATION



E.W. DOM - ASTM A-513
WALL TOLERANCES

WALL THICKNESS, INCH	INCL. .375 to .875 OD	OVER .875 to 1.875 OD	OVER 1.875 to 3.750 OD	OVER 3.750 to 15,000 OD
0.28 & .035	+0.02 -0.02	+0.02 -0.02	+0.02 -0.02	
.049	+0.02 -0.02	+0.02 -0.03	+0.02 -0.03	
.065	+0.02 -0.02	+0.02 -0.03	+0.02 -0.03	+0.04 -0.04
.083	+0.02 -0.02	+0.02 -0.03	+0.03 -0.03	+0.04 -0.05
.095	+0.02 -0.02	+0.02 -0.03	+0.03 -0.03	+0.04 -0.05
.109	+0.02 -0.03	+0.02 -0.04	+0.03 -0.03	+0.05 -0.05
.120	+0.03 -0.03	+0.02 -0.04	+0.03 -0.03	+0.05 -0.05
.134		+0.02 -0.04	+0.02 -0.04	+0.05 -0.05
.148		+0.02 -0.04	+0.02 -0.04	+0.05 -0.05
.165		+0.03 -0.04	+0.03 -0.04	+0.05 -0.06
.180		+0.04 -0.04	+0.04 -0.04	+0.06 -0.06
.203		+0.04 -0.05	+0.04 -0.05	+0.06 -0.07
.220			+0.04 -0.06	+0.07 -0.07
.238			+0.05 -0.06	+0.07 -0.07
.259			+0.05 -0.06	+0.07 -0.07
.284			+0.05 -0.06	+0.07 -0.07
.300			+0.06 -0.06	+0.08 -0.08
.320			+0.07 -0.07	+0.08 -0.08
.344			+0.08 -0.08	+0.09 -0.09
.375			+0.09 -0.09	+0.09 -0.09
.400			+0.10 -0.10	+0.10 -0.10
.438			+0.11 -0.11	+0.11 -0.11
.480			+0.12 -0.12	+0.12 -0.12
.531			+0.13 -0.13	+0.13 -0.13
.563			+0.13 -0.13	+0.13 -0.13
.580				+0.14 -0.14
.600				+0.15 -0.15
.650				+0.17 -0.17

GENERAL AND TECHNICAL INFORMATION



COLD DRAWN BUTTWELDED STEEL TUBE DATA

Round Mandrel Drawn (CDBW) ASTM A-512

DIMENSIONAL TOLERANCES

O. D. SIZE RANGE INCHES	WALL THICKNESS RANGE INCHES	DIAMETER TOLERANCES				WALL TOLERANCES	
		O. D. INCHES		I. D. INCHES		Plus	Minus
		Plus	Minus	Plus	Minus		
Under .500	Under .156	.004	.000	.000	.010	12.5%	12.5%
.500 to 1.500	Under .156	.005	.000	.000	.005	10.0%	10.0%
.500 to 1.500	0.156 & over	.005	.000	.000	.005	7.0%	7.0%
1.500 & over	Under .156	.010	.000	.000	.010	10.0%	10.0%
1.500 & over	0.156 & over	.010	.000	.000	.010	7.0%	7.0%

Tolerances can be supplied to only two of three cross-sectional dimensions. Sunk drawn CDBW tube usually is specified OD x Wall. Most Kilsby-Roberts CDBW stock is Mandrel Drawn OD x ID stress relieved. Straightness tolerance is 0.030" in any 3 feet of length.

CHEMICAL COMPOSITION

GRADE DESIGNATION	CHEMISTRY			
	CARBON	MANGANESE	PHOSPHOROUS	SULFUR
AISI 1010	.05-.15%	.30-.60%	.040% max	.050% max
AISI 1012	.10-.15%	.30-.60%	.040% max	.050% max
AISI 1020	.15-.25%	.30-.60%	.040% max	.050% max

Percentage range heat analysis, Refer ASTM-A-512 for product analysis.

MECHANICAL PROPERTIES

GRADE DESIGNATION	TENSILE STRENGTH	YIELD STRENGTH	ELONGATION IN 2 INCHES	ROCKWELL HARDNESS
AISI 1010	62,000 psi	58,000 psi	15%	R70B-R90B
AISI 1012	62,000 psi	58,000 psi	15%	R70B-R90B
AISI 1020	71,000 psi	65,000 psi	13%	R75B-R99B

Properties are approximate typical values for round cold drawn stress relieved tube.



WELDED MECHANICAL STEEL TUBE TOLERANCES As-Welded Round Hot Rolled Electric Weld (HREW)

DIAMETER TOLERANCES

OUTSIDE DIAMETER SIZE RANGE INCHES	WALL THICKNESS		OUTSIDE DIAMETER TOLERANCE, INCHES	
	BWG	INCHES	PLUS	MINUS
3/4 TO 1-1/8 INCH Over 1-1/8 to 2, incl Over 1-1/8 to 2, incl	16 to 10	.065 to .134	.0035	.0035
	16 to 7	.065 to .180	.005	.005
	6 to 3	.203 to .259	.005	.005
Over 2 to 2-1/2, incl Over 2-1/2 to 3, incl Over 2-1/2 to 3, incl	16 to 3	.065 to .259	.006	.006
	16 to 3	.065 to .259	.008	.008
	2 to .320	.284 to .320	.010	.010
Over 3 to 3-1/2, incl Over 3 to 3-1/2, inc. Over 3-1/2 to 3, incl Over 3-1/2 to 4, incl	16 to 3	.065 to .259	.009	.009
	2 to .360	.284 to .360	.012	.012
	16 to 3	.065 to .259	.010	.010
	2 to .500	.284 to .500	.015	.015
Over 4 to 5, incl Over 4 to 5, incl Over 5 to 6, incl Over 5 to 6, incl Over 6 to 8, incl Over 6 to 8, incl	16 to 3	.065 to .259	.020	.020
	2 to .500	.284 to .500	.020	.020
	16 to 3	.065 to .259	.020	.020
	2 to .500	.120 to .259	.025	.025
	11 to 3	.120 to .259	.025	.025
	2 to .500	.284 to .500	.025	.025

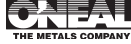
NOTE 1 - Measurements for diameter are to be taken at least 2 inches from the ends of the tubes.

NOTE 2 - OVALITY shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, in such cases the ovality may be 50 percent greater than the outside tolerances but the mean outside diameter shall be within the specified tolerances.

GENERAL AND TECHNICAL INFORMATION

WALL TOLERANCES

WALL THICKNESS		OUTSIDE DIAMETER, INCHES									
INCHES	BWG	3/4 to 1, incl		OVER 1 to 1-15/16 incl		OVER 1-15/16 to 3-3/4 incl		OVER 3-3/4 to 4-1/2, incl		OVER 4-1/2 to 8, incl	
		WALL THICKNESS TOLERANCES, INCHES									
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
.065	16	.005	.009	.004	.010	.003	.011	.002	.012	.002	.012
.072	15	.005	.009	.004	.010	.003	.011	.002	.012	.002	.012
.083	14	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.095	13	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.109	12	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.120	11	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.134	10	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.148	9	-	-	.006	.012	.005	.013	.004	.014	.004	.014
.165	8	-	-	.006	.012	.005	.013	.004	.014	.004	.014
.180	7	-	-	.006	.012	.005	.013	.004	.014	.004	.014
.203	6	-	-	-	-	.007	.015	.006	.016	.005	.017
.220	5	-	-	-	-	.007	.015	.006	.016	.005	.017
.238	4	-	-	-	-	.012	.020	.011	.021	.010	.022
.259	3	-	-	-	-	.013	.021	.012	.022	.011	.023
.284	2	-	-	-	-	.014	.022	.013	.023	.012	.024
.300	1	-	-	-	-	.015	.023	.014	.024	.013	.025
.320	-	-	-	-	-	.016	.024	.015	.025	.014	.026
.344	-	-	-	-	-	.017	.025	.016	.026	.015	.027
.360	-	-	-	-	-	.017	.025	.016	.026	.015	.027
.375	-	-	-	-	-	-	-	.016	.026	.015	.027
.406	-	-	-	-	-	-	-	.017	.027	.016	.028
.438	-	-	-	-	-	-	-	.017	.027	.016	.028
.469	-	-	-	-	-	-	-	-	-	.016	.028
.500	-	-	-	-	-	-	-	-	-	.016	.028



**TOLERANCES A-513 Type 2
WELDED MECHANICAL STEEL TUBE
As-Welded Round Cold Rolled Electric Weld (CREW)**

DIAMETER TOLERANCES

OUTSIDE DIAMETER SIZE RANGE INCHES	WALL THICKNESS		OUTSIDE DIAMETER TOLERANCE, INCHES	
	BWG	INCHES	PLUS	MINUS
1/4 TO 3/8 INCH	22 to 14	.028 to .083	.0025	.0025
Over 3/8 to 5/8, incl	22 to 16	.028 to .065	.003	.003
Over 3/8 to 5/8, incl	14 to 12	.083 to .109	.003	.003
Over 5/8 to 1-1/8, incl	22 to 14	.028 to .083	.0035	.0035
Over 5/8 to 1-1/8, incl	13 to 11	.095 to .120	.0035	.0035
Over 1-1/8 to 2, incl	22 to 14	.028 to .083	.005	.005
Over 1-1/8 to 2, incl	13 to 9	.095 to .148	.005	.005
Over 2 to 2-1/2, inc.	20 to 14	.035 to .083	.006	.006
Over 2 to 2-1/2, incl	13 to 9	.095 to .148	.006	.006
Over 2-1/2 to 3, incl	20 to 18	.035 to .049	.008	.008
Over 2-1/2 to 3, incl	16 to 9	.065 to .148	.008	.008
Over 3 to 3-1/2, incl	20 to 9	.035 to .148	.009	.009
Over 3-1/2 to 4, incl	20 to 8	.035 to .165	.010	.010
Over 4 to 5, incl	16 to 14	.065 to .083	.020	.020
Over 4 to 5, incl	13 to 8	.095 to .165	.015	.015
Over 5 to 6, incl	16 to 8	.065 to .165	.020	.020

NOTE 1 - Measurements for diameter are to be taken at least 2 inches from the ends of the tubes.

NOTE 2 - OVALITY shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, in such cases the ovality may be 50 percent greater than the outside tolerances but the mean outside diameter shall be within the specified tolerances.

GENERAL AND TECHNICAL INFORMATION

WALL TOLERANCES

WALL THICKNESS		OUTSIDE DIAMETER, INCHES									
INCHES	BWG	3/4 to 1, incl		OVER 1 to 1-15/16 incl		OVER 1-15/16 to 3-3/4 incl		OVER 3-3/4 to 4-1/2, incl		OVER 4-1/2 to 8, incl	
		WALL THICKNESS TOLERANCES, INCHES									
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
.028	22	.001	.005	.001	.005	-	-	-	-	-	-
.035	20	.002	.005	.001	.005	.001	.005	-	-	-	-
.049	18	.003	.006	.002	.006	.002	.006	-	-	-	-
.065	16	.005	.007	.004	.007	.004	.007	.004	.007	.004	.007
.083	14	.006	.007	.005	.007	.004	.007	.004	.007	.004	.007
.095	13	.006	.007	.005	.007	.004	.007	.004	.007	.004	.008
.109	12	-	-	.006	.008	.005	.008	.005	.008	.005	.009
.120	11	-	-	.007	.008	.006	.008	.005	.008	.005	.009
.134	10	-	-	.007	.008	.006	.008	.005	.008	.005	.009



HOLLOW STRUCTURALS

ASTM A-500

TOLERANCES FOR OUTSIDE DIMENSIONS and WALL THICKNESS

Largest outside dimension across flats, inches	2-1/2 3-1/2	Over 3-1/2 5-1/2 incl.	Over 5-1/2
Tolerance for outside dimensions including convexity or concavity	± .025"	± .030"	± 1%
Wall thickness tolerance*	± 10%	± 10%	± 10%

* Note: The allowable variation in wall thickness does not apply at corners.

MAXIMUM TWIST*

Longer outside dimensions, inches	2-1/2 to 4 incl.	Over 4 to 5-1/2 incl.	Over 5-1/2 to 8 incl.	Over 8
Maximum twist per 3 feet of length, inches	.075	.087	.100	.112

*Twist is measured by holding down the edge of one end of a square of rectangular hollow structural on a surface plate with the bottom side of the tube parallel to the surface plate and noting the height that either corner on the opposite end of the bottom side is above the surface plate.

LENGTHS AND PERMISSIBLE VARIATION

Tube lengths	2'0"/12'0"	12'0"/20'0"	20'0"/32'0"
Permissible variation in length	± 3/32"	± 1/8"	± 1/4"

SQUARENESS OF SIDES. . . . Adjacent sides of hollow structural may deviate from 90 degrees by plus or minus one degree.

VARIATIONS FROM EXACT STRAIGHTNESS
Permissible variations, inches (inches camber & sweep)

$$\frac{1}{8} \times \text{number of feet of total length}$$



CARBON STEEL STRUCTURAL TUBING

ASTM A-500

COLD-FORMED WELDED AND SEAMLESS
ROUNDS AND SHAPES

This specification covers cold-formed welded and seamless carbon steel round, square, rectangular, or special shape structural tubing for welded, riveted, or bolted construction of bridges and buildings, and for general structural purposes.

This tubing is produced with a maximum periphery of 64 in. and a maximum wall of .625 in.

CHEMICAL REQUIREMENTS FOR GRADES A AND B

	Ladle Analysis	Check Analysis
Carbon, max, percent	0.26	0.30
Phosphorus, max, percent	0.04	0.05
Sulfur, max, percent	0.05	0.063
Copper, when copper steel is specified, min, percent	0.20	0.18

TENSILE REQUIREMENTS

Round Structural Tubing

	Grade A	Grade B
Tensile strength, min, psi	45 000	58 000
Yield point, min, psi	33 000	42 000
Elongation in 2 in., min, percent	25a	23b

Shaped Structural Tubing

Tensile strength, min, psi	45 000	58 000
Yield point, min, psi	39 000	46 000
Elongation in 2 in., min, percent	25a	23b

- a. Applies to specified wall thicknesses 0.120 in. and over. For wall thicknesses under 0.120 in., the minimum elongation shall be calculated by the formula: per cent elongation in 2 in. = $56 t + 17.5$.
- b. Applies to specified wall thicknesses 0.180 in. and over. For wall thicknesses under 0.180 in., the minimum elongation shall be calculated by the formula: per cent elongation in 2 in. = $61 t + 12$.

GENERAL AND TECHNICAL INFORMATION



CARBON STEEL STRUCTURAL TUBING

ASTM A 501

HOT-FORMED WELDED AND SEAMLESS

This specification covers hot-formed welded and seamless carbon steel square, rectangular, or special shape structural tubing for welded, riveted or bolted construction of bridges and buildings, and for general structural purposes.

Note – When round hot-formed tubular sections are required for structural uses, such material may be ordered in accordance with either the Specification for Welded and Seamless Steel Pipe (ASTM Designation: A 53) or the Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (ASTM Designation: A 120) and in addition by specifying those processes included in 3. Process and 4. Manufacture of this specification

CHEMICAL REQUIREMENTS

	Ladle Analysis	Check Analysis
Carbon, max, percent	0.26	0.30
Phosphorus, max, percent	0.04	0.05
Sulfur, max, percent	0.05	0.063
Copper, when copper steel is specified, min, percent	0.20	0.18

TENSILE REQUIREMENTS

Shaped Structural Tubing

Tensile strength, min, psi	58 000 ^a
Yield point, min, psi	36 000
Elongation in 2 in. min, percent ^c	23
Elongation in 8 in. min, percent ^c	20 ^b

- ^a The maximum tensile strength shall be 80,000 psi.
- ^b For material under 5/16 in. in thickness, a deduction from the percentage elongation of 1.25 per cent in 8 in. specified in Table 2 shall be made for each decrease of 1/32 in. of the specified thickness under 5/16 in.
- ^c Elongation may be determined in a gauge length of either 2 in. or 8 in. at the manufacturer's option.

GENERAL AND TECHNICAL INFORMATION



WELDED AND SEAMLESS STEEL PIPE

ASTM A-53

This specification covers seamless and welded black and hot dipped galvanized steel pipe furnished in the following types and grades:

- Type F. - Furnace - butt welded
- Type E. - Electric - resistance welded, Grades A, B, and C.
- Type S. - Seamless, Grades A, B, and C.

Pipe ordered under this specification is nominal (average) wall thickness, suitable for welding, and suitable for forming operations involving coiling, bending and flanging, subject to the following qualifications:

- (1) Type F is not intended for flanging.
- (2) When Types S and E are required for close coiling or cold bending. Grade A should be specified. This provision is not intended to prohibit the cold bending of Grade B pipe.
- (3) When pipe is required for close coiling, this should be so specified on the order.

CHEMICAL REQUIREMENTS

		Phosphorus max, percent
Type S (Seamless Pipe)	open-hearth or basic-Oxygen.	0.048
	bessemer	0.11
Type F (Furnace-welded pipe)	Open-Hearth, basic-oxygen,	0.08
	electric furnace, or acid oxygen- steam, bessemer	0.13
Type E (electric-resistance- welded)	open-hearth or basic-oxygen	0.050

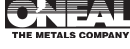
GENERAL AND TECHNICAL INFORMATION

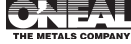
GENERAL AND TECHNICAL INFORMATION

WELDED AND SEAMLESS STEEL PIPE ASTM A-53

TENSILE REQUIREMENTS

	Type F		Types E and S	
	Acid-Bessemer	Open-Hearth Basic Oxygen, or Electric-Furnace	Grade A	Grade B
Tensile strength, min, psi	50 000	45 000	48 000	60 000
Yield point, min, psi	30 000	25 000	30 000	35 000
Elongation in 8 in., min, percent	18	20		
Elongation in 2 in., min, percent:				
Basic minimum elongation for walls $\frac{5}{16}$ in. and over in thickness, strip tests, and for all small sizes tested in full sections			35	30
When standard round 2 in. gage length test specimen is used.			28	22
For strip tests the width of the gage section shall be $1\frac{1}{2}$ in. and a deduction for each $\frac{1}{32}$ in. decrease in wall thickness below $\frac{5}{16}$ in. from the basic minimum elongation of the following percentage.			1.75	1.50





SEAMLESS CARBON STEEL PIPE

ASTM A106

FOR HIGH-TEMPERATURE SERVICE

These specifications cover seamless carbon steel pipe for high-temperature service. Pipe ordered under these specifications is nominal (average) wall and shall be suitable for bending, flanging, and similar forming operations.

Supplementary requirements of an optional nature are provided for seamless pipe intended for use in central stations having steam service pressures of 400 psi and over and high temperatures or other applications where a superior grade of pipe is required. These supplementary requirements call for additional tests to be made and when desired shall be so stated in the order.

When these products are to be used in applications conforming to ISO Recommendations for Boiler Construction, the requirements of ASTM Specification A 520, for Supplementary Requirements for Seamless and Electric-Resistance-Welded Carbon Steel Tubular Products for High Temperature Service Conforming to ISO Recommendations for Boiler Construction, shall supplement and supersede the requirements of this specification.

CHEMICAL REQUIREMENTS

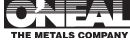
	Grade A	Grade B	Grade C ^a
Carbon, max, percent	0.25	0.30	0.35
Manganese, percent	0.27 to 0.93	0.29 to 1.06	0.29 to 1.06
Phosphorus, max, percent	0.048	0.048	0.048
Sulfur, max, percent	0.058	0.058	0.058
Silicon, min, percent	0.10	0.10	0.10

^a Grade C is a special product supplied only on agreement between the manufacturer and the purchaser.

GENERAL AND TECHNICAL INFORMATION

SEAMLESS CARBON STEEL PIPE FOR HIGH-TEMPERATURE SERVICE

ASTM A106
CONTINUED



TENSILE REQUIREMENTS

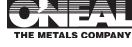
	Grade A		Grade B		Grade C	
	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
Tensile strength, min, psi		48 000		60 000		70 000
Yield point, min, psi		30 000		35 000		40 000
Elongation in 2 in., min, percent: Basic minimum elongation for walls $\frac{5}{16}$ in. and over in thickness, strip tests, and for all small sizes tested in full section	35	25	30	16.5	30	16.5
When standard round 2-in. gauge length test specimen is used	28	20	22	12	20	12
For strip tests, the width of the gauge section shall be $1\frac{1}{2}$ in. and a deduction for each $\frac{1}{32}$ in. decrease in wall thickness below $\frac{5}{16}$ in. from the basic minimum elongation of the following percentage	1.75 ^a	1.25 ^a	1.50 ^a	1.00 ^a	1.50 ^a	1.00 ^a

^a The following table gives the computed minimum values:

SEAMLESS CARBON STEEL PIPE

FOR HIGH-TEMPERATURE SERVICE

ASTM A106
CONTINUED



Wall Thickness, in.	Elongation in 2 in. min, per cent			
	Grade A		Grade B and C	
	Longitudinal	Transverse	Longitudinal	Transverse
5/16 (0.312)	35.00	25.00	30.00	16.50
9/32 (0.281)	33.25	23.75	28.50	15.50
1/4 (0.250)	31.50	22.50	27.00	14.50
5/16 (0.219)	29.75		25.50	
3/8 (0.188)	28.00		24.00	
7/16 (0.156)	26.25		25.50	
1/2 (0.125)	24.50		21.00	
5/8 (0.094)	22.75		19.50	
3/4 (0.062)	21.00		18.00	

Note – The above table gives the computed minimum elongation values for each 1/32-in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following formula:

Grade	Direction of Test	Formula
A	Longitudinal	E = 56t + 17.50
A	Transverse	E = 40t + 12.50
B and C	Longitudinal	E = 48t + 15.00
B and C	Transverse	E = 32t + 6.50

Where:
E = elongation in 2 in. in per cent, and
actual thickness of specimen, in inches.

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

STEEL PIPE SPECIFICATIONS

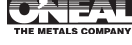
Specification	A53 – NPS 1/8 – 26 STD, XS and XXS, ANSI Schedules 10 through 160				
Scope	Covers Seamless and Welded, Black and hot-dipped galvanized nominal (average) wall pipe for coiling, bending, flanging and other special purposes and is suitable for welding. Continuous-Welded pipe is not intended for flanging. Purpose for which pipe is intended should be stated on order.				
Permissible Variations in Wall Thickness	The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.				
Chemical Requirements	C max %	Mn max %	P max %	S max %	
Seamless or ERW	0.25	0.95	0.05	0.06	
Grade A					
Grade B	0.30	1.20	0.05	0.06	
Continuous-weld			0.08	0.06	
Tensile Requirements	Continuous-Welded		Seamless and Electric-resistance-welded		Type
	Grade A	Grade B	Grade B	F-CW	
Tensile Strength, min., psi	45,000	48,000	48,000	60,000	E-ERW
Yield Strength, min., psi	25,000	30,000	30,000	35,000	S-Smis

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard or Specification for more

STEEL PIPE SPECIFICATIONS

Specification	A53 – NPS 1/8 – 26 STD, XS and XXS, ANSI Schedules 10 through 160 – continued						
Permissible Variations in Weights Per Foot	Plus or Minus 10%						
Permissible Variations in Outside Diameter	Outside Diameter at any point shall not vary from standard specified more than – <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">For NPS 1-1/2 and Smaller Sizes</td> <td style="width: 50%; border-bottom: 1px solid black;">For NPS 2 and Larger Sizes</td> </tr> <tr> <td style="border-bottom: 1px solid black;">1/64 over</td> <td style="border-bottom: 1px solid black;">1% over</td> </tr> <tr> <td style="border-bottom: 1px solid black;">1/32" under</td> <td style="border-bottom: 1px solid black;">1% under</td> </tr> </table>	For NPS 1-1/2 and Smaller Sizes	For NPS 2 and Larger Sizes	1/64 over	1% over	1/32" under	1% under
For NPS 1-1/2 and Smaller Sizes	For NPS 2 and Larger Sizes						
1/64 over	1% over						
1/32" under	1% under						
Lengths	<p>Standard Weight Single Random – 16'-22'. 5% may be jointers. If plain Ends – 5% may be 12'-16'. Double Random – Shortest Length – 22', minimum average for order – 35'. Extra Strong and Double Extra Strong Single Random – 12'-22'. 5% may be 6'-12'. Double Random (XS and lighter) – Shortest Length 22', minimum aver for order – 35'. Lengths longer than single random with wall thickness heavier than XS subject to negotiation.</p>						

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard or Specification for more details.



GENERAL AND TECHNICAL INFORMATION

STEEL PIPE SPECIFICATIONS

Specification	A106 – NPS 1/8 – 48 ANSI Schedules to 160																										
Scope	Covers SEAMLESS carbon steel nominal wall pipe for high-temperature service, suitable for bending, flanging and similar forming operations. NPS 1-1/2 and under may be either hot finished or cold drawn. NPS 2 and larger shall be hot finished unless otherwise specified.																										
Permissible Variations in Wall Thickness	The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.																										
Chemical Requirements	<table border="1"> <thead> <tr> <th></th> <th>Grade A</th> <th>Grade B</th> <th>Grade C</th> </tr> </thead> <tbody> <tr> <td>Carbon, max. %</td> <td>0.25</td> <td>0.30</td> <td>0.35</td> </tr> <tr> <td>Manganese %</td> <td>0.27 to 0.93</td> <td>0.29 to 1.06</td> <td>0.29 to 1.06</td> </tr> <tr> <td>Phosphorus, max. %</td> <td>0.025</td> <td>0.025</td> <td>0.025</td> </tr> <tr> <td>Sulfur, max %</td> <td>0.025</td> <td>0.025</td> <td>0.025</td> </tr> <tr> <td>Silicon, min %</td> <td>0.10</td> <td>0.10</td> <td>0.10</td> </tr> </tbody> </table>		Grade A	Grade B	Grade C	Carbon, max. %	0.25	0.30	0.35	Manganese %	0.27 to 0.93	0.29 to 1.06	0.29 to 1.06	Phosphorus, max. %	0.025	0.025	0.025	Sulfur, max %	0.025	0.025	0.025	Silicon, min %	0.10	0.10	0.10		
	Grade A	Grade B	Grade C																								
Carbon, max. %	0.25	0.30	0.35																								
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Silicon, min %	0.10	0.10	0.10																								
Tensile Requirements	<table border="1"> <thead> <tr> <th></th> <th>Grade A</th> <th>Grade B</th> <th>Grade C</th> </tr> </thead> <tbody> <tr> <td>Seamless</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Tensile Strength, min., psi</td> <td>48,000</td> <td>60,000</td> <td>70,000</td> </tr> <tr> <td>Yield Strength, min., psi</td> <td>30,000</td> <td>35,000</td> <td>40,000</td> </tr> </tbody> </table>		Grade A	Grade B	Grade C	Seamless				Tensile Strength, min., psi	48,000	60,000	70,000	Yield Strength, min., psi	30,000	35,000	40,000										
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Yield Strength, min., psi	30,000	35,000	40,000																								

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more

STEEL PIPE SPECIFICATIONS

Specification	A106 – NPS 1/8 – 48 ANSI Schedules to 160 – continued																		
Hydrostatic Testing	Inspection test pressures produce a stress in the pipe wall equal to 60% of specified medium yield strength (SMYS) at room temperature. Maximum Pressures are not to exceed 2500 psi for NPS 3 and under, and 2800 psi for the larger sizes. Pressure is maintained for not less than 5 seconds.																		
Permissible Variations in Weights Per Foot	Weight of any length shall not vary more than 10% over and 3.5% under that specified. NOTE – NPS 4 and smaller – weighed in lots. Larger sizes – by length.																		
Permissible Variations in Outside Diameter	Outside Diameter at any point shall not vary from standard specified more than – <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">NPS</th> <th style="text-align: center; padding: 2px;">Over</th> <th style="text-align: center; padding: 2px;">Under</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">1-1/2 and smaller</td> <td style="text-align: center; padding: 2px;">1/64"</td> <td style="text-align: center; padding: 2px;">1/32"</td> </tr> <tr> <td style="padding: 2px;">2-4</td> <td style="text-align: center; padding: 2px;">1/32"</td> <td style="text-align: center; padding: 2px;">1/32"</td> </tr> <tr> <td style="padding: 2px;">5-8</td> <td style="text-align: center; padding: 2px;">1/16"</td> <td style="text-align: center; padding: 2px;">1/32"</td> </tr> <tr> <td style="padding: 2px;">10-18</td> <td style="text-align: center; padding: 2px;">3/32"</td> <td style="text-align: center; padding: 2px;">1/32"</td> </tr> <tr> <td style="padding: 2px;">20-26</td> <td style="text-align: center; padding: 2px;">1/8"</td> <td style="text-align: center; padding: 2px;">1/32"</td> </tr> </tbody> </table>	NPS	Over	Under	1-1/2 and smaller	1/64"	1/32"	2-4	1/32"	1/32"	5-8	1/16"	1/32"	10-18	3/32"	1/32"	20-26	1/8"	1/32"
NPS	Over	Under																	
1-1/2 and smaller	1/64"	1/32"																	
2-4	1/32"	1/32"																	
5-8	1/16"	1/32"																	
10-18	3/32"	1/32"																	
20-26	1/8"	1/32"																	
Lengths	Lengths required shall be specified on order. No "joints", permitted unless otherwise specified. If no definite lengths are required, following practice applies: Single Random – 16' – 22'. 5% may be 12' – 16' Double Random – Minimum length 22', Minimum average 35'. 5% may be 16' – 22'.																		

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more details.

GENERAL AND TECHNICAL INFORMATION

STEEL PIPE SPECIFICATIONS

Specification	A252 – Piling Pipe		
Scope	Covers nominal (average) wall steel pipe piles of cylindrical shape and applies to pipe piles in which the steel cylinder acts as a permanent load-carrying member or as a shell to form cast-in-place concrete piles.		
Permissible Variations in Wall Thickness	Not more than 12.5% under the nominal wall thickness specified.		
Chemical Requirements	Seamless and Welded Pipe:		Phosphorus
	Open-hearth, Electric-furnace or Basic-oxygen		Max. % 0.050
Tensile Requirements		Grade 1	Grade 2
	Tensile Strength, min., psi	50,000	60,000
	Yield Point, min., psi	30,000	35,000
Hydrostatic Testing	None specified		

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more details.

STEEL PIPE SPECIFICATIONS

Specification	A252 – Piling Pipe – continued						
Scope	Covers nominal (average) wall steel pipe piles of cylindrical shape and applies to pipe piles in which the steel cylinder acts as a permanent load-carrying member or as a shell to form cast-in-place concrete piles.						
Permissible Variations in Weights Per Foot.	The weight of any length shall not vary more than 15% over or 5% under the weight specified. Each length shall be weighed specifically						
Permissible Variations in Outside Diameter	Shall not vary more than plus or minus 1% from the diameter specified.						
Lengths	May be ordered in single or double random lengths or in uniform lengths: <table style="margin-left: 20px; border: none;"> <tr> <td style="padding-right: 10px;">Single Random</td> <td>16' – 25', incl.</td> </tr> <tr> <td>Double Random</td> <td>Over 25' (min. avg. of 35').</td> </tr> <tr> <td>Uniform</td> <td>Plus or minus 1" on length specified.</td> </tr> </table>	Single Random	16' – 25', incl.	Double Random	Over 25' (min. avg. of 35').	Uniform	Plus or minus 1" on length specified.
Single Random	16' – 25', incl.						
Double Random	Over 25' (min. avg. of 35').						
Uniform	Plus or minus 1" on length specified.						



NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more details.

GENERAL AND TECHNICAL INFORMATION

STEEL PIPE SPECIFICATIONS

Specification	API 5L – NPS 1/8 – 26	
Scope	Covers WELDED and SEAMLESS pipe suitable for use in conveying gas, water, and oil in both the oil and natural gas industries.	
Permissible Variations in Wall Thickness	<p>NPS 2-1/2 and smaller – Seamless and welded, %</p> <p>NPS 3 – Seamless and welded, %</p> <p>NPS 4 through 18 – Seamless and welded, %</p> <p>NPS 20 and larger – Welded, %</p> <p>NPS 20 and larger – Seamless, %</p>	<p>Grade A, B, A25</p> <p>+20, -12.5</p> <p>+18, -12.5</p> <p>+15, -12.5</p> <p>+17.5, -10.0</p> <p>+15.0, -12.5</p> <p>X42 through X80</p> <p>+15, -12.5</p> <p>+15, -12.5</p> <p>+19.5, -8.0</p> <p>+17.5, -10.0</p>
Chemical Requirements	Outlines chemical requirements for seamless and welded non-expanded and cold-expanded grades A25, A, B, X42, X46, X52, X56, X60, X65, X70 and X80.	
Tensile Requirements	Lists minimum yield and tensile strength for all grades as well as a maximum tensile strength for X80. Maximum yield-to-tensile ratios outlined for cold-expanded pipe – may be waived when a fracture toughness requirement is specified.	

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more details.

STEEL PIPE SPECIFICATIONS

Specification	API 5L – NPS 1/8 – 26 – continued																			
Permissible Variations in Weights Per Foot	For each length of Standard Weight, Regular Weight, Extra Strong, and Double Extra Strong – Not more than plus 10%, minus 5%.	For Special Plain End – Not more than plus 10% minus 5%. For Carload Lots – Not more than minus 1.75%																		
Permissible Variations in Outside Diameter	Outside Diameter at any point shall not vary from standard specified More than:	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;"><u>Sizes</u></td> <td style="text-align: center;"><u>Over</u></td> <td style="text-align: center;"><u>Under</u></td> </tr> <tr> <td>NPS 1-1/2 and smaller</td> <td style="text-align: center;">1/64"</td> <td style="text-align: center;">1/32"</td> </tr> <tr> <td>NPS 2 through 4</td> <td style="text-align: center;">1%</td> <td style="text-align: center;">1% (Buttweld Only)</td> </tr> <tr> <td>NPS 2 through 18</td> <td style="text-align: center;">.75%</td> <td style="text-align: center;">.75%</td> </tr> <tr> <td>NPS 20 through 26</td> <td style="text-align: center;">1%</td> <td style="text-align: center;">1%</td> </tr> <tr> <td>Non-expanded</td> <td style="text-align: center;">1%</td> <td style="text-align: center;">1%</td> </tr> </table>	<u>Sizes</u>	<u>Over</u>	<u>Under</u>	NPS 1-1/2 and smaller	1/64"	1/32"	NPS 2 through 4	1%	1% (Buttweld Only)	NPS 2 through 18	.75%	.75%	NPS 20 through 26	1%	1%	Non-expanded	1%	1%
<u>Sizes</u>	<u>Over</u>	<u>Under</u>																		
NPS 1-1/2 and smaller	1/64"	1/32"																		
NPS 2 through 4	1%	1% (Buttweld Only)																		
NPS 2 through 18	.75%	.75%																		
NPS 20 through 26	1%	1%																		
Non-expanded	1%	1%																		
Lengths	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">Threaded & Coupled Pipe</td> <td style="text-align: center;">Shortest Length in Entire Shipment</td> <td style="text-align: center;">Shortest Length in 95% of Entire Shipment</td> <td style="text-align: center;">Minimum Average Length Entire Shipment</td> </tr> <tr> <td style="text-align: center;">Single Random</td> <td style="text-align: center;">16'-0"</td> <td style="text-align: center;">18'-0"</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">Double Random</td> <td style="text-align: center;">22'-0"</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">35'0"</td> </tr> </table>	Threaded & Coupled Pipe	Shortest Length in Entire Shipment	Shortest Length in 95% of Entire Shipment	Minimum Average Length Entire Shipment	Single Random	16'-0"	18'-0"	_____	Double Random	22'-0"	_____	35'0"							
Threaded & Coupled Pipe	Shortest Length in Entire Shipment	Shortest Length in 95% of Entire Shipment	Minimum Average Length Entire Shipment																	
Single Random	16'-0"	18'-0"	_____																	
Double Random	22'-0"	_____	35'0"																	

NOTE: This is summarized information from ASTM Standards and API Specification 5L. Please refer to the specific Standard of Specification for more details.

GENERAL AND TECHNICAL INFORMATION

STAINLESS AND HEAT RESISTING STEELS

Ladle Chemical Ranges and Limits

Chemical Composition, percent, Maximum unless otherwise shown

Type Number	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
201	0.15	5.50/7.50	0.060	0.060	1.00	16.00/18.00	3.50/5.50		N 0.25
202	0.15	7.50/10.00	0.060	0.030	1.00	17.00/19.00	4.00/6.00		N 0.25
205	.012/0.25	14.00/15.50	0.060	0.030	1.00	16.50/18.00	1.00/1.75		N 0.32/0.40
301	0.15	2.00	0.045	0.030	1.00	16.00/18.00	6.00/8.00		
302	0.15	2.00	0.045	0.030	1.00	17.00/19.00	8.00/10.00		
302Cu	0.08	2.00	0.045	0.030	1.00	17.00/19.00	8.00/10.00		Cu 3.00/4.00
302B	0.15	2.00	0.045	0.030	2.00/3.00	17.00/19.00	8.00/8/10.00		
303	0.15	2.00	0.20	0.15 min.	1.00	17.00/19.00	8.00/10.00	0.060*	
303 Se	0.15	2.00	0.20	0.060	1.00	17.00/19.00	8.00/10.00		Se 0.15 min.
304	0.08	2.00	0.045	0.030	1.00	18.00/20.00	8.00/10.50		
304L	0.030	2.00	0.045	0.030	1.00	18.00/20.00	8.00/12.00		
304N	0.08	2.00	0.045	0.030	1.00	18.00/20.00	8.00/10.50		
305	0.12	2.00	0.045	0.030	1.00	17.00/19.00	10.50/13.00		N 0.10/0.16*
308	0.08	2.00	0.045	0.030	1.00	19.00/51.00	10.00/12.00		
309	0.20	2.00	0.045	0.030	1.00	22.00/24.00	12.00/15.00		
309S	0.08	2.00	0.045	0.030	1.00	22.00/24.00	12.00/15.00		

*Also available with .16/1.30N

STAINLESS AND HEAT RESISTING STEELS

Ladle Chemical Ranges and Limits

Chemical Composition, percent, Maximum unless otherwise shown – continued

Type Number	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
310	0.25	2.00	0.045	0.030	1.50	24.00/26.00	19.00/22.00		
310S	0.08	2.00	0.045	0.030	1.50	24.00/26.00	19.00/22.00		
314	0.25	2.00	0.045	0.030	1.50/3.00	23.00/26.00	19.00/22.00		
316	0.08	2.00	0.045	0.030	1.00	16.00/18.00	10.00/14.00	2.00/3.00	
316F	0.08	2.00	0.20	0.10 min	1.00	16.00/18.00	10.00/14.00	1.75/2.50	
316L	0.030	2.00	0.045	0.030	1.00	16.00/18.00	10.00/14.00	2.00/3.00	
316N	0.08	2.00	0.045	0.030	1.00	16.00/18.00	10.00/14.00	2.00/3.00	N 0.10/0.16*
317	0.08	2.00	0.045	0.030	1.00	18.00/20.00	11.00/15.00	3.00/4.00	
317L	0.030	2.00	0.040	0.030	1.00	18.00/20.00	11.00/15.00	3.00/4.00	
321	0.08	2.00	0.045	0.030	1.00	17.00/19.00	9.00/12.00	1.00/2.00	Ti 5XC min
329	0.10	2.00	0.040	0.030	1.00	25.00/30.00	3.00/6.00		
330	0.08	2.00	0.040	0.030	0.75/1.50	17.00/20.00	34.00/37.00		
347	0.08	2.00	0.045	0.030	1.00	17.00/19.00	9.00/13.00		Cb-Ta 10xC min Cb-Ta 10xC min
348	0.08	2.00	0.045	0.030	1.00	17.00/19.00	9.00/13.00		Ta 0.10 Co 0.20
384	0.08	2.00	0.045	0.030	1.00	15.00/17.00	17.00/19.00		

*Also available with .16/.30N

GENERAL AND TECHNICAL INFORMATION

STAINLESS AND HEAT RESISTING STEELS

Ladle Chemical Ranges and Limits

Chemical Composition, percent, Maximum unless otherwise shown – continued

Type Number	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
403	0.15	1.00	0.040	0.030	0.50	11.50/13.00			Al 0.10/0.30
405	0.08	1.00	0.040	0.030	1.00	11.50/14.50			Ti 6 x C min
409	0.08	1.00	0.045	0.045	1.00	10.50/11.75			0.75
410	0.15	1.00	0.040	0.030	1.00	11.50/13.50			
414	0.15	1.00	0.040	0.030	1.00	11.50/13.50	1.25/2.50	0.60*	
416	0.15	1.25	0.060	0.15 min	1.00	12.00/14.00			Se 0.15 min
416Se	0.15	1.25	0.060	0.060	1.00	12.00/14.00			
420	Over 0.15	1.00	0.040	0.030	1.00	12.00/14.00		0.60*	
420F	Over 0.15	1.25	0.060	0.15 min	1.00	12.00/14.00		0.75/1.25	VO.15/0.30
422	0.20/0.25	1.00	0.025	0.025	0.75	11.00/13.00	0.50/1.00		W 0.75/1.25
429	0.12	1.00	0.040	0.030	1.00	14.00/16.00			
430	0.12	1.00	0.040	0.030	1.00	16.00/18.00			
430F	0.12	1.25	0.060	0.15 min	1.00	16.00/18.00		0.60*	
430F Se	0.12	1.25	0.060	0.060	1.00	16.00/18.00			Se 0.15 min

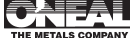
* Optional

STAINLESS AND HEAT RESISTING STEELS

Ladle Chemical Ranges and Limits

Chemical Composition, percent, Maximum unless otherwise shown – continued

Type Number	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
431	0.20	1.00	0.040	0.030	1.00	15.00/17.00	1.25/2.50	0.75/1.25	Cb-Ta 5xC Min., 0.70
434	0.12	1.00	0.040	0.030	1.00	16.00/18.00		0.75	
436	0.12	1.00	0.040	0.030	1.00	16.00/18.00		0.75	
440A	0.60/0.75	1.00	0.040	0.030	1.00	16.00/18.00		0.75	N 0.25
440B	0.75/0.95	1.00	0.040	0.030	1.00	16.00/18.00		0.75	
440C	0.95/1.20	1.00	0.040	0.030	1.00	16.00/18.00		0.75	
442	0.20	1.00	0.040	0.030	1.00	18.00/23.00			
446	0.20	1.50	0.040	0.030	1.00	23.00/27.00			
501	Over 0.10	1.00	0.040	0.030	1.00	4.00/6.00		0.40/0.65	
502	0.10	1.00	0.040	0.030	1.00	4.00/6.00		0.40/0.65	
XM-13	0.05	0.10	0.01	0.008	0.10	12.25/13.25	7.50/8.50	2.00/2.50	Al 0.90/1.35 N 0.010
XM-12	0.07	1.00	0.040	0.030	1.00	14.00/15.50	3.50/5.50		Cu 2.50/4.50 Cb-Ta 0.15/0.45



GENERAL AND TECHNICAL INFORMATION



GENERAL AND TECHNICAL INFORMATION

STAINLESS AND HEAT RESISTING STEELS

Ladle Chemical Ranges and Limits

Chemical Composition, percent, Maximum unless otherwise shown – continued

Type Number	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
17-4 PH	0.07	1.00	0.040	0.030	1.00	15.50/17.50	3.00/5.00		Cu 3.00/5.00 Cb-Ta 0.15/0.45 Al 0.75/1.50
17-7 PH	0.09	1.00	0.040	0.040	1.00	16.00/18.00	6.50/7.75		



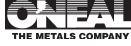
THICKNESS TOLERANCES

Cold Rolled Sheets in cut Lengths and Coils Stainless and Heat Resisting Steels

Specified Thickness, ^a in (mm)	Permissible Variations, Over and Under ^b	
	in	mm
0.005 (0.13)	0.001	0.03
Over 0.005 to 0.007 (0.13 to 0.18), incl.	0.0015	0.04
Over 0.007 to 0.016 (0.18 to 0.41), incl.	0.002	0.05
Over 0.016 to 0.026 (0.41 to 0.66), incl.	0.003	0.08
Over 0.026 to 0.040 (0.66 to 1.02), incl.	0.004	0.10
Over 0.040 to 0.058 (1.02 to 1.47), incl.	0.005	0.13
Over 0.058 to 0.072 (1.47 to 1.83), incl.	0.006	0.15
Over 0.072 to 0.083 (1.83 to 2.11), incl.	0.007	0.18
Over 0.083 to 0.098 (2.11 to 2.19), incl.	0.008	0.20
Over 0.098 to 0.114 (2.49 to 2.90), incl.	0.009	0.23
Over 0.114 to 0.130 (2.90 to 3.30), incl.	0.010	0.25
Over 0.130 to 0.145 (3.30 to 3.68), incl.	0.012	0.30
Over 0.145 to 3/16 (3.68 to 4.76), excl.	0.014	0.36

- a. Thickness measurements are taken at least 3/8 in (9.52 mm) from the edge of the sheet.
- b. Cold rolled sheets in cut lengths and coils are produced in some type numbers and some widths and thicknesses to tolerances less than those shown in the table.
- c. The tolerances shown are based on ASTM A480.

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WIDTH TOLERANCES

Hot Rolled Sheets and Cold Rolled Sheets
Not Resquared
And Cold Rolled Sheets in Coils
Stainless and Heat Resisting Steels

Tolerances, in (mm) for Specified Width		
Specified Thickness, in (mm)	24 to 48 (610 to 1,219), excl.	48 (1,219) and Over
All thicknesses	1/16 (1.59) over, 0 under	1/8 (3.8) over, 0 under

NOTE: Tolerances shown are based on ASTM A480.

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WIDTH AND LENGTH TOLERANCES Stainless Sheared Mill Plates

Width In Inches	Length in Inches	Tolerances, in inches over specified width & length for given width, length and thickness					
		Under 3/8" Thick		3/8" to 1/2" Thick, Incl.		Over 1/2" to 1" Thick, Incl.	
		Width	Length	Width	Length	Width	Length
48 and Under	144	1/8	3/16	3/16	1/4	5/16	3/8
Over 48 to 60, incl.	and	3/16	1/4	1/4	5/16	3/8	7/16
Over 60 to 84, incl.	Under	1/4	5/16	5/16	3/8	7/16	1/2
Over 84 to 108, incl.		5/16	3/8	3/8	7/16	1/2	9/16
Over 108		3/8	7/16	7/16	1/2	5/8	11/16
48 and Under	Over	3/16	3/8	1/4	1/2	5/16	5/8
Over 48 to 60, incl.	144	1/4	7/16	5/16	5/8	3/8	3/4
Over 60 to 84, incl.	To	3/8	1/2	7/16	11/16	1/2	3/4
Over 84 to 108, incl.	240	7/16	9/16	1/2	3/4	5/8	7/8
Over 108		1/2	5/8	5/8	7/8	11/16	1
48 and Under	Over	1/4	1/2	5/16	5/8	3/8	3/4
Over 48 to 60, incl.	240	5/16	5/8	3/8	3/4	1/2	3/4
Over 60 to 84, incl.	to	7/16	11/16	1/2	3/4	5/8	7/8
Over 84 to 108, incl.	360	9/16	3/4	5/8	7/8	3/4	1
Over 108		5/8	7/8	11/16	1	7/8	1
60 and Under	Over	7/16	1-1/8	1/2	1-1/4	5/8	1-3/8
Over 60 to 84, incl.	360	1/2	1-1/4	5/8	1-3/8	3/4	1-1/2
Over 84 to 108, incl.	to	9/16	1-1/4	3/4	1-3/8	7/8	1-1/2
Over 108	480	3/4	1-3/8	7/8	1-1/2	1	1-5/8
60 and Under	Over	7/16	1-1/4	1/2	1-1/2	5/8	1-5/8
Over 60 to 84, incl.	480	1/2	1-3/8	5/8	1-1/2	3/4	1-5/8
Over 84 to 108, incl.	to	5/8	1-3/8	3/4	1-1/2	7/8	1-5/8
Over 108	600	3/4	1-3/8	7/8	1-1/2	1	1-5/8
60 and Under	Over	1/2	1-3/4	5/8	1-7/8	3/4	1-7/8
Over 60 to 84, incl.	600	5/8	1-3/4	3/4	1-7/8	7/8	1-7/8
Over 84 to 108, incl.		5/8	1-3/4	3/4	1-7/8	7/8	1-7/8
Over 108		7/8	1-3/4	1	2	1-1/8	2-1/4

The tolerance under specified width and length is 1/4 inch.

GENERAL AND TECHNICAL INFORMATION



CAMBER TOLERANCES

Hot Rolled Sheets and Cold Rolled Sheets
Not Resquared
and Cold Rolled Sheets in Coils
Stainless and Heat Resisting Steels
(ASTM A480)

Camber is the greatest deviation of a side edge from a straight line, and measurement is taken by placing an 8 ft. (2,438 mm) straight edge on the concave side and measuring the greatest distance between the sheet edge and the straight edge.

Specified Width, In (mm)	Tolerance, in (mm) per Unit Length of 8 ft (2,438 mm)
24 to 36 (610 to 914), incl.	1/8 (3.18)
Over 36 (914)	3/32 (2.38)

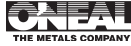
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LENGTH TOLERANCES

Hot Rolled Sheets and Cold Rolled Sheets
Not Resquared
Stainless and Heat Resisting Steels
(ASTM A480)

Length, in (mm)	Tolerance, in (mm)
Up to 120 (3,048), incl.	1/4 (6.35) over, 0 under
Over 120 to 240 (3,048 to 6,096)	1/2 (12.70) over, 0 under

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FLATNESS TOLERANCES

Hot Rolled Sheets and Cold Rolled Sheets,
Specified to Stretcher
Leveled Standard of Flatness, Not including Hard
Tempers of 2xx and 3xx series
Stainless and Heat Resisting Steels

Specified Thickness, in (mm)	Width, in (mm)	Length, in (mm)	Flatness Tolerance, ^a in (mm)
All	To 48 (1,219), incl.	To 96 (2,438), incl.	1/8 (3.18)
All	To 48 (1,219), incl.	Over 96 (2,438)	1/4 (6.35)
All	Over 48 (1,219)	To 96 (2,438), incl.	1/4 (6.35)
All	Over 48 (1,219)	Over 96 (2,438)	1/4 (6.35)

a. Maximum deviation from a horizontal flat surface.
NOTE: Tolerances shown are based on ASTM A480.

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GENERAL AND TECHNICAL INFORMATION



FLATNESS TOLERANCES

**Hot Rolled Sheets and Cold Rolled Sheets,
Not Specified to Stretcher Leveled Standard
of Flatness,
Not Including Hard Tempers of 2xx and 3xx Series,
Dead Soft Sheets and Deep Drawing Sheets
Stainless and Heat Resisting Steels
(ASTM A480)**

Specified Thickness, in (mm)	Width, in (mm)	Flatness Tolerance,^a in (mm)
Under 0.062 (1.57) incl.	To 36 (914), incl.	1/2 (12.70)
	Over 36 to 60 (914 to 1,524),	3/4 (19.05)
	Over 60 (1,564)	1 (25.40)
0.062 (1.57) and over	To 60 (1,524), incl.	1/2 (12.70)
	Over 60 to 72 (1,524 to 1,829), incl.	3/4 (19.05)

- a. Maximum deviation from a horizontal flat surface.

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RECOMMENDED MACHINING ALLOWANCES FLAME CUT PLATES

Including Circles, Rings and Sketched
Stainless and Heat Resisting Steels
(ASTM A480)

Specified Thickness, in (mm)	Machining Allowance per Edge, in (mm)
2 (51) and under	1/4 (6.35)
Over 2 to 3 (51 to 76), incl.	3/8 (9.52)
Over 3 to 6 (76 to 152), incl.	1/2 (12.70)

NOTE: The above minimum recommended machining allowances are to be added by the purchaser to each edge on all flame cut plates.

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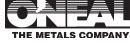
GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

THICKNESS TOLERANCES FOR PLATES

Stainless and Heat Resisting Steels

Specified thickness, in (mm)	Width, ^a in (mm)		
	To 84 (2,134), incl.	Over 84 to 120 (2,134 to 3,048), incl.	Over 120 to 144 (3,048 to 3,658), incl.
	Over 144 (3,658)		
	Tolerance, in (mm), Over Specified Thickness ^b		
3/16 to 3/8 (4.76 to 9.52), excl.	0.045 (1.14)	0.050 (1.27)	—
3/8 to 3/4 (9.52 to 19.05), excl.	0.055 (1.40)	0.060 (1.52)	0.075 (1.90)
3/4 to 1 (19.05 to 25.40), excl.	0.060 (1.52)	0.065 (1.65)	0.085 (2.16)
1 to 2 (25.40 to 50.80), excl.	0.070 (1.78)	0.075 (1.90)	0.095 (2.41)
2 to 3 (50.80 to 76.20), excl.	0.125 (3.18)	0.150 (3.81)	0.175 (4.44)
3 to 4 (76.20 to 101.60), excl.	0.175 (4.44)	0.210 (5.33)	0.245 (6.22)
4 to 6 (101.60 to 152), excl.	0.250 (6.35)	0.300 (7.62)	0.350 (8.89)
6 to 8 (152 to 203), excl.	0.350 (8.89)	0.420 (10.67)	0.490 (12.45)
8 to 10 (203 to 254), excl.	0.450 (11.43)	0.540 (13.72)	0.630 (16.00)
			0.090 (2.29)
			0.100 (2.54)
			0.115 (2.92)
			0.200 (5.08)
			0.280 (7.11)
			0.400 (10.16)
			0.560 (14.22)



- a. Thickness is measured along the longitudinal edges of the plate at least 3/8 in (9.52 mm), but not more than 3 in (76.20 mm) from the edge.
- b. For circles, the over thickness tolerances in this table apply to the diameter of the circle corresponding to the width ranges shown. For plates of irregular shape, the over thickness tolerances apply to the greatest width corresponding to the width ranges shown. For plates up to 10 in (254 mm), incl. in thickness, the tolerance under the specified thickness is 0.010 in (0.25 mm).

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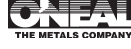
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FLATNESS TOLERANCES

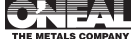
Annealed Plates Stainless and Heat Resisting Steels (ASTM A480)

Specified Thickness, in	Flatness tolerance (Deviation from a Horizontal Flat Surface), in, for Thicknesses and Width Given										
	48 or Under	Over 48 to 60, excl.	60 to 72 excl.	72 - 84 excl.	84 to 96 excl.	96 to 108 excl.	108 to 120 excl.	120 to 144 excl.	144 and Over		
3/16 to 1/4, excl.	3/4	1-1/16	1-1/4	1-3/8	1-5/8	1-7/8	2	—			
1/4 to 3/8, excl.	11/16	3/4	15/16	1-1/8	1-3/8	1-9/16	1-7/8	—			
3/8 to 1/2, excl.	1/2	9/16	11/16	3/4	15/16	1-1/4	1-7/16	1-3/4			
1/2 to 3/4, excl.	1/2	9/16	5/8	5/8	13/16	1-1/8	1-1/8	1-3/8			
3/4 to 1, excl.	1/2	9/16	5/8	5/8	3/4	15/16	1	1-1/8			
1 to 1-1/2, excl.	1/2	9/16	9/16	9/16	11/16	11/16	3/4	1			
1-1/2 to 4, excl.	3/16	5/16	3/8	7/16	1/2	5/8	3/4	7/8			
4 to 6, excl.	1/4	3/8	1/2	9/16	5/8	7/8	1	1-1/8			

Width, in



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SIZE TOLERANCES

Cold Finished Bars, Rounds Stainless and Heat Resisting Steels (ASTM A484)

Specified Size in (mm)	Size Tolerance, in (mm) ^{a, b}	
	Over	Under
Over 0.050 to 5/16 (1.27 to 7.94), excl.	0.001 (0.03)	0.001 (0.03)
5/16 to 1/2 (7.94 to 12.7), excl.	0.0015 (0.04)	0.0015 (0.04)
1/2 to 1 (12.7 to 25.4), excl.	0.002 (0.05)	0.002 (0.05)
1 to 1-1/2 (25.4 to 38.1), excl.	0.0025 (0.06)	0.0025 (0.06)
1-1/2 to 4 (38.1 to 101.6) incl. c	0.003 (0.08)	0.003 (0.08)

- a. Size tolerances are over and under as shown in the above table. Also, rounds can be produced to tolerances all over and nothing under, all under and nothing over or any combination of over and under, if the total spread in size tolerance for specified size is not less than the total spread shown in the table.
- b. When it is necessary to heat-treat or heat-treat and pickle after cold finishing, size tolerances are double those shown in the table.
- c. Cold finished bars over 4 in (101.6) in diameter are produced; size tolerances for such bars are not included herein.

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SIZE TOLERANCES

Cold Finished Bars, Hexagons, Octagons and Squares Stainless and Heat Resisting Steels (ASTM A484)

Specified Size in (mm)	Size Tolerance, in (mm) ^a	
	Over	Under
Over ^b 1/8 to 5/16 (1.59 to 7.94) excl.	0	0.002 (0.05)
Over ^b 5/16 to Ω (7.94 to 12.7), excl.	0	0.00. (0.08)
Over 1/2 to 1 (12.7 to 25), incl.	0	0.004 (0.10)
Over 1 to 2 (25 to 51), incl.	0	0.006 (0.15)
Over 2 to 3 (51 to 76), incl.	0	0.008 (0.20)
Over 3 (76)	0	0.010 (0.25)

- a. When it is necessary to heat-treat or heat-treat and pickle after cold finishing, size tolerances are double those shown in the table.
- b. Not shown in ASTM A484.

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GENERAL AND TECHNICAL INFORMATION



STRAIGHTNESS TOLERANCES

Hot Finished or Cold Finished Bars Machine Straightened Stainless and Heat Resisting Steels (ASTM A484)

Measurement is taken on the concave side of the bar with a straight edge. Hot finished or cold finished bars for machining purposes are furnished machine straightened to the following tolerances:

Hot finished:

1/8 in. in any 5 ft.; but may not exceed

$$1/8 \times \frac{\text{No. of feet in length}}{5}$$

$$\text{Tolerance in mm} - 3.18 \times \frac{\text{length (in meters)}}{1.52}$$

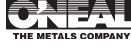
Cold finished:

1/16 in. in any 5 ft.; but may not exceed

$$1/8 \times \frac{\text{No. of feet in length}}{5}$$

$$\text{Tolerance in mm} - 1.59 \times \frac{\text{length (in meters)}}{1.52}$$

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SPECIFICATIONS

STAINLESS TUBE AND PIPE

ASTM A-249 ASME SA-249	Welded Austenitic Stainless Steel Boiler Superheater, Heat-Exchanger, and Condenser Tubes,	Pressure tubes, made from Austenitic stainless steels. (Types 304, 304H, 304L, 305, 309, 310, 316, 316H, 316L, 317, 321, 321H, 347, 347H, 348, 348H, and XM grades).
ASTM A-312 ASME SA-312	Seamless and Welded Austenitic Stainless Steel Pipe	Austenitic stainless steel pipe intended for high temperature and general corrosive service. 22 grades are covered.
ASTM A-554	Welded Stainless Steel Mechanical Tubing	Nineteen grades are covered for mechanical applications. Rounds, squares, rectangles, and special shapes are included.

STAINLESS SHEET AND SHEET COIL – COLD ROLLED ANNEALED AND PICKLED 2B FINISH

Specification	Grade
ASTM A-240 ASME A-240	304, 304L, 316, 316L, 317L 304, 304L, 316, 316L, 317L
AMS 5507	316L
AMS 5511	304L
AMS 5513	304
AMS 5524	316
QQS-766	304, 304L, 316, 316L
MIL-S-5059	304, 316

GENERAL AND TECHNICAL INFORMATION



SPECIFICATIONS

STAINLESS PLATE AND PLATE COIL

HOT ROLLED ANNEALED AND PICKLED

#1 FINISH

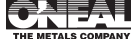
Specification	Grade
ASTM A-240 ASME SA-240	304, 304L, 316, 316L, 317L 304, 304L, 316, 316L, 317L
QQS-766	304, 304L, 316, 316L, 317L
MIL S-5059	304, 316

STAINLESS ROUNDS

COLD DRAWN, CENTERLESS GROUND, HOT ROLLED

ANNEALED AND SMOOTH TURNED

Specification	Grade
ASTM A-276	304, 304L, 316, 316L
ASTM A-479	304, 304L, 316, 316L
ASTM A-580	304, 304L, 316, 316L
ASTM A-581	416
ASTM A-582	416
AMS 5610	416
ASTM A-582	303
ASME SA-479	304, 304L, 316, 316L
QQS-763	304, 304L, 316, 316L



SPECIFICATIONS

STAINLESS FLATS

ANNEALED AND PICKLED
(TRUE FLAT BAR)

Specification	Grade
ASTM A-276	304, 304L, 316, 316L
ASTM A-479 ASME SA-479	304, 304L, 316, 316L 304, 304L, 316, 316L
QQS-763	304, 304L, 316, 316L

STAINLESS FLATS

HOT ROLLED, ANNEALED AND PICKLED
(SLIT OR SHEARED AND EDGED PLATE)

Specification	Grade
ASTM A-240 ASME SA-240	304, 304L, 316, 316L, 317L 304, 304L, 316, 316L, 317L
QQS-766	304, 304L, 316, 316L, 317L
MIL S-5059	304, 316

STAINLESS ANGLES

HOT ROLLED, ANNEALED AND PICKLED OR EXTRUDED
ANNEALED AND PICKLED

Specification	Grade
ASTM A-276	304, 304L, 316, 316L
ASTM A-479 ASME SA-479	304, 304L, 316, 316L 304, 304L, 316, 316L
QQS-763	304, 304L, 316, 316L

GENERAL AND TECHNICAL INFORMATION

CHEMICAL COMPOSITION LIMITS – WROUGHT ALUMINUM ALLOYS

AA DESIG- NATION	SILICON	IRON	COPPER	MAN- GANESE	MAG- NESIUM	CHROM- IUM	NICKEL	ZINC	TITAN- IUM	OTHERS		ALUMI- NIUM Min.
										Each	Total	
EC												
1050	0.25	0.40	0.05	0.05	0.05			0.05	0.03	0.03		99.45
1100	1.0		0.05-0.20	0.05	0.05			0.10	0.05	0.05	0.15	99.50
1145	0.55		0.05	0.05	0.05				0.05	0.03		99.00
1175	0.15		0.10	0.02	0.02			0.03	0.02	0.02	0.15	99.75
1200	1.0		0.05	0.05				0.10	0.05	0.05		99.00
1235	0.65		0.10	0.05				0.10	0.05	0.03		99.30
1345	0.30	0.40	0.10	0.05	0.05			0.10	0.05	0.03	99.45	99.35
2011	0.40	0.7	5.0-6.0						0.05	0.05		Remainder
2014	0.50-1.2	0.7	3.9-5.0	0.40-1.2	0.20-0.8	0.10		0.25	0.15	0.05	0.15	Remainder
2017	0.20-0.8	0.7	3.5-4.5	0.40-1.0	0.40-0.8	0.10		0.25	0.15	0.05	0.15	Remainder
2018	0.9	1.0	3.5-4.5	0.20	0.45-0.9	0.10		0.25	0.05	0.05	0.15	Remainder
2024	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	1.7-2.3	0.25	0.15	0.05	0.15	Remainder
2025	0.50-1.5	1.0	3.9-5.0	0.40-1.5	0.05	0.10		0.25	0.15	0.05	0.15	Remainder
2117	0.8	0.7	2.2-3.0	0.20	0.20-0.50	0.10		0.25	0.15	0.05	0.15	Remainder
2124	0.20	0.30	3.8-4.9	0.30-0.9	1.2-1.8	0.10		0.25	0.15	0.05	0.15	Remainder
2218	0.9	1.0	3.5-4.5	0.20	1.2-1.8	0.10	1.7-2.3	0.25	0.05	0.05	0.15	Remainder
2219	0.20	0.30	5.8-6.8	0.20-0.40	0.02			0.10	0.02-0.10	0.05	0.15	Remainder
2618	0.10-0.25	0.9-1.3	1.9-2.7				0.9-1.2	0.10	0.04-0.10	0.05	0.15	Remainder
3003	0.6	0.7	0.05-0.20	1.0-1.5				0.10		0.05	0.15	Remainder
3004	0.30	0.7	0.25	1.0-1.5	0.8-1.3			0.25		0.05	0.15	Remainder
3005	0.6	0.7	0.30	1.0-1.5	0.20-0.6	0.10		0.25	0.10	0.05	0.15	Remainder
3105	0.6	0.7	0.30	0.30-0.8	0.20-0.8	0.20		0.40	0.10	0.05	0.15	Remainder

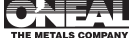
CONTINUED

CHEMICAL COMPOSITION LIMITS – WROUGHT ALUMINUM ALLOYS

CONTINUED

AA DESIGNATION	SILICON	IRON	COPPER	MAN-GANESE	MAG-NESIUM	CHROM-IUM	NICKEL	ZINC	TITAN-IUM	OTHERS		ALUMI-NUM Min.
										Each	Total	
4032	11.0-13.5	1.0	0.50-1.3		0.8-1.3	0.10	0.50-1.3	0.25		0.05	0.15	Remainder
4043	4.5-6.0	0.8	0.30	0.05	0.05			0.10	0.20	0.05	0.15	Remainder
4045	9.0-11.0	0.8	0.30	0.05	0.05			0.10	0.20	0.05	0.15	Remainder
4343	6.8-8.2	0.8	0.25	0.10				0.20		0.05	0.15	Remainder
5005	0.30	0.7	0.20	0.20	0.50-1.1	0.10		0.25		0.05	0.15	Remainder
5050	0.40	0.7	0.20	0.10	1.1-1.8	0.10		0.25		0.05	0.15	Remainder
5052	0.45	0.10	0.10	0.10	2.2-2.8	0.15-0.35		0.10		0.05	0.15	Remainder
5056	0.30	0.40	0.10	0.05-0.20	4.5-5.6	0.05-0.20		0.10		0.05	0.15	Remainder
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25		0.25	0.15	0.05	0.15	Remainder
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25		0.25	0.15	0.05	0.15	Remainder
5154	0.45		0.10	0.10	3.1-3.9	0.15-0.35		0.20	0.20	0.05	0.15	Remainder
5252	0.08	0.10	0.10	0.10	2.2-2.8					0.03	0.10	Remainder
5254	0.45		0.05	0.01	3.1-3.9	0.15-0.35		0.20	0.05	0.05	0.15	Remainder
5356	0.50	0.10	0.10	0.05-0.20	4.5-5.5	0.05-0.20		0.10	0.06-0.20	0.05	0.15	Remainder
5454	0.40		1.10	0.50-1.0	2.4-3.0	0.05-0.20		0.25	0.20	0.05	0.15	Remainder
5456	0.40		0.10	0.50-1.0	4.7-5.5	0.05-0.20		0.25	0.20	0.05	0.15	Remainder
5457	0.08	0.10	0.20	0.15-0.45	0.8-1.2			0.03		0.03	0.10	Remainder
5652	0.40		0.04	0.01	2.2-2.8	0.15-0.35		0.10		0.05	0.15	Remainder
5657	0.08	0.10	0.10	0.03	0.6-1.0			0.03		0.02	0.05	Remainder
6003	0.35-1.0	0.6	0.10	0.8	0.8-1.5	0.35		0.20	0.10	0.05	0.15	Remainder
6005	0.6-0.9	0.35	0.10	0.10	0.40-0.6	0.10		0.10	0.10	0.05	0.15	Remainder
6053		0.35	0.10		1.1-1.4	0.15-0.35				0.05	0.15	Remainder
6061	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.35		0.25	0.15	0.05	0.15	Remainder
6061	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.35		0.25	0.15	0.05	0.15	Remainder
6063	0.20-0.6	0.35	0.10	0.10	0.45-0.9	0.10		0.10	0.10	0.05	0.15	Remainder
6066	0.9-1.8	0.50	0.7-1.2	0.6-1.1	0.8-1.4	0.40		0.25	0.20	0.05	0.15	Remainder
6070	1.0-1.7	0.50	0.15-0.40	0.40-1.0	0.50-1.2	0.10		0.25	0.15	0.05	0.15	Remainder

GENERAL AND TECHNICAL INFORMATION



CHEMICAL COMPOSITION LIMITS – WROUGHT ALUMINUM ALLOYS

CONTINUED

6101	0.30-0.7	0.50	0.10	0.03	0.35-0.8	0.03	0.10	0.03	0.10	0.15	Remainder
6151	0.6-1.2	1.0	0.35	0.20	0.45-0.8	0.15-0.35	0.25	0.05	0.15	0.05	Remainder
6162	0.40-0.8	0.50	0.20	0.10	0.1-1.1	0.10	0.25	0.05	0.15	0.05	Remainder
6201	0.50-0.9	0.50	0.10	0.03	0.6-0.9	0.03	0.10	0.03	0.10	0.03	Remainder
6253	0.40-0.8	0.50	0.10	0.03	1.0-1.5	0.15-0.35	1.6-2.4	0.05	0.15	0.05	Remainder
6262	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.04-0.14	0.25	0.05	0.15	0.05	Remainder
6351	0.7-1.3	0.50	0.10	0.40-0.8	0.40-0.8	0.10	0.20	0.05	0.15	0.05	Remainder
6463	0.20-0.6	0.15	0.20	0.05	0.45-0.9	0.05	0.20	0.05	0.15	0.05	Remainder
6951	0.20-0.50	0.8	0.15-0.40	0.10	0.40-0.8	0.10	0.20	0.05	0.15	0.05	Remainder
7001	0.35	0.40	1.6-2.6	0.20	2.6-3.4	0.18-0.35	6.8-8.0	0.05	0.15	0.05	Remainder
7005	0.35	0.40	0.10	0.20-0.7	1.0-1.8	0.06-0.20	4.0-5.0	0.01-0.06	0.15	0.05	Remainder
7011	0.15	0.20	0.05	0.10-0.30	1.0-1.6	0.05-0.20	4.0-5.5	0.05	0.15	0.05	Remainder
7072	0.7	0.10	0.10	0.10	0.10	0.10	0.8-1.3	0.05	0.15	0.05	Remainder
7075	0.40	0.50	1.2-2.0	0.30	2.1-2.9	0.18-0.35	5.1-6.1	0.20	0.15	0.05	Remainder
7079	0.30	0.40	0.40-0.8	0.10-0.30	2.9-3.7	0.10-0.25	3.8-4.8	0.10	0.15	0.05	Remainder
7178	0.40	0.50	1.6-2.4	0.30	2.4-3.1	0.18-0.35	6.3-7.3	0.20	0.15	0.05	Remainder

Composition in percent maximum unless shown as a range or a minimum.

For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis is rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with AN Standard Rules for Rounding Off Numerical Values (ANSI Z25.1).

Analysis is regularly made only for the elements for which specific limits are shown, except for unalloyed aluminum. If, however, the presence of other elements is suspected to be, or in the course of routine analysis is indicated to be in excess of the specified limits, further analysis is made to determine that these other elements are not in excess of the amount specified.

The aluminum content for unalloyed aluminum not made by a refining process is the difference between 100.00 percent and the sum of all other metallic elements present in the amounts of 0.010 percent or more each expressed to the second decimal.

Also contains 0.40-0.7 percent each of lead and bismuth. Electric conductor. Cladding on a clad 2024.

Foil. Cladding on clad 1100 and clad 3003 reflector sheet. Also contains 0.20-0.6 percent each of lead and bismuth. Brazing alloy.

Bus conductor. Cladding on a clad 2014. Cladding on a clad 5056.

Cladding on a clad 2219, 3003, 3004, 6061, 7075, 7079

Silicon 45 to 65 percent of magnesium content. Beryllium 0.0008 maximum for welding electrode and filler only.

Boron 0.06 percent maximum.

Vanadium 0.05-0.15; zirconium 0.10-0.25.

Gallium 0.03 maximum; vanadium 0.04 maximum.

Zirconium plus titanium 0.20 percent maximum.

Zirconium plus titanium 0.25 percent maximum.

Zirconium 0.08-0.20

High strength cladding alloy.

BEND RADII

CONTINUED

SHEET AND PLATE – ALUMINUM

RECOMMENDED MINIMUM BEND RADII FOR 90-DEGREE
COLD FORMING OF SHEET AND PLATE

Alloy	Temper	RADII FOR VARIOUS THICKNESS EXPRESSED IN TERMS OF THICKNESS "t"										
		1/64 in.	1/32 in.	1/16 in.	1/8 in.	3/16 in.	1/4 in.	3/8 in.	1/2 in.			
1100	0	0	0	0	0	1/2t	1t	1t	1t	1 1/2t	1t	1 1/2t
	H12	0	0	0	1/2t	1t	1t	1t	1 1/2t	2t	1 1/2t	2t
	H14	0	0	1t	1t	1t	1 1/2t	2 1/2t	3t	4t	3t	4t
	H16	0	1/2t	1t	1 1/2t	1 1/2t	2 1/2t	3 1/2t	4t	4 1/2t	4t	4 1/2t
2014	0	0	0	0	1/2t	1t	1t	1t	1 1/2t	2 1/2t	2 1/2t	4t
	T3	1 1/2t	2 1/2t	3t	4t	5t	5t	5t	6t	6t	6t	7t
	T4	1 1/2t	2 1/2t	3t	4t	5t	5t	5t	6t	6t	6t	7t
	T6	3t	4t	4t	5t	6t	6t	8t	8 1/2t	9 1/2t	8 1/2t	9 1/2t
2024	0	0	0	0	1/2t	1t	1t	1t	1 1/2t	2 1/2t	2 1/2t	4t
	T3	2 1/2t	3t	4t	5t	5t	6t	6t	6t	6t	7t	7 1/2t
	T36	3t	4t	5t	6t	6t	6t	6t	6t	6t	7t	7 1/2t
	T4	3t	3t	4t	4t	5t	5t	5t	6t	6t	7t	7 1/2t
3003	T81	4 1/2t	5 1/2t	6t	7 1/2t	8t	9t	10t	10t	10 1/2t	10t	10 1/2t
	T861	5t	6t	7t	8 1/2t	9 1/2t	10t	11 1/2t	11 1/2t	11 1/2t	11 1/2t	11 1/2t
	0	0	0	0	1/2t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	H12	0	0	0	1/2t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
3003	H14	0	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	2t	2t	2 1/2t
	H16	1/2t	1t	1t	1 1/2t	2 1/2t	3t	3 1/2t	3 1/2t	3 1/2t	3 1/2t	4t
	H18	1t	1 1/2t	2t	2 1/2t	2 1/2t	4 1/2t	4 1/2t	5 1/2t	5 1/2t	5 1/2t	6 1/2t

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

SHEET AND PLATE – ALUMINUM

BEND RADII

CONTINUED

3004	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t
	H34	0	0	1t	1t	1 1/2t	1t	1t	1 1/2t	1 1/2t	2 1/2t	1 1/2t	2t
	H36	1t	1t	1t	1t	2 1/2t	3t	3t	3 1/2t	4t	4t	4 1/2t	3t
3105	H38	1t	1 1/2t	1 1/2t	1 1/2t	3t	4t	4t	5t	5t	5 1/2t	5 1/2t	6 1/2t
	H25		1/2t		1/2t								
	H12	0	0	0	0	0	1/2t	1/2t	1t	1t	1 1/2t	1 1/2t	1 1/2t
5005	H14	0	0	0	0	1t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H16	0	0	0	0	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
	H18	1t	1 1/2t	1t	1t	2 1/2t	2t	2 1/2t	3t	3t	3 1/2t	3 1/2t	4t
	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2t
	H34	0	0	0	0	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
	H36	1/2t	1 1/2t	1t	1t	2 1/2t	2 1/2t	2 1/2t	3t	3t	3 1/2t	3 1/2t	4t
	H38	1t	1 1/2t	1 1/2t	2t	2 1/2t	3 1/2t	3 1/2t	4 1/2t	4 1/2t	5 1/2t	5 1/2t	6 1/2t
	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H34	0	0	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	2t	2 1/2t	2 1/2t
5050	H36	1t	1 1/2t	1t	1 1/2t	2t	2t	2 1/2t	3t	3t	3 1/2t	3 1/2t	4t
	H38	1t	1 1/2t	1 1/2t	2 1/2t	3t	4t	4t	5t	5t	5 1/2t	5 1/2t	6 1/2t
	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H34	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
5052	H36	1t	1 1/2t	1t	1 1/2t	2 1/2t	3t	3t	3 1/2t	4t	4t	4 1/2t	5 1/2t
	H38	1t	1 1/2t	1 1/2t	2 1/2t	3t	4t	4t	5t	5t	5 1/2t	5 1/2t	6 1/2t
	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H34	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
5083	H36	1t	1 1/2t	1 1/2t	2 1/2t	3t	4t	4t	5t	5t	5 1/2t	5 1/2t	6 1/2t
	H32	0	0	0	0	1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H23		1/2t		1/2t		1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
5086	H32	0	0	0	0	1 1/2t	1t	1t	1t	1t	1 1/2t	1 1/2t	2 1/2t
	H34	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2 1/2t	2 1/2t	2 1/2t
	H36	1/2t	1t	1 1/2t	1 1/2t	2 1/2t	3 1/2t	3 1/2t	4t	4t	4 1/2t	4 1/2t	5t

SHEET AND PLATE – ALUMINUM

BEND RADII

Alloy	Temper	RADII FOR VARIOUS THICKNESS EXPRESSED IN TERMS OF THICKNESS "t"											
		1/64 in.	1/32 in.	1/16 in.	1/8 in.	3/16 in.	1/4 in.	3/8 in.	1/2 in.				
5154	0	0	0	1/2t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	H32	0	1/2t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	H34	1/2t	1t	1 1/2t	2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t
	H36	1t	1 1/2t	2t	3t	3 1/2t	3 1/2t	3 1/2t	3 1/2t	3 1/2t	3 1/2t	3 1/2t	3 1/2t
5456	H38	1 1/2t	2 1/2t	3t	4t	4t	4t	4t	4t	4t	4t	4t	4t
	0	0	0	1 1/2t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	2t	2t	2t
	H321	0	0	1 1/2t	2t	2t	2t	2 1/2t	2 1/2t	2 1/2t	3t	3t	3 1/2t
	H323	0	0	1 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	3t	3t	3 1/2t
6061	H343	0	0	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	0	0	0	0	1t	1t	1t	1t	1t	1t	1t	1 1/2t	1 1/2t
	T4	0	0	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	1t	1t	1 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t	2 1/2t
7075	0	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	0	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	3t	4t	5t	6t	6t	6t	6t	6t	6t	6t	6t	6t
7079	0	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	0	0	0	1t	1t	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	3t	4t	5t	6t	6t	6t	6t	6t	6t	6t	6t	6t
7178	0	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	0	0	0	1t	1t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t	1 1/2t
	T6	3t	4t	5t	6t	6t	6t	6t	6t	6t	6t	6t	6t

- The radii listed are the minimum recommended for bending sheets and plates without fracturing in a standard press brake with air bend dies. Other types of bending operations may require larger radii or permit smaller radii. The minimum permissible radii will also vary with the design and condition of the tooling.
- Alclad sheet in the heat-treatable alloys can be bent over slightly smaller radii than the corresponding tempers of the bare alloy
- Heat-treatable alloys can be formed over appreciably smaller radii immediately after solution heat treatment.
- The H112 temper (applicable to non-heat treatable alloys) is supplied in the as-fabricated condition without special property control but usually can be formed over radii applicable to the H14 (or H34) temper or smaller.
- Tempers T361 and T861 formerly designated T36 and T86 respectively.

GENERAL AND TECHNICAL INFORMATION

SHEET AND PLATE – ALUMINUM

ESTIMATED SHEET AND PLATE WEIGHTS IN POUNDS BASED ON ALLOY 1100*

WEIGHT TABLES
CONTINUED

For weights of other alloys and metals see conversion table at bottom of page 125.

THICKNESS INCHES	WEIGHT SQ. FT.	ESTIMATED WEIGHTS OF VARIOUS SHEET SIZES									
		24 X 72	36 X 96	36 X 120	36 X 144	48 X 96	48 X 120	48 X 144	60 X 144	60 X 180	
.012	.170	2.0	4.1	5.1	6.1	5.4	6.8	8.2	10.2	12.8	
.016	.225	2.7	5.4	6.7	8.1	7.2	9.0	10.8	13.5	16.9	
.020	.282	3.4	6.8	8.5	10.2	9.0	11.3	13.5	16.9	21.2	
.025	.353	4.2	8.4	10.6	12.7	11.3	14.1	16.9	21.2	26.5	
.032	.452	5.4	10.8	13.6	16.3	14.5	18.1	21.7	27.1	33.9	
.040	.564	6.8	13.5	16.9	20.3	18.0	22.6	27.1	33.8	42.3	
.050	.706	8.5	16.9	21.2	25.4	22.6	28.2	33.9	42.4	53.0	
.063	.889	10.7	21.3	26.7	32.0	28.4	35.6	42.7	53.3	66.7	
.071	1.00	12.0	24.0	30.0	36.0	32.0	40.0	48.0	60.0	75.0	
.080	1.13	13.6	27.1	33.9	40.7	36.2	45.2	54.2	67.8	84.8	
.090	1.27	15.2	30.5	38.1	45.7	40.6	50.8	61.0	76.5	95.3	
.100	1.41	16.9	33.8	42.3	50.8	45.1	56.4	67.7	84.6	105.8	
.125	1.76	21.1	42.2	52.8	63.4	56.3	70.4	84.5	105.6	132.0	
.160	2.25	27.0	54.0	67.5	81.0	72.0	90.0	108.0	135.0	168.8	
.190	2.69	32.3	64.6	80.7	96.1	86.1	107.6	129.1	161.4	201.8	

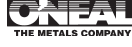
SHEET AND PLATE – ALUMINUM

WEIGHT TABLES

ESTIMATED SHEET AND PLATE WEIGHTS IN POUNDS BASED ON ALLOY 1100*

For weights of other alloys and metals see conversion table at bottom of page 125.

THICKNESS INCHES	WEIGHT SQ. FT.	ESTIMATED WEIGHTS OF VARIOUS SHEET SIZES									
		24 X 72	36 X 96	36 X 120	36 X 144	48 X 96	48 X 120	48 X 144	60 X 144	60 X 144	60 X 180
.250	3.53	42.4	84.7	105.9	127.1	113.0	141.2	169.4	211.8	264.8	
.313	4.42	53.0	106.1	132.6	159.1	141.4	176.8	212.2	265.2	331.5	
.375	5.29	63.5	127.0	158.7	190.4	169.3	211.6	253.9	317.4	396.7	
.500	7.06	84.7	169.4	211.8	254.2	225.9	282.4	338.9	423.6	529.5	
.625	8.82	106.0	212.0	264.6	317.5	282.2	352.8	423.4	529.2	661.5	
.750	10.58	127.0	254.1	317.7	381.0	339.0	423.2	508.0	635.0	794.0	
.875	12.35	148.2	296.4	370.5	444.6	395.2	494.0	592.8	741.0	926.3	
1.000	14.11	169.3	338.8	423.3	508.0	452.0	565.0	677.3	847.0	1058.3	
1.250	17.64	212.0	423.4	529.2	635.0	564.5	706.0	847.6	1058.4	1323.0	
1.500	21.17	254.0	508.3	635.1	762.1	677.4	847.0	1016.2	1270.2	1588.5	
1.750	24.70	296.4	592.8	741.0	889.2	790.4	988.0	1186.1	1482.0	1853.0	
2.000	28.22	338.6	677.3	847.0	1016.0	903.0	1129.0	1355.2	1693.0	2117.0	
2.250	31.72	381.0	762.0	953.0	1143.0	1016.0	1270.0	1524.0	1903.0	2381.3	
2.500	35.28	423.4	847.0	1058.4	1270.1	1129.0	1411.2	1693.4	2117.0	2646.0	
2.750	38.81	466.0	931.4	1164.9	1397.1	1242.0	1552.4	1863.0	2329.0	2911.0	
3.000	42.34	508.1	1016.2	1270.2	1524.2	1355.0	1694.0	2032.3	2540.4	3176.0	
4.000	56.45	677.4	1355.0	1694.0	2032.0	1806.0	2258.0	2710.0	3387.0	4234.0	
5.000	70.56	847.0	1693.0	2117.0	2540.1	2257.9	2822.4	3387.0	4233.6	5292.0	
6.000	84.67	1016.0	2032.1	2540.1	3048.1	2709.4	3387.0	4064.2	5080.2	6350.2	



GENERAL AND TECHNICAL INFORMATION

TABLE FOR ESTIMATING WEIGHTS OF ALUMINUM SHEET IN NON-STANDARD WIDTHS

Estimated pounds, per lineal foot based on alloy 1100 – for weights of other alloys, see conversion table at bottom of page 125.

THICKNESS INCHES	WIDTH – INCHES										12 (1ft.)	
	1/16	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	1 3/4		
.012	.0009	.0018	.0035	.0053	.0071	.0106	.0142	.170				
.016	.0012	.0023	.0047	.0070	.0094	.0140	.0187	.225				
.020	.0015	.0029	.0059	.0088	.0117	.0176	.0235	.282				
.025	.0018	.0037	.0074	.0110	.0147	.0221	.0294	.353				
.032	.0024	.0047	.0094	.0141	.0188	.0282	.0376	.452				
.040	.0029	.0059	.0117	.0176	.0235	.0352	.0470	.564				
.050	.0037	.0074	.0147	.0221	.0294	.0442	.0588	.706				
.063	.0046	.0093	.0185	.0278	.0378	.0555	.0740	.889				
.071	.0052	.0104	.0208	.0312	.0417	.0625	.0833	1.000				
.080	.0059	.0107	.0234	.0352	.0469	.0704	.0939	1.127				
.090	.0066	.0133	.0266	.0398	.0531	.0797	.1063	1.275				
.100	.0074	.0147	.0294	.0441	.0588	.0882	.1175	1.410				
.125	.0092	.0184	.0368	.0552	.0736	.1103	.1471	1.765				

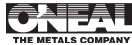
FOR WEIGHTS OF ALLOYS OR METALS OTHER THAN 1100

Multiply weights above by appropriate conversion factor below.

ALUMINUM ALLOY	CONVERSION FACTOR	ALUMINUM ALLOY	CONVERSION FACTOR	ALUMINUM ALLOY	CONVERSION FACTOR	ALUMINUM ALLOY	CONVERSION FACTOR	OTHER METALS	CONVERSION FACTOR
2014	1.03	5083	0.98	7075	1.03	Brass	3.1		
2024	1.02	5086	0.98	7079	1.01	Copper	3.3		
3003	1.01	5252	0.99	7178	1.04	Nickel	3.26		
3004	1.00	5454	0.99			Monel	3.3		
5005	1.00	5456	0.98			Steel	2.89		
5050	0.99	5457	1.00			Zinc	2.6		
5052	0.99	6061	1.00			Tin	2.69		

*0.0979 pounds per cu. in. is weight of alloy 1100, based on density of 2.71





SHEET AND PLATE – ALUMINUM
THICKNESS TOLERANCES¹

STANDARD TOLERANCES
CONTINUED

ALLOYS 2014, 2024, 2219, 3004, 5052, 5083, 5086, 5154, 5252, 5254, 5454, 5456, 5652, 6061, 7075, 7079, 7178, AND BRAZING SHEET NOS. 11, 12, 21, 22, 23 AND 24.

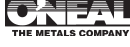
NOTE: ALSO APPLICABLE TO THE ALLOYS LISTED WHEN SUPPLIED AS ALCLAD.

SPECIFIED THICKNESS Inches	SPECIFIED WIDTH – Inches													
	Over 18 thru 18	Over 36 thru 36	Over 48 thru 48	Over 54 thru 60	Over 60 thru 66	Over 66 thru 72	Over 72 thru 78	Over 78 thru 84	Over 84 thru 90	Over 90 thru 96	Over 96 thru 132	Over 132 thru 144	Over 144 thru 156	Over 156 thru 168
	Up thru 18	Over 36 thru 48	Over 48 thru 54	Over 54 thru 60	Over 60 thru 66	Over 66 thru 72	Over 72 thru 78	Over 78 thru 84	Over 84 thru 90	Over 90 thru 96	Over 96 thru 132	Over 132 thru 144	Over 144 thru 156	Over 156 thru 168
TOLERANCE – Inches Plus and Minus														
0.321-0.438	.019	.019	.019	.020	.020	.023	.023	.025	.025	.026	.033	.038	.048	.057
0.439-0.625	.025	.025	.025	.025	.025	.025	.030	.030	.030	.030	.035	.043	.049	.067
0.626-0.875	.030	.030	.030	.030	.030	.030	.037	.037	.037	.045	.045	.054	.059	.077
0.876-1.125	.035	.035	.035	.035	.035	.035	.045	.045	.045	.055	.055	.065	.070	.088
1.126-1.375	.040	.040	.040	.040	.040	.040	.052	.052	.052	.065	.065	.075	.080	.098
1.376-1.625	.045	.045	.045	.045	.045	.045	.060	.060	.060	.075	.075	.085	.090	.108
1.626-1.875	.052	.052	.052	.052	.052	.052	.070	.070	.070	.088	.088	.100	.100	.118
1.876-2.250	.060	.060	.060	.060	.060	.060	.080	.080	.080	.100	.100	.125	.125	.143
2.251-2.750	.075	.075	.075	.075	.075	.075	.100	.100	.100	.125	.125	.150	.150	.168
2.751-3.000	.090	.090	.090	.090	.090	.090	.120	.120	.120	.150	.150	.170	.170	.188
3.001-4.000	.110	.110	.110	.110	.110	.110	.140	.140	.140	.160	.160	.180	.180	.200
4.001-5.000	.125	.125	.125	.125	.125	.125	.150	.150	.150	.160	.160	.180	.180	.200
5.001-6.000	.135	.135	.135	.135	.135	.135	.160	.160	.160	.170	.170	.190	.190	.210

GENERAL AND TECHNICAL INFORMATION

WIDTH TOLERANCES¹ SHEARED FLAT SHEET AND PLATE – ALUMINUM

SPECIFIED THICKNESS Inches	SPECIFIED WIDTH – in.					
	Up thru 6	Over 6 thru 24	Over 24 thru 60	Over 60 thru 96	Over 96 thru 132	Over 132 thru 168
0.006-0.124	+ 1/16	+ 3/32	+ 1/8	+ 1/8	+ 5/32	+ 1/2
0.125-0.249	+ 3/32	+ 3/32	+ 1/8	+ 5/32	+ 3/16	
0.250-0.499	+ 1/4	+ 5/16	+ 3/8	+ 3/8	+ 7/16	



LENGTH TOLERANCES¹ SHEARED FLAT SHEET AND PLATE – ALUMINUM

SPECIFIED THICKNESS Inches	SPECIFIED LENGTH – in.					
	Up thru 30	Over 30 thru 60	Over 60 thru 120	Over 120 thru 240	Over 240 thru 360	Over 360 thru 480
0.006-0.124	+ 1/16	+ 3/32	+ 1/8	+ 5/32	+ 3/16	+ 7/32
0.125-0.249	+ 3/32	+ 3/32	+ 1/8	+ 5/32	+ 7/32	+ 1/4
0.250-0.499	+ 1/4	+ 3/8	+ 7/16	+ 1/2	+ 9/16	+ 5/8

TOLERANCES 2-in.

Over 480
thru 600

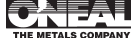
Over 600
thru 720

+ 9/32
+ 5/16
+ 11/16

—
—
+ 3/4

**WIDTH TOLERANCES¹
SLIT COILED SHEET – ALUMINUM**

SPECIFIED THICKNESS Inches	SPECIFIED WIDTH – in.					
	Up thru 6	Over 6 thru 24	Over 24 thru 60	Over 60 thru 96	Over 96 thru 132	Over 132 thru 168
	TOLERANCE 2 – in.					
0.006-0.125	0.010	0.016	1/32	3/64	1/16	1/8
0.126-0.186	0.012	0.020	1/32	1/16	3/32	—
0.187-0.249	0.016	0.025	3/64	3/32	1/8—	—



1. When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which would apply to the mean of the maximum and minimum dimensions permissible under the tolerance.
2. Tolerance applicable at ambient mill temperatures. A change in dimension of 0.013 in. per 100 in 10 F (6 C) must be recognized.

GENERAL AND TECHNICAL INFORMATION

THICKNESS TOLERANCES¹ – ALUMINUM

ALLOYS EC, 1060, 1100, 3003, 3005, 3105, 5005, 5050, 5357, 5457, 5657, 1100 REFLECTOR SHEET, CLAD 1100 REFLECTOR SHEET AND CLAD 3003 REFLECTOR SHEET.

NOTE: ALSO APPLICABLE TO THE ALLOYS LISTED WHEN SUPPLIED AS ALCLAD.

SPECIFIED THICKNESS Inches	WIDTH – Inches									
	Up thru 18	Over 18 thru 36	Over 36 thru 54	Over 54 thru 72	Over 72 thru 90	Over 90 thru 102	Over 102 thru 132	Over 132 thru 144	Over 144 thru 156	Over 156 thru 168
0.006-0.007	.001	.001	.002							
0.008-0.010	.001	.0015	.002							
0.011-0.017	.0015	.0015	.002							
0.018-0.028	.0015	.0025	.0025	.003	.004					
0.029-0.036	.002	.0025	.0025	.0035	.005	.006				
0.037-0.045	.002	.0025	.003	.004	.005	.006				
0.046-0.068	.0025	.003	.004	.005	.006	.007	.008			
0.069-0.076	.0025	.003	.004	.006	.008	.008	.009			
0.077-0.096	.003	.003	.004	.006	.008	.009	.010			
0.097-0.108	.0035	.004	.005	.007	.009	.010	.012			

THICKNESS TOLERANCES¹ – ALUMINUM

SPECIFIED THICKNESS Inches	WIDTH – Inches									
	Up thru 18	Over 18 thru 36	Over 36 thru 54	Over 54 thru 72	Over 72 thru 90	Over 90 thru 102	Over 102 thru 132	Over 132 thru 144	Over 144 thru 156	Over 156 168
TOLERANCE – Inches Plus and Minus										
0.109-0.140	.0045	.0045	.005	.007	.009	.010	.012			
0.141-0.172	.006	.006	.008	.009	.011	.012	.015			
0.173-0.203	.007	.007	.009	.011	.013	.015	.017			
0.204-0.249	.009	.009	.011	.013	.017	.020				
0.250-0.320	.013	.013	.013	.015	.017	.020	.023	.032	.040	.050
0.321-0.438	.019	.019	.019	.019	.023	.026	.026	.035	.043	.052
0.439-0.625	.025	.025	.025	.025	.030	.035	.035	.040	.046	.055
0.626-0.875	.030	.030	.030	.030	.037	.045	.045	.050	.056	.064
0.876-1.125	.035	.035	.035	.035	.045	.055	.055	.060	.066	.074
1.126-1.375	.040	.040	.040	.040	.052	.065	.065	.070	.075	.082
1.376-1.625	.045	.045	.045	.045	.060	.075	.075	.080	.085	.092
1.626-1.875	.052	.052	.052	.052	.070	.088	.088			
1.876-2.250	.060	.060	.060	.060	.080	.100	.100			
2.251-2.750	.075	.075	.075	.075	.100	.125	.125			
2.751-3.000	.090	.090	.090	.090	.120	.150	.150			
3.001-4.000	.110	.110	.110	.110	.140	.160	.160			
4.001-5.000	.125	.125	.125	.125	.150	.160				
5.001-6.000	.135	.135	.135	.135	.160	.170				

GENERAL AND TECHNICAL INFORMATION

GENERAL AND TECHNICAL INFORMATION

WIDTH AND LENGTH TOLERANCES¹ – ALUMINUM

SAWED FLAT SHEET AND PLATE

SPECIFIED THICKNESS Inches	SPECIFIED LENGTH – in.							
	Up thru 30	Over 30 thru 60	Over 60 thru 120	Over 120 thru 240	Over 240 thru 360	Over 360 thru 480	Over 480 thru 600	Over 600 thru 720
0.080-0.249 0.250-6.000	± 1/8 ± 1/4	± 1/8 ± 5/16	± 3/16 ± 3/8	± 1/4 ± 1/2	± 1/4 ± 9/16	± 5/16 ± 5/8	± 3/8 ± 3/4	± 7/16 ± 7/8

TOLERANCES 2-in.

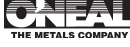
LATERAL BOW TOLERANCES

COILED SHEET

SPECIFIED THICKNESS Inches	SPECIFIED WIDTH – Inches				
	1/2 thru 1	Over 1 thru 2	Over 2 thru 4	Over 4 thru 10	Over 10
0.006-0.064 0.065-0.125 ²	3/4	9/16	3/8 3/8	1/4 1/4	3/16 3/16

TOLERANCE – Inches in 6 Feet
ALLOWABLE DEVIATION OF A SIDE EDGE
FROM A STRAIGHT LINE

1. When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which would apply to the mean of the maximum and minimum dimensions permissible under the tolerance.
2. Tolerances applicable at ambient mill temperatures. A change in dimension of 0.013 in. per 100 in. per 10 F (6° C) must be recognized.





SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
FEDERAL SPECIFICATIONS	
FED. STD. 123	Marking for domestic shipment (civilian agencies)
FED. STD. 184	Item identification marking for aluminum products
FED. STD. 245	Tolerances for aluminum wrought products
QQ-A-200	General specification for extruded rod, bar, shapes, and tube
QQ-A-200/1	3003 extruded rod, bar, shapes, and tube
QQ-A-200/2	2014 extruded rod, bar, shapes, and tube
QQ-A-200/3	2024 extruded rod, bar, shapes, and tube
QQ-A-200/4	5083 extruded rod, bar, shapes, and tube
QQ-A-200/5	5086 extruded rod, bar, shapes, and tube
QQ-A-200-6	5454 extruded rod, bar, shapes, and tube
QQ-A-200/7	5456 extruded rod, bar, shapes, and tube
QQ-A-200/8	6061 extruded rod, bar, shapes, and tube
QQ-A-200/9	6063 extruded rod, bar, shapes, and tube
QQ-A-200/10	6066 extruded rod, bar, shapes, and tube
QQ-A-200/11	7075 extruded rod, bar, shapes, and tube
QQ-A-200/12	7079 extruded rod, bar, shapes, and tube
QQ-A-200/13	7178 extruded rod, bar, shapes, and tube
QQ-A-00200/14	7178-T76 tempers-extruded rod, bar, shapes and wire
QQ-A-00200/15	7075-T76-tempers-extruded rod, bar and shapes
QQ-A-00200/16	6061 extruded structural shapes
QQ-A-200/17	6162 extruded wire, rod, bar, shapes and tube
QQ-A-225	General specification for rolled, drawn, or cold finished wire, rod, bar and special shapes
QQ-A-225/1	1100 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/2	3003 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/3	2011 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/4	2014 rolled, drawn, or cold finished wire, rod, bar, and special shapes
QQ-A-225/5	2017 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/6	2024 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/7	5052 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-225/8	6061 rolled, drawn, or cold finished wire, rod, bar, and special shapes
QQ-A-225/9	7075 rolled, drawn, or cold finished wire, rod, bar and special shapes
QQ-A-225/10	6262 rolled, drawn, or cold finished wire, rod, and bar
QQ-A-250	General specification for sheet and plate

GENERAL AND TECHNICAL INFORMATION



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
	FEDERAL SPECIFICATIONS
QQ-A-250/1	1100 sheet and plate
QQ-A-250/2	3003 sheet and plate
QQ-A-250/3	Alclad 2014 sheet and plate
QQ-A-250/4	2024 sheet and plate
QQ-A-250/5	Alclad 2024 sheet and plate
QQ-A-250/6	5083 sheet and plate
QQ-A-250/7	5086 sheet and plate
QQ-A-250/8	5052 sheet and plate
QQ-A-250/9	5456 sheet and plate
QQ-A-250/10	5454 sheet and plate
QQ-A-250/11	6061 sheet and plate
QQ-A-250/12	7075 sheet and plate
QQ-A-250/13	Alclad 7075 sheet and plate
QQ-A-250/14	7178 sheet and plate
QQ-A-250/15	Alclad 7178 sheet and plate
QQ-A-250/17	7079 sheet and plate
QQ-A-250/18	Alclad one side 7075 sheet and plate
QQ-A-250/19	5086 sheet and plate (H116 and H117)
QQ-A-250/20	5456 sheet and plate (H116 and H117)
QQ-A-00250/21	7178-T76 tempers-sheet and plate
QQ-A-00250/22	Alclad 7178-T76 tempers-sheet and plate
QQ-A-250/23	Alclad one side 7079 sheet
QQ-A-00250/24	7075-T76 tempers-sheet and plate
QQ-A-250/26	7011 Alclad 7075 sheet and plate
QQ-A-00250/27	7011 Alclad 7079 sheet and plate
QQ-A-250/28	7011 Alclad 7178 sheet and plate
QQ-A-00250/29	2124-T851 Plate
QQ-A-00250/30	2219 Plate and sheet
QQ-A-367	2014, 2018, 2025, 2218, 2219, 2618, 4032, 5083, 6061, 6066, 6151, 7075, 7076 and 7079 forgings
QQ-A-430	1100, 2017, 2024, 2117, 3003, 5052, 5056, 6053, 6061 and 7075 wire and rod for rivets and cold heading
QQ-A-435	Painted sheet
QQ-B-655	4043, 4343, 4145 and 4047 brazing filler metals
QQ-B-825	EC and 6101 bus bar
QQ-R-566	1100, 1260, 2319, 4043, 5154, 5183, 5254, 5356, 5554, 5556, 5652, 195, 142, 355, 356 and D612 welding rod
RR-W-365	Alclad 5056 insect screen wire
WW-C-00540	Rigid conduit
WW-P-402	Alclad 3004-H34 culvert pipe
WW-T-700	General specification for drawn tube, Seamless
WW-T-700/1	1100 drawn tube, seamless
WW-T-700/2	3003 drawn tube, seamless



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
FEDERAL SPECIFICATIONS	
WW-T-700/3	2024 drawn tube, seamless
WW-T-700/4	5052 drawn tube, seamless
WW-T-700/5	5086 drawn tube, seamless
WW-T-700/6	6061 drawn tube, seamless
MILITARY SPECIFICATIONS	
MIL-W-85	1100 and 6061 wave guide tube
MIL-STD-129	Marking for shipment and storage
MIL-A-148	Aluminum foil
MIL-R-1150	Rivets
MIL-C-5541	Chemical films for aluminum and aluminum alloys
MIL-H-6088	Heat treatment of aluminum alloys
MIL-W-6712	1100 and 4043 metal spraying wire
MIL-T-7081	6061 hydraulic tube
MIL-A-8625	Anodic coatings for aluminum alloys
MIL-A-8920	2219 sheet and plate
MIL-A-8923	Alclad, 7079 sheet
MIL-A-11267	8280 sheet
MIL-A-12545	1100, 2014, 6061, 6070 and 7075 impacts
MIL-E-16053	1100, 2319, 4043, 5154, 5183, 5254, 5356, 5554 and 5556 bare welding electrodes
MIL-F-17132	6061 tread plate
MIL-F-22709	Chain link fence wire and accessories
MIL-A-22771	2014, 6061, 7075 and 7079 forgings
MIL-W-23068	1100, 6061 and 6063 wave guide tube
MIL-W-23351	General specification for wave-guides
MIL-P-25995	3003, 5154, 5254, 5454, 5456, 6061 and 6063 pipe
MIL-A-45225	5083, 5456 forged armor
MIL-A-46027	5083 and 5456 armor plate
MIL-A-46083	5083, 5456 extruded armor
MIL-A-46104	6070 extruded rod, bar, shapes and tube
MIL-A-46118	2219 armor plate
MIL-A-52174	Duct sheet
MIL-A-52242	7001 extruded rod, bar and shapes
MIL-C-60536	Anodic hard coatings for aluminum alloys
MIL-C-60539	Anodic coatings for aluminum alloys
AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)	
SB209	1060, 1100, 3003, Alclad 3003, 3004, Alclad 3004, 5050, 5052, 5652, 5083, 5086, 5154, 5254, 5454, 5456, 6061 and Alclad 6061 sheet and plate
SB210	1060, 3003, Alclad 3003, 5451, 5254, 6061, and 6063 drawn seamless tube
SB211	2014, 2024 and 6061 rolled, drawn, or cold finished wire, rod and bar



SPECIFICATIONS – ALUMINUM

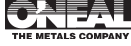
SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)	
SB221	1060, 2024, 3003, Alclad 3003, 5083, 5154, 5254, 5454, 5456, 6061 and 6063 extruded rod, bar, shapes and tube
SB234	1060, 3003, Alclad 3003, 5052, 5454 and 6061 drawn, seamless tube for condensers and heat exchangers
SB241	3003, 5083, 5154, 5454, 5456, 6061 and 6063 pipe
SB247	2014, 3003, 5083, 5456, 6053 and 6061 hand and die forgings
SB285	1100, 1260, 4043, 5652, 5154, 5254, 5554, 5356, 5556 and 5183 welding rods
SB308	6061 rolled or extruded standard structural shapes
AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)	
B209	1060, 1100, 2014, Alclad 2014, 2024, Alclad 2024, 2219, Alclad 2219, 3003, Alclad 3003, 3004, Alclad 3004, Alclad 3005, 5005, 5050, 5052, 5083, 5086, 5154, 5252, 5454, 5456, Alclad 5155, 5457, 5657, 6061, Alclad 6061, 7075, Alclad 7075, Alclad one side 7075, 7079, Alclad 7079, 7178, Alclad 7178 sheet and plate
B210	1060, 1100, 2014, 1023, 3003, Alclad 3003, 3004, 5050, 5052, 5083, 5086, 5154, 5254, 5456, 5652, 6061 6063, 6262 and 7075 drawn, seamless tube
B211	1060, 1100, 2011, 2014, 2017, 2219, 2024, 3003, 5052, 5056, 5154, 5254, Alclad 5056, 5652, 6061, 6262, and 7075 rolled, drawn, or cold-finished wire, rod and bar
B221	1060, 1100, 2014, 2219, 2024, 3003, Alclad 3003, 3004, 5052, 5652, 5083, 5085, 5154, 5254, 5454, 5456, 6005, 6061, 6063, 6262, 6351, 6463, 7075, 7079 and 7078 extruded rod, bar, shapes and tube
B230	EC-H19 wire
B231	Aluminum conductors, concentric-lay-stranded
B232	Aluminum conductors, steel reinforced, concentric-lay-stranded (ACSR)
B233	EC redraw rod
B234	1060, 3003, Alclad 3003, 5052, 5454 and 6061 drawn, seamless tube for condensers and heat exchangers
B236	EC bus conductor
B241	3003, 6061 and 6063 seamless pipe



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)	
B245	Standard weight zinc-coated (galvanized) steel core wire for aluminum conductors steel-reinforced (CASR) (ACSR)
B247	1100, 2014, 2018, 2025, 2218, 2219, 3003, 4032, 5083, 5456, 6053, 6061, 6151 and 7075 die forgings
B260	Brazing filler metal
B261	Zinc-coated (galvanized) steel core wire (with coverings heavier than standard weight) for aluminum conductors, steel-reinforced (ACSR)
B262	EC-H16 or H26 wire for electrical purposes
B285	1100, 1260, 4043, 5652, 5154, 5254, 5554, 5356, 5556, 5183, 195, 142, 355, 356 and D612 welding rod and bare electrodes
B308	6061 rolled or extruded standard structural shapes
B313	1100, 3003, 3004, Alclad 3004, 5050, 5052, 5086, 5154, and 6061 round welded tube
B314	EC-H14 or H24 wire
B316	1100, 2017, 2024, 2117, 5056, 5052, 6053, 6061 and 7075 rivet and cold-heading wire and rod
B317	6101 extruded rod, bar, structural shapes and pipe for electrical purposes
B323	EC-H14 or H24 wire
B324	EC rectangular and square wire
B341	Aluminum-coated (aluminized) steel core wire for Aluminum conductors, steel-reinforced (ACSR)
B345	1060, 3003, Alclad 3003, 3004, 5050, 5052, 5083, 5086, 5154, 5456, 6061, Alclad 6061, 6063 and 6351 pipe for gas and oil transmissions
B373	1145 and 1235 foil for capacitors
B396	5005 wire for electrical purposes
B397	Concentric-lay-stranded 5005-H19 conductor
B398	6201 wire for electrical purposes
B399	Concentric-lay-stranded 6201-T81 conductors
B400	Compact round, concentric-lay-stranded, EC conductors, hard-drawn
B401	Compact round, concentric-lay-stranded aluminum conductors, steel reinforced (ACSR)
B404	1060, 3003, Alclad 3003, 5052, 5454 and 6061 seamless condenser and heat exchanger tube with integral fins
B415	Hard drawn aluminum-clad steel wire
B416	Concentric-lay-stranded aluminum-clad steel conductors
B429	6061 and 6063 extruded structural pipe and tube

CONTINUED



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)	
B632	6061 Rolled Tread Plate
AEROSPACE MATERIAL SPECIFICATIONS (AMS)	
2201	Tolerances for rolled, drawn, cold-finished, and centerless ground wire, rod, bar and forging stock
2202	Tolerances for sheet and plate
2203	Tolerances for drawn tube
2204	Tolerances for rolled or extruded standard structural shapes
2205	Tolerances for extruded rod, bar, shapes and tube
2468	Hard-coating of aluminum alloys
2469	Process and performance requirements for hard-coating
2470	Chromic-acid anodizing of aluminum alloys
2471	Clear sulfuric-acid anodizing of aluminum alloys
2472	Dyed sulfuric-acid anodizing of aluminum alloys
2473	Chemical conversion treatments for aluminum alloys
2474	Low electrical resistivity chemical conversion treatments for aluminum alloys
2808	Identification marking of forgings
2815	Line code identification marking of welded wire
2816	Color code identification marking of welded wire
4000	1060-0 sheet
4001	1100-0 sheet and plate
4003	1100-H14 sheet and plate
4006	3003-0 sheet and plate
4008	3003-H14 sheet and plate
4010	3003-H18 foil
4012	Laminated shim stock, edge bonded
4013	Laminated shim stock, surface bonded
4014	2014-T651 plate
4015	5052-0 sheet and plate
4016	5052-H32 sheet and plate
4017	5052-H34 sheet and plate
4018	5154-0 sheet and plate
4019	5154-H32 sheet and plate
4020	Alclad 6061-T651 plate
4021	Alclad 6061-0 sheet and plate
4022	Alclad 6061-T4 sheet and T451 plate
4023	Alclad 6061-T6 sheet and T651 plate
4024	Alclad 7079-T6 sheet and 7079-T651 plate
4025	6061-0 sheet and plate
4026	6061-T4 sheet and T451 plate
4027	6061-T6 sheet and T651 plate
4028	2014-0 sheet and plate

GENERAL AND TECHNICAL INFORMATION



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AEROSPACE MATERIAL SPECIFICATIONS (AMS)	
4029	2014-T6 sheet and plate
4031	2219-0 sheet and plate
4033	2024-T351 plate
4034	Alclad 2024-T351 plate
4035	2024-0 sheet and plate
4036	Alclad one side 2024-T3 sheet and T351 plate
4037	2024-T3 sheet and T351 plate
4038	7075-T651 plate
4039	Alclad 7075-T651 plate
4040	Alclad 2024-0 sheet and plate
4041	Alclad 2024-T3 sheet and T351 plate
4042	Alclad 2024-T36 sheet and plate up through 48 in. wide
4043	6061-T451 plate
4044	7075-0 sheet and plate
4045	7075-T6 sheet and T651 plate
4046	Alclad one side 7075-T6 sheet and T651 plate
4047	7075-T6 roll tapered sheet and plate
4048	Alclad 7075-0 sheet and plate
4049	Alclad 7075-T6 sheet and plate
4051	Alclad 7178-0 sheet and plate
4052	Alclad 7178-T6 sheet and plate
4053	6061-T651 plate
4054	Brazing sheet No. 21-0
4055	Brazing sheet No. 22-0
4056	5083-0 sheet and plate
4057	5083-H323 sheet
4058	5083-H343 sheet
4059	5083-H321 sheet and plate
4060	Alclad 2024-T36 sheet and plate over 48 through 60 in. wide
4061	Alclad 2024-T36 sheet and plate over 60 in. wide
4062	1100-H14 drawn tube
4065	3003-0 drawn tube
4067	3003-H14 drawn tube
4069	5052-0 drawn tube, special tolerances
4070	5052-0 drawn tube
4071	5052-0 drawn, hydraulic tube
4072	Alclad 2024-T86 sheet and plate up through 30 in. wide
4073	Alclad 2024-T86 sheet and plate over 30 through 48 in. wide
4074	Alclad 2024-T86 sheet and plate over 48 through 60 in. wide
4075	Alclad 2024-T86 sheet and plate over 60 in. wide
4077	Alclad one side 2024-0 sheet and plate
7078	7075-T7351 plate

GENERAL AND TECHNICAL INFORMATION



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AEROSPACE MATERIAL SPECIFICATIONS (AMS)	
4079	6061-0 drawn tube, special tolerances
4080	6061-0 drawn tube
4081	6061-T4 drawn, hydraulic tube
4082	6061-T6 drawn tube
4083	6061-T6 drawn, hydraulic tube
4086	2024-T3, hydraulic tube
4087	2024-0 drawn tube
4088	2024-T3 drawn tube
4097	2024-T36 sheet and plate up through 48 in. wide
4098	2024-T36 sheet and plate over 48 through 60 in. wide
4099	2024-T36 sheet and plate over 60 in. wide
4102	1100-F rolled or cold-finished wire, rod and bar
4103	2024-T86 sheet and plate up through 30 in. wide
4104	2024-T86 sheet and plate over 30 through 48 in. wide
4105	2024-T86 sheet and plate over 48 through 60 in. wide
4106	2024-T86 sheet and plate over 60 in. wide
4110	2017-T451 rolled or cold-finished rod and bar
4112	2024-T6 rolled, drawn, or cold-finished wire, rod and bar
4114	5052-F rolled or cold finished wire, rod and bar
4115	6061-0 rolled, drawn, or cold finished wire, rod and bar
4116	6061-T4 rolled or cold finished wire, rod and bar
4117	6061-T6 rolled, drawn, or cold finished wire, rod and bar
4118	2017-T4 rolled, drawn, or cold finished wire, rod and bar
4119	2024-T351 rolled or cold finished rod and bar
4120	2024-T4 rolled, drawn, or cold finished wire, rod and bar
4121	2014-T6 rolled, drawn or cold finished wire, rod and bar
4122	7075-T6 rolled or cold finished wire, rod and bar
4123	7075-T651 rolled or cold finished rod and bar
4124	7075-T7351 rolled or cold finished bar
4125	6151-T6 forgings
4127	6061-T-6 die forgings and rolled rings and 60610F forging stock
4130	2025-T6 forgings
4132	2618-T61 forgings
4134	2014-T4 forgings
4135	2014-T6 forgings
4136	7079-T611 forgings
4138	7079-T6 forgings



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
AEROSPACE MATERIAL SPECIFICATIONS (AMS)	
4139	7075-T6 forgings
4140	2018-T61 forgings
4141	7075-T73 die forgings and forging stock
4142	2218-F forgings
4143	2219-T6 forgings
4144	2219-T852 forgings
4145	4032-T6 forgings
4146	6061-T4 die forgings and rolled rings and 6061-F forging stock
4147	7075-T7352 forgings
4148	7175-T66 forgings and 7175 forging stock
4149	7175-T736 forgings and 7175 forging stock
4150	6061-T6 extruded wire, rod, bar, shapes and tube
4152	2024-T4 extruded rod, bar, shapes and tube
4153	2014-T6 extruded rod, bar, shapes and tube
4154	7075-T6 extruded rod, bar, shapes and tube
4156	6063-T6 extruded rod, bar and shapes
4158	7178-T6 extruded rod, bar and shapes
4160	6061-0 extruded wire, rod, bar, shapes and tube
4161	6061-T4 extruded wire, rod, bar, shapes and tube
4164	2024-T3510 extruded rod, bar, shapes and round tube
4165	2024-T3511 extruded rod, bar, shapes and round tube
4167	7075-T73511 extruded rod, bar and shapes
4168	7075-T6510 extruded rod, bar, shapes and round tube
4169	7075-T6511 extruded rod, bar, shapes and round tube
4170	7075-T6 impacts
4171	7079-T6 extruded rod, bar and shapes
4172	6061-T4511 extruded rod, bar, shapes and tube
4173	6061-T6511 extruded rod, bar, shapes and tube
4175	5052-H191 aluminum alloy honeycomb core
4176	5056-H191 aluminum alloy honeycomb core
4180	1100-H18 wire for metal spraying
4182	5056-0 wire
4184	4145 brazing metal
4185	4047 brazing metal
4190	4043-F welding wire and rod
4191	2319-F welding wire and rod
4192	2024-T361 sheet and plate
4193	2024-T861 sheet and plate
4194	Alclad and 1-1/2 % alclad 2024-T361 flat sheet and plate
4195	Alclad and 1-1/2 % alclad 2024-T861 flat sheet and plate

GENERAL AND TECHNICAL INFORMATION



SPECIFICATIONS – ALUMINUM

SPECIFICATION NUMBER	ALLOY AND PRODUCT OR PROCESS COVERED
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AEROSPACE MATERIAL SPECIFICATIONS (AMS)

4196	7011 Alclad 7075-0 sheet and plate
4197	7011 Alclad 7075-T6 sheet and T651 plate
4198	7011 Alclad 7079-0 sheet and plate
4199	7011 Alclad 7079-T6 sheet and – T651 plate

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B36.10	Standard dimensions for pipe
C7.20	EC-H19 wire (same as ASTM B230)
C7.23	EC redraw rod (same as ASTM B233)
C7.35	EC-H16 or H26 wire (same as ASTM B262)
C7.40	EC-H14 or H24 wire for communication cable (same as ASTM B314)
C7.42	EC-H14 or H24 wire for electrical purposes (same as ASTM B323)
C7.43	EC rectangular and square wire (same as ASTM B324)
C80.5	Aluminum alloy rigid conduit
H35.1	Alloy and temper designation systems for wrought aluminum
H35.2	Dimensional tolerances for aluminum mill products
H38.2	Aluminum alloy sheet and plate (same as ASTM B209)
H38.3	Aluminum alloy drawn, seamless tube (same as ASTM B210)
H38.4	Aluminum alloy rolled, drawn or cold finished wire, Rod and bar (same as ASTM B211)
H38.5	Aluminum alloy extruded rod, bar, shapes and tube (same as ASTM B221)
H38.6	Aluminum alloy drawn, seamless tube for condensers and heat exchangers (same as ASTM B234)
H38.7	Aluminum alloy pipe (same as ASTM B241)
H38.8	Aluminum alloy die forgings (same as ASTM B247)
H38.10	Aluminum alloy rolled or extruded standard structural shapes (same as ATM B308)
H38.11	Aluminum alloy round, welded tube (same as ASTM B313)
H38.12	Aluminum alloy rivet and cold heading wire and rod (same as ASTM B316)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

H38.13	Aluminum alloy pipe for gas and oil transmission and distribution piping systems (same as ASTM B345)
Z25.1	Rules for rounding-off numerical values