

DATA SECTION

Chemical Compositions

| | |
|-------------------------------------|----|
| SAE Bar Composition | |
| Nonsulfurized Carbon Steel | 58 |
| Resulfurized Carbon Steel | 58 |
| Rephosphorized & Resulfurized | 58 |
| Carbon Steel | 58 |
| Standard Alloy Steel..... | 59 |
| SAE Plate Composition | 59 |

Mechanical Properties

| | |
|--|----|
| Case Hardening or Low Carbon Bars | 60 |
| Medium Carbon or Direct Hardening Bars | 60 |
| High Carbon or Direct Hardening Bars | 61 |
| Heat Treated Bars | 62 |
| Plates..... | 63 |
| Stainless Steel..... | 64 |

Tolerances

| | |
|----------------------------------|----|
| Carbon & Alloy Plate | 66 |
| Sheet Thickness Tolerances | 66 |
| HR Carbon & Alloy Bars..... | 67 |
| CF Carbon Bars | 68 |
| CF Alloy Bars | 68 |
| Structurals | 69 |
| Stainless Steel..... | 69 |
| Sheared Mill Plates | 70 |

Useful Formulas & Conversions

| | |
|---|----|
| Cold Finished Bar Machining Allowance | 71 |
| Machinability Ratings for | |
| Cold Drawn | |
| Steel Bars..... | 71 |
| Approximate Hardness Conversion Numbers for Steel | 72 |
| Circumference & Areas of Circles/Inches | 72 |
| Cold Rolled Steel Strip Tempers & Edges | 73 |
| Metric System of Measurement | 74 |
| Inches to Millimeters..... | 75 |
| Millimeters to Inches..... | 75 |
| Useful Information | 76 |
| Fractions & Decimal Equivalents..... | 77 |

| | |
|--------------------|----|
| Notes | 78 |
|--------------------|----|



SAE Bar Compositions

Reference ASTM A29 & SAE J403
Nonresulfurized Carbon Steels

| SAE No. | C | Mn | P Max. | S Max. |
|---------|-----------|-----------|--------|--------|
| 1005 | 0.06 max | 0.35 max | .040 | .050 |
| 1006 | 0.08 max | 0.25-0.40 | .040 | .050 |
| 1008 | 0.10 max | 0.30-0.50 | .040 | .050 |
| 1010 | 0.08-0.13 | 0.30-0.60 | .040 | .050 |
| 1011 | 0.08-0.13 | 0.60-0.90 | .040 | .050 |
| 1012 | 0.10-0.15 | 0.30-0.60 | .040 | .050 |
| 1013 | 0.11-0.16 | 0.50-0.80 | .040 | .050 |
| 1015 | 0.13-0.18 | 0.30-0.60 | .040 | .050 |
| 1016 | 0.13-0.18 | 0.60-0.90 | .040 | .050 |
| 1017 | 0.15-0.20 | 0.30-0.60 | .040 | .050 |
| 1018 | 0.15-0.20 | 0.60-0.90 | .040 | .050 |
| 1019 | 0.15-0.20 | 0.70-1.00 | .040 | .050 |
| 1020 | 0.18-0.23 | 0.30-0.60 | .040 | .050 |
| M1020 | 0.17-0.24 | 0.25-0.60 | .040 | .050 |
| 1021 | 0.18-0.23 | 0.60-0.90 | .040 | .050 |
| 1022 | 0.18-0.23 | 0.70-1.00 | .040 | .050 |
| 1023 | 0.20-0.25 | 0.30-0.60 | .040 | .050 |
| 1025 | 0.22-0.28 | 0.30-0.60 | .040 | .050 |
| 1026 | 0.22-0.28 | 0.60-0.90 | .040 | .050 |
| 1029 | 0.25-0.31 | 0.60-0.90 | .040 | .050 |
| 1030 | 0.28-0.34 | 0.60-0.90 | .040 | .050 |
| 1034 | 0.32-0.38 | 0.50-0.80 | .040 | .050 |
| 1035 | 0.32-0.38 | 0.60-0.90 | .040 | .050 |
| 1037 | 0.32-0.38 | 0.70-1.00 | .040 | .050 |
| 1038 | 0.35-0.42 | 0.60-0.90 | .040 | .050 |
| 1039 | 0.37-0.44 | 0.70-1.00 | .040 | .050 |
| 1040 | 0.37-0.44 | 0.60-0.90 | .040 | .050 |
| 1042 | 0.40-0.47 | 0.60-0.90 | .040 | .050 |
| 1043 | 0.40-0.47 | 0.70-1.00 | .040 | .050 |
| 1044 | 0.43-0.50 | 0.30-0.60 | .040 | .050 |
| M1044 | 0.40-0.50 | 0.25-0.60 | .040 | .050 |
| 1045 | 0.43-0.50 | 0.60-0.90 | .040 | .050 |
| 1046 | 0.43-0.50 | 0.70-1.00 | .040 | .050 |
| 1049 | 0.46-0.53 | 0.60-0.90 | .040 | .050 |
| 1050 | 0.48-0.55 | 0.60-0.90 | .040 | .050 |
| 1053 | 0.48-0.55 | 0.70-1.00 | .040 | .050 |
| 1055 | 0.50-0.60 | 0.60-0.90 | .040 | .050 |
| 1059 | 0.55-0.65 | 0.50-0.80 | .040 | .050 |
| 1060 | 0.55-0.65 | 0.60-0.90 | .040 | .050 |
| 1064 | 0.60-0.70 | 0.50-0.80 | .040 | .050 |
| 1065 | 0.60-0.70 | 0.60-0.90 | .040 | .050 |
| 1069 | 0.65-0.75 | 0.40-0.70 | .040 | .050 |
| 1070 | 0.65-0.75 | 0.60-0.90 | .040 | .050 |
| 1071 | 0.65-0.75 | 0.75-1.05 | .040 | .050 |
| 1074 | 0.70-0.80 | 0.50-0.80 | .040 | .050 |
| 1075 | 0.70-0.80 | 0.40-0.70 | .040 | .050 |
| 1078 | 0.72-0.85 | 0.30-0.60 | .040 | .050 |
| 1080 | 0.75-0.88 | 0.60-0.90 | .040 | .050 |
| 1084 | 0.80-0.93 | 0.60-0.90 | .040 | .050 |
| 1086 | 0.80-0.93 | 0.30-0.50 | .040 | .050 |
| 1090 | 0.85-0.93 | 0.60-0.90 | .040 | .050 |
| 1095 | 0.90-1.03 | 0.30-0.50 | .040 | .050 |

Continued

| SAE No. | C | Mn | P Max. | S Max. |
|---------|-----------|-----------|--------|--------|
| 1513 | 0.10-0.16 | 1.10-1.40 | .040 | .050 |
| 1518 | 0.15-0.21 | 1.10-1.40 | .040 | .050 |
| 1522 | 0.18-0.24 | 1.10-1.40 | .040 | .050 |
| 1524 | 0.19-0.25 | 1.35-1.65 | .040 | .050 |
| 1525 | 0.23-0.29 | 0.80-1.10 | .040 | .050 |
| 1526 | 0.22-0.29 | 1.10-1.40 | .040 | .050 |
| 1527 | 0.22-0.29 | 1.20-1.50 | .040 | .050 |
| 1536 | 0.30-0.37 | 1.20-1.50 | .040 | .050 |
| 1541 | 0.36-0.44 | 1.35-1.65 | .040 | .050 |
| 1547 | 0.43-0.51 | 1.35-1.65 | .040 | .050 |
| 1548 | 0.44-0.52 | 1.10-1.40 | .040 | .050 |
| 1551 | 0.45-0.56 | 0.85-1.15 | .040 | .050 |
| 1552 | 0.47-0.55 | 1.20-1.50 | .040 | .050 |
| 1561 | 0.55-0.65 | 0.75-1.05 | .040 | .050 |
| 1566 | 0.60-0.71 | 0.85-1.15 | .040 | .050 |
| 1572 | 0.65-0.76 | 1.00-1.30 | .040 | .050 |

SAE Bar Compositions

Resulfurized Carbon Steels

| SAE No. | C | Mn | P Max. | S Max. |
|---------|-----------|-----------|--------|---------|
| 1108 | 0.08-0.13 | 0.60-0.80 | .040 | .08-.13 |
| 1110 | 0.08-0.13 | 0.30-0.60 | .040 | .08-.13 |
| 1117 | 0.14-0.20 | 1.00-1.30 | .040 | .08-.13 |
| 1116 | 0.14-0.20 | 1.10-1.40 | .040 | .16-.23 |
| 1118 | 0.14-0.20 | 1.30-1.60 | .040 | .08-.13 |
| 1119 | 0.14-0.20 | 1.00-1.30 | .040 | .24-.33 |
| 1137 | 0.32-0.39 | 1.35-1.65 | .040 | .08-.13 |
| 1139 | 0.35-.430 | 1.35-1.65 | .040 | .13-.20 |
| 1140 | 0.37-.440 | 0.70-1.00 | .040 | .08-.13 |
| 1141 | 0.37-.450 | 1.35-1.65 | .040 | .08-.13 |
| 1144 | 0.40-.480 | 1.35-1.65 | .040 | .24-.33 |
| 1145 | 0.42-.490 | 0.70-1.00 | .040 | .04-.07 |
| 1146 | 0.42-.490 | 0.70-1.00 | .040 | .08-.13 |
| 1151 | 0.48-.550 | 0.70-1.00 | .040 | .08-.13 |

SAE Bar Compositions

Rephosphorized and Resulfurized Carbon Steels

| SAE No. | C | Mn | P | S | Pb |
|---------|-----------|------------|---------|---------|---------|
| 1211 | 0.13 max. | 0.60-0.90 | .07-.12 | .10-.15 | - |
| 1212 | 0.13 max. | 0.70-1.00 | .07-.12 | .16-.23 | - |
| 1213 | 0.13 max. | 0.70-1.00 | .07-.12 | .24-.33 | - |
| 12L13 | 0.13 max. | 0.70-1.00 | .07-.12 | .24-.33 | .15-.35 |
| 1215 | 0.09 max. | 0.75-1.05 | .04-.09 | .26-.35 | - |
| 12L14 | 0.15 max. | 0.85-.1.15 | .04-.09 | .26-.35 | .15-.35 |
| 12L15 | 0.09 max. | 0.75-1.05 | .04-.09 | .26-.35 | .15-.35 |

SAE Bar Compositions

Standard Alloy Steel

| SAE No. | C | Mn | Ni | Cr | Mo |
|---|----------|-----------|-----------|-----------|---------|
| MOLYBDENUM STEELS | | | | | |
| 4012 | .09-0.14 | 0.75-1.00 | — | — | .15-.25 |
| 4023 | .20-0.25 | 0.70-0.90 | — | — | .20-.30 |
| 4024 | .20-0.25 | 0.70-0.90 | — | — | .20-.30 |
| 4027 | .25-0.30 | 0.70-0.90 | — | — | .20-.30 |
| 4028 | .25-0.30 | 0.70-0.90 | — | — | .20-.30 |
| 4032 | .30-0.35 | 0.70-0.90 | — | — | .20-.30 |
| 4037 | .35-0.40 | 0.70-0.90 | — | — | .20-.30 |
| 4042 | .40-0.45 | 0.70-0.90 | — | — | .20-.30 |
| 4047 | .45-0.50 | 0.70-0.90 | — | — | .20-.30 |
| NICKEL—CHROMIUM—MOLYBDENUM STEELS | | | | | |
| 4118 | .18-0.23 | 0.70-0.90 | — | 0.40-0.60 | .08-.15 |
| 4130 | .28-0.33 | 0.40-0.60 | — | 0.80-1.10 | .15-.25 |
| 4135 | .33-0.38 | 0.70-0.90 | — | 0.80-1.10 | .15-.25 |
| 4137 | .35-0.40 | 0.70-0.90 | — | 0.80-1.10 | .15-.25 |
| 4140 | .38-0.43 | 0.75-1.00 | — | 0.80-1.10 | .15-.25 |
| 4142 | .40-0.45 | 0.75-1.00 | — | 0.80-1.10 | .15-.25 |
| 4145 | .43-0.48 | 0.75-1.00 | — | 0.80-1.10 | .15-.25 |
| 4147 | .45-0.50 | 0.75-1.00 | — | 0.80-1.10 | .15-.25 |
| 4150 | .48-0.53 | 0.75-1.00 | — | 0.80-1.10 | .15-.25 |
| 4161 | .56-0.64 | 0.75-1.00 | — | 0.70-0.90 | .25-.35 |
| NICKEL 1.75%—MOLYBDENUM 0.25% STEEL | | | | | |
| 4615 | .13-0.18 | 0.45-0.65 | 1.65-2.00 | — | .20-.30 |
| 4620 | .17-0.22 | 0.45-0.65 | 1.65-2.00 | — | .20-.30 |
| 4621 | .18-0.23 | 0.70-0.90 | 1.65-2.00 | — | .20-.30 |
| 4626 | .24-0.29 | 0.45-0.65 | 0.70-1.00 | — | .15-.25 |
| NICKEL 1.05%—CHROMIUM 0.45% MOLYBDENUM 0.20% | | | | | |
| 4718 | .16-0.21 | 0.70-0.90 | 0.90-1.20 | 0.35-0.55 | .30-.40 |
| 4720 | .17-0.22 | 0.50-0.70 | 0.90-1.20 | 0.35-0.55 | .15-.25 |
| NICKEL 3.50%—MOLYBDENUM 0.25% | | | | | |
| 4815 | .13-0.18 | 0.40-0.60 | 3.25-3.75 | — | .20-.30 |
| 4817 | .15-0.20 | 0.40-0.60 | 3.25-3.75 | — | .20-.30 |
| 4820 | .18-0.23 | 0.50-0.70 | 3.25-3.75 | — | .20-.30 |
| CHROMIUM STEEL | | | | | |
| 5017 | .12-0.17 | 0.30-0.50 | — | 0.30-0.50 | — |
| 5046 | .43-0.48 | 0.75-1.00 | — | 0.20-0.35 | — |
| 5115 | .13-0.18 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5117 | .15-0.20 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5120 | .17-0.22 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5130 | .28-0.33 | 0.70-0.90 | — | 0.80-1.10 | — |
| 5132 | .30-0.35 | 0.60-0.80 | — | 0.75-1.00 | — |
| 5135 | .33-0.38 | 0.60-0.80 | — | 0.80-1.05 | — |
| 5140 | .38-0.43 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5145 | .43-0.48 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5147 | .46-0.51 | 0.70-0.95 | — | 0.85-1.15 | — |
| 5150 | .48-0.53 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5155 | .51-0.59 | 0.70-0.90 | — | 0.70-0.90 | — |
| 5160 | .56-0.64 | 0.75-1.00 | — | 0.70-0.90 | — |
| E50100 | .98-1.10 | 0.25-0.45 | — | 0.40-0.60 | — |
| E51100 | .98-1.10 | 0.25-0.45 | — | 0.90-1.15 | — |
| E52100 | .98-1.10 | 0.25-0.45 | — | 1.30-1.60 | — |

| SAE No. | C | Mn | Ni | Cr | Mo | |
|--|----------|-----------|-----------|-----------|----------|---------|
| CHROMIUM—VANADIUM STEELS | | | | | | |
| 6118 | .16-0.21 | 0.50-0.70 | — | 0.50-0.70 | .10-.15V | |
| 6150 | .48-0.53 | 0.70-0.90 | — | 0.80-1.10 | .15min.V | |
| NICKEL 0.55%—CHROMIUM 0.50% MOLYBDENUM 0.20%—0.30% | | | | | | |
| 8615 | .13-0.18 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8617 | .15-0.20 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8620 | .18-0.23 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8622 | .20-0.25 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8625 | .23-0.28 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8627 | .25-0.30 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8630 | .28-0.33 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8637 | .35-0.40 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8640 | .38-0.43 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8642 | .40-0.45 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8645 | .48-0.48 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8650 | .48-0.53 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8655 | .51-0.59 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8660 | .56-0.64 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .15-.25 | |
| 8720 | .18-0.23 | 0.70-0.90 | 0.40-0.70 | 0.40-0.60 | .20-.30 | |
| 8740 | .38-0.43 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .20-.30 | |
| 8822 | .20-0.25 | 0.75-1.00 | 0.40-0.70 | 0.40-0.60 | .30-.40 | |
| 9260 | .56-0.64 | 0.75-1.00 | — | — | — | |
| STANDARD BORON STEELS Boron content of 0.0005% to 0.003% | | | | | | |
| SAE No. | C | Mn | Si | Ni | Cr | Mo |
| 50B40 | .38-0.43 | 0.75-1.00 | .15.35 | — | 40-.60 | — |
| 50B44 | .43-0.48 | 0.75-1.00 | .15-.35 | — | 40-.60 | — |
| 50B46 | .44-0.49 | 0.75-1.00 | .15-.35 | — | 20-.35 | — |
| 50B50 | .48-0.53 | 0.75-1.00 | .15-.35 | — | 40-.60 | — |
| 50B60 | .56-0.64 | 0.75-1.00 | .15-.35 | — | 40-.60 | — |
| 51B60 | .56-0.64 | 0.75-1.00 | .15-.35 | — | 70-.90 | — |
| 81B45 | .43-0.48 | 0.75-1.00 | .15-.35 | .20-.40 | .35-.55 | .08-.15 |
| 86B45 | .43-0.48 | 0.75-1.00 | .15-.35 | .40-.70 | 40-.60 | .15-.25 |
| 94B15 | .13-0.18 | 0.75-1.00 | .15-.35 | .30-.60 | .30-.50 | .08-.15 |
| 94B17 | .15-0.20 | 0.75-1.00 | .15-.35 | .30-.60 | .30-.50 | .08-.15 |
| 94B30 | .28-0.33 | 0.75-1.00 | .15-.35 | .30-.60 | .30-.60 | .08-.15 |

NOTE: Phosphorous is 0.35% max., sulfur, 0.040% max.

SAE Plate Compositions

Standard Alloy Steels

| SAE No. | C | Mn | Ni | Cr | Mo |
|---------|----------|----------|-----------|----------|----------|
| 4130 | .27-0.34 | .35-0.60 | — | .80-1.15 | .15-0.25 |
| 4140 | .36-0.44 | .70-1.00 | — | .80-1.15 | .15-0.25 |
| E4150 | .46-0.54 | .75-1.10 | — | .80-1.15 | .15-0.25 |
| 4340 | .36-0.44 | .55-0.80 | 1.65-2.00 | .60-0.90 | .20-0.30 |
| 6150 | .46-0.54 | .60-0.90 | — | .80-1.15 | — |
| 8615 | .12-0.18 | .60-0.90 | .40-0.70 | .35-0.60 | .15-0.25 |
| 8617 | .15-0.21 | .60-0.90 | .40-0.70 | .35-0.60 | .15-0.25 |
| 8620 | .17-0.23 | .60-0.90 | .40-0.70 | .35-0.60 | .15-0.25 |

Mechanical Properties of Steel

The mechanical properties shown below are for general information purposes and are for steels in the as-rolled condition.

Case Hardening or Low Carbon Bars (as rolled)

| SAE | Cond. of Steel | Tensile Str. KSI | Yield Str. KSI | % Elong in 2" | % Red. of Area | Hardness Br. | R | Machinability Rating (C1212 =100) |
|---|----------------|------------------|----------------|---------------|----------------|--------------|-----|-----------------------------------|
| M1020 | Hot R'd. | 55 | 30 | 25 | 50 | 111 | B62 | 50 |
| 1018 | Hot R'd. | 58 | 32 | 25 | 50 | 116 | B65 | 52 |
| | Cold Dr. | 64 | 54 | 15 | 40 | 126 | B70 | 70 |
| Core Props: carburized at 1700°F., cooled, reheated to 1425°, 350° Q&T. | | | | | | | | |
| | | 92.00 | 56 | 27 | 48 | 195 | B92 | — |
| 10L18 | Cold Dr. | 64 | 54 | 15 | 40 | 126 | B70 | 80 |
| 1020 | Hot R'd. | 55 | 30 | 25 | 50 | 111 | B62 | 52 |
| 12L14 | Cold Dr. | 78 | 60 | 10 | 35 | 165 | B85 | 180 |
| 12L14+Te | Cold Dr. | 78 | 60 | 10 | 35 | 165 | B85 | 250 |
| 1215 | Cold Dr. | 78 | 60 | 10 | 35 | 165 | B85 | 136 |
| | | | | | | | | |
| 1117 | Hot R'd. | 62 | 34 | 23 | 47 | 121 | B68 | 90 |
| | Cold Dr. | 69 | 58 | 15 | 40 | 137 | B75 | 90 |
| Core Props: carburized at 1700°F., cooled, reheated to 1450°, 350° Q&T. | | | | | | | | |
| | | 96.5 | 59 | 23 | 53 | 195 | B92 | — |
| 11L17 | Hot R'd. | 62 | 34 | 23 | 47 | 121 | B68 | 100 |
| | Cold Dr. | 69 | 58 | 15 | 40 | 137 | B75 | 125 |
| Core Props: carburized at 1700°F., cooled, reheated to 1450°, 350° Q&T. | | | | | | | | |
| | | 97 | 60 | 23 | 52 | 197 | B92 | — |
| 86L20 | Hot R'd. | 91 | 66 | 25 | 64 | 185 | B90 | 88 |
| | Cold Dr. | 103 | 86 | 23 | 58 | 210 | B95 | 92 |
| Core Props: carburized at 1700°F., cooled, reheated to 1550°, 300° Q&T. | | | | | | | | |
| | | 135 | 105 | 21 | 54 | 262 | C26 | — |
| E4320 | Hot R'd. | 84 | 61 | 29 | 58 | 165 | B85 | 55 |
| | Cold Dr. | 98 | 81 | 18 | 54 | 205 | B94 | 60 |
| Core Props: carburized at 1700°F., cooled, reheated to 1500°, 300° oil Q&T. | | | | | | | | |
| | | 218 | 178 | 14 | 48 | 429 | — | — |
| 4615-17 | Hot R'd. | 82 | 62 | 28 | 65 | 185 | B90 | 58 |
| | Cold Dr. | 99 | 84.6 | 19 | 61 | 210 | B95 | 64 |
| Core Props: carburized at 1700°F., cooled, reheated to 1550°, 300° oil Q&T. | | | | | | | | |
| | | 110 | 80 | 25 | 61 | 229 | C20 | — |
| 4620 | Hot R'd. | 85 | 63 | 28 | 64 | 185 | B90 | 58 |
| E4620 | Cold Dr. | 101 | 85 | 22 | 60 | 207 | B94 | 64 |
| | | | | | | | | |
| Core Props: carburized at 1700°F., cooled, reheated to 1550°, 300° oil Q&T. | | | | | | | | |
| | | 120 | 89 | 22 | 55 | 2448 | C24 | — |
| 8620 | Hot R'd. | 89 | 65 | 25 | 63 | 190 | B91 | 60 |
| | Cold Dr. | 102 | 85 | 22 | 58 | 210 | B95 | 63 |
| Core Props: carburized at 1700°F., cooled, reheated to 1550°, 300° oil Q&T. | | | | | | | | |
| | | 129 | 99 | 21 | 52 | 255 | C25 | — |

Medium Carbon or Direct Hardening Bars

| SAE | Cond. of Steel | Tensile Str. KSI | Yield Str. KSI | % Elong in 2" | % Red. of Area | Hardness Br. | R | Machinability Rating (C1212 =100) |
|--|--|------------------|----------------|---------------|----------------|--------------|-----|-----------------------------------|
| 1035 | Hot R'd. | 72 | 39.5 | 18 | 40 | 143 | B90 | 65 |
| | Water Quenched, 1550°F.—Tempered 1000°F. | | | | | | | |
| | | 103 | 72 | 23 | 59 | 201 | B94 | — |
| M1044 | Hot R'd. | 80 | 44 | 16 | 40 | 166 | B86 | 65 |
| 1045 | Hot R'd. | 82 | 45 | 16 | 40 | 162 | B84 | 56 |
| | Cold Dr. | 91 | 77 | 12 | 35 | 180 | B89 | 65 |
| Water Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 120 | 90 | 18 | 52 | 240 | C22 | — |
| 1045 | TG&P | 82 | 45 | 16 | 40 | 162 | B84 | 56 |
| 1137 | Cold Dr. | 88 | 48 | 15 | 35 | 180 | B89 | 70 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | |
| | | 112 | 88 | 21 | 56 | 255 | C25 | — |
| 1141 | Hot R'd. | 94 | 51.5 | 15 | 35 | 190 | B91 | 65 |
| | Cold Dr. | 105 | 88 | 10 | 30 | 210 | B95 | 70 |
| Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 126 | 100 | 19 | 54 | 277 | C29 | — |
| 1141 | TG&P | 94 | 51.5 | 15 | 35 | 190 | B91 | 65 |
| 1141 | Drawn, G&P | 105 | 88 | 10 | 30 | 205 | B94 | 70 |
| 11L41 | Hot R'd. | 94 | 51.5 | 15 | 35 | 185 | B90 | 95 |
| | Cold Dr. | 105 | 88 | 10 | 30 | 205 | B94 | 100 |
| Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 126 | 101 | 20 | 54 | 277 | C29 | — |
| 1144 | Hot R'd. | 97 | 53 | 15 | 35 | 210 | B95 | 64 |
| | Cold Dr. | 108 | 90 | 10 | 30 | 217 | C22 | 80 |
| Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 129 | 100.5 | 18 | 53 | 278 | C30 | — |
| E4130 | Hot R'd. | 86 | 56 | 29 | 57 | 185 | B90 | 65 |
| | Cold Dr. | 98 | 87 | 21 | 52 | 200 | B93 | 70 |
| Water Quenched, 1575°F.—Tempered 1000°F. | | | | | | | | |
| | | 146 | 133 | 17 | 50 | 293 | C31 | — |
| 4140 | Hot R'd. | 89 | 62 | 26 | 58 | 190 | B91 | 57 |
| | Cold Dr. | 102 | 90 | 18 | 50 | 228 | B98 | 66 |
| Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 153 | 131 | 16 | 45 | 302 | C32 | — |
| 4147-50 | Hot R'd. | 100 | 66 | 21 | 51 | 195 | B92 | 54 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | |
| | | 158 | 134 | 14 | 42 | 311 | C33 | — |
| 41L40-42 | Hot R'd. | 91 | 63 | 27 | 58 | 185 | B90 | 87 |
| | Cold Dr. | 103 | 93 | 19 | 51 | 228 | B98 | 90 |
| Oil Quenched, 1550°F.—Tempered 1000°F. | | | | | | | | |
| | | 156 | 133 | 16 | 44 | 311 | C33 | — |
| Continued on Next Page | | | | | | | | |

Mechanical Properties of Steel

Medium Carbon or Direct Hardening Bars (Cont.)

| SAE | Cond. of Steel | Tensile Str. KSI | Yield Str. KSI | % Elong in 2" | % Red. of Area | Hardness Br. | Hardness R | Machinability Rating (C1212 =100) |
|---------------------------------|--|------------------|----------------|---------------|----------------|--------------|------------|-----------------------------------|
| 41L47/50 | Hot R'd. | 103 | 69 | 23 | 51 | 205 | B94 | 80 |
| | Rounds Cold Dr. | 112 | 95 | 16 | 43 | 228 | B98 | 85 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | 162 | 138 | 14 | 40 | 311 | C33 | — |
| 4150 Mod. RS Flats, Sqs. | Hot R'd. | 103 | 69 | 23 | 51 | 205 | B94 | 73 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | 160 | 135 | 14 | 41 | 311 | C33 | — |
| 4340 C4340 | Hot R'd. | 101 | 69 | 21 | 45 | 210 | B95 | 45 |
| | Cold Dr. | 111 | 99 | 16 | 42 | 228 | B98 | 55 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | 182 | 162 | 15 | 40 | 363 | C39 | — |
| E6150 | Hot R'd. | 91 | 58 | 22 | 53 | 185 | B90 | 50 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | 155 | 132 | 15 | 44 | 302 | C32 | — |
| E8740 | Cold Dr. | 107 | 96 | 17 | 48 | 228 | B98 | 66 |
| | Oil Quenched, 1550°F.—Tempered 1000°F. | 152 | 129 | 15 | 44 | 302 | C32 | — |

High Carbon or Direct Hardening Bars

| SAE | Cond. of Steel | Tensile Str. KSI | Yield Str. KSI | % Elong in 2" | % Red. of Area | Hardness Br. | Hardness R | Machinability Rating (C1212 =100) |
|-------------|---|------------------|----------------|---------------|----------------|--------------|------------|-----------------------------------|
| 1095 | Hot R'd. | 120 | 66 | 10 | 25 | 271 | C28 | — |
| | Water Quenched, 1450°F.—Tempered 800°F. | 200 | 138 | 12 | 37 | 390 | C42 | — |
| | 52100 Hot R'd. | 100 | 81 | 25 | 57 | 192 | — | 39 |
| Cold Dr. | 107 | 87.5 | 17 | 54 | 229 | — | 41 | |
| SP. Ann | | | | | | | | |

Mechanical Properties of Steel

Heat Treated Bars/Minimum Mechanical Properties

Properties area at center of bars up to 1 1/2", and at mid-radius of bars over 1 1/2",
Yield Strength – 0.2% or .02% offset as indicated per ASTM E8.

| Grade | Thermal Condition | Tensile Strength (KSI) Range or Min. | | Min. Yield Strength (KSI) | Min. % Elong in 2" | Min. % Red. of Area | Surface Hardness | | Machinability Rating (C1212 =100) | |
|-------------------------------|---------------------|--------------------------------------|--------------|---------------------------|--------------------|---------------------|------------------|----------|-----------------------------------|----|
| | | | | | | | Brinell | HRC | | |
| 4140/42 | HR | Over | 7-9 1/2" | 105 | 80 | 15 | 40 | 269/321 | 28/34 | 55 |
| ASTM A434 | QTSR | Over | 9 1/2" | – | – | – | – | – | – | – |
| CL. BC | CF DGP | Thru | 1" | 110 | 130 | 16 | 50 | 269/321 | 28/34 | 55 |
| 4340 ASTM A434 | QTSR | Thru | 1 1/2" | 155 | 130 | 14 | 35 | 302/363 | 32/39 | 52 |
| CL. BD | TGP | Over | 1 1/2-2 1/2" | 150 | 120 | 14 | 35 | 302/363 | 32/39 | 52 |
| | | Over | 2 1/2-4" | 140 | 110 | 14 | 35 | 302/363 | 32/39 | 52 |
| | | Over | 4-7" | 135 | 105 | 14 | 35 | 302/363 | 32/39 | 52 |
| | | Over | 7-9 1/2" | 130 | 100 | 14 | 35 | 302/363 | 32/39 | 52 |
| | | Over | 9 1/2" | 130 | 100 | 14 | 35 | 302/363 | 32/39 | 52 |
| Stressproof | CD | Thru | 2" | 115 | 100 | 8 | 25 | – | – | 83 |
| ASTM A311 | As Drawn | Over | 2-3" | 115 | 100 | 8 | 20 | – | – | 83 |
| CL. B | Heavy | Over | 3-4 1/2" | 115 | 100 | 8 | 20 | – | – | 83 |
| SAE 1144 | Draft | | | | | | | | | |
| Fatigue-Proof SAE 1144 | Elevated Temp Drawn | | 140 | | 125 | 5 | 15 | 280 Min. | 30 Min. | 80 |
| e.t.d. 150 | Elevated Temp Drawn | | 150 | | 130 | 10 (Mean) | 37 (Mean) | 302 Min. | 32 Min. | – |
| 41L40/42/47 | HR & CF QTSR | | 125 | | 100 | 15 | 45 | 269/321 | 27/34 | 70 |
| 4150 Mod. RS HR Square | Norm & SR Thru 6" | | – | | – | – | – | 241/302 | 23/32 | 62 |
| 4150 Mod. RS HR Rounds | QTSR | Thru | 1 1/2" | 130 | 110 | 16 | 50 | 262/311 | 27/33 | 62 |
| | | Over | 1 1/2-2 1/2" | 125 | 110 | 16 | 50 | 262/311 | 27/33 | 62 |
| | | Over | 2 1/2-4" | 115 | 95 | 16 | 45 | 262/311 | 27/33 | 62 |
| | | Over | 4-7" | 110 | 85 | 16 | 45 | 262/311 | 27/33 | 62 |
| | | Over | 7-9 1/2" | 105 | 80 | 15 | 40 | 262/321 | 27/34 | 62 |
| | | Over | 9 1/2" | – | – | – | – | – | – | – |

Mechanical Properties of Steel

Plates

| Grade | Condition of Steel | Tensile Strength KSI | Yield Strength KSI | % Elong. in 2" | % Elong. in 8" | Approx. Brinell Hardness |
|---------------------------------------|--------------------|----------------------|--------------------|----------------|----------------|--------------------------|
| Structural Quality ALLOY | | | | | | |
| ASTM A36, ASME SA36 | As Rolled | 58 to 80 | 36 Min. | 23 | 20 | 137 |
| EX-TEN 50 | | | | | | |
| ASTM A572(50) | As Rolled | 65 Min. | 50 Min. | 21 | 18 | 143 |
| Cor-Ten A | | | | | | |
| ASTM A242 | As Rolled | 70 Min. | 50 Min. | – | 16 | 156 |
| Cor-Ten B | | | | | | |
| ASTM A588(A) | As Rolled | 70 Min. | 50 Min. | 19 | 16 | 156 |
| ASTM A656 Gr. 50 | As Rolled | 60 Min. | 50 Min. | – | 20 | 123/159 |
| ASTM A656 Gr. 80 | As Rolled | 95 Min. | 80 Min. | 18 | 12 | 212/255 |
| T-1 Type A ASTM A514 Gr. B | Q&T | 110 to 130 | 100 Min. | 16 | – | 235/293 |
| T-1 Type B ASTM A514 Gr. H | Q&T | 110 to 130 | 100 Min. | 16 | – | 235/293 |
| T-1 ASTM A514 Gr. F | Q&T | 110 to 130 | 100 Min. | 16 | – | 235/293 |
| T-1 Type C ASTM A514 Gr. Q | Q&T | 110 to 130 | 90 Min. | 14 | – | 235/293 |
| Pressure Vessel Quality Carbon | | | | | | |
| ASTM A285, ASME SA285 Grade C | As Rolled | 55 to 75 | 30 Min. | 27 | 23 | 137 |
| ASTM A516, ASME SA516 Grade 70 | As Rolled | 70 to 90 | 38 Min. | 21 | 17 | 163 |
| Norm-- | | | | | | |
| ASTM A387, ASME SA387 Grade II | Ann. | 60 to 85 | 35 Min. | 22 | 19 | 135/174 |
| ASTM A387, ASME SA387 Grade 22 | N&T | 75 to 100 | 45 Min. | 18 | – | 149/207 |
| Intermediate Carbon | | | | | | |
| AISI 1045 | As Rolled | 90 | 50 | – | – | 187 |
| Improved Machining Carbon | | | | | | |
| C1119 | As Rolled | 68 to 78 | 37 to 40 | 20/40% | 15/35% | 140/150 |
| Abrasion Resisting | | | | | | |
| AR Carbon | As Rolled | – | – | – | – | 212/255 |
| T-1 Type A 321 Min. BHN | Q&T | – | – | – | – | 321 Min |
| Through Hardening | | | | | | |
| 4130 | As Rolled | 90 | 52 | 28 | – | 179 |
| 4140 | Annealed | 95 | 54 | 25 | – | 197 |
| 4340 MTS | Annealed | 100 | 58 | 21 | – | 229 |
| E6150 | Annealed | 97 | 55 | 23 | – | 197 |
| E4150 | Norm & Temp. | 145 | 115 | 14 | – | 262/321 |

Stainless Steel

Austenitic/Chrome-Nickle (Non-Hardening)

| | 303 | 304 | 304L | 309 | 310 | 316 | 316L | 321 |
|-----------------------------------|-----------|-----------|-----------|---------------------------------|-----------|-----------|-----------|-----------|
| Chemical Comp.(%) | | | | | | | | |
| Chromium | 17.-19. | 18.-20. | 18.-20. | 22.-24. | 24.-26. | 16.-18. | 16.-18. | 17.-19. |
| Nickel | 8.-10. | 8.-11. | 8.-11. | 12.-15. | 19.-22. | 10.-14. | 10.-14. | 9.-12. |
| Other elements (a) | 5.15-4.0 | — | — | — | — | Mo.2.-3. | Mo 2.-3. | T15XCmm |
| Carbon..... | 15 max | .08 max | .03 max | .20 max | .25 max | .25max | .03 max | .08 max |
| Manganese..... | 2. max | 2.max | 2.max | 2.max | 2.max | 2.max | 2.max | 2.max |
| Silicon | 1.max | 1.max | 1.max | 1.max | 1.5max | 1.max | 1.max | 1.max |
| Machinability rating..... | 70 | 48 | 48 | — | — | 45 | 45 | 50 |
| Physical Data | | | | | | | | |
| Melting—°F | 2550 | 2550 | 2550 | 2550 | 2550 | 2550 | 2550 | 2550 |
| Density—lb./in.3 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| Specific heat— | | | | | | | | |
| Blu °F/lb(32-212F)..... | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Thermal Conductivity— | | | | | | | | |
| BTU/ft2/hr/°F/ft..... | | | | | | | | |
| 212 F..... | 9.4 | 9.4 | 9.4 | 9.0 | 8.0 | 9.4 | 9.4 | 9.3 |
| 932 F..... | 12.4 | 12.4 | 12.4 | 10.8 | 10.8 | 12.4 | 12.4 | 12.8 |
| Mean Coeffi. Of exp.— | | | | | | | | |
| In/in/°F X 106 | | | | | | | | |
| 68.212F..... | 9.2 | 9.2 | 9.2 | 8.7 | 8.0 | 9.2 | 9.2 | 8.3 |
| 68 lo indicated—F..... | 11.0 | 11.0 | 11.0 | 10.9 | 10.9 | 10.7 | 10.7 | 10.6 |
| (1600)..... | (1600) | (1600) | (2100) | (2100) | (1600) | (1600) | (1700) | |
| Electrical Prop. | | | | | | | | |
| Magnetic Perm..... | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Electrical resistivity— | | | | | | | | |
| 68F..... | 72.0 | 72.0 | 72.0 | 78.0 | 78.0 | 74.0 | 72.0 | 72.0 |
| 1200 F | 116.0 | 116.0 | 116.0 | 114.8 | — | 116.0 | 116.0 | — |
| Heat Resist. | | | | | | | | |
| Max. operating °F: | | | | | | | | |
| Intermittent | 1400 | 1600 | 1600 | 1800 | 1900 | 1600 | 1600 | 1600 |
| Continuous | 1700 | 1700 | 1700 | 2000 | 2100 | 1700 | 1700 | 1700 |
| Temperatures—°F | | | | | | | | |
| Forging—start | 2250 | 2200 | 2200 | 2150 | 2150 | 2200 | 2200 | 2200 |
| Forging—finish | 1700 | 1700 | 1700 | 1800 | 1800 | 1700 | 1700 | 1700 |
| Annealing—Ranges..... | 1800-2000 | 1800-1950 | 1800-1950 | 2050-2150 | 2050-2150 | 1975-2150 | 1800-2000 | 1800-2000 |
| Annealing—cooling (b)..... | WQ | WQ(AC) | AC | WQ(AC) | WQ(AC) | WQ(AC) | AC | WQ(AC) |
| Hardening—ranges..... | | | | Hardenable only by cold working | | | | |
| Quenching (O) Oil, (A) Air | | | | | | | | |
| Tempering—for hardness | | | | | | | | |
| Drawing—for stress relieving | | | | | | | | |
| Mech. Prop (nominal) anld. | | | | | | | | |
| Structure annealed(C) | A | A | A | A | A | A | A | A |
| Yield strength-KSI-min..... | 35 | 35 | 30 | 40 | 30 | 35 | 30 | 35 |
| Ultimate strength | | | | | | | | |
| KSI—min..... | 90 | 85 | 80 | 95 | 75 | 85 | 75 | 85 |
| Elong--%..... | | | | | | | | |
| In 2 inches—min..... | 50 | 55 | 55 | 45 | 40 | 60 | 60 | 55 |
| Red. In area--% min..... | 55 | 70 | 70 | 65 | 50 | 70 | 70 | 65 |
| Mod. Of elast. — | | | | | | | | |
| Lb/in.2 X 106 | 29 | 29 | 29 | 29 | 30 | 29 | 29 | 29 |
| Hardness—Brinell(max..... | 160mm | 180 | 180 | 200 | 180 | 200 | 180 | 200 |
| Hardness-Rockwell(max)..... | B80mm | B90 | B90 | 895 | B90 | B95 | 890 | B95 |
| Impact values—Izod | | | | | | | | |
| -ft.lb (min) | 60 | 85 | 80 | 80 | 80 | 70 | 80 | 80 |

Stainless Steel

| | Martensitic/ Chrome (Hardenable) | | Ferritic (Non- Hardenable) | |
|----------------------------------|--|----------|----------------------------------|------|
| | 410 | 416 | 440C | 430 |
| Mech. Prop. —anld. | | | | |
| Structure annealed | FC | FC | FC | FC |
| Yield strength | | | | |
| KSI-min | 40 | 40 | 65 | 45 |
| Ultimate strength | | | | |
| KSI-min | 75 | 75 | 110 | 75 |
| Elongation— | | | | |
| % in 2 inches—min | 35.0 | 30.0 | 14.0 | 30.0 |
| Red. In area % min | 70.0 | 65.0 | 25.0 | 65.0 |
| Mod of elast. | | | | |
| Lb.in.2 X 103. | 29.0 | 29.0 | 30.0 | 29.0 |
| Hardness—Brinell | | | | |
| (max) | 200 | 180 | 260 | 200 |
| Hardness-Rockwell | | | | |
| (max) | B95 | B90 | B105 | B95 |
| Impact values—Izod | | | | |
| —ft.lb (min) | 85 | — | Low | 3-85 |
| Mech. Prop. —HT: | | | | |
| Yield Strength —KSI | 38-180 | 500-115 | 60-275 | — |
| Ultimate Strength —KSI | 60-200 | 900-1400 | 100-285 | — |
| Elongation— | | | | |
| % in 2 inches | 25-2 | 25-15 | 8-1 | — |
| Hardness—Brinell | 120-400 | 180-280 | 200-600 | — |
| Hardness—Rockwell | B70-C45 | B90-C30 | B95-C58 | — |
| Creep strength | | | | |
| KSI at 1000 F: | | | | |
| 1 % Flow on 10,000 hr | 12 | — | — | 8.5 |
| 1 % Flow on 100,000 hr | 11 | — | — | 6.5 |

- (a) Phosphorus and Sulfur are present
- (b) Thin sections of the 300 Series, marked WQ(AC) are usually air cooled; heavy sections, water quenched, AC=Air Cool. FC= Furnace Cool. SFC = Slow Furnace Cool. WQ = Water Quench. C=Carbide, A=Austenite.

Stainless Steel

Precipitation Hardening

| | 17-4 Ann (Aisi 630) | 17-4 H1150 |
|---------------------------|---------------------|------------|
| Mech. Prop. —anld. | | |
| Yield strength | | |
| KSI — min | — | 105 |
| Ultimate strength | | |
| KSI-min | — | 135 |
| Elongation— | | |
| % in 2 inches —min | — | 16 |
| Reduction of area | | |
| % min | — | 50 |
| Hardness | 363 BHN | 28 MIN |
| | MAX | HRC |
| Machinability Rating | 45 | 50 |

Plate Tolerances

Carbon & Alloy Plate

Permissible Variations in Thickness for Rectangular Carbon, High-Strength, Low Alloy, and Alloy-Steel Plates, When Ordered to Thickness

NOTE 1 – Permissible variation under Specified thickness, 0.01 in.
 NOTE 2 – Thickness to be measured at 3/8 to 3/4 in. From the longitudinal edge.
 NOTE 3 – For Thickness measured at any location other than that specified in Note 2, the permissible maximum over tolerance shall be increased by 75%, rounded to the nearest 0.01 in.

| Specified Thickness, in. | Tolerance Over Specified Thickness for Widths Given, in. | | | | | | | | |
|--------------------------|--|------------------|-------------|-------------|-------------|--------------|---------------|---------------|---------------|
| | Under | 48 & 48-60, excl | 60-72, excl | 72-84, excl | 84-96, excl | 96-108, excl | 108-120, excl | 120-132, excl | 132-150, excl |
| To 1/4, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| 1/4 to 15/16, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 |
| 15/16 to 3/8, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 |
| 3/8 to 7/16, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| 7/16 to 1/2, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| 1/2 to 5/8, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| 5/8 to 3/4, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 |
| 3/4 to 1, excl | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 |
| 1 to 2, excl | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.10 |
| 2 to 3, excl | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.11 | 0.12 | 0.13 | |
| 3 to 4, excl | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.13 | 0.14 | 0.15 | |
| 4 to 6, excl | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | |
| 6 to 10, excl | 0.23 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | |
| 10 to 12, excl | 0.29 | 0.29 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | |
| 12 to 15, incl | 0.29 | 0.29 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | |

Permissible Variations in Width & Length for Sheared Plates 1/2 in. and Under in Thickness Variations over Specified Width & Length* for Specified Dimensions, in., Thicknesses, in., & Equivalent Weights, lb/ft2, Given

| Length | Width | To 3/8, excl | | 3/8-5/8 excl | | 5/8-1, excl | | 1-2, excl | |
|------------------|-----------------|--------------|------|--------------|-------|-------------|------|-----------|------|
| | | W | L | W | L | W | L | W | L |
| To 120, excl | To 60, excl | 3/8 | 1/2 | 7/16 | 5/8 | 1/2 | 3/4 | 5/8 | 1 |
| | 60 to 84, excl | 7/16 | 5/8 | 1/2 | 11/16 | 5/8 | 7/8 | 3/4 | 1 |
| | 84 to 108, excl | 1/2 | 3/4 | 5/8 | 7/8 | 3/4 | 1 | 1 | 17/8 |
| | 108 and over | 5/8 | 7/8 | 3/4 | 1 | 7/8 | 11/8 | 11/8 | 11/4 |
| 120 to 240, excl | To 60, excl | 3/8 | 3/4 | 1/2 | 7/8 | 5/8 | 1 | 3/4 | 11/8 |
| | 60 to 84, excl | 1/2 | 3/4 | 5/8 | 7/8 | 3/4 | 1 | 7/8 | 11/4 |
| | 84 to 108, excl | 9/16 | 7/8 | 11/16 | 5/16 | 13/16 | 11/8 | 1 | 13/8 |
| | 108 and over | 5/8 | 1 | 3/4 | 11/8 | 7/8 | 11/4 | 11/8 | 13/8 |
| 240 to 360, excl | To 60, excl | 3/8 | 1 | 1/2 | 11/8 | 5/8 | 11/4 | 3/4 | 11/2 |
| | 60 to 84, excl | 1/2 | 1 | 5/8 | 11/8 | 3/8 | 11/4 | 7/8 | 11/2 |
| | 84 to 108, excl | 9/16 | 1 | 11/16 | 11/8 | 7/8 | 13/8 | 1 | 11/2 |
| | 108 and over | 11/16 | 17/8 | 7/8 | 11/4 | 1 | 13/8 | 11/4 | 13/4 |
| 360 to 480, excl | To 60, excl | 7/16 | 17/8 | 1/2 | 11/4 | 5/8 | 13/8 | 3/4 | 15/8 |
| | 60 to 84, excl | 1/2 | 11/4 | 5/8 | 13/8 | 3/4 | 11/2 | 7/8 | 15/8 |
| | 84 to 108, excl | 9/16 | 11/4 | 3/4 | 13/8 | 7/8 | 11/2 | 1 | 17/8 |
| | 108 and over | 3/4 | 13/8 | 7/8 | 11/2 | 1 | 15/8 | 11/4 | 17/8 |

* Permissible variation under specified width and length, 1/4 in.

Permissible Variations in Width & Length for Rectangular Plates When Gas Cutting is Specified or Required

NOTE 1 – These variations may be taken all under or divided over and under, if so specified

| Specified Thickness, in. | ALLOY Variations Over for All Specified Widths or Lengths, in. | | CARBON Variations Over for All Specified Widths or Lengths, in. | |
|--------------------------|--|--------|---|--------|
| | Width | Length | Width | Length |
| To 2, excl | 3/4 | | 1/2 | |
| 2 to 4, excl | 1 | | 5/8 | |
| 4 to 6, excl | 1 1/8 | | 3/4 | |
| 6 to 8, excl | 1 5/16 | | 7/8 | |
| 8 to 15, incl | 1 1/2 | | 1 | |

Sheet Thickness Tolerances

Hot Rolled HR P & O Cold Rolled Galvanized

| Gage No. | Hot Rolled, HR P & O, Cold Rolled | | | | Galvanized | | |
|----------|-----------------------------------|----------------|-------|------------------|-------------|--------------|------------------|
| | Dec. Equiv. | Toler. Range | | Lbs. Per Sq. Ft. | Dec. Equiv. | Toler. Range | Lbs. Per Sq. Ft. |
| 4 | .2242 | .2332 .2152 | | 9.375 | | | |
| 5 | .2092 | .2182 .2002 | | 8.750 | | | |
| 6 | .1943 | .2033 .1853 | | 8.125 | | | |
| 7 | .1793 | .1873 | .1873 | 7.500 | | | |
| | | .1713 | .1713 | | | | |
| 8 | .1644 | .1724 | .1724 | 6.875 | .1681 | .1771 | 7.031 |
| | | .1564 | .1564 | | | .1591 | |
| 9 | .1495 | .1575 | .1575 | 6.250 | .1532 | .1622 | 6.406 |
| | | .1415 | .1415 | | | .1442 | |
| 10 | .1345 | .1425 | .1405 | 5.625 | .1382 | .1472 | 5.781 |
| | | .1265 | .1285 | | | .1292 | |
| 11 | .1196 | .1276 | .1256 | 5.000 | .1233 | .1323 | 5.156 |
| | | .1116 | .1136 | | | .1143 | |
| 12 | .1046 | .1126 | .1106 | 4.375 | .1084 | .1174 | 4.531 |
| | | .0966 | .0986 | | | .0994 | |
| 13 | .0897 | .0967 | .0947 | 3.750 | .0934 | .1014 | 3.906 |
| | | .0827 | .0847 | | | .0854 | |
| 14 | .0747 | .0817 | .0797 | 3.125 | .0785 | .0865 | 3.281 |
| | | .0677 | .0697 | | | .0705 | |
| 15 | .0673 | .0733 | .0723 | 2.813 | .0710 | .0770 | 2.969 |
| | | .0613 | .0623 | | | .0650 | |
| 16 | .0598 | .0658 | .0648 | 2.500 | 0.635 | .0695 | 2.656 |
| | | .0538 | .0548 | | | .0575 | |
| 17 | .0538 | .0598 | .0578 | 2.250 | .0575 | .0625 | 2.406 |
| | | .0478 | .0498 | | | .0525 | |
| 18 | .0478 | .0528 | .0518 | 2.000 | .0516 | .0566 | 2.156 |
| | | .0428 | .0438 | | | .0466 | |
| 19 | .0418 | .0458 | .0458 | 1.750 | .0456 | .0506 | 1.906 |
| | | .0378 | | | | .0406 | |
| 20 | .0359 | .0389 | .0389 | 1.500 | .0396 | .0436 | 1.656 |
| | | .0329 | | | | .0356 | |
| 21 | .0329 | .0359 | .0359 | 1.375 | .0366 | .0406 | 1.531 |
| | | .0299 | | | | .0326 | |
| 22 | .0299 | .0329 | .0329 | 1.250 | .0336 | .0376 | 1.406 |
| | | .0269 | | | | .0296 | |
| 23 | .0269 | .0299 | .0299 | 1.125 | .0306 | .0346 | 1.281 |
| | | .0239 | | | | .0266 | |
| 24 | .0239 | .0269 | .0269 | 1.000 | .0276 | .0316 | 1.156 |
| | | .0209 | | | | .0236 | |
| 25 | .0209 | .0239 | .0239 | .875 | .0247 | .0287 | 1.031 |
| | | .0179 | | | | .0207 | |
| 26 | .0179 | .0199 | .0199 | .750 | .0217 | .0247 | .906 |
| | | .0159 | | | | .0187 | |
| 27 | .0164 | .0184 | .0184 | .688 | .0202 | .0232 | .844 |
| | | .0144 | | | | .0172 | |
| 28 | .0149 | .0169 | .0169 | .625 | .0187 | .0217 | .781 |
| | | .0129 | | | | .0157 | |
| 29 | | | | | .0172 | .0202 | .719 |
| | | | | | | .0142 | |
| 30 | | | | | .0157 | .0187 | .656 |
| | | | | | | .0127 | |

Bar Tolerances

HR Carbon & Alloy Bars

| Specified Width, in. | Permitted Variations Over or Under Specified Thickness, for Thicknesses Given in inches, in. | | | | | | Permitted Variations From Specified Widths, in | | |
|----------------------|--|--------------------|--------------------|-----------------------|---------------------|---------------------|--|------|-------------------|
| | 0.203 to 0.230, excl | 0.230 to 1/4, excl | 1/4 to 1/2, incl.. | Over 1/2 to 1, incl.. | Over 1 to 2, incl.. | Over 2 to 3, incl.. | Over 3 | Over | Under |
| To 1, incl.. | 0.007 | 0.007 | 0.008 | 0.010 | — | — | — | 1/64 | 1/64 |
| Over 1 to 2, incl.. | 0.007 | 0.007 | 0.012 | 0.015 | 1/32 | — | — | 1/32 | 1/32 |
| Over 2 to 4, incl.. | 0.008 | 0.008 | 0.015 | 0.020 | 1/32 | 3/64 | 3/64 | 1/16 | 1/32 |
| Over 4 to 6, incl.. | 0.009 | 0.009 | 0.015 | 0.020 | 1/32 | 3/64 | 3/64 | 3/32 | 1/16 |
| Over 6 to 8, incl.. | ^A | 0.015 | 0.016 | 0.025 | 1/32 | 3/64 | 1/16 | 1/8 | 3/32 ^B |

A Flats over 6 to 8 in, incl., in width are not available as hot-rolled carbon steel bars in thickness under 0.230 in.

B For flats over 6 to 8 in, in width, and to 3 in. incl in thickness.

Bar Tolerances

Permitted Variations in Sectional Dimensions for Round and Square Bars and Round-Cornered Squares

| Specified Size, in. | Permitted Variations from Specified Size, in. | | Permitted Out-of-Round or out-of-Square, in. ^A |
|-----------------------------|---|-------|---|
| | Over | Under | |
| To 5/16 | 0.005 | 0.005 | 0.008 |
| Over 5/16 to 7/16, incl.. | 0.006 | 0.006 | 0.009 |
| Over 7/16 to 5/8, incl.. | 0.007 | 0.007 | 0.010 |
| Over 5/8 to 7/8, incl.. | 0.008 | 0.008 | 0.012 |
| Over 7/8 to 1, incl.. | 0.009 | 0.009 | 0.013 |
| Over 1 to 1 1/8, incl.. | 0.010 | 0.010 | 0.015 |
| Over 1 1/8 to 1 1/4, incl.. | 0.011 | 0.011 | 0.016 |
| Over 1 1/4 to 1 3/8, incl.. | 0.012 | 0.012 | 0.018 |
| Over 1 3/8 to 1 1/2, incl.. | 0.014 | 0.014 | 0.021 |
| Over 1 1/2 to 2, incl.. | 1/64 | 1/64 | 0.023 |
| Over 2 to 2 1/2, incl.. | 1/32 | 0 | 0.023 |
| Over 2 1/2 to 3 1/2, incl.. | 3/64 | 0 | 0.035 |
| Over 3 1/2 to 4 1/2, incl.. | 1/16 | 0 | 0.046 |
| Over 4 1/2 to 5 1/2, incl.. | 5/64 | 0 | 0.058 |
| Over 5 1/2 to 6 1/2, incl.. | 1/8 | 0 | 0.070 |
| Over 6 1/2 to 8 1/4, incl.. | 5/32 | 0 | 0.085 |
| Over 8 1/2 to 9 1/2, incl.. | 3/16 | 0 | 0.100 |
| Over 9 1/2 to 10, incl.. | 1/4 | 0 | 0.120 |

A Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same transverse cross section. Out-of-square section is the difference is perpendicular distance between opposite faces, measured at the same transverse cross section.

Bar Tolerances

Permitted Variations in Sectional Dimensions for Hexagons

| Specified Size Between Opposite Sides, in. | Permitted Variations from Specified Size, in. | | Permitted Out-of-Hexagon section, Three Measurements in. ^A |
|--|---|-------|---|
| | Over | Under | |
| 1/2 and under | 0.007 | 0.007 | 0.011 |
| Over 1/2 to 1, incl.. | 0.010 | 0.010 | 0.015 |
| Over 1 to 1 1/2 incl.. | 0.021 | 0.013 | 0.025 |
| Over 1 1/2 to 2, incl.. | 1/32 | 1/64 | 1/32 |
| Over 2 to 2 1/2 incl.. | 3/64 | 1/64 | 3/64 |
| Over 2 1/2 to 3 1/2, incl.. | 1/16 | 1/64 | 1/16 |

A Out-of-hexagon section is the greatest difference in distance between any two opposite faces measured at the same transverse cross section.

Bar Tolerances

CF Carbon Bars

Cold Drawn or Tuned & Polished

| Size Range In Inches | Undersize Variations in Inches | | | Max. Carbon Range Over 55% or all all Grades Quenched & Tempered or Normalized And Tempered Before Cold Finishing |
|--|--|--|--|--|
| | Max. Carbon Range .28% or less | Max. Carbon Range Over .28% to .55% incl. | 0.55% Incl. Stress Relieved or Annealed After 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 Drawn Hexagons | | | | |
| 3/4 or under | .002 | .003 | .004 | .006 |
| Over 3/4 to 1 1/2, incl. | .003 | .004 | .005 | .007 |
| Over 1 1/2 to 2 1/2, incl. | .004 | .005 | .006 | .008 |
| Over 2 1/2 to 3 1/8, incl. | .005 | .006 | .007 | .009 |
| Over 3 1/8 to 4, incl. | .005 | .006 | — | — |
| Cold Drawn 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 |
| Over 4 to 5, incl. | .010 | — | — | — |
| Over 5 to 6, incl. | .014 | — | — | — |
| Cold Drawn Flats | | | | |
| Tolerances for flats apply to thickness as well as width | | | | |
| Width in Inches | | | | |
| To 3/4, incl. | .003 | .004 | .006 | .008 |
| Over 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 | — | — |
| Turned, Ground and Polished Rounds Cold Drawn, Ground and Polished Rounds | | | | |
| Size Range In Inches | Undersize Variations in Inches | | | |
| | Turned, Ground and Polished Rounds | Cold Drawn, Ground and Polished Rounds | | |
| 1 1/2 and Under | -.0005 to -.0015 | .001 | | |
| Over 1 1/2 to less than 2 1/2 | -.0005 to -.0020 | .0015 | | |
| 2 1/2 to 3, incl. | -.0005 to -.0025 | .002 | | |
| Over 3 to 4, incl. | -.0005 to -.0035 | .003 | | |
| Over 4 to 6, incl. | -.0005 to -.0045 | .004 | | |
| Over 6 | -.0005 to -.0055 | .005 | | |

* All tolerances are on the minus side +.000.

Bar Tolerances

CF Alloy Bars

Cold Drawn or Tuned & Polished

| Specified Size In Inches | Undersize Variations in Inches | | | 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 |
|---|--|---|---|--|
| | Max. Carbon Range or less | Max. Carbon Range over .28 to .55% incl. | Annld. or Stress Relieved after C. F. Max. carb. tp .55% | |
| 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 | .009 | .010 | .011 | .012 |
| Cold Drawn Hexagons | | | | |
| To 3/4, incl. | .003 | .004 | .005 | .007 |
| Over 3/4 to 1 1/2 | .004 | .005 | .006 | .008 |
| Over 1 1/2 to 2 1/2 | .005 | .006 | .007 | .009 |
| Over 2 1/2 to 3 1/8 | .006 | .007 | .008 | .010 |
| Cold Drawn Squares | | | | |
| To 3/4, Incl. | .003 | .005 | .006 | .008 |
| Over 3/4 to 1 1/2 | .004 | .006 | .007 | .009 |
| Over 1 1/2 to 2 1/2 | .005 | .007 | .008 | .010 |
| Over 2 1/2 to 4 | .007 | .009 | .010 | .012 |
| Over 4 to 5 | .011 | — | — | — |
| Cold Drawn Flats | | | | |
| Tolerances for flats apply to thickness as well as width | | | | |
| Width in Inches | | | | |
| To 3/4, incl. | .004 | .005 | .007 | .009 |
| Over 3/4 to 1 1/2 | .005 | .006 | .009 | .011 |
| Over 1 1/2 to 3 | .006 | .007 | .011 | .013 |
| Over 3 to 4 | .007 | .009 | .012 | .017 |
| Over 4 to 6 | .009 | .011 | .013 | .021 |
| Over 6 | .014 | — | — | — |
| Cold Drawn Ground and Polished Rounds Turned, Ground and Polished Rounds | | | | |
| 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 | .0005 | .0015 | .0015 |
| Over 1 1/2 to 2 1/2, excl. | .0015 | .0005 | .0020 | .0020 |
| 2 1/2 to 3, incl. | .002 | .0005 | .0025 | .0025 |
| Over 3 to 4, incl. | .003 | .0005 | .0035 | .0035 |
| Over 4 to 6, incl. | — | .0005 | .0045 | .0045 |
| Over 6 | — | .0005 | .0055 | .0055 |

* All tolerances are on the minus side +.000.

Structural Tolerances

| Shape | Section Nominal Sizes In. | Depth, in. | | Flange Width, in. | | Flanges Out-of-Square max. in. * † |
|----------|---------------------------|-------------------|--------------------|-------------------|--------------------|------------------------------------|
| | | Over Theo-retical | Under Theo-retical | Over Theo-retical | Under Theo-retical | |
| | | W and HP | Up to 12, incl. | 1/8 | 1/8 | |
| | Over 12 | 1/8 | 1/8 | 1/4 | 3/16 | 5/16 |
| S and M | 3 to 7, incl. | 3/32 | 1/16 | 1/8 | 1/8 | 1/32 |
| | Over 7 to 14, incl. | 1/8 | 3/32 | 5/32 | 5/32 | 1/32 |
| | Over 14 to 24, incl. | 3/16 | 1/8 | 3/16 | 3/16 | 1/32 |
| C and MC | 1 1/2 and Under | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 |
| | Over 1 1/2 to 3, excl | 1/16 | 1/16 | 1/16 | 1/16 | 1/32 |
| | 3 to 7, incl. | 3/32 | 1/16 | 1/8 | 1/8 | 1/32 |
| | Over 7 to 14, incl. | 1/8 | 3/32 | 1/8 | 5/32 | 1/32 |
| | Over 14 | 3/16 | 1/8 | 1/8 | 3/16 | 1/32 |

*Applies when flanges of channels are toed in or out. For channels 5/8 in. and under in depth, the permissible out-of-square is 3/64 in./in. of depth.
 †Tolerance is per inch of flange width for S, M, C, and MC shapes.

Permissible Variations in Cross Section for Angles (L Shapes) and Zees

| Section | Nominal Size, in. | Depth, in. | | Flange Width or Length of Leg, in. | | Out of Sq. per in. | Variations from Thickness for Thickness Given, Over and Under, in. | | |
|------------|--------------------|-------------------|--------------------|------------------------------------|--------------------|--------------------|--|---------------------------------|--------------------|
| | | Over Theo-retical | Under Theo-retical | Over Theo-retical | Under Theo-retical | | 3/16 and under | Over 3/16 to 3/8 incl. Over 3/8 | |
| | | Angles* | 1 and under | — | — | | 1/32 | 1/32 | 3/128 [†] |
| (L Shapes) | Over 1 to 2, incl. | — | — | 3/64 | 3/64 | 3/128 [†] | 0.010 | 0.010 | 0.012 |
| | Over 2 to 3, excl | — | — | 1/16 | 1/16 | 3/128 [†] | 0.012 | 0.015 | 0.015 |
| | 3 to 4, incl. | — | — | 1/8 | 3/32 | 3/128 [†] | -- | -- | -- |
| | Over 4 to 6, incl. | — | — | 1/8 | 1/8 | 3/128 [†] | -- | -- | -- |
| | Over 6 | — | — | 3/16 | 1/8 | 3/128 [†] | -- | -- | -- |
| Zees | 3 to 4, incl. | 1/8 | 1/16 | 1/8 | 3/32 | 3/128 [†] | -- | -- | -- |
| | Over 4 to 6, incl. | 1/8 | 1/16 | 1/8 | 1/8 | 3/128 [†] | -- | -- | -- |

* For unequal leg angles, longer leg determines classification.

[†] 3/128 in./in. = 1 1/2 deg.

Permissible Variations in Straightness for S, M, C, MC, L, T, Z, Shapes

| Variable | Nominal Size, in. | Permissible Variation, in. | |
|--|-------------------|--|-------------------|
| | | Depth, in. | Flange Width, in. |
| Camber | Under 3 | 1/4 in. in any 5 ft, or 1/4 X (number of feet of total length/5) | |
| | 3 and over | 1/8 X (number of feet of total length/5) | |
| Sweep | all | Due to the extreme variations in flexibility of these shapes, straightness tolerances for sweep are subject to negotiations between the manufacturer and the purchaser for the individual sections involved. | |
| Permissible Variations in Straightness for W Shapes | | | |
| Permissible Variation, in. | | | |
| Camber and sweep | | 1/8 in. X (number of feet of total length*/10) | |

* Sections with a flange width less than 6 in. tolerance for sweep = 1/8 in. X (number of feet of total length/5).

69 in. X (number of feet of total length/5).

Stainless Tolerances

Stainless Cold Finished Rounds

Drawn, Ground or Ground & Polished

| Size, Inches | Over, Inches | Under, Inches |
|---|--------------|---------------|
| .044 to 5/16 excl. | .001 | .001 |
| 5/16 to 1/2 excl. | .0015 | .0015 |
| 1/2 to 1 excl. | .002 | .002 |
| 1 to 1 1/2 excl. | .0025 | .0025 |
| 1 1/2 to 4 incl. | .003 | .003 |
| Stainless Hexagons & Squares | | |
| .125 to .3125 excl. | .000 | -.002 |
| .3125 to .500 excl. | .000 | -.003 |
| .500 to 1.000 incl. | .000 | -.004 |
| Over 1 to 2 incl. | .000 | -.006 |
| Over 2 to 3 incl. | .000 | -.008 |
| Over 3 | .000 | -.010 |

Stainless Hot Finished Flats

| Width, Inches | Thickness, Inches, Over & Under | | | Width, Inches | |
|--------------------|---------------------------------|-----------|----------------|---------------|-------|
| | Thru 1/2" | Over 1/2" | Over 1 thru 2" | Over | Under |
| | | thru 1" | thru 2" | | |
| To 1 incl. | .008 | .010 | — | 1/64 | 1/64 |
| Over 1 to 2 incl. | .012 | .015 | 1/32 | 1/32 | 1/32 |
| Over 2 to 4 incl. | .015 | .020 | 1/32 | 1/16 | 1/32 |
| Over 4 to 6 incl. | .015 | .020 | 1/32 | 3/32 | 1/16 |
| Over 6 to 8 incl. | .016 | .025 | 1/32 | 1/8 | 5/32 |
| Over 8 to 10 incl. | .021 | .031 | 1/32 | 5/32 | 3/16 |

Stainless Bar Straightness

Measurement is taken on the concave side of the bar with a straight edge.

Hot Finished no. of feet in length
 1/8 inch in any 5 feet; but may not exceed 1/8 X $\frac{\text{no. of feet in length}}{5}$ inches.

Cold Finished no. of feet in length
 1/16 inch in any 5 feet; but may not exceed 1/16 X $\frac{\text{no. of feet in length}}{5}$ inches.

Stainless Sheet/Gauge

| Thickness, In. | Sheet Width, Inches | | | |
|----------------|---------------------|-------|----------|---------------|
| | Under, Incl. | Ga. | Handmill | |
| | | | 48 max. | 48-60 Over 60 |
| .1875 to .146 | 8&9 | .007 | .0105 | .014 |
| .146 to .131 | 10 | .006 | .009 | .012 |
| .131 to .115 | 11 | .005 | .0075 | .010 |
| .115 to .099 | 12 | .005 | .007 | .009 |
| .099 to .084 | 13 | .004 | .006 | .008 |
| .084 to .073 | 14 | .004 | .0055 | .007 |
| .073 to .059 | 15 & 16 | .003 | .0045 | .006 |
| .059 to .041 | 17 & 19 | .003 | .004 | — |
| .041 to .030 | 20 to 22 | .002 | .003 | — |
| .030 to .017 | 23 to 27 | .0015 | — | — |
| .017 to .008 | 28 to 34 | .0015 | — | — |
| .008 to .006 | 35 to 38 | .0015 | — | — |
| .006 | 39 | .001 | — | — |

WIDTH & LENGTH/Nothing under size

Widths through 48"—1/16" over. Widths over 48"—1/8" over.
 Lengths through 120"—1/4" over. Lengths over 120"—1/2" over.

CAMBER/Roller leveled, not resquared

Widths through 36": 1/8" every 8 Ft. Widths over 36": 3/32" every 8 Ft.

Stainless Tolerances

Stainless Sheet/Flatness

| Thickness in Inches | Width in Inches | Flatness Tolerance (maximum deviation from a horizontal flat surface), Inches |
|---------------------|---------------------|---|
| .062 & over | To 60 incl. | 1/2 |
| | Over 60 to 72 incl. | 3/4 |
| | Over 72 | 1 |
| Under .062 | To 36 incl. | 1/2 |
| | Over 36 to 60 incl. | 3/4 |
| | Over 60 | 1 |

Stainless Plate Thickness

| Thickness In Inches | Thickness Tolerance Over Variation* in Inches | | | |
|---------------------|---|-------------------------------|--------------------------------|------------------------|
| | Widths to 84" Incl. | Widths Over 84" to 120" Incl. | Widths Over 120" to 144" Incl. | Widths Over 144" Incl. |
| 3/16 to 3/8 excl. | .045 | .050 | — | — |
| 3/8 to 3/4 excl. | .055 | .060 | .075 | .090 |
| 3/4 to 1 excl. | .060 | .065 | .085 | .100 |
| 1 to 2 incl. | .070 | .075 | .095 | .115 |
| Over 2 | OA | OA | OA | OA |

* No plate shall vary more than .01 inch under the thickness ordered.

OA = On application.

Spot grinding not to exceed .01 inch under the specified thickness is permitted to remove surface imperfections.

Stainless Sheared Mill Plates

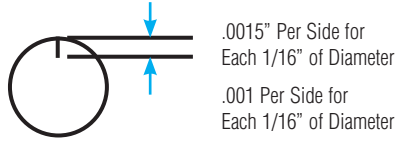
| Width In Inches | Length in inches | Tolerances, in Inches over specified width & length for given width, length and thickness | | | | | |
|----------------------|------------------|---|--------|---------------------------|--------|------------------------------|--------|
| | | Under 3/8" Thick | | 3/8" to 1/2" Thick, Incl. | | Over 1/2" to 1" Thick, Incl. | |
| | | Width | Length | Width | Length | Width | Length |
| 48 and Under | 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 | 11/8 | 1/2 | 11/4 | 5/8 | 13/8 |
| Over 60 to 84 incl. | 360 | 1/2 | 11/4 | 5/8 | 11/4 | 3/4 | 11/2 |
| Over 84 to 108 incl. | to 9/16 | 11/4 | 3/4 | 13/8 | 7/8 | 11/2 | |
| Over 108 | 480 | 3/4 | 13/8 | 7/8 | 11/2 | 1 | 15/8 |
| 60 and Under | Over | 7/16 | 11/4 | 1/2 | 11/2 | 5/8 | 15/8 |
| Over 60 to 84 incl. | 480 | 1/2 | 13/8 | 5/8 | 11/2 | 3/4 | 15/8 |
| Over 84 to 108 incl. | to 5/8 | 13/8 | 3/4 | 11/2 | 7/8 | 15/8 | |
| Over 108 | 600 | 3/4 | 11/2 | 7/8 | 15/8 | 1 | 13/4 |
| 60 and Under | | 1/2 | 13/4 | 5/8 | 17/8 | 3/4 | 7/8 |
| Over 60 to 84 incl. | Over | 5/8 | 13/4 | 3/4 | 17/8 | 7/8 | 17/8 |
| Over 84 to 108 incl. | 600 | 5/8 | 13/4 | 3/4 | 17/8 | 7/8 | 17/8 |
| Over 108 | | 7/8 | 13/4 | 1 | 2 | 11/8 | 21/4 |

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

Cold Finish Bar Machining Allowance

Resulfurized: 1100 and 1200 Series
Straight Carbon: Series 1000,
Stressproof and Fatigue-Proof

Formula for Calculating Allowable Seam Depth



This is the generally accepted industry allowance for seam depth in carbon and alloy steels. The removal of the indicated amounts of stock should minimize seams.

| Non-Resulfurized Size | Non-Resulfurized | | Non-Resulfurized | | Non-Resulfurized | | | |
|-----------------------|------------------|-----------|------------------|-----------|------------------|-----------|------|------|
| | Size | Allowance | Size | Allowance | Size | Allowance | | |
| 5/8 & under | .015 | .010 | 1 1/2 | .036 | .024 | 2 11/16 | .064 | .043 |
| 21/32 | .016 | .010 | 19/16 | .037 | .025 | 2 3/4 | .066 | .044 |
| 1 1/16 | .016 | .011 | 15/8 | .039 | .026 | 2 13/16 | .067 | .045 |
| 23/32 | .017 | .011 | 11 1/16 | .040 | .027 | 2 7/8 | .069 | .046 |
| 3/4 | .018 | .012 | 13/4 | .042 | .028 | 2 15/16 | .070 | .047 |
| 25/32 | .019 | .012 | 125/32 | .043 | .028 | 2 63/64 | .072 | .048 |
| 13/16 | .019 | .013 | 113/16 | .043 | .029 | 3 | .072 | .048 |
| 27/32 | .020 | .013 | 127/32 | .044 | .029 | 3 1/16 | .073 | .049 |
| 55/64 | .021 | .014 | 155/64 | .045 | .030 | 3 1/8 | .075 | .050 |
| 7/8 | .021 | .014 | 17/8 | .045 | .030 | 3 1/4 | .076 | .051 |
| 29/32 | .022 | .014 | 115/16 | .046 | .031 | 3 1/2 | .078 | .052 |
| 15/16 | .022 | .015 | 131/32 | .047 | .031 | 3 5/8 | .079 | .053 |
| 31/32 | .023 | .015 | 163/64 | .048 | .032 | 3 3/8 | .081 | .054 |
| 1 | .024 | .016 | 2 | .048 | .032 | 3 7/16 | .082 | .055 |
| 1 1/32 | .025 | .016 | 2 1/32 | .049 | .032 | 3 1/2 | .084 | .056 |
| 1 3/64 | .025 | .017 | 2 1/16 | .049 | .033 | 3 9/16 | .085 | .057 |
| 1 1/16 | .025 | .017 | 2 1/8 | .051 | .034 | 3 5/8 | .087 | .058 |
| 1 5/64 | .026 | .017 | 2 3/16 | .052 | .035 | 3 11/16 | .088 | .059 |
| 1 9/32 | .026 | .017 | 2 7/32 | .053 | .035 | 3 3/4 | .090 | .060 |
| 1 7/64 | .027 | .017 | 2 1/4 | .054 | .036 | 3 13/16 | .091 | .061 |
| 1 1/8 | .027 | .018 | 2 9/32 | .055 | .036 | 3 7/8 | .093 | .062 |
| 1 5/32 | .028 | .018 | 2 5/16 | .055 | .037 | 3 15/16 | .094 | .063 |
| 1 3/16 | .028 | .018 | 2 11/32 | .056 | .037 | 4 | .096 | .064 |
| 1 7/32 | .029 | .019 | 2 3/8 | .057 | .038 | 4 1/8 | .099 | .066 |
| 1 15/64 | .030 | .020 | 2 13/32 | .058 | .038 | 4 1/4 | .102 | .068 |
| 1 1/4 | .030 | .020 | 2 7/16 | .058 | .039 | 4 3/8 | .105 | .070 |
| 1 17/64 | .030 | .020 | 2 15/32 | .059 | .039 | 4 1/2 | .108 | .072 |
| 1 9/32 | .031 | .020 | 2 1/2 | .060 | .040 | 4 5/8 | .111 | .074 |
| 1 19/64 | .031 | .021 | 2 17/32 | .061 | .040 | 4 3/4 | .114 | .076 |
| 1 5/16 | .031 | .021 | 2 9/16 | .061 | .041 | 4 7/8 | .117 | .078 |
| 1 23/64 | .033 | .022 | 2 19/32 | .062 | .041 | 5 | .120 | .080 |
| 1 3/8 | .033 | .022 | 2 5/8 | .063 | .042 | | | |
| 1 7/16 | .034 | .022 | 2 21/32 | .064 | .042 | | | |

Machinability Ratings for Cold Drawn Steel Bar

Based on 1018 & 1212 as 100%

| Grade Designation | Average Mach. Rating | | Condition of Product | Grade Designation | Average Mach. Rating | | Condition of Product |
|-------------------|----------------------|------|----------------------|-------------------|----------------------|------|----------------------|
| | 1018 | 1212 | | | 1018 | 1212 | |
| 1008 | 71 | 66 | Cold Drawn | 1212 | 149 | 100 | Cold Drawn |
| 1010 | 73 | 68 | Cold Drawn | 1213 | 235 | 136 | Cold Drawn |
| 1012 | 73 | 68 | Cold Drawn | 12L14 | 334 | 180 | Cold Drawn |
| 1015 | 86 | 72 | Cold Drawn | 12L14 + Te | 422 | 250 | Cold Drawn |
| 1016 | 100 | 78 | Cold Drawn | Incut 100 | 334 | 185 | Cold Drawn |
| 1017 | 86 | 72 | Cold Drawn | Incut 200 | 422 | 250 | Cold Drawn |
| 1018 | 100 | 70 | Cold Drawn | Ledloy AX | 422 | 250 | Cold Drawn |
| 10L18 | 126 | 92 | Cold Drawn | 1215 | 235 | 136 | Cold Drawn |
| 1020 | 86 | 72 | Cold Drawn | 1330 | 61 | 60 | Annealed & CD |
| 1021 | 100 | 78 | Cold Drawn | 1335 | 61 | 60 | Annealed & CD |
| 1022 | 100 | 78 | Cold Drawn | 1340 | 53 | 65 | Annealed & CD |
| 1023 | 95 | 76 | Cold Drawn | 4047 | 71 | 65 | Annealed & CD |
| 1025 | 86 | 72 | Cold Drawn | 4118 | 100 | 70 | Cold Drawn |
| 1030 | 80 | 70 | Cold Drawn | 4130 | 86 | 70 | Annealed & CD |
| 1035 | 80 | 70 | Cold Drawn | 4137 | 80 | 70 | Annealed & CD |
| 1038 | 66 | 64 | Cold Drawn | 4140 | 91 | 66 | Annealed & CD |
| 1040 | 66 | 64 | Cold Drawn | 4142 | 71 | 65 | Annealed & CD |
| 1042 | 66 | 64 | Cold Drawn | 4145 | 66 | 64 | Annealed & CD |
| 1043 | 53 | 65 | Cold Drawn | 4147 | 66 | 64 | Annealed & CD |
| 1044 | 53 | 65 | Cold Drawn | 4150 | 61 | 62 | Annealed & CD |
| 1045 | 53 | 65 | Cold Drawn | 4320 | 61 | 60 | Annealed & CD |
| 1045 | 86 | 72 | Annealed & CD | 4340 | 53 | 55 | Annealed & CD |
| 10L45 | 91 | 84 | Annealed & CD | 4620 | 71 | 64 | Cold Drawn |
| 1050 | 50 | 54 | Cold Drawn | 52100 | 28 | 41 | Annealed & CD |
| 1055 | 46 | 85 | Annealed & CD | 6150 | 61 | 60 | Annealed & CD |
| 1060 | 46 | 85 | Annealed & CD | 8615 | 80 | 70 | Cold Drawn |
| 1065 | 40 | 80 | Annealed & CD | 8617 | 71 | 63 | Cold Drawn |
| 1070 | 40 | 80 | Annealed & CD | 8620 | 71 | 63 | Cold Drawn |
| 1074 | 40 | 75 | Annealed & CD | 8622 | 71 | 63 | Cold Drawn |
| 1078 | 40 | 75 | Annealed & CD | | | | |
| 1080 | 32 | 70 | Annealed & CD | | | | |
| 1090 | 32 | 70 | Annealed & CD | | | | |
| 1095 | 32 | 70 | Annealed & CD | | | | |
| 1541 | 53 | 65 | Cold Drawn | | | | |
| 1110 | 109 | 81 | Cold Drawn | | | | |
| 1117 | 122 | 91 | Cold Drawn | | | | |
| 11L17 | 152 | 125 | | | | | |
| 1118 | 122 | 90 | Cold Drawn | | | | |
| 1137 | 86 | 72 | Cold Drawn | | | | |
| 1140 | 86 | 72 | Cold Drawn | | | | |
| 1141 | 80 | 70 | Cold Drawn | | | | |
| 1141 | 109 | 81 | Annealed & CD | | | | |
| 11L41 | 133 | 94 | Annealed & CD | | | | |
| 1144 | 95 | 80 | Cold Drawn | | | | |
| 1144 | 114 | 85 | Annealed & CD | | | | |
| 11L44 | 119 | 87 | Cold Drawn | | | | |
| 11L44 | 142 | 98 | Annealed & CD | | | | |
| 1146 | 80 | 70 | Cold Drawn | | | | |
| 1151 | 80 | 70 | Cold Drawn | | | | |

Approximate Hardness Conversion Numbers for Steel

Based on Brinell Hardness Numbers

| Brinell Indentation Diam. mm | Brinell Hardness No. 10-mm Tungsten Carbide Ball, 3,000 Kg Load | ROCKWELL HARDNESS NO. | | | Diamond Pyramid Hardness No. Vickers | Shore Sciro-scope Hardness No. | Tensile Strength (approximate) in 1,000 psi |
|------------------------------|---|--------------------------------------|---|-------------------------------------|--------------------------------------|--------------------------------|---|
| | | C- | B- | A- | | | |
| | | Scale, 150-Kg Load, Brale Penetrator | Scale, 100-Kg Load, 1/16-in. Brale Penetrator | Scale, 60-Kg Load, Brale Penetrator | | | |
| 2.25 | 745 | 65.3 | — | 84.1 | 840 | 91 | — |
| 2.30 | 712 | — | — | — | — | — | — |
| 2.35 | 682 | 61.7 | — | 82.2 | 737 | 84 | — |
| 2.40 | 653 | 60.0 | — | 81.2 | 697 | 81 | — |
| 2.45 | 627 | 58.7 | — | 80.5 | 667 | 79 | — |
| 2.50 | 601 | 57.3 | — | 79.8 | 640 | 77 | — |
| 2.55 | 578 | 56.0 | — | 79.1 | 615 | 75 | — |
| 2.60 | 555 | 54.7 | — | 78.4 | 591 | 73 | 298 |
| 2.65 | 534 | 53.5 | — | 77.8 | 569 | 71 | 288 |
| 2.70 | 514 | 52.1 | — | 76.9 | 547 | 70 | 274 |
| 2.75 | 495 | 51.0 | — | 76.3 | 528 | 68 | 264 |
| 2.80 | 477 | 49.6 | — | 75.6 | 508 | 66 | 252 |
| 2.85 | 461 | 48.5 | — | 74.9 | 491 | 65 | 242 |
| 2.90 | 444 | 47.1 | — | 74.2 | 472 | 63 | 230 |
| 2.95 | 429 | 45.7 | — | 73.4 | 455 | 61 | 219 |
| 3.00 | 415 | 44.5 | — | 72.8 | 440 | 59 | 212 |
| 3.05 | 401 | 43.1 | — | 72.0 | 425 | 58 | 202 |
| 3.10 | 388 | 41.8 | — | 71.4 | 410 | 56 | 193 |
| 3.15 | 375 | 40.4 | — | 70.6 | 396 | 54 | 184 |
| 3.20 | 363 | 39.1 | — | 70.0 | 383 | 52 | 177 |
| 3.25 | 352 | 37.9 | (110.0) | 69.3 | 372 | 51 | 171 |
| 3.30 | 341 | 36.6 | (109.0) | 68.7 | 360 | 50 | 164 |
| 3.35 | 331 | 35.5 | (108.5) | 68.1 | 350 | 48 | 159 |
| 3.40 | 321 | 34.3 | (108.0) | 67.5 | 339 | 47 | 154 |
| 3.45 | 311 | 33.1 | (107.5) | 66.9 | 328 | 46 | 149 |
| 3.50 | 302 | 32.1 | (107.0) | 66.3 | 319 | 45 | 146 |
| 3.55 | 293 | 30.9 | (106.0) | 65.7 | 309 | 43 | 141 |
| 3.60 | 285 | 29.9 | (105.5) | 65.3 | 301 | — | 138 |
| 3.65 | 277 | 28.8 | (104.5) | 64.6 | 292 | 41 | 134 |
| 3.70 | 269 | 27.6 | (104.0) | 64.1 | 284 | 40 | 130 |
| 3.75 | 262 | 26.6 | (103.0) | 63.6 | 276 | 39 | 127 |
| 3.80 | 255 | 25.4 | (102.0) | 63.0 | 269 | 38 | 123 |
| 3.85 | 248 | 24.2 | (101.0) | 62.5 | 261 | 37 | 120 |
| 3.90 | 241 | 22.8 | 100.0 | 61.8 | 253 | 36 | 116 |
| 3.95 | 235 | 21.7 | 99.0 | 61.4 | 247 | 35 | 114 |
| 4.00 | 229 | 20.5 | 98.2 | 60.8 | 241 | 34 | 111 |
| 4.05 | 223 | (18.8) | 97.3 | — | 234 | — | — |
| 4.10 | 217 | (17.5) | 96.4 | — | 228 | 33 | 105 |
| 4.15 | 212 | (16.0) | 95.5 | — | 222 | — | 102 |
| 4.20 | 207 | (15.2) | 94.6 | — | 218 | 32 | 100 |
| 4.25 | 201 | (13.8) | 93.8 | — | 212 | 31 | 98 |
| 4.30 | 197 | (12.7) | 92.8 | — | 207 | 30 | 95 |
| 4.35 | 192 | (11.5) | 91.9 | — | 202 | 29 | 93 |
| 4.40 | 187 | (10.0) | 90.7 | — | 196 | — | 90 |
| 4.45 | 183 | (9.0) | 90.0 | — | 192 | 28 | 89 |
| 4.50 | 79 | (8.0) | 89.0 | — | 188 | 27 | 87 |
| 4.55 | 174 | (6.4) | 87.8 | — | 182 | — | 85 |
| 4.60 | 170 | (5.4) | 86.8 | — | 178 | 26 | 83 |
| 4.65 | 167 | (4.4) | 86.0 | — | 175 | — | 81 |
| 4.70 | 163 | (3.3) | 85.0 | — | 171 | 25 | 79 |
| 4.80 | 156 | (0.9) | 82.9 | — | 163 | — | 76 |
| 4.90 | 149 | — | 80.8 | — | 156 | 23 | 73 |
| 5.00 | 143 | — | 78.7 | — | 150 | 22 | 71 |
| 5.10 | 137 | — | 76.4 | — | 143 | 21 | 67 |
| 5.20 | 131 | — | 74.0 | — | 137 | — | 65 |

Circumference & Area of Circles/Inches

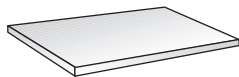
| Diameter | | | | Diam. | | | Diam. | | |
|----------|---------|--------|--------|-------|---------|---------|-------|--------|----------|
| Frac. | Decimal | Circ. | Area | Diam. | Circ. | Area | Diam. | Circ. | Area |
| 1/64 | .015625 | .04909 | .00019 | 1 | 3.1416 | .7854 | 64 | 201.06 | 3216.99 |
| 1/32 | .03125 | .09818 | .00077 | 2 | 6.2832 | 3.1416 | 65 | 204.20 | 3318.31 |
| 3/64 | .046875 | .14726 | .00173 | 3 | 9.4248 | 7.0686 | 66 | 207.34 | 3421.19 |
| 1/16 | .0625 | .19635 | .00307 | 4 | 12.5664 | 12.5664 | 67 | 210.49 | 3525.65 |
| 5/64 | .078125 | .24545 | .00479 | 5 | 15.7080 | 19.635 | 68 | 213.63 | 3631.68 |
| 3/32 | .09375 | .29452 | .00690 | 6 | 18.850 | 28.274 | 69 | 216.77 | 3739.28 |
| 7/64 | .109375 | .34363 | .00939 | 7 | 21.991 | 38.485 | 70 | 219.91 | 3848.45 |
| 1/8 | .125 | .39270 | .01227 | 8 | 25.133 | 50.266 | 71 | 223.05 | 3959.19 |
| 9/64 | .140625 | .44181 | .01553 | 9 | 28.274 | 63.617 | 72 | 226.19 | 4071.50 |
| 5/32 | .15625 | .49087 | .01917 | 10 | 31.416 | 78.540 | 73 | 229.34 | 4185.39 |
| 11/64 | .171875 | .53999 | .02320 | 11 | 34.558 | 95.033 | 74 | 232.48 | 4300.84 |
| 3/16 | .1875 | .58905 | .02761 | 12 | 37.699 | 113.10 | 75 | 235.62 | 4417.86 |
| 13/64 | .203125 | .63817 | .03241 | 13 | 40.841 | 132.73 | 76 | 238.76 | 4536.46 |
| 7/32 | .21875 | .68722 | .03758 | 14 | 43.982 | 153.94 | 77 | 241.90 | 4656.63 |
| 15/64 | .234375 | .73635 | .04314 | 15 | 47.124 | 176.72 | 78 | 245.04 | 4778.36 |
| 1/4 | .25 | .78540 | .04909 | 16 | 50.265 | 201.06 | 79 | 248.19 | 4901.67 |
| 17/64 | .265625 | .83453 | .05542 | 17 | 53.407 | 226.98 | 80 | 251.33 | 5026.55 |
| 9/32 | .28125 | .88367 | .06213 | 18 | 56.549 | 254.47 | 81 | 254.47 | 5153.00 |
| 19/64 | .296875 | .93271 | .06922 | 19 | 59.690 | 283.53 | 82 | 257.61 | 5281.02 |
| 5/16 | .3125 | .98175 | .07670 | 20 | 62.832 | 314.16 | 83 | 260.75 | 5410.61 |
| 21/64 | .328125 | 1.0309 | .08456 | 21 | 65.973 | 346.36 | 84 | 263.89 | 5541.77 |
| 11/32 | .34375 | 1.0799 | .09281 | 22 | 69.115 | 380.13 | 85 | 267.04 | 5674.50 |
| 23/64 | .359375 | 1.1291 | .10144 | 23 | 72.257 | 415.48 | 86 | 270.18 | 5808.80 |
| 3/8 | .375 | 1.1781 | .11045 | 24 | 75.398 | 452.39 | 87 | 273.32 | 5944.68 |
| 25/64 | .390625 | 1.2273 | .11984 | 25 | 78.540 | 490.87 | 88 | 276.46 | 6082.12 |
| 13/32 | .40625 | 1.2763 | .12962 | 26 | 81.681 | 530.93 | 89 | 279.60 | 6221.14 |
| 27/64 | .421875 | 1.3254 | .13979 | 27 | 84.823 | 572.56 | 90 | 282.74 | 6361.73 |
| 7/16 | .4375 | 1.3744 | .15033 | 28 | 87.965 | 615.75 | 91 | 285.88 | 6503.88 |
| 29/64 | .453125 | 1.4236 | .16126 | 29 | 91.106 | 660.52 | 92 | 289.03 | 6647.61 |
| 15/32 | .46875 | 1.4726 | .17257 | 30 | 94.248 | 706.86 | 93 | 292.17 | 6792.91 |
| 31/64 | .484375 | 1.5218 | .18427 | 31 | 97.389 | 754.77 | 94 | 295.31 | 6939.78 |
| 1/2 | .5 | 1.5708 | .19635 | 32 | 100.53 | 804.25 | 95 | 298.45 | 7088.22 |
| 33/64 | .515625 | 1.6199 | .20880 | 33 | 103.67 | 855.30 | 96 | 301.59 | 7238.23 |
| 17/32 | .53125 | 1.6690 | .22166 | 34 | 106.81 | 907.92 | 97 | 304.73 | 7389.81 |
| 35/64 | .546875 | 1.7181 | .23489 | 35 | 109.96 | 962.11 | 98 | 307.88 | 7542.96 |
| 9/16 | .5625 | 1.7671 | .24850 | 36 | 113.10 | 1017.88 | 99 | 311.02 | 7697.69 |
| 37/64 | .578125 | 1.8163 | .26248 | 37 | 116.24 | 1075.21 | 100 | 314.16 | 7853.98 |
| 19/32 | .59375 | 1.8653 | .27688 | 38 | 119.38 | 1134.11 | 101 | 317.30 | 8011.85 |
| 39/64 | .609375 | 1.9145 | .29164 | 39 | 122.52 | 1194.59 | 102 | 320.44 | 8171.28 |
| 5/8 | .625 | 1.9635 | .30680 | 40 | 125.66 | 1256.64 | 103 | 323.58 | 8332.29 |
| 41/64 | .640625 | 2.0127 | .32232 | 41 | 128.81 | 1320.25 | 104 | 326.73 | 8494.87 |
| 21/32 | .65625 | 2.0617 | .33824 | 42 | 131.95 | 1385.44 | 105 | 329.87 | 8659.01 |
| 43/64 | .671875 | 2.1108 | .35453 | 43 | 135.09 | 1452.20 | 106 | 333.01 | 8824.73 |
| 11/16 | .6875 | 2.1598 | .37122 | 44 | 138.23 | 1520.53 | 107 | 336.15 | 8992.02 |
| 45/64 | .703125 | 2.2090 | .38828 | 45 | 141.37 | 1590.43 | 108 | 339.29 | 9160.88 |
| 23/32 | .71875 | 2.2580 | .40574 | 46 | 144.51 | 1661.90 | 109 | 342.43 | 9331.32 |
| 47/64 | .734375 | 2.3072 | .42356 | 47 | 147.65 | 1734.94 | 110 | 345.58 | 9503.32 |
| 3/4 | .75 | 2.3562 | .44179 | 48 | 150.80 | 1809.56 | 111 | 348.72 | 9676.89 |
| 49/64 | .765625 | 2.4054 | .45253 | 49 | 153.94 | 1885.74 | 112 | 351.86 | 9852.03 |
| 25/32 | .78125 | 2.4544 | .47937 | 50 | 157.08 | 1963.50 | 113 | 355.00 | 10028.75 |
| 51/64 | .796875 | 2.5036 | .49872 | 51 | 160.22 | 2042.82 | 114 | 358.14 | 10207.03 |
| 13/16 | .8125 | 2.5525 | .51849 | 52 | 163.36 | 2123.72 | 115 | 361.28 | 10386.89 |
| 53/64 | .828125 | 2.6017 | .53862 | 53 | 166.50 | 2206.18 | 116 | 364.42 | 10568.32 |
| 27/32 | .84375 | 2.6507 | .55914 | 54 | 169.65 | 2290.22 | 117 | 367.57 | 10751.32 |
| 55/64 | .859375 | 2.6999 | .58003 | 55 | 172.79 | 2375.83 | 118 | 370.71 | 10935.88 |
| 7/8 | .875 | 2.7489 | .60132 | 56 | 175.93 | 2463.01 | 119 | 373.85 | 11122.02 |
| 57/64 | .890625 | 2.7981 | .62298 | 57 | 179.07 | 2551.76 | 120 | 376.99 | 11309.73 |
| 29/32 | .90625 | 2.8471 | .64504 | 58 | 182.21 | 2642.08 | 121 | 380.13 | 11499.01 |
| 59/64 | .921875 | 2.8963 | .66746 | 59 | 185.35 | 2733.97 | 122 | 383.27 | 11689.87 |
| 15/16 | .9375 | 2.9452 | .69029 | 60 | 188.50 | 2827.43 | 123 | 386.42 | 11882.29 |
| 61/64 | .953125 | 2.9945 | .71349 | 61 | 191.64 | 2922.07 | 124 | 389.56 | 12076.28 |
| 31/32 | .96875 | 3.0434 | .73708 | 62 | 194.78 | 3019.07 | 125 | 392.70 | 12271.85 |
| 63/64 | .984375 | 3.0928 | .76097 | 63 | 197.92 | 3117.25 | 126 | 395.84 | 12468.98 |

Cold Rolled Steel Strip

Tempers

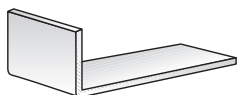
No. 1 – Hard

Carbon 0.25% max.
Thickness: 0.070" and thicker – RB 84 min.
Under 0.070" – RB 90 min.



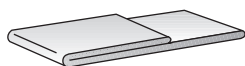
No. 2 – Half Hard

Carbon 0.25% max.
Thickness: 0.040" and thicker – RB 70 min.



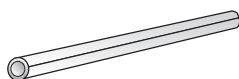
No. 3 – Quarter Hard

Carbon 0.25% max.
Thickness: 0.040" and thicker – RB 60 min.
to RB 75 approx. max.



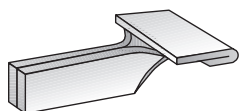
No. 4 – Pinch Pass or Skin Rolled

Carbon 0.25% max.
Thickness: 0.040" and thicker – RB 65 max.



No. 5 – Dead Soft

Carbon 0.15% max.
Thickness: 0.040" and thicker – RB 55 max.



NOTE: For these tempers, it's customary not to exceed 0.60% manganese by ladle analysis. If manganese is specified above 0.60% by ladle analysis or in the case of temper Nos. 4 and 5, the carbon is specified above 0.15% by ladle analysis, these Rockwell Hardness values don't apply.

Cold Rolled Steel Strip

Edges

No.1

Perfect square or round edge.



No. 2

Natural mill edge.



No. 3

Approx. square edge by slitting, not filed.



No. 4

Round edge produced by edge rolling.



No. 5

Approx. sq. edge by rolling or filling after slitting.



No. 6

Square edge produced by edge rolling



Metric System of Measurement

In the metric system of measurements, the principal unit for length is the meter; the principal unit for capacity, the liter; and the principal unit for weight, the gram. The following prefixes are used for sub-divisions and multiples: milli = 1/1000; centi = 1/mlli; deci = 1/10; deca = 10; hecto = 100; kilo = 1000. In abbreviations, the sub-divisions are frequently used with a small letter and the multiples with a capital letter, although this practice is not universally followed everywhere where the metric system is used.

All the multiples and sub-divisions are not used commercially. Those ordinarily used for length are kilometer, meter, centimeter and millimeter; for capacity, square meter, square centimeter and square millimeter; for cubic measures, cubic meter, cubic decimeter (liter), cubic centimeter, and cubic millimeter. The most commonly used weights are the kilogram and gram. The metric system was legalized in the United States by an Act of Congress in 1866.

Measures of Length

| | | |
|----------------------|---|--------------------|
| 10 millimeters (mm.) | = | 1 centimeter (cm.) |
| 10 centimeters | = | 1 decimeter (dm.) |
| 10 decimeters | = | 1 meter (m.) |
| 1000 meters | = | 1 kilometer (km.) |

Square Measure

| | | |
|-------------------------------|---|----------------------------|
| 100 square millimeters (mm.2) | = | 1 square centimeter (cm.2) |
| 100 square centimeters | = | 1 square decimeter (dm.2) |
| 100 square decimeters | = | 1 square meter (m.2) |

Surveyor's Square Measure

| | | |
|-------------------------|---|----------------------------|
| 100 square meters (m.2) | = | 1 are (ar.). |
| 100 ares | = | 1 hectare (har.). |
| 100 hectares | = | 1 square kilometer (km.2). |

Cubic Measure

| | | |
|-------------------------------|---|---------------------------|
| 1000 cubic millimeters (mm.3) | = | 1 cubic centimeter (cm.3) |
| 1000 cubic centimeters | = | 1 cubic decimeter (dm.3) |
| 1000 cubic decimeters | = | 1 cubic meter (m.3) |

Dry and Liquid Measure

| | | |
|----------------------|---|---------------------|
| 10 milliliters (ml.) | = | 1 centiliter (cl.). |
| 10 centiliters | = | 1 deciliter (dl.). |
| 10 deciliters | = | 1 liter (l.). |
| 100 liters | = | 1 hectoliter (Hl.). |

1 liter = 1 cubic decimeter = the volume of 1 kilogram of pure water at a temperature of 39.2 degrees F.

Measures of Weight

| | | |
|---------------------|---|----------------------|
| 10 milligrams (mg.) | = | 1 centigram (cg.). |
| 10 centigrams | = | 1 decigram (dg.). |
| 10 decigrams | = | 1 gram (g.). |
| 10 grams | = | 1 decagram (Dg.). |
| 10 decagrams | = | 1 hectogram (Hg.). |
| 10 hectograms | = | 1 kilogram (Kg.). |
| 1000 kilograms | = | 1 (metric) ton (T.). |

Metric and English Conversion Table

Linear Measure

| | | | |
|----------------|---------------|----------|--------------------|
| 1 kilometer = | 0.6214 mile. | 1 mile = | 1.609 kilometer. |
| 1 meter { = | 39.37 inches. | 1 yard = | 0.9144 meter. |
| | 3.2808 feet. | 1 foot = | 0.3048 meter. |
| | 1.0936 yard. | 1 foot = | 304.8 millimeters. |
| 1 centimeter = | 0.3937 inch. | 1 inch = | 2.542 centimeters. |
| 1 millimeter = | 0.03937 | 1 inch = | 25.4 millimeters. |

Square Measure

| | | |
|-----------------------|----------------------------|---------------------------|
| 1 square kilometer = | 0.3861 square mile = | 247.1 acres. |
| 1 hectare = | 2.471 acre = | 107, 640 square feet. |
| 1 are = | 0.0247 acre = | 1076.4 square feet. |
| 1 square meter = | 10.764 square feet = | 1/196 square yard. |
| 1 square centimeter = | 0.155 square inch. | |
| 1 square millimeter = | 0.00155 square inch. | |
| 1 square mile = | 2.5899 square kilometers. | |
| 1 acre = | 0.4047 hectare = | 40.47 ares. |
| 1 square yard = | 0.836 square meter. | |
| 1 square foot = | 0.0929 square meter = | 929 square centimeters. |
| 1 square inch = | 6.452 square centimeters = | 645.2 square millimeters. |

Cubic Measure

| | | |
|-----------------------------|-----------------------------|----------------------|
| 1 cubic meter = | 25.314 cubic feet = | 1.308 cubic yard |
| 1 cubic meter = | 264.2 U.S. gallons. | |
| 1 cubic centimeter = | 0.061 cubic inch. | |
| 1 liter (cubic decimeter) = | 0.0353 cubic foot = | 61.023 cubic inches. |
| 1 liter = | 0.2642 U.S. gallon = | 1.0567 U.S. quart. |
| 1 cubic yard = | 0.7645 cubic meter. | |
| 1 cubic foot = | 0.02832 cubic meter = | 28.317 liters. |
| 1 cubic inch = | 16.38716 cubic centimeters. | |
| 1 U.S. gallon = | 3.785 liters. | |
| 1 U.S. quart = | 0.946 liter. | |

Weight

| | | |
|------------------------------------|--|----------------------------|
| 1 metric ton = | 0.9842 ton (of 2240 pounds) = | 2204.6 pounds. |
| 1 kilogram = | 2.2046 pounds = | 35.274 ounces avoirdupois. |
| 1 gram = | 0.03215 ounce troy = | 0.03527 ounce avoirdupois |
| 1 gram = | 15.432 grains. | |
| 1 ton (of 2240 pounds) = | 1.016 metric ton = | 1016 kilograms. |
| 1 pound = | 0.4536 kilogram = | 453.6 grams. |
| 1 ounce avoirdupois = | 28.35 grams. | |
| 1 ounce troy = | 31.103 grams. | |
| 1 grain = | 0.0648 gram. | |
| 1 kilogram per square millimeter = | 1422.32 pounds per square inch. | |
| 1 kilogram per square centimeter = | 14.223 pounds per square inch. | |
| 1 kilogram-meter = | 7.233 foot-pounds. | |
| 1 pound per square inch = | 0.0703 kilogram per square centimeter. | |
| 1 calorie (kilogram calorie) = | 3.968 B.T.U. (British thermal unit). | |

Inches to Millimeters

| Fraction | Inches | M/M | Fraction | Inches | M/M |
|----------|--------|--------|----------|---------|--------|
| 1/64 | .01563 | .397 | 33/64 | .51563 | 13.097 |
| 1/32 | .03125 | .794 | 17/32 | .53125 | 13.494 |
| 3/64 | .04688 | 1.191 | 35/64 | .54688 | 13.891 |
| 1/16 | .06250 | 1.587 | 9/16 | .56250 | 14.287 |
| 5/64 | .07813 | 1.984 | 37/64 | .57813 | 14.684 |
| 3/32 | .09375 | 2.381 | 19/32 | .59375 | 15.081 |
| 7/64 | .10938 | 2.778 | 39/64 | .60938 | 15.478 |
| 1/8 | .12500 | 3.175 | 5/8 | .62500 | 15.875 |
| 9/64 | .14063 | 3.572 | 41/64 | .64063 | 16.272 |
| 5/32 | .15625 | 3.969 | 21/32 | .65625 | 16.669 |
| 11/64 | .17188 | 4.366 | 43/64 | .67188 | 17.066 |
| 3/16 | .18750 | 4.762 | 11/16 | .68750 | 17.462 |
| 13/64 | .20313 | 5.159 | 45/64 | .70313 | 17.859 |
| 7/32 | .21875 | 5.556 | 23/32 | .71875 | 18.256 |
| 15/64 | .23438 | 5.953 | 47/64 | .73438 | 18.653 |
| 1/4 | .25000 | 6.350 | 3/4 | .75000 | 19.050 |
| 17/64 | .26563 | 6.747 | 49/64 | .76563 | 19.447 |
| 9/32 | .28125 | 7.144 | 25/32 | .78125 | 19.844 |
| 19/64 | .29688 | 7.541 | 51/64 | .79688 | 20.241 |
| 5/16 | .31250 | 7.937 | 13/16 | .81250 | 20.637 |
| 21/64 | .32813 | 8.334 | 53/64 | .82813 | 21.034 |
| 11/32 | .34375 | 8.731 | 27/32 | .84375 | 21.431 |
| 23/64 | .35938 | 9.128 | 55/64 | .85938 | 21.828 |
| 3/8 | .37500 | 9.525 | 7/8 | .87500 | 22.225 |
| 25/64 | .39063 | 9.922 | 57/64 | .89063 | 22.622 |
| 13/32 | .40625 | 10.319 | 29/32 | .90625 | 23.019 |
| 27/64 | .42188 | 10.716 | 59/64 | .92188 | 23.416 |
| 7/16 | .43750 | 11.113 | 15/16 | .93750 | 23.812 |
| 29/64 | .45313 | 11.509 | 61/64 | .95313 | 24.209 |
| 15/32 | .46875 | 11.906 | 31/32 | .96875 | 24.606 |
| 31/64 | .48438 | 12.303 | 63/64 | .98438 | 25.003 |
| 1/2 | .50000 | 12.700 | | 1.00000 | 25.400 |

To Convert Inches to Millimeters Multiply by 25.4

- 10' to mm ÷ 3048
- 12' to mm ÷ 3658
- 20' to mm ÷ 6096

Millimeters to Inches

| M/M | Inches | M/M | Inches | M/M | Inches |
|-----|--------|-----|--------|-----|--------|
| 1 | .0394 | 34 | 1.3396 | 67 | 2.6398 |
| 2 | .0788 | 35 | 1.3790 | 68 | 2.6792 |
| 3 | .1182 | 36 | 1.4184 | 69 | 2.7186 |
| 4 | .1576 | 37 | 1.4578 | 70 | 2.7580 |
| 5 | .1979 | 38 | 1.4972 | 71 | 2.7974 |
| 6 | .2364 | 39 | 1.5366 | 72 | 2.8368 |
| 7 | .2758 | 40 | 1.5760 | 73 | 2.8762 |
| 8 | .3152 | 41 | 1.6154 | 74 | 2.9156 |
| 9 | .3546 | 42 | 1.6548 | 75 | 2.9550 |
| 10 | .3940 | 43 | 1.6942 | 76 | 2.9944 |
| 11 | .4334 | 44 | 1.7336 | 77 | 3.0338 |
| 12 | .4728 | 45 | 1.7730 | 78 | 3.0732 |
| 13 | .5122 | 46 | 1.8124 | 79 | 3.1126 |
| 14 | .5516 | 47 | 1.8518 | 80 | 3.1520 |
| 15 | .5910 | 48 | 1.8912 | 81 | 3.1914 |
| 16 | .6304 | 49 | 1.9306 | 82 | 3.2308 |
| 17 | .6698 | 50 | 1.9700 | 83 | 3.2702 |
| 18 | .7092 | 51 | 2.0094 | 84 | 3.3096 |
| 19 | .7486 | 52 | 2.0488 | 85 | 3.3490 |
| 20 | .7880 | 53 | 2.0882 | 86 | 3.3884 |
| 21 | .8274 | 54 | 2.1276 | 87 | 3.4278 |
| 22 | .8668 | 55 | 2.1670 | 88 | 3.4672 |
| 23 | .9062 | 56 | 2.2064 | 89 | 3.5066 |
| 24 | .9456 | 57 | 2.2458 | 90 | 3.5460 |
| 25 | .9850 | 58 | 2.2852 | 91 | 3.5854 |
| 26 | 1.0244 | 59 | 2.3246 | 92 | 3.6248 |
| 27 | 1.0638 | 60 | 2.3640 | 93 | 3.6642 |
| 28 | 1.1032 | 61 | 2.4034 | 94 | 3.7036 |
| 29 | 1.1426 | 62 | 2.4428 | 95 | 3.7430 |
| 30 | 1.1820 | 63 | 2.4822 | 96 | 3.7824 |
| 31 | 1.2214 | 64 | 2.5216 | 97 | 3.8218 |
| 32 | 1.2608 | 65 | 2.5610 | 98 | 3.8612 |
| 33 | 1.3002 | 66 | 2.6004 | 99 | 3.9006 |

To Convert Millimeters to Inches Multiply By 0394 .03937

Useful Information

To find the circumference of a circle:

Multiply the radius by 6.2832, or
 Multiply the diameter by 3.1416, or
 Multiply the square root of the area by 3.3449

To find the radius of a circle:

Multiply the diameter by .5, or
 Multiply the circumference by .15913, or
 Multiply the square root of the area by .56419

To find the diameter of a circle:

Multiply the radius by 2, or
 Multiply the circumference by .31831, or
 Multiply the square root of the area by 1.1284

To find the area of a circle:

Multiply the square of the radius by 3.1416, or
 Multiply the square of the diameter by .7854, or
 Multiply the square of the circumference by .07958

To find the area of a hexagon:

Multiply the square of the distance across by .86603, or
 Multiply the area of the inscribed circle by 1.1027

To find the area of an octagon:

Multiply the square of the distance across by .82843, or
 Multiply the area of the inscribed circle by 1.0348

To find the area of a rectangle:

Multiply the length by the width

To find the area of a triangle:

Multiply the base by one-half the perpendicular height

To find the side of an inscribed square:

Multiply the diameter by .7071, or
 Multiply the circumference by .2251

To find the side of an equal square:

Multiply the diameter by .8862

To find the diameter of the circumscribing circle of a square:

Multiply a side by 1.4142

To find the circumference of the circumscribing circle of a square:

Multiply a side by 4.443

To find the cubic contents of a cone:

Multiply the area of the base by one-third the altitude

To find the area of an ellipse:

Multiply the product of its axes by .7854

To find the area of a parallelogram:

Multiply the base times the perpendicular height

To find the volume of a parallelogram:

Multiply the area of cross section times the length

To find the area of a cylinder:

Multiply the length times the circumference of the body plus the area of both ends.

To find the volume of a cylinder:

Multiply the area of the base by the perpendicular height

To find the area of a sphere:

Multiply the square of the diameter by 3.1416, or
 Multiply the diameter times the circumference

To find the volume of a sphere:

Multiply the cube of the diameter by .5236

To find the capacity of a tank in gallons:

All measurements must be reduced to inches

For cylindrical tanks, multiply the length by the square of the diameter by .0034.

For rectangular tanks, multiply the length by the width by the depth and divide by 231.

For elliptical tanks, multiply the length by the short diameter by the long diameter by .0034

To convert Brinell hardness to tensile strength:

Divide the Brinell Hardness number by two to get the approximate tensile strength in thousands of pounds per square inch.

Example: Assume Brinell Hardness of 248.
 $248 \div 2 = 124,000$ p.s.i. (approx. tensile strength.)

Conversely, drop the last three figures of the tensile strength and multiply by two to get the approximate Brinell Hardness number.

Example: Assume tensile strength of 122,000 p.s.i.
 $122 \times 2 = 244$ (approximate Brinell Hardness).

To estimate the weight of a round steel bar:

Multiply the diameter by 4, square the product, and divide by 6. The result is the approximate weight in pounds per foot of length.

To estimate the weight of a square steel bar:

Square the size, add a zero and divide by 3. The result is the approximate weight in pounds per foot of length.

To estimate the weight of a flat steel bar:

Multiply the width by the thickness, add a zero and divide by 3. The result is the approximate weight in pounds per foot of length.

To calculate sheet weight

Sheet Weight = Width x Length x Decimal thickness

Fractions & Decimal Equivalents

| Fraction | Decimal | Fraction | Decimal |
|-----------------|---------|-----------------|---------|
| $\frac{1}{64}$ | .01563 | $\frac{33}{64}$ | .51563 |
| $\frac{1}{32}$ | .03125 | $\frac{17}{32}$ | .53125 |
| $\frac{3}{64}$ | .04688 | $\frac{35}{64}$ | .54688 |
| $\frac{1}{16}$ | .06250 | $\frac{9}{16}$ | .56250 |
| $\frac{5}{64}$ | .07813 | $\frac{37}{64}$ | .57813 |
| $\frac{3}{32}$ | .09375 | $\frac{19}{32}$ | .59375 |
| $\frac{7}{64}$ | .10938 | $\frac{39}{64}$ | .60938 |
| $\frac{1}{8}$ | .12500 | $\frac{5}{8}$ | .62500 |
| $\frac{9}{64}$ | .14063 | $\frac{41}{64}$ | .64063 |
| $\frac{5}{32}$ | .15625 | $\frac{21}{32}$ | .65625 |
| $\frac{11}{64}$ | .17188 | $\frac{43}{64}$ | .67188 |
| $\frac{3}{16}$ | .18750 | $\frac{11}{16}$ | .68750 |
| $\frac{13}{64}$ | .20313 | $\frac{45}{64}$ | .70313 |
| $\frac{7}{32}$ | .21875 | $\frac{23}{32}$ | .71875 |
| $\frac{15}{64}$ | .23438 | $\frac{47}{64}$ | .73438 |
| $\frac{1}{4}$ | .25000 | $\frac{3}{4}$ | .75000 |
| $\frac{17}{64}$ | .26563 | $\frac{49}{64}$ | .76563 |
| $\frac{9}{32}$ | .28125 | $\frac{25}{32}$ | .78125 |
| $\frac{19}{64}$ | .29688 | $\frac{51}{64}$ | .79688 |
| $\frac{5}{16}$ | .31250 | $\frac{13}{16}$ | .81250 |
| $\frac{21}{64}$ | .32813 | $\frac{53}{64}$ | .82813 |
| $\frac{11}{32}$ | .34375 | $\frac{27}{32}$ | .84375 |
| $\frac{23}{64}$ | .35938 | $\frac{55}{64}$ | .85938 |
| $\frac{3}{8}$ | .37500 | $\frac{7}{8}$ | .87500 |
| $\frac{25}{64}$ | .39063 | $\frac{57}{64}$ | .89063 |
| $\frac{13}{32}$ | .40625 | $\frac{29}{32}$ | .90625 |
| $\frac{27}{64}$ | .42188 | $\frac{59}{64}$ | .92188 |
| $\frac{7}{16}$ | .43750 | $\frac{15}{16}$ | .93750 |
| $\frac{29}{64}$ | .45313 | $\frac{61}{64}$ | .95313 |
| $\frac{15}{32}$ | .46875 | $\frac{31}{32}$ | .96875 |
| $\frac{31}{64}$ | .48438 | $\frac{63}{64}$ | .98438 |
| $\frac{1}{2}$ | .50000 | 1 | 1.00000 |

IMPORTANT

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