

## Carbon Steels

| Alloy Type | Similar Designation          | Condition                      | Hardness Min.                          | Ultimate Tensile Strength psi | Yield Strength psi | Elongation % in 1 in. | Remarks                                                                                                               | Castability | Resistance to Hot Tearing | Shrinkage | Fluidity |
|------------|------------------------------|--------------------------------|----------------------------------------|-------------------------------|--------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------|-------------|---------------------------|-----------|----------|
| 1010       | MIL-S-11310E                 | As Cast                        | R <sub>B</sub> 50                      | 50,000                        | 30,000             | 30                    | Electrical Components                                                                                                 | 75          | B                         | C         | C        |
| 1015       | ASTM-A-29                    | As Cast                        | R <sub>B</sub> 55                      | 50,000                        | 30,000             | 25                    | High Impact, Strength                                                                                                 | 80          | C                         | C         | C        |
| 1018       | MIL-S-11310E                 | As Cast                        | R <sub>B</sub> 60                      | 65,000                        | 45,000             | 20                    | High Impact, Carburizing                                                                                              | 80          | C                         | C         | C        |
|            |                              | Annealed                       | R <sub>B</sub> 60                      | 65,500                        | 35,000             | 25                    |                                                                                                                       |             |                           |           |          |
|            |                              | Normalized & Drawn 300°F       | R <sub>B</sub> 70                      | 70,000                        | 45,000             | 25                    |                                                                                                                       |             |                           |           |          |
| 1020       | ASTM A-27, Gr 1A<br>IC1020   | As Cast                        | R <sub>B</sub> 60                      | 60,000                        | 45,000             | 20                    | High Impact, Carburizing                                                                                              | 80          | C                         | C         | C        |
|            |                              | Annealed                       | R <sub>B</sub> 60                      | 57,500                        | 37,500             | 28                    |                                                                                                                       |             |                           |           |          |
|            |                              | Normalized & Drawn 300°F       | R <sub>B</sub> 60                      | 65,000                        | 45,000             | 20                    |                                                                                                                       |             |                           |           |          |
| 1030       | MIL-S-81591<br>IC1030        | As Cast                        | R <sub>B</sub> 70                      | 70,000                        | 45,000             | 12                    | Flame Hardening Grade                                                                                                 | 85          | B                         | B         | C        |
|            |                              | Annealed                       | R <sub>B</sub> 70                      | 65,000                        | 40,000             | 25                    |                                                                                                                       |             |                           |           |          |
| 1040       | IC1040                       | As Cast                        | R <sub>B</sub> 85                      | 85,000                        | 55,000             | 7                     | Medium Strength<br>Structural Parts                                                                                   | 85          | B                         | B         | B        |
|            |                              | Annealed                       | R <sub>B</sub> 70                      | 70,000                        | 40,000             | 22                    |                                                                                                                       |             |                           |           |          |
|            |                              | Oil Quench & Drawn 300°F       | R <sub>C</sub> 28                      | 135,000                       | 90,000             | 8                     |                                                                                                                       |             |                           |           |          |
|            |                              | Oil Quench & Drawn 1000°F      | R <sub>C</sub> 24                      | 100,000                       | 90,000             | 10                    |                                                                                                                       |             |                           |           |          |
| 1045       | ASTM-A-684                   | Annealed<br>Oil Quench & Drawn | R <sub>B</sub> 75<br>R <sub>C</sub> 30 | 75,000<br>140,000             | 40,000<br>95,000   | 20<br>7               | Medium Strength<br>Structural Parts                                                                                   | 85          | B                         | B         | B        |
| 1050       | MIL-S-81591<br>IC1050        | Annealed<br>Oil Quench & Drawn | R <sub>B</sub> 85<br>R <sub>C</sub> 35 | 90,000<br>150,000             | 45,000<br>100,000  | 14<br>6               | Induction Hardening                                                                                                   | 85          | B                         | B         | B        |
| 1060       | ASTM-A-680                   | Annealed                       | R <sub>B</sub> 90                      | 100,000                       | 55,000             | 12                    | Good Strength and<br>Impact Combination                                                                               | 85          | B                         | A         | B        |
| 4130       | MIL-S-22141B<br>IC 4130      | Annealed                       |                                        | 80,000                        | 60,000             | 18                    | Structural Parts Requiring<br>Welding, High Fatigue<br>Resistance, Strength                                           | 90          | B                         | B         | B        |
|            |                              | Quench & Tempered @ 350°F      |                                        | 200,000                       | 170,000            | 6                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1250°F     |                                        | 105,000                       | 85,000             | 18                    |                                                                                                                       |             |                           |           |          |
| 4140       | AMS 5338C                    | Annealed                       |                                        | 90,000                        | 60,000             | 17                    | Structural Parts. Good<br>Combination of Fatigue<br>Wear Resistance and<br>Hardness.                                  | 90          | B                         | B         | B        |
|            |                              | Quench & Tempered @ 350°F      |                                        | 220,000                       | 200,000            | 4                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 900°F      |                                        | 180,000                       | 155,000            | 9                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1000°F     |                                        | 155,000                       | 135,000            | 10                    |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1200°F     |                                        | 120,000                       | 100,000            | 14                    |                                                                                                                       |             |                           |           |          |
| 4340       | ASTM A-732, Gr 10Q           | Annealed                       |                                        | 90,000                        | 70,000             | 15                    | Structural Parts, Good<br>Combination of Fatigue, Wear<br>Resistance, and Hardness. Better<br>Hardenability than 4140 | 90          | B                         | B         | B        |
|            |                              | Quench & Tempered @ 350°F      |                                        | 220,000                       | 205,000            | 4                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 900°F      |                                        | 180,000                       | 160,000            | 6                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1250°F     |                                        | 110,000                       | 90,000             | 16                    |                                                                                                                       |             |                           |           |          |
| 6150       | MIL-S-22141B<br>IC 6150      | Annealed                       |                                        | 100,000                       | 60,000             | 12                    | High Strength Hardness                                                                                                | 90          | B                         | B         | B        |
|            |                              | Quench & Tempered @ 350°F      |                                        | 230,000                       | 210,000            | 2                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1250°F     |                                        | 110,000                       | 90,000             | 10                    |                                                                                                                       |             |                           |           |          |
| 8620       | IC 8620<br>ASTM-A-732,Gr 13Q | Annealed                       |                                        | 70,000                        | 50,000             | 22                    | Carburizing Alloy Steel<br>For Stressed Parts.                                                                        | 85          | B                         | C         | B        |
|            |                              | Quench & Tempered @ 1200°F     |                                        | 100,000                       | 80,000             | 16                    |                                                                                                                       |             |                           |           |          |
| 8630       | MIL-S-22141B<br>IC8630       | Annealed                       |                                        | 80,000                        | 60,000             | 18                    | Structural Parts. Good<br>Combination of Fatigue<br>and Hardness                                                      | 85          | B                         | C         | B        |
|            |                              | Quench & Tempered @ 350°F      |                                        | 200,000                       | 170,000            | 6                     |                                                                                                                       |             |                           |           |          |
|            |                              | Quench & Tempered @ 1250°F     |                                        | 105,000                       | 85,000             | 18                    |                                                                                                                       |             |                           |           |          |
| 52100      | ASTM-A-732, Gr 15A           | Quench & Tempered @ 800°F      |                                        | 230,000                       | 220,000            | 1                     | High Hardness and<br>Abrasion Resistance.                                                                             | 80          | B                         | B         | A        |
|            |                              | Quench & Tempered @ 1000°F     |                                        | 180,000                       | 175,000            | 5                     |                                                                                                                       |             |                           |           |          |

## Carbon Steels

| Carbon      | Manganese   | Silicon     | Chromium     | Molybdenum | Nickel       | Tungsten | Cobalt | Phosphorous | Sulfer | Vanadium | Iron | Copper | Aluminum | Zinc | Titanium | Magnesium | Other       |
|-------------|-------------|-------------|--------------|------------|--------------|----------|--------|-------------|--------|----------|------|--------|----------|------|----------|-----------|-------------|
| .08<br>.13  | .30<br>.60  | 0.20        |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .13<br>.18  | .30<br>.60  |             |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .15<br>.20  | .60<br>.90  | 0.20        |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .15<br>.25  | .20<br>.60  | .20<br>1.00 | 0.35         |            | 0.50         |          |        | 0.04        | 0.05   |          | Bal. | 0.50   |          |      |          |           | Mo + W 0.25 |
| .25<br>.35  | .70<br>1.00 | .20<br>1.00 |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .25<br>.35  | .70<br>1.00 | .20<br>1.00 | 0.25         | 0.25       | 0.25         |          |        | 0.04        | 0.04   |          | Bal. |        |          |      |          |           |             |
| .42<br>.50  | .60<br>.90  | .15<br>.30  |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .45<br>.55  | .70<br>1.00 | .20<br>1.00 |              |            |              |          |        | 0.04        | 0.04   |          | Bal. |        |          |      |          |           |             |
| .55<br>.66  | .60<br>.90  | .15<br>.30  |              |            |              |          |        | 0.04        | 0.05   |          | Bal. |        |          |      |          |           |             |
| .25<br>.35  | .40<br>.70  | .20<br>.80  | .80<br>1.10  | .15<br>.25 |              |          |        | 0.04        | 0.04   |          | Bal. |        |          |      |          |           |             |
| .35<br>.45  | .75<br>1.00 | 1.00        | .80<br>1.10  | .15<br>.25 | 0.25         |          |        | 0.04        | 0.04   |          | Bal. | 0.35   |          |      |          |           |             |
| .35<br>.45  | .70<br>1.00 | .20<br>.80  | .70<br>.90   | .20<br>.30 | 1.65<br>2.00 | 0.10     |        | 0.04        | 0.05   |          | Bal. | 0.50   |          |      |          |           |             |
| .45<br>.55  | .65<br>.95  | .20<br>.80  | .80<br>1.10  |            | 0.50         |          |        | 0.04        | 0.04   | 0.15     | Bal. |        |          |      |          |           |             |
| .15<br>.25  | .65<br>.95  | .20<br>.80  | .40<br>.70   | .15<br>.25 | .40<br>.70   |          |        | 0.04        | 0.05   |          | Bal. | 0.25   |          |      |          |           |             |
| .25<br>.35  | .65<br>.95  | .20<br>.80  | .40<br>.60   | .15<br>.25 | .40<br>.70   |          |        | 0.04        | 0.04   |          | Bal. |        |          |      |          |           |             |
| .95<br>1.10 | .25<br>.55  | .20<br>.80  | 1.30<br>1.60 |            | 0.50         | 0.10     |        | 0.04        | 0.05   |          | Bal. | 0.50   |          |      |          |           |             |