

Carbon Steels

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	Carbon	Manganese	Silicon	Chromium	Molybdenum	Nickel	Tungsten	Cobalt	Phosphorous	Sulfur	Vanadium	Iron	Copper	Aluminum	Zinc	Titanium	Magnesium	Other
1010	MIL-S-11310E	As Cast	R _b 50	50,000	30,000	30	Electrical Components	75	B	C	C	.08 .13	.30 .60	0.20						0.04	0.05		Bal.						
1015	ASTM-A-29	As Cast	R _b 55	50,000	30,000	25	High Impact, Strength	80	C	C	C	.13 .18	.30 .60							0.04	0.05		Bal.						
1018	MIL-S-11310E	As Cast Annealed Normalized & Drawn 300 F	R _b 60 R _b 60 R _b 70	65,000 65,500 70,000	45,000 35,000 45,000	20 25 25	High Impact, Carburizing	80	C	C	C	.15 .20	.60 .90	0.20						0.04	0.05		Bal.						
1020	ASTM A-27, Gr 1A IC1020	As Cast Annealed Normalized & Drawn 300 F	R _b 60 R _b 60 R _b 60	60,000 57,500 65,000	45,000 37,500 45,000	20 28 20	High Impact, Carburizing	80	C	C	C	.15 .25	.20 .60	.20 1.00	0.35		0.50			0.04	0.05		Bal.	0.50					Mo + W 0.25
1030	MIL-S-81591 IC1030	As Cast Annealed	R _b 70 R _b 70	70,000 65,000	45,000 40,000	12 25	Flame Hardening Grade	85	B	B	C	.25 .35	.70 1.00	.20 1.00						0.04	0.05		Bal.						
1040	IC1040	As Cast Annealed Oil Quench & Drawn 300 F Oil Quench & Drawn 1000 F	R _b 85 R _b 70 R _c 28 R _c 24	85,000 70,000 135,000 100,000	55,000 40,000 90,000 90,000	7 22 8 10	Medium Strength Structural Parts	85	B	B	B	.25 .35	.70 1.00	.20 1.00	0.25	0.25	0.25			0.04	0.04		Bal.						
1045	ASTM-A-684	Annealed Oil Quench & Drawn	R _b 75 R _c 30	75,000 140,000	40,000 95,000	20 7	Medium Strength Structural Parts	85	B	B	B	.42 .50	.60 .90	.15 .30						0.04	0.05		Bal.						
1050	MIL-S-81591 IC1050	Annealed Oil Quench & Drawn	R _b 85 R _c 35	90,000 150,000	45,000 100,000	14 6	Induction Hardening	85	B	B	B	.45 .55	.70 1.00	.20 1.00						0.04	0.04		Bal.						
1060	ASTM-A-680	Annealed	R _b 90	100,000	55,000	12	Good Strength and Impact Combination	85	B	A	B	.55 .66	.60 .90	.15 .30						0.04	0.05		Bal.						
4130	MIL-S-22141B IC 4130	Annealed Quench & Tempered @ 350 F Quench & Tempered @ 1250 F		80,000 200,000 105,000	60,000 170,000 85,000	18 6 18	Structural Parts Requiring Welding, High Fatigue Resistance, Strength	90	B	B	B	.25 .35	.40 .70	.20 .80	.80 1.10	.15 .25				0.04	0.04		Bal.						
4140	AMS 5338C	Annealed Quench & Tempered @ 350 F Quench & Tempered @ 900 F Quench & Tempered @ 1000 F Quench & Tempered @ 1200 F Quench & Tempered @ 1250 F		90,000 220,000 180,000 155,000 120,000 110,000	60,000 200,000 155,000 135,000 100,000 90,000	17 4 9 10 14 17	Structural Parts. Good Combination of Fatigue Wear Resistance and Hardness.	90	B	B	B	.35 .45	.75 1.00	1.00	.80 1.10	.15 .25	0.25			0.04	0.04		Bal.	0.35					
4340	ASTM A-732, Gr 10Q	Annealed Quench & Tempered @ 350 F Quench & Tempered @ 900 F Quench & Tempered @ 1250 F		90,000 220,000 180,000 110,000	70,000 205,000 160,000 90,000	15 4 6 16	Structural Parts, Good Combination of Fatigue, Wear Resistance, and Hardness. Better Hardenability than 4140	90	B	B	B	.35 .45	.70 1.00	.20 .80	.70 .90	.20 .30	1.65 2.00	0.10		0.04	0.05		Bal.	0.50					
6150	MIL-S-22141B IC 6150	Annealed Quench & Tempered @ 350 F Quench & Tempered @ 1250 F		100,000 230,000 110,000	60,000 210,000 90,000	12 2 10	High Strength Hardness	90	B	B	B	.45 .55	.65 .95	.20 .80	.80 1.10		0.50			0.04	0.04	0.15	Bal.						
8620	IC 8620 ASTM-A-732,Gr 13Q	Annealed Quench & Tempered @ 1200 F		70,000 100,000	50,000 80,000	22 16	Carburizing Alloy Steel For Stressed Parts.	85	B	C	B	.15 .25	.65 .95	.20 .80	.40 .70	.15 .25	.40 .70			0.04	0.05		Bal.	0.25					
8630	MIL-S-22141B IC8630	Annealed Quench & Tempered @ 350 F Quench & Tempered @ 1250 F		80,000 200,000 105,000	60,000 170,000 85,000	18 6 18	Structural Parts. Good Combination of Fatigue and Hardness	85	B	C	B	.25 .35	.65 .95	.20 .80	.40 .60	.15 .25	.40 .70			0.04	0.04		Bal.						
52100	ASTM-A-732, Gr 15A	Quench & Tempered @ 800 F Quench & Tempered @ 1000 F		230,000 180,000	220,000 175,000	1 5	High Hardness and Abrasion Resistance.	80	B	B	A	.95 1.10	.25 .55	.20 .80	1.30 1.60		0.50	0.10		0.04	0.05		Bal.	0.50					

Nickel Base

Nickel Base

Monel	QQ-N-288-A	As Cast	B ₇ 125-150	65,000	25,000	25		75	C	C	C	0.35	1.50	2.00									2.50	26.0 33.0	0.50				
Monel-D (S-Monel)	QQ-N-288-D	As Cast	Br 300 min.	*	*			75	C	C	C	0.25	1.50	3.5 4.5									2.50	27.0 31.0	0.50				
Monel-F	QQ-N-288-F	As Cast		70,000	40,000	10		80	C	C	C	.40 .70	1.50	2.3 3.0					1.00				2.50	29.0 34.0					
Ni Alloy C (Hastelloy C)	AMS-5388E	Solution Annealed	Hb 96	85,000	50,000	11	Chemical Processing Equipment	70	C	C	C	0.15	1.00	1.00	15.5 17.5	16.0 18.0	Bal.	3.75 5.25	2.50	0.03	0.03	.20 .60	4.50 7.00						
Ni Alloy C276 (Hastelloy C276)	ASTM-A-494 Gr. CW-12MW	Solution Annealed	Hb 96	85,000	50,000	11	Chemical Processing Equipment	70	C	C	C	0.12	1.00	1.00	15.5 17.5	16.0 18.0	Bal.	3.75 5.25		0.04	0.03	.20 .40	4.50 7.00						

Stainless Steels							Stainless 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	Carbon	Manganese	Silicon	Chromium	Molybdenum	Nickel	Tungsten	Cobalt	Phosphorous	Sulfur	Vanadium	Iron	Copper	Aluminum	Zinc	Titanium	Magnesium	Other		
302	AMS 5358C	As Cast or Solution Annealed	R _h 85	65,000	30,000	35	Best Combination of Castability and Corrosion Resistance	100	A	A	A	0.25	1.50	2.00	17.0 19.0	0.75	8.0 10.0			0.04	0.20		Bal.	0.75							
303	MIL-S-81591 IC303	As Cast or Solution Annealed	R _h 85	65,000	30,000	35	Free Machining Stainless	95	B	A	A	0.16	1.50	2.00	18.0 21.0	.40 .80	9.0 12.0			0.04	.20 .40		Bal.	0.50							
304L	ASTM-A-744 Gr CF3 AMS 5370	As Cast or Solution Annealed	R _h 85	63,000	28,000	35	Cryogenic Applications	100	A	A	A	0.03	1.50	2.00	17.0 21.0		8.0 12.0			0.04	0.04		Bal.								
310	ASTM-A-297 Gr HK	As Cast or Solution Annealed	R _h 85	65,000	30,000	35	Oxidation Resistance of 2000 F	90	A	A	A	.20 .60	2.00	2.00	24.0 28.0	0.50	18.0 22.0			0.04	0.04		Bal.								
316L	ASTM-A-744 Gr CF3M AMS 5360	As Cast or Solution Annealed	R _h 85	65,000	30,000	35	Food Equipment. Paper Making Equipment	100	A	A	A	0.03	1.50	1.50	17.0 21.0	2.0 3.0	9.0 13.0			0.04	0.04		Bal.								
347	ASTM-A-743 Gr CF6C	As Cast or Solution Annealed	R _h 85	70,000	32,000	30	Weldable Grade	95	A	A	A	0.08	1.50	2.00	18.0 21.0		9.0 12.0			0.04	0.04		Bal.							Cb/Ta 8 x C-1.0	
CN-7M	ASTM-A-743 Gr CN7M	As Cast or Solution Annealed	R _h 80	65,000	25,000	35	Sulfuric Acid Resistant	95	A	A	A	0.07	1.50	1.50	19.0 22.0	2.0 3.0	27.5 30.5			0.04	0.04		Bal.	3.0 4.0							
410	MIL-S-81591 IC410	Air or Oil Quench and Draw	R _c 42	200,000	150,000	6	Good Combination of Hardness and Corrosion Resistance	95	B	C	A	.05 .15	1.00	1.00	11.5 14.0	0.50	0.50			0.04	0.03		Bal.	0.50							
		R _c 40	180,000	140,000	8																										
		R _c 36	160,000	120,000	12																										
		R _h 95	95,000	75,000	18																										
	Annealed	R _h 95 max	70,000	45,000	20																										
416	MIL-S-81591 IC416	Air or Oil Quench and Draw	R _c 38	160,000	130,000	5	Free Machining Grade of 410. Not as Tough as 410	85	B	C	A	0.15	1.25	1.50	11.5 14.0	0.50	0.50			0.05	.15 .35		Bal.	0.50							Zr 0.50
		R _h 95	95,000	75,000	12																										
		Annealed	R _h 95 max	70,000	40,000	15																									
420	ASTM-A-743 Gr CA40 IC CA-40	Low Carbon Quench and Draw	R _c 46	200,000	150,000	3	Similar to 410. Higher Hardness but Less Tough Better wear resistance	90	B	C	A	.20 .40	1.00	1.50	11.5 14.0	0.50	1.00			0.04	0.04		Bal.								
		High Carbon Quench and Draw	R _c 48	200,000	150,000	3																									
		Annealed	R _c 28 max	90,000	60,000	12																									
431	MIL-S-81591 IC431	Quench and Draw	R _c 38	170,000	130,000	5	Best Corrosion Resistance of Series	90	B	C	A	.08 .15	1.00	1.00	15.0 17.0		1.50 2.20			0.04	0.04		Bal.							N ₂ 0.03/0.12 C+ N ₂ .22 max.	
		Annealed	R _c 28 max	90,000	60,000	12																									
440C	AMS 5352C	Quench and Draw	R _c 58	*	*	Nil	Highest Hardness	85	B	C	A	.95 1.20	1.00	1.00	16.0 18.0	.35 .75	0.75			0.04	0.03		Bal.	0.75							
		Annealed	R _c 30 max	90,000	60,000	2																									Best Cutlery Grade
17-4PH	IC 17-4PH AMS 5355F	Normalized & Solution Anneal or Double Solution Anneal	R _c 30-36	140,000	100,000	10	Age Hardening Alloy. Best Combination of Corrosion Resistance and Hardness	95	B	B	A	0.06	0.70	.50 1.00	15.5 16.7		3.60 4.60			0.04	0.03		Bal.	2.80 3.50						N ₂ 0.05 Cb/Ta 0.15/0.40	
		Normalized & Solution Anneal or Double Solution Anneal Plus Aging	R _c 40	180,000	160,000	6																									

Copper Base							Copper Base																						
Everdur	C87300	As Cast		45,000	18,000	20	Excellent Castability	100	A	A	A		.80 1.50	3.5 4.5									0.20	Bal.		0.25			Pb 0.20
13-B Silicon Brass	C87500 13-B	As Cast	R _h 55	60,000	35,000	16	Good Castability	100	A	A	A			3.0 5.0									Bal.	0.50	12.0 16.0				Pb 0.50

Aluminum							Aluminum																					
C355 (T6)	QQ-A-371F MIL-C-11866C	Low Tensile Heat Treat	R _F 80	38,000	25,000	5	Good Strength and Corrosion Resistance	100	A	A	A		0.50	4.5 5.5	0.25								0.50	1.0 1.5	Bal.	0.35	0.25	.45 .60
		High Tensile Heat Treat	R _F 80	40,000	30,000	3																						
A356 (T6)	QQ-A-601E MIL-C-11866C	Low Tensile Heat Treat	R _F 75	38,000	30,000	5	Good Strength and Corrosion Resistance. Good Stability and Weldability. Poor Brazability	100	A	A	A		0.35	6.5 7.5									0.60	0.25	Bal.	0.35	0.25	.20 .45
		High Tensile Heat Treat	R _F 80	40,000	28,000	3																						

Cobalt Base							Cobalt Base																							
Cobalt 6 (Stellite #6)	AMS 5387B	As Cast	R _c 40	100,000	85,000	3	Best Impact. Oxidation Resistant to 1600 F	80	B	A	A	.90 1.40	1.00	1.50	27.0 31.0	1.50	3.0	3.50 5.50	Bal.	0.04	0.04		3.00							

Cast Iron							Cast Iron																							
Grey Iron Class 30		Stress Relieve	R _h 85	30,000	*	Nil	Excellent Damping Characteristics	90	A	A	A	3.25 3.50	.60 .90	1.80 2.30	0.5 .20	.05 .10	.05 .20							Bal.	.15 .40					CE => 4.10 {TC = C + 1/3 (Si)}

Tool Steels		Tool Steels																										
Alloy Type	Similar Destinations	Approx. Tempered Hardness	Distortion in Heat Testing	Toughness	Wear Resistance	Resistance to Softening at High Heat	Castability	Resistance to Hot Tearing	Shrinkage	Fluidity	Carbon	Manganese	Silicon	Chromium	Molybdenum	Nickel	Tungsten	Cobalt	Phosphorous	Sulfur	Vanadium	Iron	Copper	Aluminum	Zinc	Titanium	Magnesium	Other
A-2	ASTM A-597, GR. CA-2	Rc55	Best	Fair to Poor	Good	Good	85	B	B	B	.95 1.05	0.75	1.50	4.75 5.50	.90 1.40				0.03	0.03	.20 .50	Bal.						
A-6	IC CA-6	Rc55	Best	Fair to Poor	Good	Fair	80	B	B	B	.65 .75	1.80 2.20	1.00	.80 1.20	.80 1.30				0.025	0.025		Bal.						
D-2	ASTM A-597, GR. CD-2	Rc60	Best	Poor	Very Good	Good	85	B	B	C	1.40 1.60	1.00	1.50	11.0 13.0	.70 1.20			.70 1.00	0.03	0.03	.40 1.00	Bal.						
D-3	IC CD-3	Rc60	Very Good	Poor	Very Good	Good	85	B	B	C	2.10 2.30	0.75	1.00	11.5 13.0	0.40				0.025	0.025		Bal.						
D-6	IC CD-6	Rc61	Very Good	Poor	Very Good	Good	80	B	B	C	2.10 2.35	0.75	.80 1.20	11.5 13.0	0.40		.80 1.20		0.025	0.025		Bal.						
H-11	IC CH-11	Rc52	Very Good	Poor	Fair	Good	80	B	B	B	.30 .40	0.75	.95 1.15	4.60 5.60	1.20 1.60				0.025	0.025	.30 .50	Bal.						
H-13	ASTM A-597, GR. CH-13	Rc50	Very Good	Fair	Fair	Good	85	B	B	B	.30 .42	0.75	1.50	4.75 5.75	1.25 1.75				0.03	0.03	.75 1.20	Bal.						
L-6	IC CL-6	Rc62	Good	Fair	Poor	Poor	80	B	B	B	.65 .75	0.75	1.00	.80 1.00		1.50 1.90			0.025	0.025		Bal.						
M-2	ASTM A-597, GR. CM-2	Rc63	Fair	Poor	Very Good	Very Good	80	C	B	B	.78 .88	0.75	1.00	3.75 4.50	4.50 5.50	0.25	5.50 6.75	0.25	0.03	0.03	1.25 2.20	Bal.						
M-4	IC CM-4	Rc64	Fair	Poor	Best	Very Good	75	C	B	B	1.25 1.35	0.75	1.00	3.75 4.50	4.50 5.50		5.20 6.20		0.025	0.025	3.60 4.40	Bal.						
M-42	IC CM-42	Rc68	Fair	Poor	Very Good	Best	75	B	B	B	1.00 1.20	0.75	1.00	3.50 4.25	9.0 10.0		1.25 1.75	7.50 8.50	0.025	0.025	.95 1.35	Bal.						
O-1	ASTM A-597, GR. CO-1	Rc60	Very Good	Fair to Poor	Fair	Poor	80	B	A	B	.85 1.00	1.00 1.30	1.50	.40 1.00			.40 .60		0.03	0.03	0.30	Bal.						
O-2	IC CO-2	Rc60	Very Good	Fair to Poor	Fair	Poor	80	B	A	B	.85 .95	1.50 1.80	1.00	0.40	0.30				0.025	0.025	0.30	Bal.						
O-7	IC CO-7	Rc62	Very Good	Fair to Poor	Fair	Poor	80	B	A	B	1.10 1.20	0.75	1.00	.50 .70			1.65 1.85		0.025	0.025	.15 .25	Bal.						
S-1	IC CS-1	Rc50	Fair	Good	Poor	Fair	90	B	B	B	.45 .55	0.75	1.00	1.35 1.65			2.35 2.65		0.025	0.025		Bal.						
S-2	IC CS-2	Rc56	Poor	Good	Poor	Poor	90	B	B	B	.45 .55	0.75	.90 1.20		.40 .60				0.025	0.025	0.30	Bal.						
S-4	IC CS-4	Rc56	Poor	Good	Poor	Poor	90	B	B	B	.50 .60	.70 .90	1.80 2.20	0.30					0.025	0.025	0.30	Bal.						
S-5	ASTM A-597, GR. CS-5	Rc58	Fair	Good	Poor	Poor	90	B	B	B	.50 .60	.60 1.00	1.75 2.25	0.35	.20 .80				0.03	0.03	0.35	Bal.						
S-7	ASTM A-597, GR. CS-7	Rc58	Fair	Good	Poor	Poor	90	B	B	B	.45 .55	.40 .80	.60 1.00	3.00 3.50	1.20 1.60				0.03	0.03		Bal.						
T-1	IC CT-1	Rc63	Fair	Poor	Very Good	Very Good	85	C	A	B	.65 .75	0.75	1.00	3.75 4.50			17.25 18.75		0.025	0.025	.90 1.30	Bal.						