

- ▲ Aleaciones grises y nodulares  
ASTM A436 / ASTM 439 / ASTM A48 /  
ASTM A536 / ASTM 539
- ▲ Aleaciones base Fe, Cr, Ni, Co  
SAE 4140 / ASTM A436 / ASTM A439
- ▲ Aceros refractarios  
ASTM A297 / ASTM A351
- ▲ Aceros inoxidables especiales  
ASTM A743 / ASTM A494 / ASTM A351
- ▲ Aceros al carbono  
ASTM A216 / ASTM A217 / ASTM A352
- ▲ Aceros al Mg y antidesgaste  
ASTM A128 / ASTM A532
- ▲ Aceros duplex  
ASTM A890 / ASTM A351



**+ Aleaciones nodulares y grises**

**ASTM A436**

Chemical requirements								
Element	Composition, %							
	Type 1	Type 1b	Type 2	Type 2b	Type 3	Type 4	Type 5	Type 6
Carbon, total, max	3.00	3.00	3.00	3.00	2.60	2.60	2.40	3.00
Silicon	1.00–2.80	1.00–2.80	1.00–2.80	1.00–2.80	1.00–2.00	5.00–6.00	1.00–2.00	1.50–2.50
Manganese	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5	0.5–1.5
Nickel	13.50–17.50	13.50–17.50	18.00–22.00	18.00–22.00	28.00–32.00	29.00–32.00	34.00–36.00	18.00–22.00
Copper	5.50–7.50	5.50–7.50	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	3.50–5.50
Chromium	1.5–2.5	2.50–3.50	1.5–2.5	3.00–6.00 <sup>A</sup>	2.50–3.50	4.50–5.50	0.10 max	1.00–2.00
Sulfur, max	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Molybdenum, max	...	...	...	...	...	...	...	1.00

**ASTM A439**

Mechanical requirements									
Element	Type								
	D-2	D-2B	D-2C	D-3	D-3A	D-4	D-5	D-5B	D-5S
Properties									
Tensile strength, min, ksi (MPa)	58 (400)	58 (400)	58 (400)	55 (379)	55 (379)	60 (414)	55 (379)	55 (379)	65 (449)
Yield strength (0.2 percent offset), min, ksi (MPa)	30 (207)	30 (207)	28 (193)	30 (207)	30 (207)	...	30 (207)	30 (207)	30 (207)
Elongation in 2 in. or 50 mm, min, %	8.0	7.0	20.0	6.0	10.0	...	20.0	6.0	10
Brinell hardness (3000 kg)	139–202	148–211	121–171	139–202	131–193	202–273	131–185	139–193	131–193

**ASTM A536**

	Grade 60-40-18	Grade 65-45-12	Grade 80-55-06	Grade 100-70-03	Grade 120-90-02
Tensile strength, min, psi	60 000	65 000	80 000	100 000	120 000
Tensile strength, min, MPa	414	448	552	689	827
Yield strength, min, psi	40 000	45 000	55 000	70 000	90 000
Yield strength, min, MPa	276	310	379	483	621
Elongation in 2 in. or 50 mm, min, %	18	12			

**ASTM A539**

Chemical requirements		Tensile requirements	
Element	Composition, %, max		
Carbon	0.15	Tensile strength, min, ksi (MPa)	45 (310)
Manganese	0.63	Yield strength, min, ksi (MPa)	35 (241)
Phosphorus	0.035	Elongation in 2 in. or 50 mm, min, %	<sup>A</sup>
Sulfur	0.035	<sup>A</sup> The minimum elongation in 2 in. or 50 mm shall be that determined by the following equation:	

**ASTM A48**

Requirements for tensile strength of gray cast irons in separately cast test bars					
Class	Tensile Strength, min, ksi (MPa)	Nominal Test Bar Diameter, in. (mm)	Class	Tensile Strength, min, ksi (MPa)	Nominal Test Bar Diameter, in. (mm)
No. 20 A No. 20 B No. 20 C No. 20 S	20 (138)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>	No. 40 C No. 40 S		2.0 (50.8) Bars S <sup>A</sup>
No. 25 A No. 25 B No. 25 C No. 25 S	25 (172)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>	No. 45 A No. 45 B No. 45 C No. 45 S	45 (310)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>
No. 30 A No. 30 B No. 30 C No. 30 S	30 (207)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>	No. 50 A No. 50 B No. 50 C No. 50 S	50 (345)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>
No. 35 A No. 35 B No. 35 C No. 35 S	35 (241)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>	No. 55 A No. 55 B No. 55 C No. 55 S	55 (379)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>
No. 40 A No. 40 B	40 (276)	0.88 (22.4) 1.2 (30.5)	No. 60 A No. 60 B No. 60 C No. 60 S	60 (414)	0.88 (22.4) 1.2 (30.5) 2.0 (50.8) Bars S <sup>A</sup>

All dimensions of test bar S shall be as agreed upon between the manufacturer and the purchaser.

Correlation has not been established between the test bar and the casting	
Thickness of the Wall of the Controlling Section of the Casting, in. (mm)	Test Bar
Under 0.25 (6)	S
0.25 to 0.50 (6 to 12)	A
0.51 to 1.00 (13 to 25)	B
1.01 to 2 (26 to 50)	C
Over 2 (50)	S

**+ Aceros de baja y mediana aleación (aleaciones base Hierro, Cr, Ni, Mo)**

**SAE 4140**

	Norma			Composición química													Propiedades mecánicas				
	AIS / SAE	DIN / WNR	ASTM	C	Si	Mn	P	S	Cr	Ni	Mo	Co	V	Fe	W	Otros	Condición	Dureza	Tens Rolura (Kg/mm <sup>2</sup> )	Tens Fluen (Kg/mm <sup>2</sup> )	Elong (%)
Piezas estructurales, buena resistencia mecánica, resistente a fatiga	4140	17225	A 732 GR8Q	0,38 0,43	0,15 0,60	0,75 1,00	-	-	0,80 0,10	-	0,15 0,25	-	-	resto	-	-	Recocido Templ. Rev	50/100RB 29/57HRC	91/40	70/100	5/20
Piezas estructurales, buena combinación de ductilidad, resistencia a fatiga y abrasión al impacto	4320	-	A 352 GRLC2-1	0,17 0,22	0,15 0,30	0,45 0,65	-	-	0,40 0,60	1,65 2,00	0,20 0,30	-	-	resto	-	-	Recocido Templ. Rev	20RB 25/48HRC	91/133	70/140	5/20
Media resistencia, puede ser cementado	4340	1.6585	A 732 Gr09	0,38 0,43	0,15 0,30	0,60 0,80	-	-	0,70 0,90	1,65 2,00	0,20 0,30	-	-	resto	-	-	Recocido Templ. Rev	20RB 20/55HRC	91/140	70/126	5/20
Media resistencia, puede ser cementado	5115	-	-	0,13 0,18	0,15 0,30	0,70 0,90	-	-	0,70 0,90	-	-	-	-	resto	-	-	Recocido Templ. Rev	190RB 20/45HRC	70/140	60/130	12/28
Acero para resortes	5150	-	-	0,48 0,53	0,15 1,35	0,70 0,90	-	-	0,70 0,90	-	-	-	-	resto	-	-	Recocido Templ. Rev	180RB 30/60HRC	90/180	80/160	5/25
Alta resistencia a golpe, fatiga y abrasión	6150	1.8159	A 732 Gr129	0,45 0,55	0,20 0,50	0,65 0,95	0,040	0,045	0,80 1,10	-	-	-	-	resto	-	-	Recocido Templ. Rev	100RB 30/60HRC	98/140	84/126	5/10
Acero para cementación y nitratación, resistencia al desgaste	8620	1.6520	A 487 GR4N	0,15 0,25	0,20 0,80	0,65 0,95	0,040	0,045	0,40 0,70	0,40 0,70	0,15 0,25	-	-	resto	-	-	Recocido Templ. Rev	100RB 30/60HRC	70/91	56/77	10/20
Alta resistencia, alta dureza, buena resistencia a fatiga	8640	1.6546	-	0,35 0,45	0,20 0,80	0,70 1,00	0,040	0,040	0,40 0,60	0,40 0,70	0,15 0,25	-	-	resto	-	-	Recocido Templ. Rev	20HRC 30/60HRC	91/140	70/125	5/20
Alta resistencia pueda ser cementado	9315	1.5752	-	0,13 0,18	0,20 0,35	0,45 0,65	0,030	0,030	1,00 1,40	3,50 3,50	0,08 0,15	-	-	resto	-	-	Recocido Templ. Rev	170HB 25/45HRC	80/160	80/150	7/22
Aceros para roletes, esferas capas de rolamento, excelente dureza y resistencia al desgaste	52100	1.3505	A 732 GR15A	0,90 1,10	0,15 0,60	0,25 0,70	-	-	1,30 1,60	-	-	-	-	resto	-	-	Recocido Templ. Rev	30HRC 40/65HRC	124/158	96/124	1/7

ASTM A436

Chemical requirements								
Element	Composition, %							
	Type 1	Type 1b	Type 2	Type 2b	Type 3	Type 4	Type 5	Type 6
Carbon, total, max	3.00	3.00	3.00	3.00	2.60	2.60	2.40	3.00
Silicon	1.00-2.80	1.00-2.80	1.00-2.80	1.00-2.80	1.00-2.00	5.00-6.00	1.00-2.00	1.50-2.50
Manganese	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5
Nickel	13.50-17.50	13.50-17.50	18.00-22.00	18.00-22.00	28.00-32.00	29.00-32.00	34.00-36.00	18.00-22.00
Copper	5.50-7.50	5.50-7.50	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	3.50-5.50
Chromium	1.5-2.5	2.50-3.50	1.5-2.5	3.00-6.00 <sup>A</sup>	2.50-3.50	4.50-5.50	0.10 max	1.00-2.00
Sulfur, max	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Molybdenum, max	...	...	...	...	...	...	...	1.00

ASTM A439

Mechanical requirements									
Element	Type								
	D-2	D-2B	D-2C	D-3	D-3A	D-4	D-5	D-5B	D-5S
	Properties								
Tensile strength, min, ksi (MPa)	58 (400)	58 (400)	58 (400)	55 (379)	55 (379)	60 (414)	55 (379)	55 (379)	65 (449)
Yield strength (0.2 percent offset), min, ksi (MPa)	30 (207)	30 (207)	28 (193)	30 (207)	30 (207)	...	30 (207)	30 (207)	30 (207)
Elongation in 2 in. or 50 mm, min, %	8.0	7.0	20.0	6.0	10.0	...	20.0	6.0	10
Brinell hardness (3000 kg)	139-202	148-211	121-171	139-202	131-193	202-273	131-185	139-193	131-193

+ Aceros refractarios

ASTM A297

Grade	Type	Carbon	Manganese, max	Silicon, max	Phosphorus, max	Sulfur, max	Chromium	Nickel	Molybdenum, max <sup>A</sup>
HF	19 Chromium, 9 Nickel	0.20-0.40	2.00	2.00	0.04	0.04	18.0-23.0	8.0-12.0	0.50
HH	25 Chromium, 12 Nickel	0.20-0.50	2.00	2.00	0.04	0.04	24.0-28.0	11.0-14.0	0.50
HI	28 Chromium, 15 Nickel	0.20-0.50	2.00	2.00	0.04	0.04	26.0-30.0	14.0-18.0	0.50
HK	25 Chromium, 20 Nickel	0.20-0.60	2.00	2.00	0.04	0.04	24.0-28.0	18.0-22.0	0.50
HE	29 Chromium, 9 Nickel	0.20-0.50	2.00	2.00	0.04	0.04	26.0-30.0	8.0-11.0	0.50
HT	15 Chromium, 35 Nickel	0.35-0.75	2.00	2.50	0.04	0.04	15.0-19.0	33.0-37.0	0.50
HU	19 Chromium, 39 Nickel	0.35-0.75	2.00	2.50	0.04	0.04	17.0-21.0	37.0-41.0	0.50
HW	12 Chromium, 60 Nickel	0.35-0.75	2.00	2.50	0.04	0.04	10.0-14.0	58.0-62.0	0.50
HX	17 Chromium, 66 Nickel	0.35-0.75	2.00	2.50	0.04	0.04	15.0-19.0	64.0-68.0	0.50
HC	28 Chromium	0.50 max	1.00	2.00	0.04	0.04	26.0-30.0	4.00 max	0.50
HD	28 Chromium, 5 Nickel	0.50 max	1.50	2.00	0.04	0.04	26.0-30.0	4.0-7.0	0.50
HL	29 Chromium, 20 Nickel	0.20-0.60	2.00	2.00	0.04	0.04	28.0-32.0	18.0-22.0	0.50
HN	20 Chromium, 25 Nickel	0.20-0.50	2.00	2.00	0.04	0.04	19.0-23.0	23.0-27.0	0.50
HP	26 Chromium, 35 Nickel	0.35-0.75	2.00	2.50	0.04	0.04	24-28	33-37	0.50

Castings having a specified molybdenum range agreed upon by the manufacturer and the purchaser may also be furnished under these specifications.

ASTM A351 - Aceros especiales

Element, % (max, except where range is given)	CF3	CF3A	CF8	CF8A	CF3M	CF3MA	CF8M	CF3MN	CF8C	CF10	CF-10M (J92-901)	CH8	CH10	CH20	CK20	HK30	HK40	HT30	CF-10MC	CN7M	CN-3MN	CD-4MCu	CE8MN	CG-6MMN	CG8M	CF10S-MnN	CT15C	CK-3MNCuN	CE20N	CG-3M (J92-999)	CD3M-WCuN	
Carbon	0.03	0.08	0.03	0.08	0.03	0.08	0.08	0.04-0.10	0.04-0.10	0.08	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10	0.07	0.03	0.04	0.08	0.06	0.08	0.10	0.05-0.15	0.025	0.20	0.03	0.0	
Manganese	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	2.00	1.50	1.50	2.00	1.00	1.00	4.00-6.00	1.50	7.00-9.00	0.15-1.50	1.20	1.50	1.50	1.00	
Silicon	2.00	2.00	1.50	1.50	1.50	2.00	2.00	1.50	1.50	2.00	1.50	1.50	2.00	2.00	1.75	1.75	1.75	2.50	1.50	1.50	1.00	1.00	1.50	1.00	1.50	3.50-4.50	0.50-1.50	1.00	1.50	1.50	1.00	
Sulfur	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.010	0.04	0.040	0.030	0.04	0.030	0.03	0.03	0.01	
Phosphorus	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.04	0.040	0.04	0.060	0.03	0.045	0.040	0.04	0.030	
Chromium	17.0-21.0	18.0-21.0	17.0-21.0	18.0-21.0	17.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	22.0-26.0	22.0-27.0	22.0-27.0	22.0-27.0	23.0-27.0	23.0-27.0	23.0-27.0	23.0-27.0	13.0-22.0	15.0-26.5	19.0-25.5	20.0-23.50	24.5-21.0	22.5-18.0	20.50-21.0	18.0-20.5	16.0-26.0	19		
Nickel	8.0-12.0	8.0-13.0	9.0-12.0	9.0-13.0	9.0-12.0	9.0-13.0	9.0-12.0	9.0-12.0	9.0-12.0	9.0-12.0	9.0-12.0	9.0-12.0	12.0-15.0	12.0-15.0	12.0-15.0	12.0-22.0	19.0-22.0	19.0-37.0	19.0-37.0	19.0-37.0	13.0-30.5	15.0-30.5	17.5-30.5	6.00-11.0	13.50-13.0	9.0	34.0	19.5	11.0	13.0	8.5	
Molybdenum	0.50	0.50	2.0-3.0	2.0-3.0	2.0-3.0	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.75-2.25	2.0-3.0	6.0-7.0	2.25-4.5	3.00-4.0	1.50-3.0	...	6.0-7.0	0.50-4.0	3.0-4.0		
Columbium (niobium)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.10-0.30	...	...	0.50-1.50	...	...	...	...	
Vanadium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.10-0.30	...	...	...	...	...	...	...	
Nitrogen	...	...	...	...	...	...	...	...	...	0.10-0.20	...	...	...	...	...	...	...	...	...	...	0.18-0.26	...	0.10-0.30	0.40	...	0.08-0.18	...	0.18-0.24	0.08-0.20	...	0.20-0.30	
Copper	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3.0-4.0	0.75 max	2.75-3.25	...	...	...	...	0.50-1.00	...	...	0.5-1.0	
Tungsten	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.5-1.0
Iron	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

<sup>A</sup> % Cr + 3.3% Mo + 16% N ≤ 40.

<sup>B</sup> Grade CF8C shall have a columbium content of not less than 8 times the carbon content but not over 1.00%.

<sup>C</sup> Grade CF10MC shall have a columbium content of not less than 10 times the carbon content but not over 1.20%.

+ Aceros al Mg y antidesgaste

ASTM A128

Grade <sup>A</sup>	Carbon	Manganese	Chromium	Molybdenum	Nickel	Silicon	Phosphorus
A <sup>B</sup>	1.05-1.35	11.0 min	...	...	...	1.00 max	0.07 max
B-1	0.9 -1.05	11.5-14.0	...	...	...	1.00 max	0.07 max
B-2	1.05-1.2	11.5-14.0	...	...	...	1.00 max	0.07 max
B-3	1.12-1.28	11.5-14.0	...	...	...	1.00 max	0.07 max
B-4	1.2 -1.35	11.5-14.0	...	...	...	1.00 max	0.07 max
C	1.05-1.35	11.5-14.0	1.5-2.5	...	...	1.00 max	0.07 max
D	0.7 -1.3	11.5-14.0	...	...	3.0-4.0	1.00 max	0.07 max
E-1	0.7 -1.3	11.5-14.0	...	0.9-1.2	...	1.00 max	0.07 max
E-2	1.05-1.45	11.5-14.0	...	1.8-2.1	...	1.00 max	0.07 max
F (J91340)	1.05-1.35	6.0-8.0	...	0.9-1.2	...	1.00 max	0.07 max

<sup>A</sup>Section size precludes the use of all grades and the producer should be consulted as to grades practically obtainable for a particular design required shall be by mutual agreement between manufacturer and purchaser.

<sup>B</sup>Unless otherwise specified, Grade A will be supplied.

ASTM A532

Class	Type	Designation	Hardness Value-HB														Typical Section Thickness		
			Sand Cast, min <sup>A</sup>											Chill Cast, min <sup>B</sup>				Softened, max	
			As Cast or As Cast and Stress Relieved			Hardened or Hardened and Stress Relieved													
						Level 1				Level 2									
			HB	HRC	HV	HB	HRC	HV	HB	HRC	HV	HB	HRC	HV	HB	HRC	HV		
I	A	Ni-Cr-HiC	550	53	600	600	56	660	650	59	715	600	56	660	...	...	...	...	
I	B	Ni-Cr-LoC	550	53	600	600	56	660	650	59	715	600	56	660	...	...	...	...	
I	C	Ni-Cr-GB	550	53	600	600	56	660	650	59	715	600	56	660	400	41	430	...	
I	D	Ni-HiCr	500	50	540	600	56	660	650	59	715	550	53	600	...	...	...	...	
II	A	12 % Cr	550	53	600	600	56	660	650	59	715	550	53	600	400	41	430	...	
II	B	15 % Cr-Mo	450	46	485	600	56	660	650	59	715	...	...	...	400	41	430	...	
II	D	20 % Cr-Mo	450	46	485	600	56	660	650	59	715	...	...	...	400	41	430	...	
III	A	25 % Cr	450	46	485	600	56	660	650	59	715	...	...	...	400	41	430	...	

<sup>A</sup> 90 % of the minimum surface hardness level shall be maintained to a depth of 40 % of the casting section, with any softer material being at the the beginning, by agreement between the supplier and the purchaser.

<sup>B</sup> Non-chilled areas of casting shall meet minimum hardness or sand cast requirements.

+ Aceros inoxidables especiales

ASTM A494

Chemical requirements																
Element	Composition, %															
	CZ-100	M-35-1 (A)	M-35-2	M-30H	M-25S	M-30C (A)	N-12MV	N-7M	CY-40	CW-12MW	CW-6M	CW-2M	CW-6MC	CY5SnBiM	CX2MW (N26022)	CU5MCuC (N28820)
C, max	1.00	0.35	0.35	0.30	0.25	0.30	0.12	0.07	0.40	0.12	0.07	0.02	0.06	0.05	0.02	0.050 max
Min, max	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.50	1.00	1.00	1.00	1.00	1.5	1.00	1.0 max
Si, max	2.00	1.25	2.00	2.7-3.7	3.5-4.5	1.0-2.0	1.00	1.00	3.00	1.00	1.00	0.80	1.00	0.5	0.80	1.0 max
P, max	0.03	0.03	0.03	0.03	0.03	0.03	0.040	0.040	0.3	0.040	0.040	0.03	0.015	0.03	0.025	0.030 max
S, max	0.03	0.03	0.03	0.03	0.03	0.03	0.030	0.030	0.3	0.030	0.030	0.03	0.015	0.03	0.025	0.030 max
Cu	1.25 max	26.0-33.0	26.0-33.0	27.0-33.0	27.0-33.0	0.03	0.030	0.030	0.3	0.030	0.030	0.03	0.015	0.03	0.025	0.030 max
Mo	---	---	---	---	---	---	26.0-30.0	30.0-33.0	---	16.0-18.0	17.0-20.0	15.0-17.5	8.0-10.0	2.0-3.5	12.5-14.5	2.5-3.5
Fe	3.00 max	3.50 max	3.50 max	3.50 max	3.50 max	3.50 max	4.0-6.0	3.00 max	11.0 max	4.5-7.5	17.0-20.0	2.0 max	5.0 max	2.0 max	2.0-6.0	balance
Ni	95.00 min	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	38.0-44.0
Cr	---	---	---	---	---	---	1.00	1.0	14.0-17.0	15.5-17.5	17.0-20.0	15.0-17.5	20.0-23.0	11.0-14.0	20.0-22.5	19.5-23.5
Cb (Nb)	---	0.5 max	0.5 max	---	---	1.0-3.0	---	---	---	---	---	---	3.15-4.50	---	---	0.60-1.20
W	---	---	---	---	---	---	---	---	---	3.75-5.25	---	1.0 max	---	---	2.5-3.5	---
V	---	---	---	---	---	---	---	0.20-0.60	---	0.20-0.40	---	---	---	---	0.35 max	---
Bi	---	---	---	---	---	---	---	---	---	---	---	---	---	3.0-5.0	---	---
Sn	---	---	---	---	---	---	---	---	---	---	---	---	---	3.0-5.0	---	---

Note: Values are maximum unless otherwise indicated.

A: Order M-35-1 or M-30C when weldability is required.

ASTM A743

Chemical requirements															
Grade	Type	Composition, %													
		Carbon, max	Manganese, max	Silicon, max	Phosphorus, max	Sulfur, max	Chromium	Nickel	Molybdenum	Columbium	Selenium	Copper	Tungsten, max	Vanadium, max	Nitrogen
CF-8	19 Chromium, 9 Nickel	0.08	1.50	2.00	0.04	0.04	18.0–21.0	8.0–11.0	...	...	...	...	...	...	
CG-12	22 Chromium, 12 Nickel	0.12	1.50	2.00	0.04	0.04	20.0–23.0	10.0–13.0	...	...	...	...	...	...	
CF-20	19 Chromium, 9 Nickel	0.20	1.50	2.00	0.04	0.04	18.0–21.0	8.0–11.0	...	...	...	...	...	...	
CF-8M	19 Chromium, 10 Nickel, with Molybdenum	0.08	1.50	2.00	0.04	0.04	18.0–21.0	9.0–12.0	2.0–3.0	...	...	...	...	...	
CF-8C	19 Chromium, 10 Nickel, with Columbium	0.08	1.50	2.00	0.04	0.04	18.0–21.0	9.0–12.0	...	A	...	...	...	...	
CF-16F	19 Chromium, 9 Nickel, Free Machining	0.16	1.50	2.00	0.17	0.04	18.0–21.0	9.0–12.0	1.50 max	...	0.20–0.35	...	...	...	
CF-16Fa	19 Chromium, 9 Nickel, Free Machining	0.16	1.50	2.00	0.04	0.20–0.40	18.0–21.0	9.0–12.0	0.40–0.80	...	...	...	...	...	
CH-10	25 Chromium, 12 Nickel	0.10	1.50	2.00	0.04	0.04	22.0–26.0	12.0–15.0	...	...	...	...	...	...	
CH-20	25 Chromium, 12 Nickel	0.20	1.50	2.00	0.04	0.04	22.0–26.0	12.0–15.0	...	...	...	...	...	...	
CK-20	25 Chromium, 20 Nickel	0.20	2.00	2.00	0.04	0.04	23.0–27.0	19.0–22.0	...	...	...	...	...	...	
CE-30	29 Chromium, 9 Nickel	0.30	1.50	2.00	0.04	0.04	26.0–30.0	8.0–11.0	...	...	...	...	...	...	
CA-15	12 Chromium	0.15	1.00	1.50	0.04	0.04	11.5–14.0	1.00	0.50 max	...	...	...	...	...	
CA-15M	12 Chromium	0.15	1.00	0.65	0.040	0.040	11.5–14.0	1.0	0.15–1.0	...	...	...	...	...	
CB-30	20 Chromium	0.30	1.00	1.50	0.04	0.04	18.0–21.0	2.00 max	...	...	...	...	...	...	
CC-50	28 Chromium	0.50	1.00	1.50	0.04	0.04	26.0–30.0	4.00 max	...	...	...	...	...	...	
CA-40	12 Chromium	0.20–0.40	1.00	1.50	0.04	0.04	11.5–14.0	1.0 max	0.5 max	...	...	...	...	...	
CA-40F	12 Chromium, Free Machining	0.20–0.40	1.00	1.50	0.04	0.20–0.40	11.5–14.0	1.0 max	0.5 max	...	...	...	...	...	
CF-3	19 Chromium, 9 Nickel	0.03	1.50	2.00	0.04	0.04	17.0–21.0	8.0–12.0	...	...	...	...	...	...	
CF10SMnN	17 Chromium, 8.5 Nickel with Nitrogen	0.10	7.00–9.00	3.50–4.50	0.060	0.030	16.0–18.0	8.0–9.0	...	...	...	...	...	0.08–0.18	
CF-3M	19 Chromium, 10 Nickel, with Molybdenum	0.03	1.50	1.50	0.04	0.04	17.0–21.0	9.0–13.0	2.0–3.0	...	...	...	...	...	
CF-3MN	19 Chromium, 10 Nickel, with Molybdenum, and Nitrogen	0.03	1.50	1.50	0.040	0.040	17.0–22.0	9.0–13.0	2.0–3.0	...	...	...	...	0.10–0.20	
CG6MMN		0.06	4.00–6.00	1.00	0.04	0.03	20.5–23.5	11.5–13.5	1.50–3.00	0.10–0.30	...	...	0.10–0.30	0.20–0.40	
CG-3M (J92999)	19 Chromium, 11 Nickel, with Molybdenum	0.03	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...	...	
CG-8M	19 Chromium, 11 Nickel, with Molybdenum	0.08	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...	...	
CN-3M (J94652)		0.03	2.0	1.0	0.03	0.03	20.0–22.0	23.0–27.0	4.5–5.5	...	...	...	...	...	
CN-3MN	21 Chromium, 24 Nickel with Molybdenum and Nitrogen	0.03	2.00	1.00	0.040	0.010	20.0–22.0	23.5–25.5	6.0–7.0	...	...	0.75 max	...	0.18–0.26	
CN-7M	20 Chromium, 29 Nickel, with Copper and Molybdenum	0.07	1.50	1.50	0.04	0.04	19.0–22.0	27.5–30.5	2.0–3.0	...	...	3.0–4.0	...	...	
CN-7MS	19 Chromium, 24 Nickel, with Copper and Molybdenum	0.07	1.00	2.50–3.50	0.04	0.03	18.0–20.0	22.0–25.0	2.5–3.0	...	...	1.5–2.0	...	...	
CA-6NM	12 Chromium, 4 Nickel	0.06	1.00	1.00	0.04	0.03	11.5–14.0	3.5–4.5	0.40–1.0	...	...	...	...	...	

**ASTM A351 - Aceros especiales**

Element, % (max, except where range is given)	CF3, CF3A	CF8, CF8A	CF3M CF-3MA	CF8M	CF3MN	CF8C	CF10	CF-10M (J92-901)	CH8	CH10	CH20	CK20	HK30	HK40	HT30	CF-10MC	CN7M	CN-3MN	CD-4MCu	CE8MN	CG-6MMN	CG8M	CF10S-MnN	CT15C	CK-3MCuN	CE20N	CG-3M (J92-999)	CD3M- WCuN
Carbon	0.03	0.08	0.03	0.08	0.03	0.08	0.04-0.10	0.04-0.10	0.08	0.04-0.10	0.04-0.20	0.04-0.20	0.25-0.35	0.35-0.45	0.25-0.35	0.10	0.07	0.03 max	0.04	0.08	0.06	0.08	0.10	0.05-0.15	0.025	0.20	0.03	0.0
Manganese	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	2.00	1.50	1.50	2.00 max	1.00	1.00	4.00-6.00	1.50	7.00-9.00	0.15-1.50	1.20	1.50	1.50	1.00
Silicon	2.00	2.00	1.50	1.50	1.50	2.00	2.00	1.50	1.50	2.00	2.00	1.75	1.75	1.75	2.50	1.50	1.50	1.00 max	1.00	1.50	1.00	1.50	3.50-4.50	0.50-1.50	1.00	1.50	1.50	1.00
Sulfur	...	...	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040 max	0.040	0.040	0.010	0.04	0.040	0.030	0.04	0.030	0.03	0.01
Phosphorus	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040 max	0.04	0.040	0.040	0.04	0.060	0.03	0.045	0.040	0.04	0.030
Chromium	17.0-21.0	18.0-21.0	17.0-21.0	18.0-21.0	17.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	18.0-21.0	22.0-26.0	22.0-26.0	22.0-27.0	23.0-27.0	23.0-27.0	23.0-27.0	23.0-27.0	13.0-22.0	15.0-22.0	19.0-25.5	20.0-25.5	24.5-25.5	22.5-25.5	20.5-21.0	20.5-21.0	18.0-20.5	18.0-20.5	16.0-19.0	19.0-26.0
Nickel	8.0-12.0	8.0-11.0	9.0-13.0	9.0-12.0	9.0-13.0	9.0-12.0	9.0-12.0	9.0-12.0	12.0-15.0	12.0-15.0	12.0-15.0	15.0-22.0	15.0-22.0	19.0-22.0	19.0-22.0	33.0-37.0	13.0-16.0	27.5-30.5	4.75-6.00	8.0-11.0	11.50-13.00	8.0-9.0	31.0-34.0	17.5-19.5	8.0-11.0	9.0-11.0	6.5-8.5	8.5
Molybdenum	0.50	0.50	2.0-3.0	2.0-3.0	2.0-3.0	0.50	0.50	2.0-3.0	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.75-2.25	2.0-3.0	6.0-7.0	1.75-2.25	3.0-4.5	1.50-3.00	3.0-4.0	...	...	6.0-7.0	0.50	3.0-4.0	
Columbium (niobium)	...	...	...	...	...	B	...	...	...	...	...	...	...	...	...	C	...	...	...	...	0.10-0.30	...	...	0.50-1.50	...	...	...	...
Vanadium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.10-0.30	...	...	...	...	...	...	...
Nitrogen	...	...	...	...	0.10-0.20	...	...	...	...	...	...	...	...	...	...	...	0.18-0.26	...	...	0.10-0.30	0.20-0.40	...	0.08-0.18	...	0.18-0.24	0.08-0.20	...	0.20-0.30
Copper	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3.0-4.0	0.75 max	2.75-3.25	...	...	...	...	...	...	0.50-1.00	...	...	0.5-1.0
Tungsten	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.5-1.0
Iron	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Bal	...	

A= % Cr + 3.3% Mo + 16% N 40 \$./ // B= Grade CF8C shall have a columbium content of not less than 8 times the carbon content but not over 1.00% // C= Grade CF10 MC shall have a columbium content of not less than 10 times the carbon content but not over 1.20%.

**+ Aceros al carbono  
ASTM A216**

Chemical requirements			
Element	Composition, %		
	Grade WCA	Grade WCB	Grade WCC
Carbon, max	0.25 <sup>A</sup>	0.30 <sup>B</sup>	0.25 <sup>C</sup>
Manganese, max	0.70 <sup>A</sup>	1.00 <sup>B</sup>	1.20 <sup>C</sup>
Phosphorus, max	0.04	0.04	0.04
Sulfur, max	0.045	0.045	0.045
Silicon, max	0.60	0.60	0.60
Specified residual elements:			
Copper, max	0.30	0.30	0.30
Nickel, max	0.50	0.50	0.50
Chromium, max	0.50	0.50	0.50
Molybdenum, max	0.20	0.20	0.20
Vanadium, max	0.03	0.03	0.03
Total of these specified residual elements, max <sup>D</sup>	1.00	1.00	1.00

Tensile requirements			
	Grade WCA	Grade WCB	Grade WCC
	Tensile strength, ksi [MPa]	60 to 85 [415 to 585]	70 to 95 [485 to 655]
Yield strength, <sup>A</sup> min, ksi [MPa]	30 [205]	36 [250]	40 [275]
Elongation in 2 in. [50 mm], min, % <sup>B</sup>	24	22	22
Reduction of area, min, %	35	35	35

<sup>A</sup> Determine by either 0.2 % offset method or 0.5 % extension-under-load method.

<sup>B</sup> When ICI test bars are used in tensile testing as provided for in Specification A 703/A 703M, the gage length to reduced section diameter ratio shall be 4 to 1.

**ASTM A217**

Chemical requirements										
Grade Identification Symbol	Composition, %									
	Carbon	Nickel Chromium Molybdenum	Nickel Chromium Molybdenum	Chromium Molybdenum	Chromium Molybdenum	Chromium Molybdenum	Chromium Molybdenum	Chromium Molybdenum	Chromium Molybdenum Vanadium	Chromium
	WC1	WC4	WC5	WC6	WC9	WC11	C5	C12	C12A (J84090)	CA15
Carbon	0.25	0.05-0.20	0.05-0.20	0.05-0.20	0.05-0.18	0.15-0.21	0.20	0.20	0.08-0.12	0.15
Manganese	0.50-0.80	0.50-0.80	0.40-0.70	0.50-0.80	0.40-0.70	0.50-0.80	0.40-0.70	0.35-0.65	0.30-0.60	1.00
Phosphorus	0.04	0.04	0.04	0.04	0.04	0.020	0.04	0.04	0.030	0.040
Sulfur	0.045	0.045	0.045	0.045	0.045	0.015	0.045	0.045	0.010	0.040
Silicon	0.60	0.60	0.60	0.60	0.60	0.30-0.60	0.75	1.00	0.20-0.50	1.50
Nickel	...	0.70-1.10	0.60-1.00	...	...	...	...	...	0.40	1.00
Chromium	...	0.50-0.80	0.50-0.90	1.00-1.50	2.00-2.75	1.00-1.50	4.00-6.50	8.00-10.00	8.0-9.5	11.5-14.0
Molybdenum	0.45-0.65	0.45-0.65	0.90-1.20	0.45-0.65	0.90-1.20	0.45-0.65	0.45-0.65	0.90-1.20	0.85-1.05	0.50
Columbium	...	...	...	...	...	...	...	...	0.060-0.10	...
Nitrogen	...	...	...	...	...	...	...	...	0.030-0.070	...
Specified residual elements										
Aluminum	...	...	...	...	...	0.01	...	...	0.040	...
Copper	0.50	0.50	0.50	0.50	0.50	0.35	0.50	0.50	...	...
Nickel	0.50	...	...	0.50	0.50	0.50	0.50	0.50	...	...
Chromium	0.35	...	...	...	...	...	...	...	...	...
Tungsten	0.10	0.10	0.10	0.10	0.10	...	0.10	0.10	...	...
Vanadium	...	...	...	...	...	0.03	...	...	0.18-0.25	...
Total content of these residual elements	1.00	0.60	0.60	1.00	1.00	1.00	1.00	1.00	...	...

NOTE—All values are maximum unless otherwise indicated.

**ASTM A352**

	Norma			Composición química														Propiedades mecánicas						
	AIS / SAE	DIN / WNR	ASTM	C	Si	Mn	P	S	Cr	Ni	Mo	Co	V	Fe	W	Otros	Condición	Dureza	Tens Rotura (Kg/mm2)	Tens Fluen (Kg/mm2)	Elong (%)			
Uso general puede ser cementado, resiste bien al impacto	1020	1.1151	A 216 WCB	0,15 0,25	0,30 0,60	0,30 0,60	0,040	0,050	-	-	-	-	-	-	-	-	resto	-	-	Recocido Recocido	75RB 50/100RB	42/49 56/63	28/31 35/42	25/40 20/25
Media resistencia para piezas estructurales	1045	1.1195	AU 87 GRDN	0,40 0,50	0,20 1,00	0,70 1,00	0,040	0,050	-	-	-	-	-	-	-	-	resto	-	-	Templ. Rev Recocido	25/55HRC 100RB	70/126 63/77	63/126 35/45	0/10 20/25
Media a alta resistencia para piezas estructurales	1050	1.1210	A 732 GR4A	0,48 0,55	0,20 1,00	0,60 0,90	0,040	0,050	-	-	-	-	-	-	-	-	resto	-	-	Templ. Rev	30/60HRC	88/126	70/126	0/10

**+ Aceros duplex**

**ASTM A890**

	1A	1B	1C <sup>A</sup>	2A
Grade	25Cr-5Ni-Mo-Cu	25Cr-5Ni-MO-Cu-N	25Cr-6Ni-Mo-Cu-N	24Cr-10Ni-Mo-N
Type	J93370	J93372	J93373	J93345
UNS	CD4MCu	CD4MCuN	CD3MCuN	CE8MN
ACI				
Composition:				
Carbon, max	0.04	0.04	0.030	0.08
Manganese, max	1.00	1.0	1.20	1.00
Silicon, max	1.00	1.0	1.10	1.50
Phosphorus, max	0.040	0.04	0.030	0.04
Sulfur, max	0.040	0.04	0.030	0.04
Chromium	24.5–26.5	24.5–26.5	24.0-26.7	22.5–25.5
Nickel	4.75–6.00	4.7–6.0	5.6-6.7	8.0–11.0
Molybdenum	1.75–2.25	1.7–2.3	2.9-3.8	3.0–4.5
Copper	2.75–3.25	2.7–3.3	1.40-1.90	...
Tungsten	...	...	...	...
Nitrogen		0.10–0.25	0.22-0.33	0.10–0.30

  

	3A	4A	5A <sup>A</sup>	6A <sup>A</sup>
Grade	25Cr-5Ni-Mo-N	22Cr-5Ni-Mo-N	25Cr-7Ni-Mo-N	25Cr-7Ni-Mo-N
Type	J93371	J92205	J93404	J93380
UNS	CD6MN	CD3MN	CE3MN	CD3MWCuN
ACI				
Composition:				
Carbon, max	0.06	0.03	0.03	0.03
Manganese, max	1.00	1.50	1.50	1.00
Silicon, max	1.00	1.00	1.00	1.00
Phosphorus, max	0.040	0.04	0.04	0.030
Sulfur, max	0.040	0.020	0.04	0.025
Chromium	24.0–27.0	21.0–23.5	24.0–26.0	24.0–26.0
Nickel	4.0–6.0	4.5–6.5	6.0–8.0	6.5–8.5
Molybdenum	1.75–2.5	2.5–3.5	4.0–5.0	3.0–4.0
Copper	...	1.00, max	...	0.5–1.0
Tungsten	...	...	...	0.5–1.0
Nitrogen	0.15–0.25	0.10–0.30	0.10–0.30	0.20–0.30

<sup>A</sup> % Cr + 3.3 % Mo + 16 % N \$ 40.

**ASTM A351 - Aceros especiales**

Element, % (max. except where range is given)	CF3	CF8	CF3M	CF8M	CF3MN	CF8C	CF10	CF-10M (J92-901)	CH8	CH10	CH20	CK20	HK30	HK40	HT30	CF-10MC	CN7M	CN-3MN	CD-4MCu	CE8MN	CG-6MMN	CG8M	CF10S-MnN	CT15C	CK-3MCuN	CE20N	CG-3M (J92-999)	CD3M-CuN	
Carbon	0.03	0.08	0.03	0.08	0.03	0.08	0.04–0.10	0.04–0.10	0.08	0.04–0.10	0.04–0.20	0.04–0.20	0.04–0.25	0.04–0.35	0.04–0.45	0.04–0.35	0.10	0.07	0.03 max	0.04	0.08	0.06	0.08	0.10	0.05–0.15	0.025	0.20	0.03	0.0
Manganese	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	2.00 max	1.00	1.00	4.00–6.00	1.50	7.00–9.00	0.15–1.50	1.20	1.50	1.50	1.00	
Silicon	2.00	2.00	1.50	1.50	1.50	2.00	2.00	1.50	1.50	2.00	2.00	1.75	1.75	1.75	2.50	1.50	1.50	1.00 max	1.00	1.50	1.00	1.50	3.50–4.50	0.50–1.50	1.00	1.50	1.50	1.00	
Sulfur	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040 max	0.040	0.010	0.04	0.04	0.040	0.030	0.04	0.030	0.03	0.01	
Phosphorus	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040 max	0.04	0.040	0.040	0.04	0.060	0.03	0.045	0.040	0.04	0.030	
Chromium	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	18.0–21.0	18.0–21.0	18.0–26.0	22.0–26.0	22.0–26.0	22.0–27.0	23.0–27.0	23.0–33.0	23.0–37.0	23.0–37.0	23.0–37.0	13.0–16.0	15.0–16.0	19.0–22.0	20.0–23.0	24.5–25.5	21.0	22.5–25.5	20.5–21.0	20.5–21.0	18.0–21.0	16.0–21.0	19
Nickel	8.0–12.0	8.0–11.0	9.0–13.0	9.0–12.0	9.0–13.0	9.0–12.0	9.0–11.0	9.0–12.0	12.0–15.0	12.0–15.0	12.0–15.0	12.0–15.0	12.0–15.0	19.0–22.0	19.0–22.0	19.0–22.0	33.0–37.0	13.0–16.0	16.0–17.5	23.5–25.5	4.75–6.00	8.0–11.0	13.50–13.0	9.0	31.0–34.0	17.5–19.5	8.0–11.0	6.5–8.5	
Molybdenum	0.50	0.50	2.0–3.0	2.0–3.0	2.0–3.0	0.50	0.50	2.0–3.0	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.75–2.25	2.0–3.0	6.0–7.0	1.75–2.25	3.0–4.5	1.50–3.00	3.0–4.0	...	6.0–7.0	0.50–4.0	3.0–4.0	
Columbium (niobium)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.10–0.30	...	...	0.50–1.50	...	...	...	...	
Vanadium	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.10–0.30	...	...	...	...	...	...	
Nitrogen	...	...	...	...	...	0.10–0.20	...	...	...	...	...	...	...	...	...	...	...	0.18–0.26	...	0.10–0.30	0.20–0.40	...	0.08–0.18	...	0.18–0.24	0.08–0.20	...	0.20–0.30	
Copper	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3.0–4.0	0.75 max	2.75–3.25	...	...	...	...	...	0.50–1.00	...	0.5–1.0	
Tungsten	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.5–1.0	
Iron	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Bal	...	

<sup>A</sup> % Cr + 3.3 % Mo + 16 % N \$ 40.

<sup>B</sup> Grade CF8C shall have a columbium content of not less than 8 times the carbon content but not over 1.00 %.

<sup>C</sup> Grade CF10MC shall have a columbium content of not less than 10 times the carbon content but not over 1.20 %.