

SA-182/SA-182M

Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

This specification covers forged low alloy and stainless steel piping components for use in pressure systems. Included are flanges, fittings, valves, and similar parts to specified dimensions or to dimensional standards, such as the ASME specifications that are referenced in Section 2. It also includes bars and products machined directly from bar.

Products made to this specification are limited to a maximum weight of 10 000 lb [4540 kg].

A. Manufacture

1. The low-alloy ferritic steels shall be made by the open-hearth, electric-furnace, or basic-oxygen process with the option of separate degassing and refining processes in each case.
2. The stainless steels shall be melted by one of the following processes: (a) electric-furnace (with the option of separate degassing and refining processes); (b) vacuum furnace; or (c) one of the former followed by vacuum or electroslag-consumable remelting. Grade F XM-27Cb may be produced by electron-beam melting.

B. Heat Treatment

1. After hot working, forgings shall be cooled to a temperature below 1000 °F [538 °C] prior to heat treating in accordance with the requirements of Table 1.
2. Low Alloy Steels and Ferritic and Martensitic Stainless Steels—
 - i. The low alloy steels and ferritic and martensitic stainless steels shall be heat treated in accordance with the requirements of point B.1 and Table 1.
 - ii. When more than one heat treatment option is listed for a Grade in Table 1, any one of the heat treatments listed shall be performed. The selection of the heat treatment shall be at the manufacturer's option, unless otherwise stated in the purchase order.
 - iii. Liquid Quenching—Except as permitted in point B.2.iv, for F 1, F 2, and F 3, and in point B.2.v, for F 91, and when agreed to by the purchaser, liquid quenching followed by tempering shall be permitted provided the temperatures in Table 1 for each grade are used.
 - iv. Alternatively, Grade F 1, F 2, and F 12, Classes 1 and 2 may be given a heat treatment of 1200 °F [650 °C] minimum after final hot or cold forming.
 - v. Alternatively, Grade F 91 forged fittings having any section thickness greater than 3 in. [75 mm], at the time of heat treatment, shall be normalized and tempered or quenched and tempered at the manufacturer's option, provided that the temperatures in Table 1 for F 91 are used.
3. Austenitic and Ferritic-Austenitic Stainless Steels—
 - i. The austenitic and ferritic-austenitic stainless steels shall be heat treated in accordance with the requirements of point B.1 and Table 1.
 - ii. Alternatively, immediately following hot working, while the temperature of the forging is not less than the minimum solution annealing temperature specified in Table 1, forgings made from austenitic grades (except grades F 304H, F 309H, F 310, F 310H, F 316H, F 316Ti, F 321, F 321H, F 347, F 347H, F 348, F 348H, F 45, and F 56) may be individually rapidly quenched in accordance with the requirements of Table 1.
4. Heat treatment of forgings may be performed before machining.

Table 1

Grade	Heat Treat Type	Austenitizing/Solutioning Temperature, Minimum or Range, °F [°C] ^A	Cooling Media	Quenching Cool Below °F [°C]	Tempering Temperature, Minimum or Range, °F [°C]
Low Alloy Steels					
F 1	anneal	1650 [900]	furnace cool	B	B
	normalize and temper	1650 [900]	air cool	B	1150 [620]
F 2	anneal	1650 [900]	furnace cool	B	B
	normalize and temper	1650 [900]	air cool	B	1150 [620]
F 5, F 5a	anneal	1750 [955]	furnace cool	B	B
	normalize and temper	1750 [955]	air cool	B	1250 [675]
F 9	anneal	1750 [955]	furnace cool	B	B
	normalize and temper	1750 [955]	air cool	B	1250 [675]
F 10	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 91	normalize and temper	1900-1975 [1040-1080]	air cool	B	1350-1470 [730-800]
F 92	normalize and temper	1900-1975 [1040-1080]	air cool	B	1350-1470 [730-800]
F 122	normalize and temper	1900-1975 [1040-1080]	air cool	B	1350-1470 [730-800]
F 911	normalize and temper	1900-1975 [1040-1080]	air cool or liquid	B	1365-1435 [740-780]
F 11, Class 1, 2, 3	anneal	1650 [900]	furnace cool	B	B
	normalize and temper	1650 [900]	air cool	B	1150 [620]
F 12, Class 1, 2	anneal	1650 [900]	furnace cool	B	B
	normalize and temper	1650 [900]	air cool	B	1150 [620]
F 21, F 3V, and F3VCb	anneal	1750 [955]	furnace cool	B	B

	normalize and temper	1750 [955]	air cool	B	1250 [675]
F 22, Class 1, 3	anneal	1650 [900]	furnace cool	B	B
	normalize and temper	1650 [900]	air cool	B	1250 [675]
F 22V	normalize and temper or	1650 [900]	air cool or liquid	B	1250 [675]
	quench and temper				
F 23	normalize and temper	1900-1975 [1040-1080]	air cool	B	1350–1470 [730–800]
			accelerated cool		
F 24	normalize and temper	1800-1975 [980-1080]	air cool	B	1350–1470 [730–800]
			or liquid		
FR	anneal	1750 [955]	furnace cool	B	B
	normalize	1750 [955]	air cool	B	B
	normalize and temper	1750 [955]	air cool	B	1250 [675]
F 36, Class 1	normalize and temper	1650 [900]	air cool	B	1100 [595]
F 36, Class 2	normalize and temper	1650 [900]	air cool	B	1100 [595]
			accelerated air cool		
	quench and temper	1650 [900]	or liquid		1100 [595]
Martensitic Stainless Steels					
F 6a Class 1	anneal	not specified	furnace cool	B	B
	normalize and temper	not specified	air cool	400 [205]	1325 [725]
	temper	not specified	B	B	1325 [725]
F 6a Class 2	anneal	not specified	furnace cool	B	B
	normalize and temper	not specified	air cool	400 [205]	1250 [675]
	temper	not specified	B	B	1250 [675]
F 6a Class 3	anneal	not specified	furnace cool	B	B
	normalize and temper	not specified	air cool	400 [205]	1100 [595]
F 6a Class 4	anneal	not specified	furnace cool	B	B
	normalize and temper	not specified	air cool	400 [205]	1000 [540]

F 6b	anneal	1750 [955]	furnace cool	B	B
	normalize and temper	1750 [955]	air cool	400 [205]	1150 [620]
F 6NM	normalize and temper	1850 [1010]	air cool	200 [95]	1040-1120 [560-600]
Ferritic Stainless Steels					
F XM-27 Cb	anneal	1850 [1010]	furnace cool	B	B
F 429	anneal	1850 [1010]	furnace cool	B	B
F 430	anneal	not specified	furnace cool	B	B
Austenitic Stainless Steels					
F 304	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 304H	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 304L	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 304N	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 304LN	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 309H	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 310	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 310H	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 310MoLN	solution treat and quench	1900–2010 [1050–1100]	liquid	500 [260]	B
F 316	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 316H	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 316L	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 316N	solution treat and quench	1900 [1040]	liquid	500 [260]	B

F 316LN	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 316Ti	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 317	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 317L	solution treat and quench	1900 [1040]	liquid	500 [260]	B
S31727	solution treat and quench	1975–2155 [1080–1180]	liquid	500 [260]	B
S32053	solution treat and quench	1975–2155 [1080–1180]	liquid	500 [260]	B
F 347	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 347H	solution treat and quench	2000 [1095]	liquid	500 [260]	B
F 347LN	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 348	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 348H	solution treat and quench	2000 [1095]	liquid	500 [260]	B
F 321	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 321H	solution treat and quench	2000 [1095]	liquid	500 [260]	B
F XM-11	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F XM-19	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 20	solution treat and quench	1700-1850 [925-1010]	liquid	500 [260]	B
F 44	solution treat and quench	2100 [1150]	liquid	500 [260]	B
F 45	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 46	solution treat and quench	2010-2140 [1100-1140]	liquid	500 [260]	B

F 47	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 48	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 49	solution treat and quench	2050 [1120]	liquid	500 [260]	B
F 56	solution treat and quench	2050-2160 [1120-1180]	liquid	500 [260]	B
F 58	solution treat and quench	2085 [1140]	liquid	500 [260]	B
F 62	solution treat and quench	2025 [1105]	liquid	500 [260]	B
F 63	solution treat and quench	1900 [1040]	liquid	500 [260]	B
F 64	solution treat and quench	2010-2140 [1100-1170]	liquid	500 [260]	B
F 904L	solution treat and quench	1920-2100 [1050-1150]	liquid	500 [260]	B
F70	solution treat and quench	1900 [1040]	liquid ^D	500 [260]	B
Ferritic-Austenitic Stainless Steels					
F 50	solution treat and quench	1925 [1050]	liquid	500 [260]	B
F 51	solution treat and quench	1870 [1020]	liquid	500 [260]	B
F 52 ^C			liquid	500 [260]	B
F 53	solution treat and quench	1880 [1025]	liquid	500 [260]	B
F 54	solution treat and quench	1920-2060 [1050-1125]	liquid	500 [260]	B
F 55	solution treat and quench	2010-2085 [1100-1140]	liquid	500 [260]	B
F 57	solution treat and quench	1940 [1060]	liquid	175 [80]	B
F 59	solution treat and quench	1975-2050 [1080-1120]	liquid	500 [260]	B

F 60	solution treat and quench	1870 [1020]	liquid	500 [260]	B
F 61	solution treat and quench	1920-2060 [1050-1125]	liquid	500 [260]	B
F 65	solution treat and quench	1830-2100 [1000-1150]	liquid ^D	500 [260]	B
F 66	solution treat and quench	1870–1975 [1020–1080]	liquid	500 [260]	B
F 67	solution treat and quench	1870–2050 [1020–1120]	liquid	500 [260]	B
F 68	solution treat and quench	1700–1920 [925–1050]	liquid	500 [260]	B
F 69	solution treat and quench	1870 [1020]	liquid	500 [260]	B
F 71	solution treat and quench	1925–2100 [1050–1150]	liquid	500 [260]	B

^A Minimum unless temperature range is listed.

^B Not applicable.

^C Grade F 52 shall be solution treated at 1825 to 1875 °F [995 to 1025 °C] 30 min/in. of thickness and water quenched.

^D The cooling media for Grades F 65 and F70 shall be quenching in water or rapidly cooling by other means.

C. Chemical Composition

The steel shall conform to the requirements as to chemical composition prescribed in Table 2.

Table 2

Identification Symbol	UNS Designation	C	Mn	P	S	Si	Cr	Ni	Mo	Other Elements
Low Alloy Steels										
F 1	K12822	0.28	0.6-0.9	0.045	0.045	0.15-0.35			0.44-0.65	
F 2 ^B	K12122	0.05-0.21	0.3-0.8	0.04	0.04	0.1-0.6	0.5-0.81		0.44-0.65	
F 5 ^C	K41545	0.15	0.3-0.6	0.03	0.03	0.5	4.0-6.0	0.5	0.44-0.65	
F 5a ^C	K42544	0.25	0.6	0.04	0.03	0.5	4.0-6.0	0.5	0.44-0.65	
F 9	K90941	0.15	0.3-0.6	0.03	0.03	0.5-1	8.0-10.0		0.9-1.1	
F 10	S33100	0.1-0.2	0.5-0.8	0.04	0.03	1-1.4	7.0-9.0	19-22		
F 91	K90901	0.08-0.12	0.3-0.6	0.02	0.01	0.2-0.5	8-9.5	0.4	0.85-1.05	N[0.03-0.07] Al [0.02 ^D]

										Ti [0.01 ^D] Cb [0.06-0.1] V [0.18-0.25] Zr [0.01 ^D]
F 92	K92460	0.07-0.13	0.3-0.6	0.02	0.01	0.5	8.5-9.5	0.4	0.3-0.6	N[0.03-0.07] Al [0.02 ^D] Ti [0.01 ^D] Cb[0.04-0.09] B [0.001-0.006] W [1.5-2.0] V [0.15-0.25] Zr [0.01 ^D]
F 122	K91271	0.07-0.14	0.7	0.02	0.01	0.5	10-11.5	0.5	0.25-0.6	N[0.04-0.1] Cu [0.3-1.7] Al [0.02 ^D] Ti [0.01 ^D] Cb [0.04-0.1] B [0.005] W [1.5-2.5] V [0.15-0.3] Zr [0.01 ^D]
F 911	K91061	0.09-0.13	0.3-0.6	0.02	0.01	0.1-0.5	8.5-9.5	0.4	0.9-1.1	N[0.04-0.09] Al [0.02 ^D] Ti [0.01 ^D] Cb [0.06-0.1] B [0.0003-0.006] W [0.9-1.1] V [0.18-0.25] Zr [0.01 ^D]
F 11 Class 1	K11597	0.05-0.15	0.3-0.6	0.03	0.03	0.5-1.0	1-1.5		0.44-0.65	
F 11 Class 2	K11572	0.1-0.2	0.3-0.8	0.04	0.04	0.5-1.0	1-1.5		0.44-0.65	
F 11 Class 3	K11572	0.1-0.2	0.3-0.8	0.04	0.04	0.5-1.0	1-1.5		0.44-0.65	
F 12 Class 1	K11562	0.05-0.15	0.3-0.6	0.045	0.045	0.5 max	0.8-1.25		0.44-0.65	
F 12 Class 2	K11564	0.1-0.2	0.3-0.8	0.04	0.04	0.1-0.6	0.8-1.25		0.44-0.65	
F 21	K31545	0.05-0.15	0.3-0.6	0.04	0.04	0.5 max	2.7-3.3		0.8-1.06	
F 3V	K31830	0.05-0.18	0.3-0.6	0.02	0.02	0.1	2.8-3.2		0.9-1.1	Ti [0.015-0.035] B [0.001-0.003]

F 3VCb	K31390	0.1-0.15	0.3-0.6	0.02	0.01	0.1	2.7-3.3	0.25	0.9-1.1	V [0.2-0.3] Cu [0.25] Ti [0.015] Cb [0.015-0.07] V [0.2-0.3] Ca [0.0005-0.0150]
F 22 Class 1	K21590	0.05-0.15	0.3-0.6	0.04	0.04	0.5	2.0-2.5		0.87-1.13	
F 22 Class 3	K21590	0.05-0.15	0.3-0.6	0.04	0.04	0.5	2.0-2.5		0.87-1.13	
F 22V	K31835	0.11-0.15	0.3-0.6	0.015	0.01	0.1	2.0-2.5	0.25	0.9-1.1	Cu [0.2] Ti [0.03] Cb [0.07] B [0.002] V [0.25-0.35] Ca [0.015 ^E]
F 23	K41650	0.04-0.1	0.1-0.6	0.03	0.01	0.5	1.9-2.6	0.4	0.05-0.3	N[0.015F] Al [0.03] Ti [0.005-0.06 ^F] Cb [0.02-0.08] B [0.001-0.006] W [1.45-1.75] V [0.2-0.3]
F 24	K30736	0.05-0.1	0.3-0.7	0.02	0.01	0.15-0.45	2.2-2.6		0.9-1.1	N[0.12] Al [0.02] Ti [0.06-0.1] B [0.0015-0.007] V [0.2-0.3]
FR	K22035	0.2	0.4-1.06	0.045	0.05			1.6-2.24		Cu [0.75-1.25]
F 36	K21001	0.1-0.17	0.8-1.2	0.03	0.025	0.25-0.5	0.3	1-1.3	0.25-0.5	N[0.02] Cu [0.5-0.8] Al [0.05] V [0.02]
Martensitic Stainless Steels										
F 6a	S41000	0.15	1	0.04	0.03	1	11.5-13.5	0.5		

F 6b	S41026	0.15	1	0.02	0.02	1	11.5-13.5	1.0-2.0	0.4-0.6	Cu [0.5]
F 6NM	S41500	0.05	0.5-1	0.03	0.03	0.6	11.5-14	3.5-5.5	0.5-1	
Ferritic Stainless Steels										
F XM-27 Cb	S44627	0.01 ^H	0.4	0.02	0.02	0.4	25-27.5	0.5 ^H	0.75-1.5	N[0.015 ^H] Cu [0.2 ^H] Cb [0.05-0.2]
F 429	S42900	0.12	1	0.04	0.03	0.75	14-16	0.5		
F 430	S43000	0.12	1	0.04	0.03	0.75	16-18	0.5		
Austenitic Stainless Steels										
F 304	S30400	0.08	2	0.045	0.03	1	18.0-20.0	8.0-11.0		N[0.1]
F 304H	S30409	0.04-0.1	2	0.045	0.03	1	18.0-20.0	8.0-11.0		
F 304L	S30403	0.03	2	0.045	0.03	1	18.0-20.0	8.0-13.0		N[0.1]
F 304N	S30451	0.08	2	0.045	0.03	1	18.0-20.0	8-10.5		N[0.1-0.16]
F 304LN	S30453	0.03	2	0.045	0.03	1	18.0-20.0	8-10.5		N[0.1-0.16]
F 309H	S30909	0.04-0.1	2	0.045	0.03	1	22-24	12.0-15.0		
F 310	S31000	0.25	2	0.045	0.03	1	24-26	19-22		
F 310H	S31009	0.04-0.1	2	0.045	0.03	1	24-26	19-22		
F 310MoLN	S31050	0.03	2	0.03	0.015	0.4	24-26	21-23	2.0-3.0	N[0.1-0.16]
F 316	S31600	0.08	2	0.045	0.03	1	16-18	10.0-14.0	2.0-3.0	N[0.1]
F 316H	S31609	0.04-0.1	2	0.045	0.03	1	16-18	10.0-14.0	2.0-3.0	
F 316L	S31603	0.03	2	0.045	0.03	1	16-18	10.0-15.0	2.0-3.0	N[0.1]
F 316N	S31651	0.08	2	0.045	0.03	1	16-18	11.0-14.0	2.0-3.0	N[0.1-0.16]
F 316LN	S31653	0.03	2	0.045	0.03	1	16-18	11.0-14.0	2.0-3.0	N[0.1-0.16]
F 316Ti	S31635	0.08	2	0.045	0.03	1	16.0-18.0	10.0-14.0	2.0-3.0	N[0.1] Ti [5*(C+N) min, 0.7 max]
F 317	S31700	0.08	2	0.045	0.03	1	18-20	11.0-15.0	3.0-4.0	
F 317L	S31703	0.03	2	0.045	0.03	1	18-20	11.0-15.0	3.0-4.0	
S31727	S31727	0.03	1	0.03	0.03	1	17.5-19	14.5-16.5	3.8-4.5	N[0.15-0.21] Cu [2.8-4]
F 70	S31730	0.03	2	0.04	0.01	1	17-19	15-16.5	3.0-4.0	N[0.045] Cu [4.0-5.0]
S32053	S32053	0.03	1	0.03	0.01	1	22-24	24-28	5.0-6.0	N[0.17-0.22]
F 321	S32100	0.08	2	0.045	0.03	1	17-19	9.0-12		Ti [5*C min, 0.7 max]

F 321H	S32109	0.04-0.1	2	0.045	0.03	1	17-19	9.0-12		Ti [4*C min, 0.7 max]
F 347	S34700	0.08	2	0.045	0.03	1	17-20	9.0-13		Cb [10*C min., 1.1 max]
F 347H	S34709	0.04-0.1	2	0.045	0.03	1	17-20	9.0-13		Cb [8*C min., 1.1 max]
F 347LN	S34751	0.005-0.02	2	0.045	0.03	1	17-19	9.0-13		N[0.06-0.1] Cb [0.2-0.5N]
F 348	S34800	0.08	2	0.045	0.03	1	17-20	9.0-13		Ti [0.1] Cb [^L] Co [0.2]
F 348H	S34809	0.04-0.1	2	0.045	0.03	1	17-20	9.0-13		Ti [0.1] Cb [^M] Co [0.2]
F XM-11	S21904	0.04	8.0-10.0	0.06	0.03	1	19-21.5	5.5-7.5		N[0.15-0.4]
F XM-19	S20910	0.06	4.0-6.0	0.04	0.03	1	20.5-23.5	11.5-13.5	1.5-3	N[0.2-0.4] Cb [0.1-0.3] V [0.1-0.3]
F 20	N08020	0.07	2	0.045	0.035	1	19-21	32-38	2.0-3.0	Cu [3.0-4.0] Cb [8*C min, 1 max]
F 44	S31254	0.02	1	0.03	0.01	0.8	19.5-20.5	17.5-18.5	6-6.5	N[0.18-0.25] Cu [3.0-4.0]
F 45	S30815	0.05-0.1	0.8	0.04	0.03	1.4-2	20-22	10.0-12.0		N[0.14-0.2] Ce [0.03-0.08]
F 46	S30600	0.18	2	0.02	0.02	3.7-4.3	17-18.5	14.0-15.5	0.2	Cu [0.5]
F 47	S31725	0.03	2	0.45	0.03	0.75	18-20	13-17.5	4.0-5.0	N[0.1]
F 48	S31726	0.03	2	0.45	0.03	0.75	17-20	13-17.5	4.0-5.0	N[0.1-0.2]
F 49	S34565	0.03	5.0-7.0	0.03	0.01	1	23-25	16-18	4.0-5.0	N[0.4-0.6] Cb [0.1]
F 56	S33228	0.04-0.08	1	0.02	0.015	0.3	26-28	31-33		Al [0.025] Cb [0.6-1] Ce [0.05-0.1]
F 58	S31266	0.03	2.0-4.0	0.035	0.02	1	23-25	21-24	5.2-6.2	N[0.35-0.6] Cu [1-2.5] W [1.5-2.5]
F 62	N08367	0.03	2	0.04	0.03	1	20-22	23.5-25.5	6.0-7.0	N[0.18-0.25] Cu [0.75]
F 63	S32615	0.07	2	0.045	0.03	4.8-6	16.5-19.5	19-22	0.3-1.5	Cu [1.5-2.5]
F 64	S30601	0.015	0.5-0.8	0.03	0.013	5-5.6	17-18	17-18	0.2	N[0.05] Cu [0.35]
F 904L	N08904	0.02	2	0.04	0.03	1	19-23	23-28	4.0-5.0	N[0.1] Cu [1-2.0]

Ferritic-Austenitic Stainless Steels										
F 50	S31200	0.03	2	0.045	0.03	1	24-26	5.5-6.5	1.2-2	N[0.14-0.2]
F 51	S31803	0.03	2	0.03	0.02	1	21.0-23.0	4.5-6.5	2.5-3.5	N[0.08-0.2]
F 69	S32101	0.04	4.0-6.0	0.04	0.03	1	21-22	1.35-1.7	0.1-0.8	N[0.2-0.25] Cu [0.1-0.8]
F 52	S32950	0.03	2	0.035	0.01	0.6	26-29	3.5-5.2	1-2.5	N[0.15-0.35]
F 53	S32750	0.03	1.2	0.035	0.02	0.8	24-26	6.0-8.0	3.0-5.0	N[0.24-0.32] Cu [0.5]
F 54	S39274	0.03	1	0.03	0.02	0.8	24-26	6.0-8.0	2.5-3.5	N[0.24-0.32] Cu [0.2-0.8] W [1.5-2.5]
F 55	S32760	0.03	1	0.03	0.01	1	24-26	6.0-8.0	3.0-4.0	N[0.2-0.3] Cu [0.5-1.0] W [0.5-1 ^o]
F 57	S39277	0.025	0.8	0.025	0.002	0.8	24-26	6.5-8	3.0-4.0	N[0.23-0.33] Cu [1.2-2] W [0.8-1.2]
F 59	S32520	0.03	1.5	0.035	0.02	0.8	24-26	5.5-8	3.0-5.0	N[0.2-0.35] Cu [0.5-3]
F 60	S32205	0.03	2	0.03	0.02	1	22-23	4.5-6.5	3.0-3.5	N[0.14-0.2]
F 61	S32550	0.04	1.5	0.04	0.03	1	24-27	4.5-6.5	2.9-3.9	N[0.1-0.25] Cu [1.5-2.5]
F 65	S32906	0.03	0.8-1.5	0.03	0.03	0.8	28-30	5.8-7.5	1.5-2.6	N[0.3-0.4] Cu [0.8]
F 66	S32202	0.03	2	0.04	0.01	1	21.5-24	1-2.8	0.45	N[0.18-0.26]
F 67	S32506	0.03	1	0.04	0.015	0.9	24-26	5.5-7.2	3-3.5	N[0.08-0.2] W [0.05-0.3]
F 68	S32304	0.03	2.5	0.04	0.03	1	21.5-24.5	3-5.5	0.05-0.6	N[0.05-0.2] Cu [0.05-0.6]
F 71	S32808	0.03	1.1	0.03	0.01	0.5	27-27.9	7-8.2	0.8-1.2	N[0.3-0.4] W [2.1-2.5]

^A All values are maximum unless otherwise stated. Where ellipses (...) appear in this table, there is no requirement and analysis for the element need not be determined or reported.

^B Grade F 2 was formerly assigned to the 1 % chromium, 0.5 % molybdenum grade which is now Grade F 12.

^C The present grade F 5a (0.25 max carbon) previous to 1955 was assigned the identification symbol F 5. Identification symbol F 5 in 1955 was assigned to the 0.15 max carbon grade to be consistent with ASTM specifications for other products such as pipe, tubing, bolting, welding fittings, and the like.

^D Applies to both heat and product analyses.

^E For Grade F22V, rare earth metals (REM) may be added in place of calcium, subject to agreement between the producer and the purchaser. In that case the total amount of REM shall be determined and reported.

^F The ratio of Titanium to Nitrogen shall be ≤ 3.5 . Alternatively, in lieu of this ratio limit, Grade F23 shall have a minimum hardness of 275 HV (26 HRC, 258 HBW) in the hardened condition (see 3.2.1). Hardness testing shall be performed in accordance with 9.6.3, and the hardness testing results shall be reported on the material test report (see 18.2.5).

^H Grade F XM-27Cb shall have a nickel plus copper content of 0.50 max %. Product analysis tolerance over the maximum specified limit for carbon and nitrogen shall be 0.002 %.

^I Grade F 316Ti shall have a titanium content not less than five times the carbon plus nitrogen content and not more than 0.70 %.

^J Grade F 321 shall have a titanium content of not less than five times the carbon content and not more than 0.70 %.

^K Grade F 321H shall have a titanium content of not less than four times the carbon content and not more than 0.70 %.

^L Grades F 347 and F 348 shall have a columbium content of not less than ten times the carbon content and not more than 1.10 %.

^M Grades F 347H and F 348H shall have a columbium content of not less than eight times the carbon content and not more than 1.10 %.

^N Grade F347LN shall have a columbium content of not less than 15 times the carbon content.

$0\% \text{ Cr} + 3.3 \times \% \text{ Mo} + 16 \times \% \text{ N} = 40 \text{ min.}$

D. Mechanical Properties

The material shall conform to the requirements as to mechanical properties for the grade ordered as listed in Table 3.

1. Tension Tests:- Testing shall be performed as specified in Specification A961/A961M using the largest feasible of the round specimens.
2. Hardness Tests:- The material shall be hardness tested as specified in Specification A961/A961M to ensure that the forgings are within the hardness limits given for each grade in Table 3
1. Notch Toughness Requirements :- Grades F 3V, F 3VCb, and F 22V. The Charpy V-notch tests shall meet a minimum energy absorption value of 40 ft-lbf [54 J] average of three specimens. One specimen only in one set may be below 40 ft-lbf [54 J], and it shall meet a minimum value of 35 ft-lbf [48 J].
2. Impact test specimens shall be Charpy V-notch Type. The impact test temperature shall be 0 °F [-18 °C].

E. Grain Size for Austenitic Grades

- All H grades and grade F 63 shall be tested for average grain size by Test Methods E112.
- Grades F 304H, F 309H, F 310H, and F 316H shall have a grain size of ASTM No. 6 or coarser.
- Grades F 321H, F 347H, and F 348H shall have a grain size of ASTM No. 7 or coarser.
- Grade F 63 shall have a grain size of ASTM No. 3 or finer.

Table 3^A

Grade Symbol	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa] ^B	Elongation in 2 in. [50 mm] or 4D, min, %	Reduction of Area, min, %	Brinell Hardness Number, HBW, unless

					otherwise indicated
Low Alloy Steels					
F 1	70 [485]	40 [275]	20	30	143–192
F 2	70 [485]	40 [275]	20	30	143–192
F 5	70 [485]	40 [275]	20	35	143–217
F 5a	90 [620]	65 [450]	22	50	187–248
F 9	85 [585]	55 [380]	20	40	179–217
F 10	80 [550]	30 [205]	30	50	...
F 91	90 [620]	60 [415]	20	40	190–248
F 92	90 [620]	64 [440]	20	45	269 max
F 122	90 [620]	58 [400]	20	40	250 max
F 911	90 [620]	64 [440]	18	40	187–248
F 11 Class 1	60 [415]	30 [205]	20	45	121–174
F 11 Class 2	70 [485]	40 [275]	20	30	143–207
F 11 Class 3	75 [515]	45 [310]	20	30	156–207
F 12 Class 1	60 [415]	32 [220]	20	45	121–174
F 12 Class 2	70 [485]	40 [275]	20	30	143–207
F 21	75 [515]	45 [310]	20	30	156–207
F 3V & F 3VCb	85–110 [585–760]	60 [415]	18	45	174–237
F 22 Class 1	60 [415]	30 [205]	20	35	170 max
F 22 Class 3	75 [515]	45 [310]	20	30	156–207
F 22V	85–110 [585–780]	60 [415]	18	45	174–237
F 23	74 [510]	58 [400]	20	40	220 max
F 24	85 [585]	60 [415]	20	40	248 max
FR	63 [435]	46 [315]	25	38	197 max
F 36 Class 1	90 [620]	64 [440]	15	...	252 max

F 36 Class 2	95.5 [660]	66.5 [460]	15	...	252 max
Martensitic Stainless Steels					
F 6a Class 1	70 [485]	40 [275]	18	35	143–207
F 6a Class 2	85 [585]	55 [380]	18	35	167–229
F 6a Class 3	110 [760]	85 [585]	15	35	235–302
F 6a Class 4	130 [895]	110 [760]	12	35	263–321
F 6b	110–135 [760–930]	90 [620]	16	45	235–285
F 6NM	115 [790]	90 [620]	15	45	295 max
Ferritic Stainless Steels					
F XM-27 Cb	60 [415]	35 [240]	20	45	190 max
F 429	60 [415]	35 [240]	20	45	190 max
F 430	60 [415]	35 [240]	20	45	190 max
Austenitic Stainless Steels					
F 304	75 [515] ^C	30 [205]	30	50	...
F 304H	75 [515] ^C	30 [205]	30	50	...
F 304L	70 [485] ^D	25 [170]	30	50	...
F 304N	80 [550]	35 [240]	30 ^E	50 ^F	...
F 304LN	75 [515] ^C	30 [205]	30	50	...
F 309H	75 [515] ^C	30 [205]	30	50	...
F 310	75 [515] ^C	30 [205]	30	50	...
F 310H	75 [515] ^C	30 [205]	30	50	...
F 310MoLN	78 [540]	37 [255]	25	40	...
F 316	75 [515] ^C	30 [205]	30	50	...
F 316H	75 [515] ^C	30 [205]	30	50	...
F 316L	70 [485] ^D	25 [170]	30	50	...
F 316N	80 [550]	35 [240]	30 ^E	50 ^F	...
F 316LN	75 [515] ^C	30 [205]	30	50	...
F 316Ti	75 [515]	30 [205]	30	40	...
F 317	75 [515] ^C	30 [205]	30	50	...
F 317L	70 [485] ^D	25 [170]	30	50	...
S31727	80 [550]	36 [245]	35	50	217
S32053	93 [640]	43 [295]	40	50	217
F 347	75 [515] ^C	30 [205]	30	50	...

F 347H	75 [515] ^c	30 [205]	30	50	...
F 347LN	75 [515]	30 [205]	30	50	...
F 348	75 [515]	30 [205]	30	50	...
F 348H	75 [515]	30 [205]	30	50	...
F 321	75 [515]	30 [205]	30	50	...
F 321H	75 [515]	30 [205]	30	50	...
F XM-11	90 [620]	50 [345]	45	60	...
F XM-19	100 [690]	55 [380]	35	55	...
F 20	80 [550]	35 [240]	30	50	...
F 44	94 [650]	44 [300]	35	50	...
F 45	87 [600]	45 [310]	40	50	...
F 46	78 [540]	35 [240]	40	50	...
F 47	75 [525]	30 [205]	40	50	...
F 48	80 [550]	35 [240]	40	50	...
F 49	115 [795]	60 [415]	35	40	...
F 56	73 [500]	27 [185]	30	35	...
F 58	109 [750]	61 [420]	35	50	...
F 62	95 [655]	45 [310]	30	50	...
F 63	80 [550]	32 [220]	25	...	192 max
F 64	90 [620]	40 [275]	35	50	217 max
F 70	70 [480]	25 [175]	35	...	HRB 90 max
F 904L	71 [490]	31 [215]	35
Ferritic-Austenitic Stainless Steels					
F 50	100–130 [690–900]	65 [450]	25	50	...
F 51	90 [620]	65 [450]	25	45	...
F 52	100 [690]	70 [485]	15
F 53	116 [800]	80 [550]	15	...	310 max
F 54	116 [800]	80 [550]	15	30	310 max
F 55	109–130 [750–895]	80 [550]	25	45	...
F 57	118 [820]	85 [585]	25	50	...
F 59	112 [770]	80 [550]	25	40	...
F 60	95 [655]	65 [450]	25	45	...
F 61	109 [750]	80 [550]	25	50	...

F 65	109 [750]	80 [550]	25
F 66	94 [650]	65 [450]	30	...	290 max
F 67	90 [620]	65 [450]	18	...	302
F 68	87 [600]	58 [400]	25	...	290 max
F 69	94 [650]	65 [450]	30
F 71	101 [700]	72 [500]	15	...	321

^A Where ellipses appear in this table, there is no requirement and the test for the value need neither be performed nor a value reported.

^B Determined by the 0.2 % offset method. For ferritic steels only, the 0.5 % extension-under-load method may also be used.

^C For sections over 5 in. [130 mm] in thickness, the minimum tensile strength shall be 70 ksi [485 MPa].

^D For sections over 5 in. [130 mm] in thickness, the minimum tensile strength shall be 65 ksi [450 MPa].

^E Longitudinal. The transverse elongation shall be 25 % in 2 in. or 50 mm, min.

^F Longitudinal. The transverse reduction of area shall be 45 % min.

F. Nondestructive Test Requirements :-

1. Hollow forgings of Grades F 91, F 92, F 122, and F 911, NPS 4 [DIN 100] and larger, whose internal surfaces are not accessible to magnetic particle or liquid penetrant examination, shall be examined by an ultrasonic test in accordance with Practice A388/A388M.
2. Hollow forgings of Grades F 91, F 92, F 122, and F 911, NPS 4 [DIN 100] and larger, whose internal surfaces are accessible to magnetic particle or liquid penetrant examination, shall be examined on their internal surfaces by either a magnetic particle test, or by a liquid penetrant examination in accordance with Practice A275/A275M, or by a liquid penetrant examination in accordance with Test Method E165, as applicable.

G. Supplementary Requirements :-

1. Macroetch Test.
2. Material for Optimum Resistance to Stress-Corrosion Cracking.
3. Corrosion Tests.
4. Special Filler Metal.
5. Heat Treatment of Austenitic Forgings.
6. Grain Size for Austenitic Grades.
7. Stabilization Treatment :- Subsequent to the solution anneal for Grades F 321, F 321H, F 347, F 347H, F 348, and F 348H, these grades shall be given a stabilization heat treatment at 1500 to 1600 °F [815 to 870 °C] for a minimum of 2 h/in. [4.7 min/mm] of thickness and then cooling in the furnace or in air.
8. Grain Size Requirements for Non-H-Grade Austenitic Steels Used Above 1000 °F [540 °C] :- Non-H grades of austenitic stainless steels shall have a grain size of No. 7 or coarser as determined in accordance with Test Methods E112.
9. Detection of Detrimental Phases in Austenitic/Ferritic Stainless Steels.