ASTM A182/A182M-10

Standard Specification forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service[1]

1. Scope :-

1.1 This specification covers forged low alloy and stainless steel piping components for use in pressure system. Included are flanges, fittings, valves, and similar parts to specified dimensional standards, such as the ASME specifications that are referenced in section 2.

1.2 For bars and products machined directly from bar (other than those directly addressed by this specification; see 6.4), refer to specifications A479/A479 M and A739 for the similar grades available in those specifications. Products made to this specification are limited to a maximum weight of 10000 lb [4540 kg]. For larger products for other application, refer to specifications A336/A336M and A965/A965M for the similar ferritic and austenitic grades, respectively, available in those specifications.

1.3 Several grades of low alloy steels and ferritic, martensitic, austenitic, and ferritic-austenitic stainless steels are included in this specification. Selection will depend upon design and service requirements. Several of the ferritic/austenitic (duplex) grades are also found in specification A1049/A1049M.

1.4 Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order.

1.5 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished to inch-pound units.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two system may result in non-conformance with the standard.

2. Referenced Documents :-

2.1 In addition to the referenced documents listed in specification A961/A961M, the following list of standards apply to this specification.

2.2 ASTM Standards :-

A262 practices for detecting susceptibility to inter granular attack in Austenitic Stainless Steels

A275/A275M Practice for magnetic Examination of Steel forgings

A336/A336M specification for alloy steel forgings for pressure and high-temperature parts

A370 test methods and definitions for mechanical testing of steel products

A479/A479M specification for stainless steel bars and shapes for use in boilers and shapes for use in boiler and other pressure vessels

A484/A484M specification for general requirements for stainless steel bars, billers, and forgings

A739 specification for steel bar, alloy, hot-wrought, for elevated temperature or pressure-containing parts, or both

A763 practices for detecting susceptibility to inter granular attack in ferritic stainless steels
A788/A788M specification for steel forgings, general requirements
A961/A961M specification for common requirements for steel flanges, forged fittings, valves, and parts for piping application
A965/A965M specification for steel forgings, austenitic, for pressure and high temperature partsA1049/A1049M specification for stainless steel forgings, ferritic/Austenitic (duplex), for pressure vessels and related components
E92 test method for Vickers hardness of metallic material
E112 test methods for determining average Grain size
E165 practice for liquid penetrant examination for general industry
E340 test method for Macroetching metals and alloys

2.3 ASME boiler and pressure vessel codes:
Section IX welding and brazing qualifications

2.4 AWS Specification
A5.4/A5.4M specification for stainless steel electrodes for shielded metals arc welding
A5.5/A5.5M specification for low alloy steel electrodes for shielded metal arc welding
A5.9/A5.9M specification for bare stainless steel welding electrodes and rods
A5.11/A5.11M specification for nickel and nickel alloy welding electrodes for shielded metal arc welding
A5.14/A5.14M specification for nickel and nickel alloy bare welding electrodes and rods
A5.23/A5.23M specification for low alloy steel electrodes and fluxes for submerged arc welding
A5.29/A5.29M low alloy steel electrodes for flux cored arc welding

3. Terminology :-

3.1 Definitions – for definition of terms used in this specification, refer to specification A961/A9691M.

3.2 Definitions of terms specific to this standard:

3.2.1 Hardened condition, n – for F23, the metallurgical condition achieved after normalizing and cooling to room temperature but prior to tempering.

4. Ordering Information :-

4.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. In addition to the ordering information guidelines in specification A961/A961M, orders should include the following information:

4.1.1 Additional requirements (see 7.2.1, Table 2 footnotes, 9.3, and 18.2), and

4.1.2 Requirement, if any, that manufacturer shall submit drawings for approval showing the shape of the rough forging before machining and the exact location of test specimen material (see9.3.1).

5. General Requirements :-

5.1 Product furnished to this specification shall conform to the requirements of specification A961/A961M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of specification A961/A961M constitutes non-conformance with this specification. In case of conflict

between the requirements of this specification and specificationA961/A961M, this specification shall prevail.

6. Manufacture :-

6.1 The low-alloy ferritic steels may be made by the open-hearth, electric-furnace, or basic-oxygen process with separate degassing and refining processes in each case.

6.2 The stainless steel shall be melted by one of the following processes: (a) electro-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 electro-beam melting.

6.3 A sufficient discard shall be made to secure freedom from injurious piping and undue segregation.

6.4 The material shall be forged as close as practicable to the specified shape and size.

6.4.1 Flange of any type, elbow, return bends, tees, and header tees shall not be machined directly from bar stock.

6.4.2 Cylindrically-shaped parts may be machined from forged or rolled solution-annealed austenitic stainless steel bar without additional hot working.

6.4.3 Small cylindrically-shaped low alloy and martensitic stainless steel parts, NPS-4 [DN 100] and under, may be machined from forged or rolled bar, without additional hot working.

6.5 Except as provided for in 4.4, the finished product shall be a forging as defined in the Terminology section of Specification A 788/A788M.

7. Heat Treatment :-

7.1perature below 1000°F [538°C] prior to heat treating in accordance with the requirements of Table 1.

7.2 Low Alloy Steels and Ferritic and Martensitic Stainless Steels—The low alloy steels and ferritic and martensitic stainless steels shall be heat treated in accordance with the requirements of 7.1 and Table 1. When more than one heat treatment option is listed for a grade in Table 1, any one of the heat treatment listed shall be performed. The section of the heat treatment shall be at the manufacturer's option, unless otherwise stated in the purchase order.

7.2.1 Liquid Quenching—When agreed to by the purchaser, liquid quenching followed by tempering shall be permitted provided the temperatures in Table 1 for each grade are utilized.

7.2.1.1 Marking – parts that are liquid quenched and tempered shall be marked "QT."

7.2.2 Alternatively, Grade F 1, F 2, and F 12, Classes one and two may be given a heat treatment of 1200°F (650°C) minimum after final hot or cold forming.

7.3 Austenitic and Ferritic-Austenitic Stainless Steels—The austenitic and ferritic-austenitic stainless steels shall be heat treated in accordance with the requirements of 7.1 and Table 1.

7.3.1 Alternatively, immediately following hot working,

while the temperature of the forging is not less than the minimum solution annealing temperature specified in Table 1, forging made from austenitic grades (except grades F 304H, F 309H, F 310H, F 316H, F 321, F 321 H, F 347, F 347H, F348, F 348H, F 45, and F 56)may be individually rapidly quenched in accordance with the requirements of Table 1.

7.3.2 See Supplementary Requirement S14 if a particular heat treatment method is to be employed.

7.4 Time of Heat Treatment—Heat treatment of forgingsmay be performed before machining.

7.5 Forged or Rolled Bar—Forged or rolled austenitic stainless bar from which small cylindrically shaped parts are to be machined, as permitted by 6.4, and the parts machined from such bar, without heat treatment after machining, shall be furnished to the annealing requirements of Specification A 479/A479M or this specification, with subsequent light cold drawing and straightening permitted (see Supplementary Requirement S9 if annealing must be the final operation).

TABLE 1 Heat Treating Requirements

Grade	Heat treat type	Austenitizing/Solutioning Temperature, min °F (°C)A	Cooling Media	Quenching Cool Below °F (°C)	Tempering Temperature min °F (°C
		Low Alloy Steel			
F 1	Anneal normalize and temper	1650 [900] 1650 [900]	furnace cool air cool	B B	B 1150 [620]
F 2	Anneal normalize and temper	1650 [900] 1650 [900]	furnace cool air cool	B B	B 1150 [620]
F 5, F 5a	Anneal normalize and temper	1750 [955] 1750 [955]	furnace cool air cool	B B	B 1250 [675
F 9	Anneal normalize and temper	1750 [955] 1750 [955]	furnace cool air cool	B B	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	1900-1975 [1040-1080]	Air cool	B	1350-1470 [730-800]

	temper				
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 normalize and temper	1650 [900] 1650 [900]	furnace cool air cool	B B	B 1150 [620]
F 12, Class 1, 3	Anneal normalize and temper	1650 [900] 1650 [900]	furnace cool air cool	B B	B 1150 [620]
F 21, F 3V, and F 3VCb	Anneal normalize and temper	1750 [955] 1750 [955]	furnace cool air cool	B B	B 1250 [675]
F 22, Class 1,3	Anneal normalize and temper	1650 [900] 1650 [900]	furnace cool air cool	B B	B 1250 [675]
F 22V	normalize and temper or quench and temper	1650 [900]	air cool or liquid	B	1250 [675]
F 23	normalize and temper	1900-1975 [1040-1080]	air cool accelerate	B	1350-1470 [730-800]
F 24	normalize and temper	1800-1975 [980-1080]	air cool or liquid	B	1350-1470 [730-800]
FR	Anneal Normaliz normalize and temper	1750 [955] 1750 [955] 1750 [955]	furnace cool air cool air cool	B B B	B B 1250 [675]
F 36, Class 1	normalize and temper	1650 [900]	air cool	B	1100 [595]
F 36, Class 2	normalize and temper quench and	1650 [900] 1650 [900]	air cool accelerate air cool	B B	1100 [595] 1100 [595]

	temper		or liquid		
		Martensitic Stainless	Steel		
F 6a Class 1	Anneal normalize and temper temper	Not specified Not specified Not specified	furnace cool air cool air cool	B 400[205] B	B 1325[725] 1325[725]
F 6a Class 2	Anneal normalize and temper temper	Not specified Not specified Not specified	furnace cool air cool air cool	B 400[205] B	B 1250[675] 1250[675]
F 6a Class 3	Anneal normalize and temper	Not specified Not specified	furnace cool air cool	B 400[205]	B 1100[595]
F 6a Class 4	Anneal normalize and temper	Not specified Not specified	furnace cool air cool	B 400[205]	B 1000[540]
F 6b	Anneal normalize and temper	1750 [955] 1750 [955]	furnace cool air cool	B 400[205]	B 1150[620]
F 6NM	normalize and temper	1850 [1010]	air cool	200 [95]	1040-1120 [560-600]
		Ferritic Stainless Steel			
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	Steel		
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	1900 [1040]	Liquid	500 [260]	B

	treat and quench				
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]	BB
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	1900 [1040]	liquid	500 [260]	B

	quench				
F 347H	Solution treat and quench	2000 [1095]	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]	BB
F 321	Solution treat and quench	1900 [1040]	Liquid	500 [260]	
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]	BB
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]	
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	2025 [1105]	Liquid	500 [260]	B

	treat and quench				
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
		Ferritic - Austenitic	Stainless	Steel	
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

8. Chemical Composition :-

8.1 A chemical heat analysis in accordance with specification A961/A961M shall be made and conform to the chemical composition prescribed in Table 2.

8.2 Grades to which lead, selenium, or other elements are added for the purpose of rendering the material free-machining shall not be used.

8.3 Starting material product to a specification that specifically requires the addition of any element beyond those listed in Table 2 for the applicable grade of material, is not permitted.

8.4 The steel shall conform to the requirements as to chemical composition for the grade ordered as listed in Table 2.

8.5 Product Analysis – The purchaser may make a product analysis on product supplied to this specification in accordance with specification A961/A961M.

9. Mechanical Properties :-

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

9.2 pared from the stock used to make the finished product. In either case, mechanical test specimens shall not be removed until after all heat treatment is complete. If repair welding is required, test specimens shall not be removed until after post-weld heat treatment is complete, except for ferritic grades when the post-weld heat treatment is conducted at least 50°F [30°C] below the actual tempering temperature. When test blanks are used, they shall receive approximately the same
working as the finished product. The test blanks shall be heat treated with the finished product and shall approximate the maximum cross section of the forgings they represent.

9.3 For normalized and tempered, or quenched and tem pered forgings, the central axis of the test specimen shall correspond to the 1⁄4 T plane or deeper position where T is the maximum heat treated thickness of the represented forging. In addition, for quenched and tempered forgings, the midlength of the test specimen shall be at least T from any second heat treated surface. When the section thickness does not permit this positioning, the test specimen shall be positioned as near as
possible to the prescribed location, as agreed to by the purchaser and the supplier

9.3.1 With prior purchase approval, the test specimen for ferritic steel forgings may be taken at a depth (t) corresponding to the distance from the area of significant stress to the nearest heat treated surface and at least twice this distance (2 t) from
any second surface. However, the test depth shall not be nearer to one treated surface than 3⁄4 in. [19 mm] and to the second treated surface than 11⁄2 in. [38 mm]. This method of test specimen location would normally apply to contour-forged
parts, or parts with thick cross-sectional areas where 1⁄4 T 3 T testing (7.3) is not practical. Sketches showing the exact test locations shall be approved by the purchaser when this method is used.

9.4 For annealed low alloy steels, ferritic stainless steels, and martensitic stainless steels and also for austenitic and ferritic-austenitic stainless steels, the test specimen may be taken from any convenient location.

9.5 Tension Tests:

9.5.1 Low alloy steel and ferritic and martensitic stainless Steels—One tension test shall be made for each heat in each heat treatment charge.

9.5.1.1 When the heat-treating cycles are the same and the furnaces (either batch or continuous type) are controlled within 625°F [614°C] and equipped with recording pyrometers so that complete records of heat treatment are available, then only one tension test from each heat of each forging type (Note 1) and section size is required instead of one test from each heat in each heat-treatment charge.

9.5.2 Austenitic and Ferritic-Austenitic Stainless Steel Grades—One tension test shall be made for each heat.

9.5.2.1 When heat treated in accordance with 5.1, the test blank or forging used to provide the test specimen shall be heat treated with a finished forged product.

9.5.2.2 When the alternative method in 5.3.1 is used, the test blank or forging used to provide the test specimen shall be forged and quenched under the same processing conditions as the forgings they represent.

9.5.3 Testing shall be performed in accordance with Test Methods and Definitions A 370 using the largest feasible of the round specimens. The gage length for measuring elongation shall be four times the diameter of the test section.

9.6 Hardness Tests:

9.6.1 Except when only one forging is produced, a minimum of two pieces per batch or continuous run as defined in 9.6.2 shall be hardness tested in accordance with Test Methods and Definitions A 370 to ensure that the forgings are within the hardness limits given for each grade in Table 3. The purchaser may verify that the requirement has been met by testing at any location on the forging provided such testing does not render the forging useless.

9.6.2 When the reduced number of tension tests permitted by 9.5.1.1 is applied, additional hardness tests shall be made on forgings or samples as defined in 9.2 scattered throughout the load (Note 2). At least eight samples shall be checked from each batch load and at least one check per hour shall be made from a continuous run. When the furnace batch is less than eight forgings, each forging shall be checked. If any check falls outside the prescribed limits, the entire lot of forgings shall be reheat treated and the requirements of 9.5.1 shall apply.

9.6.3 When the alternative to the Ti/N ratio limit for F23 is applied, (see Note P in Table 2), a minimum of two pieces per batch or continuous run as defined in 9.6.2 shall be hardness tested, in the hardened condition (see 3.2.1), to ensure that the forgings are within the hardness limit given for F23 in Note P of Table 2. The test sample shall be taken at the mid thickness of the thickest section of the product. Testing shall be performed in accordance with the test method E92 or with Test Methods and definitions A370.

9.7 Notch Toughness Requirements—Grades F 3V, F 3VCb, and F 22V.

9.7.1 Impact test specimens shall be Charpy V-notch Type, as shown in Fig. 11a of Test Methods and Definitions A 370. The usage of subsize specimens due to material limitations must have prior purchaser approval.

9.7.2 The Charpy V-notch test specimens shall be obtained as required for tension tests in 7.2, 7.3 and 7.5. One set of three Charpy V-notch specimens shall be taken from each tensile specimen location.

9.7.3 The longitudinal axis and mid-length of impact specimen shall be located similarly to the longitudinal axis of the tension test specimens. The axis of the notch shall be normal to the nearest heat treated surface of the forging.

9.7.4 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].

9.7.5 The impact test temperature shall be 0°F [−18°C].

TABLE 2 Chemical Requirements[A]

Composition %													
Identi-fication System	UNS Desig-nation	Grade	C	Mn	P	S	Si	Ni	Ch	*Mo*	Cb	Ti	Other element
Low Alloy Steel													
F 1	K12822	C-Mo	0.28	0.60-0.90	0.045	0.045	0.15-0.35	...	...	*0.44-0.65*	...	...	...
F 2[B]	K12122	0.5% Cr, 0.5% Mo	0.05-0.21	0.30-0.80	0.040	0.040	0.10-0.60	...	0.50-0.81	*0.44-0.65*	...	...	...
F 5[c]	K41545	4 to 6 % Cr	0.15	0.30-0.60	0.030	0.030	0.50	0.50	4.0-6.0	*0.44-0.65*	...	...	...
F 5a[c]	K42544	4 to 6 % Cr	0.25	0.60	0.040	0.030	0.50	0.50	4.0-6.0	*0.44-0.65*	...	...	...
F 9	K90941	9 % Cr	0.15	0.30-0.60	0.030	0.030	0.50-1.00	...	8.0-10.0	*0.90-1.10*	...	...	...
F 10	K33100	20 Ni, 8 Cr	0.10-0.20	0.50-0.80	0.040	0.030	1.00-1.40	19.0-22.0	7.0-9.0	...	...	...	...
F 91	K90901	9 % Cr,1 %Mo, 0.2% V, Plus, Cb and N	0.08-0.12	0.30-0.60	0.020	0.010	0.20-0.50	0.40	8.0-9.5	*0.85-1.05*	0.06-0.10	...	N 0.03-0.07, Al 0.02[D] V 0.18-0.25 Ti 0.01[D] Zr 0.01[D]
F 92	K92460	9 % Cr, 1.8% Tungsten, 0.2% V Plus Cb and N	0.07-0.13	0.30-0.60	0.020	0.010	0.50	0.40	8.50-9.50	*0.30-0.60*	0.04-0.09	...	V 0.15-0.25 N 0.030-0.070 Al 0.02[D] W 1.50-2.00 B 0.001-0.006 Ti 0.01[D]

													Zr 0.01[D]
F 122	K91271	11% Cr, 2% Tungsten, 0.2% V Plus	0.07-0.14	0.70	0.020	0.010	0.50	0.50	10.00-11.50	*0.25-0.60*	0.04-0.10	...	V 0.15-0.30 B 0.005 N 0.040-0.100 Al 0.02[D] Cu 0.30-1.70 W 1.50-2.50 Ti 0.01[D] Zr 0.01[D]
F 911	K91061	9% Cr, 1% Mo, 0.2% V, Plus Cb and N	0.09-0.13	0.30-0.60	0.020	0.010	0.10-0.50	0.40	8.5-9.5	*0.90-1.10*	0.060-0.10	...	W 0.90-1.10 Al 0.02[D] N 0.04-0.09 V 0.18-0.25 B 0.0003-0.006 Ti 0.01[D] Zr 0.01[D]
F 11 Class1	K11597	1.25% Cr, 0.5% Mo	0.05-0.15	0.30-0.60	0.030	0.030	0.50-1.00	...	1.00-1.50	*0.44-0.65*	...	...	...
F 11 Class2	K11572	1.25% Cr, 0.5% Mo	0.10-0.20	0.30-0.80	0.040	0.040	0.50-1.00	...	1.00-1.50	*0.44-0.65*	...	...	...
F 11 Class 3	K11572	1.25% Cr, 0.5% Mo	0.10-0.20	0.30-0.80	0.040	0.040	0.50-1.00	...	1.00-1.50	*0.44-0.65*	...	...	...
F 12 Class 1	K11562	1% Cr, 0.5% Mo	0.05-0.15	0.30-0.60	0.045	0.045	0.50 max	...	0.80-1.25	*0.44-0.65*	...	...	...
F 12 Class 2	K11564	1% Cr, 0.5% Mo	0.10-0.20	0.30-0.80	0.040	0.040	0.10-0.60	...	0.80-1.25	*0.44-0.65*	...	...	...
F 21	K31545	Cr-Mo	0.05-0.15	0.30-0.60	0.040	0.040	0.50 max	...	2.7-3.3	*0.80-1.06*	...	...	...
F 3V	K31830	3% Cr, 1% Mo, 0.25% V Plus B AND Ti	0.05-0.18	0.30-0.60	0.020	0.020	0.10	...	2.8-3.2	*0.90-1.10*	...	0.015-0.035	V 0.20-0.30 B 0.001-0.003
F 3VCb	K31390	3% Cr, 1% Mo, 0.25% V Plus B, Cb AND Ti	0.10-0.15	0.30-0.60	0.020	0.010	0.10	0.25	2.7-3.3	0.90-1.10	*0.015-0.070*	0.015	V 0.20-0.30 Cu 0.25 Ca 0.0005-0.015
F 22	K21590	Cr-Mo	0.05-	0.30-	0.040	0.040	0.50	...	2.00-	*0.87-*	...	...	...

Class 1			0.15	0.60					2.50	*1.13*			
F 22 Class 2	K21590	Cr-Mo	0.05-0.15	0.30-0.60	0.040	0.040	0.50	...	2.00-2.50	*0.87-1.13*	...	...	...
F 22V	K31835	2.25% Cr, 1% Mo 0.25% V	0.11-0.15	0.30-0.60	0.015	0.010	0.10	0.25	2.00-2.50	*0.90-1.10*	0.07	0.030	Cu 0.20 V 0.25-0.35 B 0.002 Ca 0.015[E]
F 23	K41650	2.25% Cr, 1.6% W, 0.25% V, Plus Cb, and B	0.04-0.10	0.10-0.60	0.030	0.010	0.50	0.40	1.90-2.60	*0.05-0.30*	0.02-0.08	0.005-0.060[3]	V 0.20-0.30 B 0.0010-0.006 N 0.015[3] Al 0.030 W 1.45-1.75
F 24	K30736	2.25% Cr, 1% Mo 0.25% V Plus Ti and B	0.05-0.10	0.30-0.70	0.020	0.010	0.15-0.45	...	2.20-2.60	*0.90-1.10*	...	0.06-0.10	V 0.20-0.30 N 0.12 Al 0.020 B 0.0015-0.0070
FR	K22035	2% Ni, 1% Cu	0.20	0.40-1.06	0.045	0.050	...	1.60-2.24	...	...	...	...	Cu 0.75-1.25
F 36	K21001	1.15% Ni, 0.65% Cu, Mo and Cb	0.10-0.17	0.80-1.20	0.030	0.025	0.25-0.50	1.00-1.30	*0.30*	0.25-0.50	0.015-0.045	...	N 0.020 Al 0.050 Cu 0.50-0.80 V 0.02
Martensitic Stainless steel													
F 6a	S41000	13% Cr 410[6]	0.15	1.00	0.040	0.030	1.00	0.50	11.5-13.5	...	...	...	...
F 6b	S41026	13% Cr, 0.5% Mo	0.15	1.00	0.020	0.020	1.00	1.00-2.00	11.5-13.5	*0.40-0.60*	...	...	Cu 0.50
F 6NM	S41500	13% Cr, 4% Ni	0.05	0.50-1.00	0.030	0.030	0.60	3.5-5.5	11.5-14.0	*0.50-1.00*	...	...	...
Ferritic Stainless Steel													
F XM-27Cb[H]	S44627	27 Cr, 1 Mo XM-27[6]	0.010	0.40	0.020	0.020	0.40	0.50	25.0-27.5	*0.75-1.50*	0.05-0.20		N 0.015 Cu 0.20
F 429	S42900	15 Cr 429[6]	0.12	1.00	0.040	0.030	0.75	0.50	14.0-16.0	...	...	...	...
F 430	S43000	17 Cr 430[6]	0.12	1.00	0.040	0.030	0.75	0.50	16.0-18.0	...	...	...	...
Austenitic Stainless Steel													
F 304[I]	S30400	18 Cr, 8 Ni 304[6]	0.08	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	...	...	...	...
F 304H	S30409	18 Cr,	0.04-	2.00	0.045	0.030	1.00	8.0-	18.0-	...	....	...	...

		8 Ni 304H[6]	0.10					11.0	20.0				
F 304L[I]	S30403	18 Cr, 8 Ni, Low C 304L[6]	0.030	2.00	0.045	0.030	1.00	8.0-13.0	18.0-20.0	...	...	...	...
F 304N[J]	S30451	18 Cr, 8 Ni, modified with N 304N[6]	0.08	2.00	0.045	0.030	1.00	8.0-10.5	18.0-20.0	...	...	...	...
F 304LN[J]	S30453	18 Cr, 8 Ni, modified with N 304LN[6]	0.030	2.00	0.045	0.030	1.00	8.0-10.5	18.0-20.0	...	...	...	...
F 309H	S30909	23 Cr, 13.5 Ni 309H[6]	0.04-0.10	2.00	0.045	0.030	1.00	12.0-15.0	22.0-24.0	...	...	...	...
F 310	S31000	25 Cr, 20 Ni 310[6]	0.25	2.00	0.045	0.030	1.00	19.0-22.0	24.0-26.0	...	...	...	...
F 310H	S31009	25 Cr, 20 Ni 310H[6]	0.04-0.10	2.00	0.045	0.030	1.00	19.0-22.0	24.0-26.0	....	...	...	...
F 310 MoLN	S31050	25 Cr, 22 Ni, Modified with Mo and N, Low C 310 MoLN[6]	0.030	2.00	0.030	0.015	0.40	21.0-23.0	24.0-26.0	*2.00-3.00*	...	...	N 0.10-0.16
F 316[I]	S31600	18 Cr, 8 Ni, modified with Mo 316[6]	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	*2.00-3.00*	...	...	...
F 316H	S31609	18 Cr, 8 Ni, modified with Mo 316H[6]	0.04-0.10	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	*2.00-3.00*	...	...	...
F 316L[I]	S31603	18 Cr, 8 Ni, modified with Mo Low C 316L[6]	0.030	2.00	0.045	0.030	1.00	10.0-15.0	16.0-18.0	*2.00-3.00*	...	...	...
F 316N[J]	SS31651	18 Cr, 8 Ni, modified with Mo and N 316N[6]	0.08	2.00	0.045	0.030	1.00	11.0-14.0	16.0-18.0	*2.00-3.00*	...	...	...
F 316LN[J]	S31653	18 Cr, 8 Ni,	0.030	2.00	0.045	0.030	1.00	11.0-14.0	16.0-18.0	*2.00-3.00*	...	...	...

		modified with Mo and N 316LN[6]											
F 316Ti	S31635	18 Cr, 8 Ni, modified with Mo and N 316Ti[6]	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	*2.00-3.00*	...	K	N 0.10 max
F 317	S31700	19 Cr, 13 Ni, 3.5 Mo 317[6]	0.08	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	*3.0-4.0*	...	...	...
F 317L	S31703	19 Cr, 13 Ni, 3.5 Mo 317L[6]	0.030	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	*3.0-4.0*	...	...	...
S31727	S31727	18 Cr, 15 Ni, 4.5 Mo, 3.5 C With N	0.030	1.00	0.030	0.030	1.00	14.5-16.5	17.5-19.0	*3.8-4.5*	...	...	Cu 2.8-4.0 N 0.15-0.21
S32053	S32053	23 Cr, 25 Ni 5.5 Mo, with N	0.030	1.00	0.030	0.010	1.00	24.0-28.0	22.0-24.0	*5.0-6.0*	...	...	N 0.17-0.22
F 321	SS32100	18 Cr, 8 Ni modified with Ti 321[6]	0.08	2.00	0.045	0.030	1.00	9.0-12.0	17.0-19.0	....	...	L	...
F 321H	S32109	18 Cr, 8 Ni modified with Ti 321H[6]	0.04-0.10	2.00	0.045	0.030	1.00	9.0-12.0	17.0-19.0	...	...	M	...
F 347	S34700	18 Cr, 8 Ni modified with Cb 347[6]	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	...	N	...	...
F 347H	S34709	18 Cr, 8 Ni modified with Cb 347H[6]	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	...	O	....	...
F 348	S34800	18 Cr, 8 Ni modified with Cb 348[6]	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	...	N	...	Co 0.20 Ta 0.10
F 348H	S34809	18 Cr, 8 Ni modified	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	...	O	...	Co 0.20 Ta

		with Cb 348H[6]											0.10
F XM-11	S21904	20 Cr, 6 Ni, 9 Mn XM-11[6]	0.040	8.0-10.0	0.060	0.030	1.00	5.5-7.5	19.0-21.5	...	...	...	N 0.15-0.40
F XM-19	S20910	22 Cr, 13 Ni, 5 Mn XM-19[6]	0.06	4.0-6.0	0.040	0.030	1.00	11.5-13.5	20.5-23.5	*1.50-3.00*	0.10-0.30	...	N 0.20-0.40 V 0.10-0.30
F 20	N08020	35 Ni, 20 Cr, 3.5 Cu, 2.5 Mo	0.07	2.00	0.045	0.035	1.00	32.0-38.0	19.0-21.0	*2.00-3.00*	8x Cmin-1.00	...	Cu 3.0-4.0
F 44	S31254	20 Cr, 18 Ni, 6 Mo, Low C	0.020	1.00	0.030	0.010	0.80	17.5-18.5	19.5-20.5	*6.0-6.5*	...	...	Cu 0.50-1.00 N 0.18-0.22
F 45	S30815	21 Cr, 11 Ni modified with N and Ce	0.05-0.10	0.80	0.040	0.030	1.40-2.00	10.0-12.0	20.0-22.0	...	...	....	N 0.14-0.20 Ce 0.03-0.08
F 46	S30600	18 Cr, 15 Ni, 4 Si	0.018	2.00	0.020	0.020	3.7-47.3	14.0-15.5	17.0-18.5	*0.20*	...	...	Cu 0.50
F 47	S31725	19 Cr, 15 Ni, 4 Mo 317LM[6]	0.030	2.00	0.045	0.030	0.75	13.0-17.5	18.0-20.0	*4.0-5.0*	...	...	N 0.10
F 48	S31726	19 Cr, 15 Ni, 4 Mo 317LMN[6]	0.030	2.00	0.045	0.030	0.75	13.5-17.5	17.0-20.0	*4.0-5.0*	...	...	N 0.10-0.20
F 49	S34565	24 Cr, 17 Ni, 6 Mn, 5 Mo	0.030	5.0-7.0	0.030	0.010	1.00	16.0-18.0	23.0-25.0	*4.0-5.0*	0.10	...	N 0.40-0.60
F 56	S33228	32 Ni, 27 Cr, With Cb	0.04-0.08	1.00	0.020	0.015	0.30	31.0-33.0	26.0-28.0	...	0.6-1.0	...	Ce 0.05-0.10 Al 0.025
F 58	S31266	24 Cr, 20 Ni, 6 Mo, 2 W with N	0.030	2.0-4.0	0.035	0.020	1.00	21.0-24.0	23.0-25.0	*5.2-6.2*	...	...	N 0.35-0.60 Cu 1.00-2.50 W 1.50-2.50
F 62	N08367	21 Cr, 25 Ni, 6.5 Mo	0.030	2.00	0.040	0.030	1.00	23.5-25.5	20.0-22.0	*6.0-7.0*	...	...	N 0.18-0.25 Cu 0.75
F 63	S32615	18 Cr, 20 Ni, 5.5 Si	0.07	2.00	0.045	0.030	4.8-6.0	19.0-22.0	16.5-19.5	*0.30-1.50*	...	...	Cu 1.50-2.50

F 64	S30601	17.5 Cr, 17.5 Ni, 5.3 Si	0.015	0.50-0.80	0.030	0.013	5.0-5.6	17.0-18.0	17.0-18.0	*0.20*	...	...	Cu 0.35 N 0.05
F 904L	N08904	21 Cr, 26 Ni, 4.5 Mo 904L[6]	0.020	2.0	0.040	0.030	1.00	23.0-28.0	19.0-23.0	*4.0-5.0*	...	...	Cu 1.00-2.00 N 0.10
Ferritic Austenitic Stainless Steel													
F 50	S31200	25 Cr, 6 Ni, Modified with N	0.030	2.00	0.045	0.030	1.00	5.5-6.5	24.0-26.0	*1.20-2.00*	...	...	N 0.14-0.20
F 51	S31803	22 Cr, 5.5 Ni, Modified with N	0.030	2.00	0.030	0.020	1.00	4.5-6.5	21.0-23.0	*2.5-3.5*	...	...	N 0.08-0.20
F 52	S32950	26 Cr, 3.5 Ni, 1.0 Mo	0.030	2.00	0.035	0.010	0.60	3.5-5.2	26.0-29.0	*1.00-2.50*	...	...	N 0.15-0.35
F 53	S32750	25 Cr, 7 Ni, 4 Mo modified with N 2507[6]	0.030	1.20	0.035	0.020	0.80	6.0-8.0	24.0-26.0	*3.0-5.0*	...	...	N 0.24-0.32 Cu 0.50
F 54	S39274	25 Cr, 7 Ni, Modified with N and W	0.030	1.00	0.030	0.020	0.80	6.0-8.0	24.0-26.0	*2.5-3.5*	...	...	N 0.24-0.32 Cu 0.20-0.80 W 1.50-2.50
F 55	S32760	25 Cr, 7 Ni, 3.5 Mo, Modified with N and W	0.030	1.00	0.030	0.010	1.00	6.0-8.0	24.0-26.0	*3.0-4.0*	....	...	N 0.20-0.30 Cu 0.50-1.00 W 0.50-1.00[P]
F 57	S39277	26 Cr, 7 Ni, 3.7 Mo	0.025	0.80	0.025	0.002	0.80	6.5-8.0	24.0-26.0	*3.0-4.0*	...	...	Cu 1.20-2.00 W 0.80-1.20 N 0.23-0.33
F 59	S32520	25 Cr, 6.5 Ni, 4 Mo with N	0.030	1.50	0.035	0.020	0.80	5.5-8.0	24.0-26.0	*3.0-5.0*	...	...	N 0.20-0.35 Cu 0.50-3.00
F 60	S32205	22 Cr, 5.5 Ni, 3 Mo, Modified with N 2205[6]	0.030	2.00	0.030	0.020	1.00	4.5-6.5	22.0-23.0	*3.0-3.5*	...	...	N 0.14-0.20
F 61	S32550	26 Cr,	0.040	1.50	0.040	0.030	1.00	4.5-	24.0-	*2.9-*	...	..	Cu

		6 Ni, 3.5 Mo with N and C 255[6]						6.5	27.0	*3.9*			1.50-2.50 N 0.10-0.25
F 65	S32906	29 Cr, 6.5 Ni, 2 Mo Modified with N and W	0.030	0.80-1.50	0.030	0.030	0.80	5.8-7.5	28.0-30.0	*1.5-2.6*	...	...	Cu 0.80 N 0.30-0.40
F 66	S32202	25 Cr, 7 Ni, N	0.030	2.00	0.040	0.010	1.00	1.00-2.80	21.5-24.0	*0.45*	...	...	N 0.18-0.20
F 67	S32506S	25 Cr, 6 Ni, 3 Mo, with N and W	0.030	1.00	0.040	0.015	0.90	5.5-7.2	24.0-26.0	*3.0-3.5*	...	...	N 0.08-0.20 W 0.05-0.30

TABLE 3. Tensile and Hardness Requirements[A]

Grade Symbol	Tensile Strength, min, ksi[MPa]	Yield Strength, min, ksi[MPa]	Elongation in 2 in. [50mm] or 4D, min, %	Reduction of Area, min, %	Brinell Hardness Number
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	85[585]	60 [415]	20	40	248 max
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 Class1	60[415]	30[205]	20	45	121-174
F 11 Class2	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, and 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 2	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 Steel					
F XM-27Cb	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[3]	...
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 310 MoLN	78[540]	37[255]	25	40	...
F 310H	75[515][c]	30[205]	30	50	...
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[3]	...
F 316LN	75[515][c]	30[205]	30	50	...
F 316Ti	75[515][c]	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 321	75[515][c]	30[205]	30	50	...
F 321H	75[515][c]	30[205]	30	50	...
F 347	75[515][c]	30[205]	30	50	...
F 347H	75[515][c]	30[205]	30	50	...
F 348	75[515][c]	30[205]	30	50	...
F 348H	75[515][c]	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 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][6]	80[550][6]	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	...	390 max
F 67	90[620]	65[450]s	18	...	302

10. Grain Size for Austenitic Grades
11. Corrosion Testing for Austenitic Grades
12. Retreatment
13. Workmanship, Finish, and Appearance
14. Repair by Welding

TABLE 4 Repair Welding requirements

Grade Symbol	Electrodes[A]	Recommended Preheat and Interpass Temperature Range, °F[°C]	Post Weld Heat-Trearment Temperature, Minimum or Range, °F[°C]
Low Alloy Steels			
F 1	E 7018-A 1	200-400 [95-205]	1150 [620]
F 2	E 8018-B 1	300-600 [150-315]	1150 [620]
F 5	E80XX-B6,Where XX can be 15, 16, or 18	400-700 [205-370]	1250 [675]
F 5a	E80XX-B6,Where XX can be 15, 16, or 18	400-700 [205-370]	1250 [675]
F 9	E80XX-B8,Where XX can be 15, 16, or 18	400-700 [205-370]	1250 [675]

F 10[B]	...	400-700 [205-370]	...
F 91	...C	400-700 [205-370]	1350-1470 [730-800]
F 92	....D	400-700 [205-370]	1350-1470 [730-800]
F 122	....D	400-700 [205-370]	1350-1470 [730-800]
F 911	...D	400-700 [205-370]	1365-1435 [740-780]
F 11 Class 1, 2, and 3	E 8018-B 2	300-600 [150-315]	1150 [620]
F 12 Class 1 and 2	E 8018-B 2	300-600 [150-315]	1150 [620]
F 21	E 9018-B 3	300-600 [150-315]	1250 [675]
F 3V, and F 3VCb	3% Cr, 1% Mo, ¼ % V-Ti	300-600 [150-315]	1250 [675]
F 22 Class 1	E 9018-B 3	300-600 [150-315]	1250 [675]
F 22 Class 2	E 9018-B 3	300-600 [150-315]	1250 [675]
F 22V	2.25% Cr, 1% Mo, 0.25% V-Cb	300-600 [150-315]	1250 [675]
F 23	2.25% Cr, 1.6% W, 0.25% V-Mo-Cb-B	300-600 [150-315]	1350-1470 [730-800]
F 24	2.25% Cr, 1% Mo, 0.25% V	200-400 [95-205][E]	1350-1470 [730-800][E]
F 36 Class 1	1.15 Ni, 0.65 Cu, Mo, Cb	400-700 [205-370]	1100-1200 [595-650]
F 36 Class 2	1.15 Ni, 0.65 Cu, Mo, Cb SSSSSS	400-700 [205-370]	1000-1150 [540-620]
Martensitic Stainless Steels			
F 6a Class 1	E 410-15 or 16	400-700 [205-370]	1250 [675]
F 6a Class 2	E 410-15 or 16	400-700 [205-370]	1250 [675]
F 6b	13% Cr, 11/2 % Ni, ½ % Mo	400-700 [205-370]	1150 [620]
F 6NM	13% Cr, 4% Ni	300-700 [150-370]	1050 [565]
Ferritic Stainless Steels			
F XM-27Cb	26% Cr, 1% Mo	NR[3]	NR
F 429	E 430-16	400-700 [205-370]	1400 [760]
F 430	E 430-16	NRS	1400 [760]
FR	E 8018-C2	NR	NR
Austenitic Stainless Steels			
F 304	E 308-15 or 16	NR	1900[1040]+WQ[6]
F 304L	E 308L-15 or 16	NR	1900[1040]+WQ
F 304H	E 308-15 or 16[H] or E308H-XX	NR	1900[1040]+WQ
F 304N	E 308-15 or 16	NR	1900[1040]+WQ
F 304LN	E 308L-15 or 16	NR	1900[1040]+WQ
F 309H	E 309-15 or 16[H] or E309H-XX	NR	1900[1040]+WQ

F 310	E 310-15 or 16	NR	1900[1040]+WQ
F 310 MoLN	E 310Mo-15 or 16	NR	1920-2010 [1050-1100]+WQ
F 310H	E 308-15 or 16[H]	NR	1900[1040]+WQ
F 316	E 316-15 or 16	NR	1900[1040]+WQ
F 316L	E 316L-15 or 16	NR	1900[1040]+WQ
F 316H	E 316-15 or 16[H] or E316H-XX	NR	1900[1040]+WQ
F 316N	E 316-15 or 16	NR	1900[1040]+WQ
F 316LN	E 316L-15 or 16	NR	1900[1040]+WQ
F 316Ti	E 316-15 or 16	NR	1900[1040]+WQ
F 317	E 317-15 or 16	NR	1900[1040]+WQ
F 317L	E 317L-15 or 16	NR	1900[1040]+WQ
S31727	...	NR	1900[1040]+WQ
S32053	...	NR	1900[1040]+WQ
F 321[B]	E 347-15 or 16	NR	1900[1040]+WQ
F 321H[B]	E 347-15 or 16[H]	NR	1925[1050]+WQ
F 347	E 347-15 or 16	NR	1900[1040]+WQ
F 347H	E 347-15 or 16[H]	NR	1925[1050]+WQ
F 348	E 347-15 or 16	NR	1900[1040]+WQ
F 348H	E 347-15 or 16[H]	NR	1925[1050]+WQ
F XM-11	XM-10W	NR	NR
F XM-19	XM-19W	NR	NR
F 20	E/ER-320, 320LR	NR	1700-1850 [925-1010]+ WQ
F 44	E NiCrMo-3	NR	2100 [1150]+WQ
F 45[B]	...	...	...
F 46	...I	...	...
F 47	...I	...	2100 [1150]+WQ
F 48	...I	...	2100 [1150]+WQ
F 49	...	...	2100 [1150]+WQ
F 58	E NiCrMo-10	...	2100 [1150]+WQ
F 62	E NiMo-3	NR	2100 [1150]+WQ
F 904L	E NiMo-3SS	NR	1920-2100 [1050-1150]+WQ
Ferritic- Austenitic Stainless Steels			
F 50	25% Cr, 6% Ni, 1.7% Mo	NR	NR
F 51	22% Cr, 5.5% Ni, 3% Mo	NR	NR
F 52	26% Cr, 8% Ni, 2% Mo	NR	NR
F 53	25% Cr, 7% Ni, 4% Mo	NR	NR
F 54	25% Cr, 7% Ni, 3% Mo, W	NR	NR
F 55	25% Cr, 7% Ni, 3.5% Mo	NR	NR
F 57	25% Cr, 7% Ni, 3%	NR	NR

	Mo, 1.5% Cu, 1% W		
F 59	E Ni CrMo-10	NR	NR
F 60	22% Cr, 5.5% Ni, 3% Mo	NR	NR
F 61	26% Cr, 9% Ni, 3.5% Mo	NR	NR
F 65	29% Cr, 6.5% Ni, 2% Mo	NR	NR
F 66	22% Cr, 2% Ni, 0.25% Mo	NR	NR
F 67	...	NR	NR

15. Inspection

16. Rejection and Rehearing

17. Certification :-

17.1 In addition to the certification requirements of specification A961/A961M, test reports shall be furnished to the purchaser or his representative.

17.2 Test reports, when required, shall include certification that all requirements of this specification have been met. The specification designation included on test reports shall include year of issue and revision letter, if any. The manufacturer shall provide the following where applicable:

17.2.1 1 Type heat treatment, Section 7,

17.2.2 Product analysis results, Section 8 of specification A961/A961M,

17.2.3 Tensile property results, Section 9 (Table 3), report the yield strength and ultimate strength, in ksi [MPa], elongation and reduction in area, in percent,

17.2.4 Chemical analysis results, Section 8 (Table 2),

17.2.5 Hardness results, Section 9 (Table 3 and for F23, Tables 2 and 3),

17.2.6 Grain size results, Section 10, and

17.2.7 Any supplementary testing required by the purchase order.

18. Product Marking

19. Keyword :-

19.1 austenitic stainless steel; chromium alloy steel; chromium-molybdenum steel; ferritic/austenitic stainless steel; ferritic stainless steel; martensitic stainless steel; nickel alloy steel; notch toughness requirements; pipe fittings; steel; piping applications; pressure containing parts; stainless steel fittings; stainless steel forgings; steel flanges; steel forgings, alloy; steel valves; temperature service applications, elevated; temperature service applications, high; wrought material

SUPPLEMENTARY REQUIREMENTS :-

S1. Macroetch Test

S2.Heat treatment Details

S3. Material for Optimum Resistance to Stress-Corrosion Cracking

S4. Corrosion Tests

S5. Special Filler Metal
S6. Hardness Test
S7. Alternate Heat Treatment (Grade F 91 and F 92)
S8. Heat Treatment of Austenitic Forgings
S9. Grain Size for Austenitic Grades
S10. Stabilization Treatment
S11.Grain Size Requirements for Non-H-Grade Austenitic Steels Used Above 1000 °F [540 °C]