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Used in USDOE-NE Standards

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

This standard is issued under the fixed designation A 182/A 182M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification[2] 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.

1.2 For bars and products machined directly from bar, refer to Specifications A 479/A 479MA 479/A 479M and A 739A 739 for the similar grades available in those specifications. Products made to this specification are limited to a maximum weight of 10 000 lb [4540 kg]. For larger products and products for other applications, refer to Specification A 336/A 336MA 336/A 336M for the similar grades available in that specification.

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.

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 inch-pound units or SI 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 are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 In addition to the referenced documents listed in Specification A 961A 961, the following list of standards apply to this specification.

2.2 *ASTM Standards:*[3]

A 234/A 234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings

A 336/A 336M Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 403/A 403M Specification for Wrought Austenitic Stainless Steel Piping Fittings

A 479/A 479M Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A 739 Specification for Steel Bars, Alloy, Hot-Wrought, for Elevated Temperature or Pressure-Containing Parts, or Both

A 763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels

A 788 Specification for Steel Forgings, General Requirements

A 961 Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications

E 112 Test Methods for Determining Average Grain Size

E 165 Test Method for Liquid Penetrant Examination

E 340 Test Method for Macroetching Metals and Alloys

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Steel Forgings and Wrought Fittings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-182 in Section II of that Code.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

2.3 *ASME Boiler and Pressure Vessel Codes:*[4]
Section IX Welding Qualifications
SFA-5.4 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes
SFA-5.5 Specification for Low-Alloy Steel Covered Arc-Welding Electrodes
SFA-5.9 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes
SFA-5.11 Specification for Nickel and Nickel-Alloy Covered Welding Electrodes

3. Ordering Information

3.1 It is the purchaser's responsibility to specify in the purchase order information necessary to purchase the needed material. In addition to the ordering information guidelines in Specification A 961A 961, orders should include the following information:

3.1.1 Additional requirements (see 6.2.2, Table 2 footnotes, 8.3, and 17.2), and

3.1.2 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 (see 8.3.1).

4. General Requirements

4.1 Product furnished to this specification shall conform to the requirements of Specification A 961A 961, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A 961A 961 constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 961A 961, this specification shall prevail.

5. Manufacture

5.1 The low-alloy ferritic steels may be made by the open-hearth, electric-furnace, or basic-oxygen process with separate degassing and refining optional. Unless followed by separate refining, the basic oxygen process shall be limited to steels containing not over 6 % chromium.

5.2 The stainless steels shall be melted by one of the following processes: (*1*) electric-furnace (with separate degassing and refining optional); (*2*) vacuum-furnace; or (*3*) one of the former followed by vacuum or electroslag-consumable remelting. Grade F XM-27Cb may be produced by electron-beam melting. Because of difficulties that may be met in retaining nitrogen, vacuum melting or remelting processes should not be specified for Grades F XM-11, F 304LN, F 316LN, F 304N, F 316N, F XM-19, F 44, F 45, F 48, F 49, F 50, F 51, F 52, F 53, F 54, F 55, F 58, F 59, F 60, F 62, or F 904L.

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

5.4 The material shall be forged as close as practicable to the specified shape and size. Except for flanges of any type, forged or rolled bar may be used without additional hot working for small cylindrically shaped parts within the limits defined by Specification A 234/A 234MA 234/A 234M for low alloy steels and martensitic stainless steels and Specification A 403/A 403MA 403/A 403M for austenitic and ferritic-austenitic stainless steels. Elbows, return bends, tees, and header tees shall not be machined directly from bar stock.

5.5 Except as provided for in 5.4, the finished product shall be a forging as defined in the Terminology section of Specification A 788A 788.

6. Heat Treatment[5]

6.1 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.

6.2 *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 6.1 and Table 1.

6.2.1 Grade F 22V shall be furnished in the normalized and tempered, or liquid quenched and tempered condition. The minimum austenitizing temperature shall be 1650 °F [900 °C], and the minimum tempering temperature shall be 1250 °F [677 °C].

6.2.2 *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.

6.2.2.1 *Marking*—Parts that are liquid quenched and tempered shall be marked "QT."

6.2.3 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.

6.3 *Austenitic and Ferritic-Austenitic Stainless Steels*—The austenitic and ferritic-austenitic stainless steels shall be heat treated in accordance with the requirements of 6.1 and Table 1.

6.3.1 Alternatively, immediately following hot working, while the temperature of the forging is not less than the minimum solutioning temperature specified in Table 1, forgings made from austenitic grades (except grades F 304H, F 316H, F 321, F 321H, F 347, F 347H, F 348, and F 348H) may be individually rapidly quenched in accordance with the requirements of Table 1.

6.3.2 See Supplementary Requirement S8 if a particular heat treatment method is to be employed.

6.4 *Time of Heat Treatment*—Heat treatment of forgings may be performed before machining.

6.5 *Forged or Rolled Bar*—Forged or rolled austenitic stainless bar from which small cylindrically shaped parts are to be machined, as permitted by 5.4, and the parts machined from

[4] Available from American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.

[5] A solution annealing temperature above 1950 °F [1065 °C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in F 321, F 321H, F 347, F 347H, F 348, and F 348H. When specified by the purchaser, a lower temperature stabilization or resolution annealing shall be used subsequent to the initial high temperature solution anneal (see Supplementary Requirement S10).

such bar, without heat treatment after machining, shall be furnished to the annealing requirements of Specification A 479/A 479MA 479/A 479M or this specification, with subsequent light cold drawing and straightening permitted (see Supplementary Requirement S3 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 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]
F5, 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 91	normalize and temper	1900-2000 [1040-1095]	air cool	[B]	1350 [730]
F 92	normalize and temper	1900 [1040]	air cool	[B]	1350 [730]
F911	normalize and temper	1900-2000 [1040-1095]	air cool or liquid	[B]	1350 [730]
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 F 3VCb	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 23	normalize and temper	1900 [1040]	air cool	[B]	1350 [730]
F 24	normalize and temper	1800 [980]	accelerated cool air cool or liquid	[B]	1350 [730]
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]
		Martensitic Stainless Steels			
F 122	normalize and temper	1900 [1040]	air cool	[B]	1350 [730]
F 6a Class 1	anneal	not specified	furnace cool	[B]	[B]
	normalize and temper	not specified	air cool	400 [205]	1325 [725]
	temper	not required	[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 required	[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]

TABLE 1 *Continued*

Grade	Heat Treat Type	Austenitizing/Solutioning Temperature, min, °F (°C)[A]	Cooling Media	Quenching Cool Below °F (°C)	Tempering Temperature, min, °F (°C)
		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 317	solution treat and quench	1900 [1040]	liquid	500 [260]	[B]
F 317L	solution treat and quench	1900 [1040]	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 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 10	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]
		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 904L	solution treat and quench	1920-2100 [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.

7. Chemical Composition

7.1 A chemical heat analysis in accordance with Specification A 961A 961 shall be made and conform to the chemical composition prescribed in Table 2.

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

7.3 Starting material produced 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.

7.4 Stainless steel grades covered in this specification shall not contain an unspecified element, other than nitrogen, for the ordered grade to the extent that the steel conforms to the requirements of another grade for which that element is a specified element having a required minimum content. For this requirement, a grade is defined as an alloy described individually and identified by its own UNS designation in Table 2 of Chemical Requirements with being covered by this specification.

7.5 *Product Analysis*—The purchaser may make a product analysis on products supplied to this specification in accordance with Specification A 961A 961.

8. Mechanical Properties

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

8.2 Mechanical test specimens shall be obtained from production forgings, or from separately forged test blanks prepared 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.

8.3 For normalized and tempered, or quenched and tempered forgings, the central axis of the test specimen shall correspond to the ¼ *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.

8.3.1 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 ¾ in. [19 mm] and to the second treated surface than 1½ in. [38 mm]. This method of test specimen location would normally apply to contour-forged parts, or parts with thick cross-sectional areas where ¼ *T* × *T* testing (see 8.3) is not practical. Sketches showing the exact test locations shall be approved by the purchaser when this method is used.

8.3.2 *Metal Buffers*—The required distances from heat-treated surfaces may be obtained with metal buffers instead of integral extensions. Buffer material may be carbon or low-alloy steel, and shall be joined to the forging with a partial penetration weld that seals the buffered surface. Specimens shall be located at ½-in. [13-mm] minimum from the buffered surface of the forging. Buffers shall be removed and the welded areas subjected to magnetic particle test to ensure freedom from cracks unless the welded areas are completely removed by subsequent machining.

8.4 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.

8.5 *Tension Tests*:

8.5.1 *Low Alloy Steels and Ferritic and Martensitic Stainless Steels*—One tension test shall be made for each heat in each heat treatment charge.

8.5.1.1 When the heat-treating cycles are the same and the furnaces (either batch or continuous type) are controlled within ±25 °F [±14 °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 (see Note 1) and section size is required, instead of one test from each heat in each heat-treatment charge.

NOTE 1—"Type" in this case is used to describe the forging shape such as a flange, ell, tee, and the like.

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

8.5.2.1 When heat treated in accordance with 6.1, the test blank or forging used to provide the test specimen shall be heat treated with a finished forged product.

8.5.2.2 When the alternative method in 6.3.1 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.

8.5.3 Testing shall be performed in accordance with Test Methods and Definitions A 370A 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.

TABLE 2 Chemical Requirements[A]

Identification Symbol	UNS Designation	Grade	Composition, %										
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Columbium	Titanium	Other Elements
			Low Alloy Steels										
F 1	K12822	carbon-molybdenum	0.28	0.60–0.90	0.045	0.045	0.15–0.35			0.44–0.65			
F 2[B]	K12122	0.5 % chromium, 0.5 % molybdenum	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 % chromium	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 % chromium	0.25	0.60	0.040	0.030	0.50	0.50	4.0–6.0	0.44–0.65			
F 9	K90941	9 % chromium	0.15	0.30–0.60	0.030	0.030	0.50–1.00		8.0–10.0	0.90–1.10			
F 91	K90901	9 % chromium, 1 % molybdenum, 0.2 % vanadium plus columbium and nitrogen	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 0.04 V 0.18–0.25
F 92		9 % chromium, 1.8 % tungsten, 0.2 % vanadium plus columbium	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 0.04 W 1.50–2.00 B 0.001–0.006
F 911		9 % chromium, 1 % molybdenum, 0.2 % vanadium plus columbium and nitrogen	0.09–0.13	0.30–0.60	0.020	0.010	0.10–0.50	0.40	8.5–10.5	0.90–1.10	0.060–0.10		W 0.90–1.10 Al 0.04 N 0.04–0.09 V 0.18–0.25 B 0.0003–0.006
F 11 Class 1	K11597	1.25 % chromium, 0.5 % molybdenum	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 Class 2	K11572	1.25 % chromium, 0.5 % molybdenum	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 % chromium, 0.5 % molybdenum	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 % chromium, 0.5 % molybdenum	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 % chromium, 0.5 % molybdenum	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	chromium-molybdenum	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 % chromium, 1 % molybdenum, 0.25 % vanadium plus boron and titanium	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	...	...	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 0.0005–0.0150
F 22 Class 1	K21590	chromium-molybdenum	0.05–0.15	0.30–0.60	0.040	0.040	0.50		2.00–2.50	0.87–1.13			
F 22 Class 3	K21590	chromium-molybdenum	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 % chromium, 1 % molybdenum, 0.25 % vanadium	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 [D]