



Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service¹

This standard is issued under the fixed designation A182/A182M; 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 specification² 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 (other than those directly addressed by this specification; see 6.4), refer to Specifications [A479/A479M](#) and [A739](#) 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 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 systems 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:³

- [A262](#) Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- [A275/A275M](#) Practice for Magnetic Particle 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
- [A388/A388M](#) Practice for Ultrasonic Examination of Steel Forgings
- [A479/A479M](#) Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
- [A484/A484M](#) Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
- [A739](#) Specification for Steel Bars, Alloy, Hot-Wrought, for Elevated Temperature or Pressure-Containing Parts, or Both
- [A763](#) Practices for Detecting Susceptibility to Intergranular 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 Applications
- [A965/A965M](#) Specification for Steel Forgings, Austenitic, for Pressure and High Temperature Parts

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.



A1049/A1049M Specification for Stainless Steel Forgings, Ferritic/Austenitic (Duplex), for Pressure Vessels and Related Components

E92 Test Method for Vickers Hardness of Metallic Materials⁴

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*:⁵

Section IX Welding and Brazing Qualifications

2.4 *AWS Specifications*⁶

A5.4/A5.4M Specification for Stainless Steel Electrodes for Shielded Metal 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

A5.28/A5.28M Specification for Low-Alloy Steel Electrodes for Gas Shielded Arc Welding

A5.29/A5.29M Low-Alloy Steel Electrodes for Flux Cored Arc Welding

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Specification **A961/A961M**.

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 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 **19.2**), 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 (see **9.3.1**).

⁴ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁶ Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.

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 nonconformance with this specification. In case of conflict between the requirements of this specification and Specification **A961/A961M**, this specification shall prevail.

6. Manufacture

6.1 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.

6.2 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.

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 Flanges of any type, elbows, 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 **6.4**, the finished product shall be a forging as defined in the Terminology section of Specification **A788/A788M**.

7. Heat Treatment⁷

7.1 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**.

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 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.

7.2.1 *Liquid Quenching*—Except as permitted in **7.2.2**, for F 1, F 2, and F 3, and in **7.2.3**, for F 91, and when agreed to by

⁷ 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).



the purchaser, liquid quenching followed by tempering shall be permitted provided the temperatures in **Table 1** for each grade are used.

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 1 and 2 may be given a heat treatment of 1200 °F [650 °C] minimum after final hot or cold forming.

7.2.3 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.

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, forgings made from austenitic grades (except grades F 304H, F 309H, F 310, F 310H, F 316H, 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**.

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

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

7.5 *Forged or Rolled Bar*—Forged or rolled austenitic stainless bar from which 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 **A479/A479M** 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, 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	<i>B</i>	<i>B</i>
	normalize and temper	1650 [900]	air cool	<i>B</i>	1150 [620]
F 2	anneal	1650 [900]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1650 [900]	air cool	<i>B</i>	1150 [620]
F 5, F 5a	anneal	1750 [955]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1750 [955]	air cool	<i>B</i>	1250 [675]
F 9	anneal	1750 [955]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1750 [955]	air cool	<i>B</i>	1250 [675]
F 10	solution treat and quench	1900 [1040]	liquid	500 [260]	<i>B</i>
F 91	normalize and temper	1900-1975 [1040-1080]	air cool	<i>B</i>	1350-1470 [730-800]
F 92	normalize and temper	1900-1975 [1040-1080]	air cool	<i>B</i>	1350-1470 [730-800]
F 122	normalize and temper	1900-1975 [1040-1080]	air cool	<i>B</i>	1350-1470 [730-800]
F 911	normalize and temper	1900-1975 [1040-1080]	air cool or liquid	<i>B</i>	1365-1435 [740-780]
F 11, Class 1, 2, 3	anneal	1650 [900]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1650 [900]	air cool	<i>B</i>	1150 [620]
F 12, Class 1, 2	anneal	1650 [900]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1650 [900]	air cool	<i>B</i>	1150 [620]
F 21, F 3V, and F 3VCb	anneal	1750 [955]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1750 [955]	air cool	<i>B</i>	1250 [675]
F 22, Class 1, 3	anneal	1650 [900]	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	1650 [900]	air cool	<i>B</i>	1250 [675]
F 22V	normalize and temper or quench and temper	1650 [900]	air cool or liquid	<i>B</i>	1250 [675]
F 23	normalize and temper	1900-1975 [1040-1080]	air cool	<i>B</i>	1350-1470 [730-800]
			accelerated cool	<i>B</i>	
F 24	normalize and temper	1800-1975 [980-1080]	air cool or liquid	<i>B</i>	1350-1470 [730-800]
FR	anneal	1750 [955]	furnace cool	<i>B</i>	<i>B</i>
	normalize	1750 [955]	air cool	<i>B</i>	<i>B</i>
	normalize and temper	1750 [955]	air cool	<i>B</i>	1250 [675]
F 36, Class 1	normalize and temper	1650 [900]	air cool	<i>B</i>	1100 [595]
F 36, Class 2	normalize and temper	1650 [900]	air cool	<i>B</i>	1100 [595]
	quench and temper	1650 [900]	accelerated air cool or liquid		1100 [595]
Martensitic Stainless Steels					
F 6a Class 1	anneal	not specified	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	not specified	air cool	400 [205]	1325 [725]
	temper	not required		<i>B</i>	1325 [725]
F 6a Class 2	anneal	not specified	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	not specified	air cool	400 [205]	1250 [675]
	temper	not required		<i>B</i>	1250 [675]
F 6a Class 3	anneal	not specified	furnace cool	<i>B</i>	<i>B</i>
	normalize and temper	not specified	air cool	400 [205]	1100 [595]