



Designation: A522/A522M – 11

Standard Specification for Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service¹

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1. Scope*

1.1 This specification² covers 8 and 9 % nickel-alloy steel forged or rolled flanges, fittings, valves, and parts intended for use in welded pressure vessels for low-temperature service. The specification is applicable to forgings with maximum section thickness of 3 in. [75 mm] in the double normalized and tempered condition and 5 in. [125 mm] in the quenched and tempered condition. Forgings under this specification are intended for service at operating temperatures not lower than $-320\text{ }^{\circ}\text{F}$ [$-196\text{ }^{\circ}\text{C}$] for Type I or $-275\text{ }^{\circ}\text{F}$ [$-170\text{ }^{\circ}\text{C}$] for Type II or higher than $250\text{ }^{\circ}\text{F}$ [$121\text{ }^{\circ}\text{C}$].

1.2 Material under this specification is available in two types having different chemical compositions as follows:

Type	Nominal Nickel Content, %
I	9
II	8

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

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as 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 *ASTM Standards*:³

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-522 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.

[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](#)

3. General Requirements and Ordering Information

3.1 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 requirements of Specification [A961/A961M](#) constitutes nonconformance with this specification.

3.2 It is the purchaser’s responsibility to specify in the purchase order all ordering information necessary to furnish the needed material. Examples of such information include but are not limited to the ordering information in Specification [A961/A961M](#) and following:

3.2.1 Any supplementary requirements, and

3.2.2 Additional requirements, (See [4.5](#), [5.2](#), [6.1](#), [7.2](#), and [10.3](#)).

4. Materials and Manufacture

4.1 The steel shall be produced in accordance with the melting process section of Specification [A788/A788M](#).

4.2 Material for forgings shall consist of ingots, or either forged or rolled blooms, billets, or bars.

4.3 The finished product shall be a forging as defined in the Terminology Section of Specification [A788/A788M](#).

4.4 Except for flanges of all types, hollow cylindrically shaped parts may be made from hot-rolled or forged bar, provided that the axial length of the part is approximately parallel to the metal flow lines of the stock. Except for all types of flanges, elbows, return bends, tees, and header tees, other parts up to and including NPS 4 may be machined from hot-rolled or forged bar.

4.5 When specified in the order, the manufacturer shall submit for purchaser’s approval a sketch showing the shape of the rough forging before machining.

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

5. Chemical Composition

5.1 The steel shall conform to the requirements of **Table 1**.

5.2 If required by the purchaser, product analysis may be performed in accordance with the requirements of **A961/A961M**.

6. Heat Treatment

6.1 The forgings shall be heat treated by the manufacturer by either of the following methods as mutually agreed upon between the purchaser and the manufacturer.

6.1.1 *Quenched and Tempered*—Heat to a uniform temperature of 1475 ± 25 °F [800 ± 15 °C]; hold at this temperature for a minimum time of 1 h/in. [2.5 min/mm] of thickness but in no case less than 30 min; quench by immersion in circulating water. Reheat until the forging attains a uniform temperature within the range from 1050 to 1125 °F [565 to 605 °C]; hold at this temperature for a minimum time of 1 h/in. [2.5 min/mm] of thickness but in no case less than 30 min; cool in air or water quench, at a rate not less than 300 °F [165 °C]/h.

6.1.2 *Double Normalized and Tempered*—Heat to a uniform temperature of 1650 °F [900 °C]; hold at this temperature for a minimum time of 1 h/in. [2.5 min/mm] of thickness but in no case less than 30 min; cool in air. Reheat until the forging attains a uniform temperature of 1450 °F [790 °C]; hold at this temperature for a minimum time of 1 h/in. [2.5 min/mm] of thickness but in no case less than 30 min; cool in air. Reheat to a uniform temperature within the range from 1050 to 1125 °F [565 to 605 °C]; hold at this temperature for a minimum time of 1 h/in. [2.5 min/mm] of thickness but in no case less than 30 min; cool in air or water quench, at a rate not less than 300 °F [165 °C]/h.

6.2 When stress relieving is to be performed after fabrication, the recommended stress-relieving treatment is as follows: gradually and uniformly heat the steel to a temperature between 1025 and 1085 °F [550 and 585 °C]; hold for a minimum of 2 h for thicknesses up to 1 in. [25 mm]. For thicknesses over 1 in. [25 mm], a minimum additional holding time in the ratio of 1 h/in. [2.5 min/mm] of thickness in excess of 1 in. [25 mm] shall be added. Cool at a minimum rate of 300 °F [165 °C]/h to a temperature not exceeding 600 °F [315 °C].

7. Mechanical Properties

7.1 *Tension Test*—Forgings to Types 1 and 2 shall conform to the tensile requirements of **Table 2**.

TABLE 2 Tensile Requirements at Room Temperature

Tensile strength, min, ksi [MPa]	100 [690]
Yield strength, min, (0.2 % off-set), ksi [MPa]	75 [515]
Elongation in 2 in. [50mm], min, %	22
Reduction of area, min, %	45

7.2 *Impact Test*—The Charpy impact test requirements in **Table 3** shall be met unless Supplementary Requirement S2 of this specification has been specified.

7.2.1 The values for energy absorption and the fracture appearance in percentage of shear fracture for each specimen shall be recorded and reported for information.

8. Workmanship, Finish, and Appearance

8.1 The forgings shall have a workman-like finish and shall be free of injurious defects.

9. Number of Tests and Retests

9.1 At least one tension test and one set of Charpy V-notch impact tests shall be made from each heat in each heat-treatment charge.

9.2 If the results of the mechanical tests do not conform to the specified requirements, the manufacturer may retreat the forgings, but not more than three additional times. Retreatment involves re-austenitizing the forgings. Retests shall be made in accordance with this section.

9.3 If the lateral expansion result from one Charpy impact specimen falls below 0.015in. [0.38mm], but not less than 0.010in. [0.25mm], and the average test result equals or exceeds 0.015mm [0.38mm], then one retest of three additional specimens may be made. The lateral expansion obtained from each of the three retest specimens shall equal or exceed 0.015in. [0.38mm].

10. Test Specimens

10.1 The test specimens shall be located at any point midway between the center and surface of solid forgings, and at any point mid-thickness of the heaviest section of hollow or bored forgings. For solid forgings where test metal is provided on the periphery, test specimens shall be taken at mid-thickness of the test prolongation.

10.2 Tests shall be oriented so that the longitudinal axis of the specimen is parallel to the major direction of grain flow.

TABLE 1 Chemical Requirements

	Composition, %	
	Type I	Type II
Carbon, max	0.13	0.13
Manganese, max	0.90	0.90
Phosphorus, max	0.025	0.025
Sulfur, max	0.025	0.025
Silicon ^A	0.15–0.30	0.15–0.30
Nickel	8.5–9.5	7.5–8.5

^A When vacuum carbon deoxidation is used, the maximum silicon content shall be 0.10 %.

TABLE 3 Charpy V-Notch Lateral Expansion Requirements For Standard Size [10 X 10 mm] Specimens

Type	Lateral expansion in. [mm]	Temperature °F [°C] ^A	Report absorbed energy and % shear fracture
1	0.015 [0.38]	–320 [–195]	Yes
2	0.015 [0.38]	–275 [–170]	Yes

^A Except when Supplementary Requirement S2 is specified.