



# Standard Specification for Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service<sup>1</sup>

This standard is issued under the fixed designation A 522/A 522M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification<sup>2</sup> 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  $-320^{\circ}\text{F}$  [ $-196^{\circ}\text{C}$ ] for Type I or  $-275^{\circ}\text{F}$  [ $-170^{\circ}\text{C}$ ] for Type II or higher than  $250^{\circ}\text{F}$  [ $121^{\circ}\text{C}$ ].

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 Supplementary requirements S1 and S2 are optional and shall apply when specified by the purchaser.

1.4 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.

1.5 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 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 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3</sup>

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>3</sup>

<sup>1</sup> 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 Valves and Fittings.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-522 in Section II of that Code.

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.03.

A 788 Specification for Steel Forgings, General Requirements<sup>4</sup>

## 3. Ordering Information

3.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. Examples of such information include but are not limited to the following:

3.1.1 Quantity,

3.1.2 Size and pressure class or dimensions (Tolerances and surface finishes should be included),

3.1.3 Specification number and type (The year date should be included),

3.1.4 Supplementary requirements, and

3.1.5 Additional requirements, (See 4.4, 13.6, 16.1, 17.1, 17.2, and 18.3).

## 4. Materials and Manufacture

4.1 The steel shall be produced in accordance with the melting process section of Specification A 788.

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 A 788.

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

## 5. Chemical Composition

5.1 The steel shall conform to the requirements for chemical composition as prescribed in Table 1. Test Methods, Practices, and Terminology A 751 shall apply.

## 6. Tensile Requirements

6.1 The forgings shall conform to the tensile property requirements prescribed in Table 2.

6.2 The forgings shall be tested in accordance with the latest issue of Test Methods and Definitions A 370.

## 7. Impact Requirements

7.1 Impact tests shall be conducted at  $-320^{\circ}\text{F}$  [ $-195^{\circ}\text{C}$ ] for Type I and at  $-275^{\circ}\text{F}$  [ $-170^{\circ}\text{C}$ ] for Type II, except when a

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.05.

**TABLE 1 Chemical Requirements**

	Composition, %	
	Type I	Type II
Carbon, max	0.13	0.13
Manganese, max	0.90	0.90
Phosphorus, max		
Heat analysis	0.025	0.025
Product analysis	0.030	0.030
Sulfur, max	0.025	0.025
Silicon <sup>A</sup>		
Heat analysis	0.15–0.30	0.15–0.30
Product analysis	0.13–0.32	0.13–0.32
Nickel		
Heat analysis	8.5–9.5	7.5–8.5
Product analysis	8.40–9.60	7.40–8.60

<sup>A</sup>When vacuum carbon deoxidation is used, the maximum silicon content shall be 0.10 %.

**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

higher temperature is specified in accordance with Supplementary Requirement S2. Each test shall consist of three specimens and each specimen shall have a lateral expansion opposite the notch of not less than 0.015 in. [15 mils] [0.38 mm].

7.2 The values of energy absorption in footpounds (or joules) and the fracture appearance in percent shear shall be recorded and reported for information.

## 8. Heat Treatment

8.1 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.

8.1.1 *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. (2.4 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. 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.

8.1.2 *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. (2.4 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. 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. 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.

8.2 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. (2.4 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].

## 9. Cast or Heat (Formerly Ladle) Analysis

9.1 An analysis of each heat of steel shall be made by the manufacturer to determine percentages of the elements specified in Table 1.

## 10. Product (Check) Verification Analysis

10.1 An analysis may be made by the purchaser from a forging representing each heat. Samples for analysis shall be taken not less than ¼ in. [6 mm] below the surface of the forgings, or from tension test specimens. The chemical composition thus determined shall conform to the requirements specified in Table 1.

## 11. Workmanship, Finish, and Appearance

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

## 12. Number of Tests and Retests

12.1 At least one tension test and one set of impact tests (three specimens) shall be made from each heat in each heat-treatment charge, subject to the provisions of 13.5.

12.2 If any test specimens fail due to mechanical causes, such as testing-equipment failure or improper specimen preparation, the specimens may be discarded and replacement specimens shall be considered as original tests.

12.3 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. Retests shall be made in accordance with this section.

12.4 If the percentage elongation of any tension test specimen is less than that prescribed in Table 2 and any part of the fracture is outside the middle half of the gage length, a retest shall be allowed.

12.5 If the results of mechanical tests do not conform to the specified requirements because a flaw develops in the test specimen, a retest shall be allowed if the defect is not caused by ruptures, cracks, or flakes in the steel.

12.6 If the result from a test on one Charpy impact specimen from a set is below 0.015 in. [0.38 mm] in lateral expansion but not below 0.010 in. [0.25 mm] and the average test result on the set of specimens equals or exceeds 0.015 in. [0.38 mm], one retest of three additional specimens may be made. Each of the test results on the retested specimens shall equal or exceed 0.015 in. [0.38 mm].

## 13. Test Specimens

13.1 The tension and impact specimens may be obtained from a rough or finished production forging, or prolongation thereof, or from special forged blocks, suitably worked and heat treated with the production forgings. These tension and impact tests may represent all forgings from the same heat and heat treatment charge, provided the maximum thickness of