Designation: A 522/A 522M – 07

Standard Specification for Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service[1]

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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification[2] 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 °F [−196 °C] for Type I or −275 °F [−170 °C] for Type II or higher than 250 °F [121 °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 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:* [3]

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

A 788/A 788M Specification for Steel Forgings, General Requirements

A 961/A 961M 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 A 961, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the requirements of Specification A 961 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 A 961 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 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 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.

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 A 961.

[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.

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

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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 %.

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.

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.

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

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.

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.

10.3 When fabrication requires stress relieving, the purchaser shall specify stress relieving of the test pieces prior to machining of the test specimens. Stress relieving shall be carried out as prescribed in 6.2.

11. Method of Impact Testing

11.1 The impact test shall be made in accordance with the simple beam, Charpy type of test described in the latest issue of Test Methods and Definitions A 370.

11.2 Precaution shall be taken so that when broken, the test specimens shall be within ± 3 °F [1.7 °C] of the specified test temperature.

12. Inspection

12.1 The inspector representing the purchaser shall have free entry, at all times while work on the contract of the

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purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the material is being furnished in accordance with this specification. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted so as not to interfere unnecessarily with the operation of the works.

12.2 The manufacturer shall report to the purchaser or the purchaser's representative the heat treatments applied to the material and to the test blocks and the results of the chemical analysis and mechanical tests made in accordance with this specification and the heat number or his heat identification.

13. Rejection

13.1 Unless otherwise specified, any rejection based on tests made in accordance with Section 5 and 7 shall be reported to the manufacturer within 60 days from the receipt of samples or test reports by the purchaser.

13.2 Each forging in which injurious metal defects are exposed during subsequent machining shall be rejected and the manufacturer notified.

14. Certification

14.1 Test reports, when required, shall include certification that all requirements of this specification have been met. The manufacturer shall provide the following where applicable:

14.1.1 Whether Type 1 or Type 11 material has been supplied and the chemical analysis results in accordance with Section 5,

14.1.2 Type of heat treatment used,

14.1.3 Results of tension and Charpy impact tests (together with absorbed energy and % shear fracture) including the impact test temperature, and test coupon stress relief details if applicable,

14.1.4 Results of any additional or supplementary requirements specified by the purchaser, and

14.1.5 The year date and revision letter, if any, of the specification. Note, this information is not required to be marked on the forgings.

15. Product Marking

15.1 Each forging shall be legibly stamped by the manufacturer with the heat number or his heat identification, the manufacturer's name (see Note 1) or trademark, and this specification number, A 522 or A 522M as applicable, 8NI, or 9NI, and QT or NNT as applicable.

NOTE 1—For purposes of identification marking, the manufacturer is considered the organization that certifies the piping component was manufactured, sampled, and tested in accordance with this specification and the results have been determined to meet the requirements of this specification.

15.2 Forgings impact tested at a temperature other than that specified in Table 3, by the use of Supplementary Requirement S2, shall be marked with the letters LTV following the specification number, as well as the temperature scale used. For forgings to A 522, these letters shall be followed by the impact test temperature in degrees Fahrenheit. A prefix 0 to the test temperature indicates a temperature below 0 °F, for example A 522 Type 1 LTV0300F indicates −300 °F. For forgings to A 522M, the letters LTV shall be followed by the impact test temperature in degrees Celsius. A prefix 0 to the test temperature indicates a temperature below 0 °C, for example A 522M Type 1 LTV0150C indicates −150 °C.

15.3 The purchaser may specify additional identification marking and the location of all stamping. The type of stamps shall be round or "interrupted-dot" die stamps having a radius of 1/32 in. [0.8 mm].

15.4 *Bar Coding*—In addition to the requirements in 15.1, 15.2, and 15.3, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of the published industry standards for bar coding. If used on small parts, the bar code may be applied to the box or a substantially applied tag.

16. Keywords

16.1 low temperature applications; nickel alloy steel; pipe fittings; steel; piping applications; pressure containing parts; steel flanges; steel forgings; alloy; steel valves

SUPPLEMENTARY REQUIREMENTS

One or more of the supplementary requirements described below may be included in purchaser's order or contract. When so included, a supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirement details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

S1. Nondestructive Tests

S1.1 *Ultrasonic Tests*—Ultrasonic tests may be made by agreement between manufacturer and purchaser.

S1.2 *Liquid Penetrant Tests*—Liquid penetrant tests may be made by agreement between manufacturer and purchaser.

S2. Other Impact Test Temperatures

S2.1 The purchaser may specify an impact test temperature higher than that in Table 3 but no higher than the minimum intended operating temperature for the forging.

S2.2 Marking shall be in accordance with 15.2.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 522/A 522M – 06, that may impact the use of this specification. (Approved March 1, 2007)

(*1*) Revised marking requirements in 15.2.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 522/A 522M – 01, that may impact the use of this specification. (Approved December 1, 2006)

(*1*) Revised SI cooling rate in Section 6.

(*2*) Revised 15.1 and 15.2 to reference SI temperatres.

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