Designation: A 694/A 694M – 03

Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service[1]

This standard is issued under the fixed designation A 694/A 694M; 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 covers forged or rolled steel pipe flanges, forged fittings, valves, and parts suitable for use with high-strength transmission-service pipe. Included are flanges, fittings, and similar parts ordered either to dimensions specified by the purchaser or to ASME or MSS dimensional standards referenced in Section 2.

1.2 Several grades of material, based on minimum yield strength requirements, are covered, as indicated in Table 1.

1.3 Supplementary Requirements are provided. Supplementary Requirement S 1 is provided for use when purchaser approval is required for repair welding.

1.4 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.

1.5 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.

TABLE 1 Tensile Requirements

Grade	Yield Strength (0.2 % Offset), min, ksi [MPa]	Tensile Strength, min, ksi [MPa]	Elongation in 2 in. or 50 mm, min %
F42	42 [290]	60 [415]	20
F46	46 [315]	60 [415]	20
F48	48 [330]	62 [425]	20
F50	50 [345]	64 [440]	20
F52	52 [360]	66 [455]	20
F56	56 [385]	68 [470]	20
F60	60 [415]	75 [515]	20
F65	65 [450]	77 [530]	20
F70	70 [485]	82 [565]	18

2. Referenced Documents

2.1 In addition to those reference documents listed in Specification A 961, the following list of standards apply to this specification:

2.2 *ASTM Standards:* [2]

A 53/A 53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A 106 Specification for Seamless Carbon Steel Pipe for High-Temperature Service

A 381 Specification for Metal-Arc-Welded Steel Pipe for Use with High-Pressure Transmission Systems

A 707/A 707M Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service

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

2.3 *ASME Standards:*

ASME B 16.5 Steel Pipe Flanges and Flanged Fittings[3]

ASME B 16.9 Steel Butt-Welding Fittings[3]

ASME B 16.10 Face-to-Face and End-to-End Dimensions of Ferrous Valves[3]

ASME B 16.11 Forged Steel Fittings, Socket Welding and Threaded[3]

ASME B 16.28 Wrought Steel Butt-Welding Short Radius Elbows[3]

ASME B 16.47 Large Diameter Steel Flanges[3]

2.4 *MSS Standards:*[4]

MSS SP-44 Standard for Steel Pipe Line Flanges

MSS SP-75 Specification for High-Test Welding Fittings

MSS SP-95 Swage (d) Nipples and Bull Plugs

MSS SP-97 Integrally Reinforced Forged Branch Outlet Fittings

2.5 *API Standard:*

[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 Valves and Fittings.

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[2] 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.

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

[4] Available from the Manufacturers' Standardization Society of the Valve and Fittings Industry, 127 Park St., Northeast, Vienna, VA 22180.

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

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5L Specification for Line Pipe[5]

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. In addition to the ordering guidelines in Specification A 961, orders should include the following information:

3.1.1 Additional requirements (see 8.1 and 10.1).

4. General Requirements

4.1 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 general requirements of Specification A 961 constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 961, this specification shall prevail.

5. Manufacture

5.1 *Melting Process*:

5.1.1 The steel shall be made by any of the following processes: open hearth, electric furnace, or basic oxygen. The steel shall be fully deoxidized.

5.1.2 The steel shall be carbon steel, high-strength low-alloy steel, or alloy steel, as agreed upon between the manufacturer and purchaser. Analysis of the steel used, including all alloying elements, shall be reported by the manufacturer to the purchaser. The steel shall be suitable for field welding (as established by the purchaser) to other fittings, valve materials and flanges, and to pipe manufactured under the following ASTM specifications: Specification A 53, Specification A 106, Specification A 381, and API Standard 5L pipe, as well as to fittings manufactured under MSS SP-75.

5.2 *Manufacturing Practice*:

5.2.1 Material for forgings shall consist of ingots or blooms, billets, slabs, or bars of forged or rolled form and cut to the required length by a suitable process.

5.2.2 The finished product shall be a forging as defined in the Terminology section of Specification A 788.

5.2.3 Hot working shall be sufficient to develop a wrought structure throughout the part.

5.2.4 Flanges shall not be machined directly from plate nor from solid bar stock.

5.3 *Heat Treatment*:

5.3.1 All items shall be heat treated. Heat treatment of carbon steel and high-strength low-alloy steel may consist of normalizing, normalizing-and-tempering, or quenching-and-tempering. Heat treatment of alloy steel may consist of normalizing and precipitation heat treatment or quenching and precipitation heat treatment.

5.3.2 The tempering temperature shall be at least 1000°F [540°C]. The precipitation heat treatment of the alloy steel shall be in the range from 1000 to 1225°F [540 to 665°C].

6. Chemical Composition

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

6.2 High-strength low-alloy steels shall be of specified alloy element composition, with the elements covered in 6.1 restricted within the limits prescribed therein as may be necessary to ensure weldability and specified minimum tensile properties. When high-strength low-alloy steel is furnished, appropriate procedures are required for field welding.

6.3 Alloy steel shall conform to the requirements for Grade L 5 of Specification A 707/A 707M .

7. Tensile Requirements

7.1 The material shall conform to the requirements as to tensile properties prescribed in Table 1, when tested in accordance with the mechanical testing requirements of Specification A 961.

7.2 The tension test specimen shall be obtained from a production forging, or from an integral prolongation representative of the hub location of a flange, or the heaviest cross section of a fitting, valve, or other part within the scope of this specification. Alternatively, the test specimen may be taken from a separately forged test block which has been taken from the same heat of steel as the production forgings, and which has been reduced by forging in a manner similar to that for the forgings it represents.

7.2.1 The test specimen shall represent all forgings from the same heat and heat treatment load whose maximum thicknesses do not exceed the thickness of the test forging or blank by more than ¼ in. [6 mm].

7.3 The axis of the tension test sample shall be located in the test forging, or prolongation so as to represent mid-wall of the flange hub, or mid-wall of the thickest cross section of the valve, fitting, or other part.

7.4 The axis of the tension test specimen shall be oriented parallel to the direction of maximum forging work for fittings, valves, and other parts, except for flanges when the specimen shall be oriented in the tangential direction.

7.5 One tension test shall be taken from each heat in each heat treatment load, and shall be representative of the largest flange hub, or valve or fitting wall thickness in the load.

7.6 When heat treatment is done either continuous or batch type furnaces in which the working zones are controlled to within +/- 25°F [+/- 14°C] of the required heat treatment temperature, and when the furnace is equipped with functioning recording pyrometers such that complete heat treatment records are available, then one tension test from each heat shall be required instead of from each heat in each heat treatment

TABLE 2 Chemical Requirements

	Composition, %	
	Heat Analysis	Product Analysis
Carbon, max	0.26	0.265
Manganese, max	1.40	1.44
Phosphorus, max	0.025	0.030
Sulfur, max	0.025	0.030
Silicon	0.15–0.35	0.10–0.40

[5] Available from American Petroleum Institute, 1801 K St. N. W., Washington, DC 20037.

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load. However, this provision is limited to forgings with heat treated weights not exceeding 10 000 lbs [4540 kg], and the test forging must accompany a production charge.

8. Workmanship, Finish, and Appearance

8.1 The forgings shall be free of injurious defects as defined in Specification A 961.

8.2 *Repair by Welding of Injurious Defects*—Repair of injurious defects shall be permitted at the discretion of the manufacturer in accordance with Specification A 961.

8.2.1 Deposited weld metal shall be capable of meeting all mechanical properties upon heat treatment.

8.2.2 All forgings to be repaired by welding shall be repair welded prior to heat treatment.

9. Retests

9.1 If any of the results of the tension tests of any lot do not conform to the requirements specified, the manufacturer may reheat treat such lots, but not more than twice, except with the approval of the purchaser, on the basis of satisfactory metallurgical evidence that the cause of failure is curable and the quality of the material is satisfactory.

10. Rejection and Rehearing

10.1 The purchaser shall comply with the requirements of Specification A 961.

11. Certification

11.1 Certification shall comply with Specification A 961. However, if high-strength low-alloy steel is used, the analysis and the heat number or manufacturer's heat identification shall be reported to the purchaser.

12. Product Marking

12.1 Product marking shall comply with Specification A 961.

12.2 Forgings repaired by welding shall be marked with the letter "W" following the ASTM designation.

12.3 *Bar Coding*—In addition to the requirements in 12.1 and 12.2, 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.

13. Keywords

13.1 high strength low alloy steel; pipe fittings, steel; piping applications; pressure containing parts; steel flanges; steel forgings, alloy; steel forgings, carbon; steel valves

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, and order:

S1. Special Flanges

S1.1 Flanges shall meet the requirements of MSS SP-44, except the chemical requirements shall conform to Table 2.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 694/A 694M - 00, which may impact the use of this specification. (Approved October 1, 2003)

(*1*) Revised Section 10 to reference Specification A 961 requirements.

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