



Designation: A193/A193M – 22

Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications¹

This standard is issued under the fixed designation A193/A193M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification² covers alloy and stainless steel bolting materials and bolting components for pressure vessels, valves, flanges, and fittings for high temperature or high pressure service, or other special purpose applications. See Specification [A962/A962M](#) for the definition of bolting. Bars and wire shall be hot-wrought and may be further processed by centerless grinding or by cold drawing. Austenitic stainless steel may be carbide solution treated or carbide solution treated and strain-hardened. When strain hardened austenitic stainless steel is ordered, the purchaser should take special care to ensure that [Appendix X1](#) is thoroughly understood.

1.2 Several grades are covered, including ferritic steels and austenitic stainless steels designated B5, B8, and so forth. Selection will depend upon design, service conditions, mechanical properties, and high temperature characteristics.

1.3 The following referenced general requirements are indispensable for application of this specification: Specification [A962/A962M](#).

NOTE 1—The committee formulating this specification has included several steel types that have been rather extensively used for the present purpose. Other compositions will be considered for inclusion by the committee from time to time as the need becomes apparent.

NOTE 2—For grades of alloy-steel bolting suitable for use at the lower range of high temperature applications, reference should be made to Specification [A354](#).

NOTE 3—For grades of alloy-steel bolting suitable for use in low temperature applications, reference should be made to Specification [A320/A320M](#).

1.4 Nuts for use with bolting are covered in Section [13](#).

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-193 in Section II of that Code.

1.5 Supplementary Requirements are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified in the purchase order or contract.

1.6 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable *M* specification designation (SI units), the inch-pound units shall apply.

1.7 The values stated in either SI units or inch-pound 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.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:³

[A153/A153M](#) Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

[A194/A194M](#) Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

[A320/A320M](#) Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service

[A354](#) Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

[A788/A788M](#) Specification for Steel Forgings, General Requirements

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

- [A962/A962M](#) Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range
- [B633](#) Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- [B695](#) Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- [B696](#) Specification for Coatings of Cadmium Mechanically Deposited
- [B766](#) Specification for Electrodeposited Coatings of Cadmium
- [E18](#) Test Methods for Rockwell Hardness of Metallic Materials
- [E21](#) Test Methods for Elevated Temperature Tension Tests of Metallic Materials
- [E112](#) Test Methods for Determining Average Grain Size
- [E139](#) Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
- [E150](#) Recommended Practice for Conducting Creep and Creep-Rupture Tension Tests of Metallic Materials Under Conditions of Rapid Heating and Short Times (Withdrawn 1984)⁴
- [E151](#) Recommended Practice for Tension Tests of Metallic Materials at Elevated Temperatures with Rapid Heating and Conventional or Rapid Strain Rates (Withdrawn 1984)⁴
- [E292](#) Test Methods for Conducting Time-for-Rupture Notch Tension Tests of Materials
- [E328](#) Test Methods for Stress Relaxation for Materials and Structures
- [E566](#) Practice for Electromagnetic (Eddy Current/Magnetic Induction) Sorting of Ferrous Metals
- [E709](#) Guide for Magnetic Particle Testing
- [F606/F606M](#) Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
- [F1940](#) Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners
- [F1941/F1941M](#) Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric
- [F2329/F2329M](#) Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

2.2 ASME Standards:⁵

- [B18.2.1](#) Square and Hex Bolts and Screws
- [B18.2.3.3M](#) Metric Heavy Hex Screws
- [B18.3](#) Hexagon Socket and Spline Socket Screws
- [B18.3.1M](#) Metric Socket Head Cap Screws

2.3 AIAG Standard:⁶

- [AIAG B-5 02.00](#) Primary Metals Identification Tag Application Standard

3. General Requirements and Ordering Information

3.1 The inquiry and orders shall include the following, as required, to describe the desired bolting material or bolting components adequately:

3.1.1 Heat-treated condition (that is carbide solution treated (Class 1), carbide solution treated after finishing (Class 1A), and carbide solution treated and strain-hardened (Classes 2, 2B and 2C), for the austenitic stainless steels; Classes 1B and 1C apply to the carbide solution-treated nitrogen-bearing stainless steels; Class 1D applies to bolting material that is carbide solution treated by cooling rapidly from the rolling temperature),

3.1.2 Description of items required (that is, bars, bolts, screws, or studs),

3.1.3 Nuts, if required by purchaser, in accordance with [13.1](#),

3.1.4 Supplementary requirements, if any, and

3.1.5 Special requirements, in accordance with [6.1.5.1](#), [6.2.6](#), [8.1](#), and [13.1](#).

3.2 *Coatings*—Coatings are prohibited unless specified by the purchaser (See Supplementary Requirements S13 and S14). When coated bolting components are ordered the purchaser should take special care to ensure that [Appendix X2](#) is thoroughly understood.

4. Common Requirements

4.1 Bolting materials and bolting components supplied to this specification shall conform to the requirements of Specification [A962/A962M](#). These requirements include test methods, finish, thread dimensions, macroetch (alloy steels only), marking, certification, optional supplementary requirements, and others. Failure to comply with the requirements of Specification [A962/A962M](#) constitutes nonconformance with this specification. In case of conflict between this specification and Specification [A962/A962M](#), this specification shall prevail.

5. Manufacture (Process)

5.1 *Melting*—See Specification [A962/A962M](#) for requirements.

5.2 *Quality*—See Specification [A962/A962M](#) for requirements.

6. Heat Treatment

6.1 Ferritic Steels:

6.1.1 Ferritic steels shall be allowed to cool to a temperature below the cooling transformation range immediately after rolling or forging. Bolting materials shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as a *quenching charge*), quenched

⁴ 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, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁶ Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, <http://www.aiag.org>.



TABLE 1 Chemical Requirements (Composition, percent)^A

Ferritic Steels																
Grade	Description and UNS Designation	Class	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Cooper	Niobium ^F	Titanium	Vanadium	Aluminum	Nitrogen
B5	5 % Chromium		0.10 min	1.00	0.040	0.030	1.00	4.0–6.0	...	0.40–0.65	...	...	...	...	...	...
Product Analysis Variation ^B			0.01	0.03	0.005	0.005	0.05	0.10	...	0.05	...	...	...	...	...	...
B6, B6X	12 % Chromium (410), S41000		0.08–0.15	1.00	0.040	0.030	1.00	11.5–13.5	...	...	...	...	...	...	...	...
Product Analysis Variation ^B			0.01 over	0.03	0.005	0.005	0.05	0.15	...	...	...	...	...	...	...	...
B7, B7M	Chromium-Molybdenum ^C		0.38–0.48 ^D	0.75–1.00	0.035	0.040	0.15–0.35	0.80–1.10	...	0.15–0.25	...	...	...	...	...	...
Product Analysis Variation ^B			0.02	0.04	0.005	0.005	0.02	0.05	...	0.02	...	...	...	...	...	...
B16	Chromium-Molybdenum-Vanadium		0.36–0.47	0.45–0.70	0.035	0.040	0.15–0.35	0.80–1.15	...	0.50–0.65	...	...	...	0.25–0.35	0.015 ^E	...
Product Analysis Variation ^B			0.02	0.03	0.005	0.005	0.02	0.05	...	0.03	...	...	...	0.03	...	...
Austenitic Steels																
Grade	Description and UNS Designation	Classes	Carbon	Manganese	Phosphorous	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Copper	Niobium ^F	Titanium	Vanadium	Aluminum	Nitrogen
B8, B8A	304, S30400	1, 1A, 1D, 2	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	...	...	...	...	...	...	...
Product Analysis Variation ^B			0.01	0.04	0.010	0.005	0.05	0.20	0.15	...	...	...	...	...	...	...
B8C, B8CA	347, S34700	1, 1A, 1D, 2	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	10 × C to 1.10	...	...	...	...
Product Analysis Variation ^B			0.01	0.04	0.010	0.005	0.05	0.20	0.15	...	...	0.05 under	...	...	...	...
B8M, B8MA, B8M2, B8M3	316, S31600	1, 1A, 1D, 2	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	...	...	...	...	...	...
Product Analysis Variation ^B			0.01	0.04	0.010	0.005	0.05	0.20	0.15	0.10	...	...	...	...	...	...