
Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High- Temperature Service, or Both

AASHTO Designation: M 292M/M 292-24

Technically Revised: 2024

Technical Subcommittee: 4f, Metals

ASTM Designation: A194/A194M-22a



**American Association of State Highway and Transportation Officials
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AASHTO

1. SCOPE
- 1.1.

This specification covers a variety of carbon, alloy, and martensitic stainless steel nuts in the size range M12 through M100 [$\frac{1}{4}$ through 4 in.] nominal. It also covers austenitic stainless steel nuts in the size range M12 [$\frac{1}{4}$ in.] nominal and above. These nuts are intended for high-pressure or high-temperature service, or both. Grade substitutions without the purchaser’s permission are not allowed.
- 1.2.

Bars from which the nuts are made shall be hot wrought. The material may be further processed by centerless grinding or by cold drawing. Austenitic stainless steel may be solution annealed or annealed and strain hardened. When annealed and strain-hardened austenitic stainless steel is ordered in accordance with Supplementary Requirement S1, the purchaser should take special care to ensure that Section 8.2.2, Supplementary Requirement S1, and Appendix X1 are thoroughly understood.
- 1.3.

Supplementary requirements (Sections S1 through S8) of an optional nature are provided. These shall apply only when specified in the inquiry, contract, and order.
- 1.4.

This specification is applicable to orders in either SI units (as M 292M) or inch-pound units (as M 292). SI units and inch-pound units are not necessarily equivalent. Inch-pound units are shown in brackets in the text. Material shall be furnished to SI units when the order specifies the applicable “M” designation.

2. REFERENCED DOCUMENTS
- 2.1.

AASHTO Standards:

■ M 232M/M 232, Zinc Coating (Hot-Dip) on Iron and Steel Hardware

■ M 339M/M 339, Thermometers Used in the Testing of Construction Materials

■ T 244, Mechanical Testing of Steel Products
- 2.2.

ASTM Standards:

■ A276/A276M, Standard Specification for Stainless Steel Bars and Shapes

- A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
- A962/A962M, Standard Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range
- B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- B696, Standard Specification for Coatings of Cadmium Mechanically Deposited
- B766, Standard Specification for Electrodeposited Coatings of Cadmium
- E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E112, Standard Test Methods for Determining Average Grain Size
- E230, Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E566, Standard Practice for Electromagnetic (Eddy-Current/Magnetic Induction) Sorting of Ferrous Metals
- E2877, Standard Guide for Digital Contact Thermometers
- F1940, Standard Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners
- F1941/F1941M, Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric
- F2329/F2329M, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

- 2.3. *ASME/ANSI Standards:*¹
- B1.1, Unified Screw Threads
 - B1.2, Gages and Gaging for Unified Inch Screw Threads
 - B1.13M, Metric Screw Threads
 - B18.2.2, Square and Hex Nuts
 - B18.2.4.6M, Metric Heavy Hex Nuts

- 2.4. *International Electrotechnical Commission Standard:*
- IEC 60584-1: 2013, Thermocouples - Part 1: EMF Specifications and Tolerances

3. TERMINOLOGY

- 3.1. *Definitions of Terms Specific to This Standard:*
- 3.1.1. *austenitic grades*—all grades with a prefix of “8” or “9.”
- 3.1.2. *ferritic grades*—Grades 1, 2, 2H, 2HM, 3, 6, 6F, 7, 7M, 43, and 16.
- 3.1.3. *Lot:*
- 3.1.3.1. Unless otherwise specified (Section 3.1.3.2), a lot is the quantity of nuts of a single nominal size and grade produced by the same manufacturing process.
- 3.1.3.2. *When Supplementary Requirement S5 is invoked on the purchase order, the following definitions of a lot shall apply:*

- 3.1.3.2.1. *for Grade 8 nuts*—the quantity of all the nuts of a single nominal diameter and grade made from the same heat of steel and made by the same manufacturing process.
- 3.1.3.2.2. *for all other grade nuts (Sections 8.2 and 8.1.2.1)*—all the nuts of a single nominal diameter and grade made from the same heat number and heat treated in the same batch, if batch-type heat-treating equipment is used, or heat treated in the same continuous run of not more than 8 h under the same conditions if continuous-type heat-treating equipment is used.
- 3.1.4. *Type:*
 - 3.1.4.1. *for Grade 8 nuts*—variations within the grade designated by a letter and differentiated by chemistry and by manufacturing process.
 - 3.1.4.2. *for Grade 6 nuts*—variations within the grade designated by the letter F and differentiated by chemical additions made for machinability.
- 3.1.5. *series*—the dimensional relationship and geometry of the nuts as described in ANSI B18.2.2 for inch nuts or B18.2.4.6M for metric nuts.

4. ORDERING INFORMATION

- 4.1. *The inquiry and order for material under this specification shall include the following as required to describe the material adequately:*
 - 4.1.1. Specification designation, year date, grade, issue date, and revision letter;
 - 4.1.2. Quantity, number of pieces;
 - 4.1.3. Dimensions (Section 9);
 - 4.1.4. Options in accordance with Sections 8.2.2.1, 9.1, 9.2, 10.3, and 12; and
 - 4.1.5. Supplementary Requirements, if any.
- 4.2. *Coatings*—Coatings are prohibited unless specified by the purchaser (see Supplementary Requirements S7 and S8). When coated nuts are ordered, the purchaser should take special care to ensure that Appendix X2 is thoroughly understood.
- 4.3. See Supplementary Requirement S3 for nuts to be used in low-temperature applications (Specification ASTM A320/A320M).
- 4.4. See Supplementary Requirement S9 for proof-load testing of nuts manufactured to dimensions and configurations other than those covered in Table 3 or Table 4.

5. COMMON REQUIREMENTS

- 5.1. Material and fasteners supplied to this specification shall conform to the requirements of ASTM A962/A962M. These requirements include test methods, finish, thread dimensions, marking, certification, optional supplementary requirements, and others. Failure to comply with the requirements of specification ASTM A962/A962M constitutes nonconformance with this specification. In case of conflicts between the requirements of this specification and specification ASTM A962/A962M, this specification shall prevail.

6. MANUFACTURE (PROCESS)

- 6.1. *Stainless steels for all types of Grade 6 and Grade 8 nuts shall be made by one of the following processes:*
- 6.1.1. Electric furnace (with separate degassing and refining optional),
- 6.1.2. Vacuum induction furnace, or
- 6.1.3. Either of the above followed by electroslag remelting or consumable-arc remelting.
- 6.2. The steel producer shall exercise adequate control to eliminate excessive inhomogeneity, nonmetallics, pipe, porosity, and other defects.
- 6.3. Grades 1 and 2 nuts shall be hot or cold forged or shall be machined from hot-forged, hot-rolled, or cold-drawn bars.
- 6.3.1. *All Grade 1 and 2 nuts shall be stress-relieved at a temperature of at least 538°C [1000°F] after forming or machining from bar with the following exceptions:*
- 6.3.1.1. Nuts made by hot forging.
- 6.3.1.2. Nuts machined from hot-forged or hot-rolled bar.
- 6.3.1.3. Nuts machined from hot-forged/hot-rolled and cold-finished (max 10 percent reduction in area) bar.
- 6.3.1.4. Nuts machined from cold-drawn and annealed (min 538°C [1000°F]) bar.
- 6.3.2. Grades 1 and 2 nuts made by hot forging or by machining from hot-forged or hot-rolled bars need not be stress-relieved.
- 6.4. Grades 2H, 2HM, 3, 6, 6F, 7, 7M, 43, and 16 nuts shall be hot or cold forged or shall be machined from hot-forged, hot-rolled, or cold-drawn bars and shall be heat treated to meet the required mechanical properties. These grades shall be uniformly reheated to the proper austenitizing temperature (a group thus reheated being known as a quenching charge) and quenched under substantially uniform conditions for each quenching charge and tempered as shown below. Grades 2H, 2HM, 3, 7, and 7M shall be liquid quenched. Grades 6 and 6F shall be quenched in liquid or inert gas. Grade 16 shall be heated to a temperature range from 925 to 955°C [1700 to 1750°F] and oil quenched. The oven or furnace used to heat nuts shall be capable of operation at the temperatures required and shall have an indicating controller or pyrometer accurate within $\pm 10^{\circ}\text{C}$ [$\pm 18^{\circ}\text{F}$], as corrected, if necessary, by standardization.
- 6.4.1. When measuring temperatures during heat treatment, the thermometer for measuring the temperature of the oven or furnace/the temperature of the specimen being heated shall meet the requirements of M 339M/M 339 with a temperature range of at least 425 to 1000°C [797 to 1832°F], and an accuracy of $\pm 5^{\circ}\text{C}$ [$\pm 9^{\circ}\text{F}$] (see Note 1).
- 6.4.2. When measuring temperatures during heat treatment, the thermometer for measuring the temperature of the specimen being heated shall meet the requirements of M 339M/M 339 with a temperature range of at least 425 to 1000°C [797 to 1832°F], and an accuracy of $\pm 5^{\circ}\text{C}$ [$\pm 9^{\circ}\text{F}$] (see Note 2).
- Note 1**—Thermometer types suitable for use include ASTM E230 thermocouple thermometer, Type K, Class Special.

Note 2—Thermometer types suitable for use include ASTM E2877 digital metal stem thermometers; or non-contact infrared thermometers.

Grade and Type	Minimum Tempering Temperature, °C [°F]
2H	455 [850]
2HM	620 [1150]
3	565 [1050]
6 and 6F	595 [1100]
7	595 [1100]
7M	620 [1150]
43	595 [1100]
16	650 [1200]

6.4.3. Grades 6 and 6F nuts shall be tempered for a minimum of 1 h within the temperature range.

6.5. For Grade 2HM and 7M nuts, a final stress relief shall be performed, after all machining, cutting, and forming operations, at a minimum temperature of 28°C [50°F] below the original tempering temperature. A tempering operation may be substituted for this post-machining/cutting/forming stress relief. Surface preparation for hardness testing or nondestructive evaluation is permitted.

6.5.1. In the case where the original temper was performed via induction heat treatment at a temperature above 705°C [1300°F] but the post-machining/cutting/forming stress relief will be performed in a standard furnace, the minimum stress relief temperature shall be 650°C [1200°F].

Note 3—A specific minimum stress relief temperature is given in Section 6.5.1 because no correlation can be drawn between the original tempering temperature utilizing induction and the stress relieving temperature in a standard furnace.

6.6. Grades 8, 8C, 8CLN, 8CLNCuB, 8M, 8T, 8F, 8P, 8N, 8MN, 8R, 8S, 8LN, 8MLN, 8MLCuN, and 9C nuts shall be hot or cold forged or shall be machined from hot-forged, hot-rolled, or cold-drawn bars.

6.7. Grades 8A, 8CA, 8CLNA, 8CLNCuB, 8MA, 8TA, 8FA, 8PA, 8NA, 8MNA, 8RA, 8SA, 8LNA, 8MLNA, 8MLCuNA, and 9CA nuts shall be hot or cold forged or shall be machined from hot-forged, hot-rolled, or cold-drawn bars and the nuts shall subsequently be carbide-solution treated by heating them for a sufficient time at a temperature to dissolve chromium carbides followed by cooling at a rate sufficient to prevent reprecipitation of the carbides.