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Officials Standard
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Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength[1]

This standard is issued under the fixed designation A 490; 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.

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

1. Scope *

1.1 This specification covers the chemical and mechanical requirements of heat-treated steel bolts, ½ to 1 ½ in., incl, in diameter. These bolts are intended for use in structural joints that are made under the Specification for Structural Joints Using ASTM A 325 or A 490 Bolts[2] issued by the Research Council on Structural Connections of the Engineering Foundation. The various types of bolts covered by this specification are:

1.1.1 *Type 1*—Bolts made of alloy steel, supplied in sizes ½ to 1 ½ in., inclusive, in diameter.

1.1.2 *Type 2*—Bolts made from what is generally described as low-carbon martensite steel, supplied in sizes ½ to 1 in., inclusive, in diameter.

1.1.3 *Type 3*—Bolts ½ to 1 ½ in., inclusive, in diameter having atmospheric corrosion resistance and weathering characteristics comparable to that of the steels covered in Specifications A 588/A 588M, A 242/A 242M, and A 709/A 709M. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition. See 6.3. When properly exposed to the atmosphere, these steels can be used bare (uncoated) for many applications.

1.2 The purchaser should specify either Type 1, 2, or 3 bolts. When the bolt type is not specified, Type 1, 2, or 3 may be furnished at the option of the manufacturer.

1.3 When atmospheric corrosion resistance and weathering characteristics are required, Type 3 bolts should be specified by the purchaser.

1.4 Unless otherwise specified, all nuts used on these bolts shall conform to the requirements of Specification A 194/A 194M or A 563, shall be heavy hex, and shall be of the class and surface finish for each type of bolt as follows:

Bolt Type and Finish	Nut Class and Finish
1 and 2, plain (noncoated)	A 563 – DH, DH3, plain A 194 – 2H, plain
3, plain	A 563 – DH3, plain

1.5 Unless otherwise specified, all washers used on these bolts shall conform to the requirements of Specification F 436 and shall be of a surface finish for each type of bolt as follows:

Bolt Type and Finish	Washer Finish
1 and 2, plain (uncoated)	plain (uncoated)
3, plain	weathering steel, plain

1.6 This specification provides that heavy hex structural bolts shall be furnished unless other dimensional requirements are stipulated in the purchase inquiry and order.

NOTE 1—For quenched and tempered alloy steel bolts, studs, and other externally threaded fasteners with diameters greater than 1 ½ in., but with similar mechanical properties, refer to Grade BD of Specification A 354.

NOTE 2—A complete metric companion to Specification A 490 has been developed—Specification A 490M; therefore no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service[3]

A 242/A242M Specification for High-Strength Low-Alloy Structural Steel[4]

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength[5]

A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners[5]

A 563 Specification for Carbon and Alloy Steel Nuts[5]

A 588/A588M Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4 in. [100 mm] Thick[4]

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, and Washers.

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[2] Published by the American Institute of Steel Construction, Wrigley Building, 400 N. Michigan Ave., Chicago, IL 60611.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

[4] *Annual Book of ASTM Standards*, Vol 01.04.

[5] *Annual Book of ASTM Standards*, Vol 01.08.

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

A 709/A709M Specification for Structural Steel for Bridges[4]
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[6]
D 3951 Practice for Commercial Packaging[7]
E 3 Methods of Preparation of Metallographic Specimens[8]
E 138 Method for Wet Magnetic Particle Inspection[9]
E 709 Guide for Magnetic Particle Examination[10]
F 436 Specification for Hardened Steel Washers[5]
F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets[5]
F 788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series[5]
G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels[11]
2.2 *ANSI/ASME Standards:*
B1.1 Unified Screw Threads[12]
B18.2.1 Square and Hex Bolts and Screws[12]
B18.24.1 Part Identifying Number (PIN) Code System[13]
2.3 *Military Standard:*
MIL-STD-105 Sampling Procedure and Tables for Inspection by Attributes[14]

3. Terminology

3.1 *Definitions*—Surface discontinuities covered in this specification are defined as follows:

3.1.1 *acceptable quality level (AQL)*—as defined in MIL-STD-105, the maximum percent defective that, for purposes of sampling inspection, can be considered satisfactory as the process average.

3.1.2 *burst*—a break located at the periphery of the bolt head.

3.1.3 *crack*—a clean crystalline break passing through the grain boundary without inclusion of foreign elements.

3.1.4 *process average*—as defined in MIL-STD-105, the average percent defective of product at the time of original inspection. Original inspection is that first inspection of a particular quantity of product which is being reinspected after rejection and reconditioning.

3.1.5 *seam or lap*— a noncrystalline break through the metal which is inherent in the raw material.

4. Ordering Information

4.1 Orders for products under this specification shall include the following:

4.1.1 Quantity (number of pieces of bolts and accessories),

4.1.2 Name of products, including accessories such as nuts and washers when desired,

4.1.3 Dimensions, including nominal bolt diameter and length. For bolts of dimensional requirements other than heavy hex structural bolts (see 1.6) it is normally necessary to specify grip length,

4.1.4 Type of bolt (that is, Type 1, 2, or 3). Note that Type 1, 2, or 3 bolts may be supplied by the manufacturer when bolt type is not specified,

4.1.5 ASTM designation and year of issue,

4.1.6 Whether proof load tests are required,

4.1.7 Specify if Test Reports are required, and

4.1.8 Any special requirements.

4.1.9 For establishment of a part identifying system, see ASME B18.24.1.

NOTE 3—Two examples of ordering descriptions follow: (*1*) 1000 pieces, heavy hex structural bolts, each with two hardened washers, ASTM F 436, and one heavy hex nut, ASTM A 563 Grade DH, 1 by 4, ASTM A 490–XX. (*2*) 1000 pieces, heavy hex structural bolts, no nuts or washers, ⅞ by 2¼ Type 1, ASTM A 490–XX.

5. Materials and Manufacture

5.1 *Process*—Steel shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

5.2 *Heat Treatment*—Type 1 bolts shall be heat treated by quenching in oil from above the transformation temperature. Type 2 and Type 3 bolts shall be quenched in a suitable liquid from above the transformation temperature. Type 1 and Type 3 bolts shall be tempered by reheating to a temperature of not less than 800°F. Type 2 bolts shall be tempered by reheating to a temperature of not less than 650°F. If heat treatment is performed by a subcontractor, the heat-treated material shall be returned to the manufacturer for testing.

5.3 Threads of bolts may be cut or rolled.

5.4 *Protective Coatings*—The bolts shall not be hot dip, mechanically, or electroplated with zinc or other metallic coatings as such bolts are subject to hydrogen embrittlement with subsequent stress corrosion cracking and delayed brittle failure in service. See Appendix X1 for additional information on hot dip zinc coatings.

6. Chemical Composition

6.1 Type 1 bolts shall be made from alloy steel conforming to the chemical composition requirements given in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel.

NOTE 4—Steel is considered to be alloy, by the American Iron and Steel Institute, when the maximum of the range given for the content of alloying

TABLE 1 Chemical Requirements for Type 1 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1⅜ in.	0.30–0.48	0.28–0.50
For size 1½ in.	0.35–0.53	0.33–0.55
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Alloying Elements ←	→ See 6.1	

[6] *Annual Book of ASTM Standards*, Vol 01.03.
[7] *Annual Book of ASTM Standards*, Vol 15.09.
[8] *Annual Book of ASTM Standards*, Vol 03.01.
[9] Discontinued; see 1980 *Annual Book of ASTM Standards*, Part 11.
[10] *Annual Book of ASTM Standards*, Vol 03.03.
[11] *Annual Book of ASTM Standards*, Vol 03.02.
[12] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.
[13] Available from American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.
[14] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

elements exceeds one or more of the following limits: manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

6.2 Type 2 bolts shall be made from steel conforming to the chemical composition requirements given in Table 2.

6.3 Type 3 bolts shall be made from steel conforming to the chemical composition requirements given in Table 3. See Guide G 101 for methods of estimating the atmospheric corrosion resistance of low alloy steel.

6.4 Product analyses may be made by the purchaser from finished material representing each lot of bolts. The chemical composition thus determined shall conform to the requirements given in Table 1, Table 2, or Table 3, as applicable.

6.5 Application of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for bolts.

6.6 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

7. Mechanical Properties

7.1 *Product Hardness*:

7.1.1 The bolts shall conform to the hardness specified in Table 4.

7.2 *Tensile Properties*:

7.2.1 Bolts 1 ¼ in. in diameter or less, other than those excepted in 7.1, shall be wedge tested full size and conform to the minimum and maximum tensile strength requirements as specified in Table 5.

7.2.2 Bolts larger than 1¼ in. in diameter, other than those excepted in 7.1, shall preferably be wedge tested full size and when so tested, shall conform to the minimum and maximum tensile strength requirements as specified in Table 5. When equipment of sufficient capacity for full-size testing is not available, or when the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements of Table 6. In the event that bolts are tested by both full-size and by the machined test specimen methods, the full-size test shall govern if a controversy between the two methods exists.

7.2.3 The proof load test is not a mandatory production test. When specified on the inquiry and order, the bolts shall be tested to either the proof load or alternative proof load requirements specified in Table 5 in addition to the tensile strength requirements. In case of controversy the bolts shall be capable of conforming to the proof load requirements in addition to all other requirements.

TABLE 2 Chemical Requirements for Type 2 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon	0.15–0.34	0.13–0.37
Manganese, min	0.70	0.67
Phosphorus, max	0.040	0.048
Sulfur, max	0.050	0.058
Boron, min	0.0005	0.0005

TABLE 3 Chemical Requirements for Type 3 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes 0.75 in. and smaller	0.20–0.53	0.19–0.55
Sizes larger than 0.75 in.	0.30–0.53	0.28–0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.040	0.045
Sulfur, max	0.050	0.055
Copper, max	0.60	0.63
Chromium, min	0.45	0.42
Nickel, min or	0.20	0.17
Molybdenum, min	0.15	0.14

TABLE 4 Hardness Requirements for Bolts ½ to 1 ½ in. Nominal Size

Length, in.	Brinell		Rockwell C	
	min	max	min	max
Less than 3 × dia.	311	352	33	38
3 × dia. and longer	—	352	—	38

7.3 For bolts on which hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event that there is controversy over low readings of hardness tests.

8. Carburization

8.1 *Definition*—This test is intended to evaluate freedom from carburization as determined by the difference in hardness at the surface and subsurface.

8.2 *Requirement*—The bolts shall be free from carburization. The hardness measured at a maximum of 0.003 in. from the surface shall not be more than 3 points Rockwell C (26 points Knoop) (27 points Vickers DPH) higher than the hardness measured 0.125 in. from the surface. See Fig. 1.

8.3 *Procedure*:

8.3.1 Section the bolt longitudinally through the axis in the threaded area. Mount and polish metallographically in accordance with Methods E 3.

8.3.2 Conduct a microhardness test using either a Knoop or Vickers DPH hardness testing penetrator.

8.3.3 Locate a point at the pitch diameter 0.003 in. in from the flank of the thread on a line perpendicular to the flank and take a hardness reading. For the next reading, locate a point 0.125 in. from the major diameter (crest of thread) perpendicular to the axis of the bolt and take a second reading. See Fig. 1.

8.3.4 Both hardness readings shall be taken on the same axial longitudinal section through the threaded length of the bolt, shall be taken at the same time, and the same hardness scale shall be used.

9. Dimensions

9.1 Unless otherwise specified, bolts shall conform to the dimensions for heavy hex structural bolts specified in ANSI B18.2.1.

9.2 Threads shall be the Unified Coarse Thread Series as specified in ANSI B1.1, and shall have Class 2A tolerances. When specified, 8 pitch thread series shall be used on bolts over 1 in. in diameter.