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American Association  
State Highway and  
Transportation Officials  
Standard AASHTO No.: M 164

## Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength<sup>1</sup>

This standard is issued under the fixed designation A 325; 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 ( $\epsilon$ ) 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<sup>2</sup> covers two types of quenched and tempered steel heavy hex structural bolts having a minimum tensile strength of 120 ksi for sizes 1.0 in. and less and 105 ksi for sizes over 1.0 to 1½ in., inclusive.

1.2 The bolts are intended for use in structural connections. These connections are covered under the requirements of the Specification for Structural Joints Using ASTM A 325 or A 490 Bolts, approved by the Research Council on Structural Connections, endorsed by the American Institute of Steel Construction and by the Industrial Fastener Institute.<sup>3</sup>

1.3 The bolts are furnished in sizes ½ to 1½ in., inclusive. They are designated by type, denoting chemical composition as follows:

Type	Description
Type 1	Medium carbon, carbon boron, or medium carbon alloy steel.
Type 2	Withdrawn in November 1991.
Type 3	Weathering steel.

NOTE 1—Bolts for general applications, including anchor bolts, are covered by Specification A 449. Also refer to Specification A 449 for quenched and tempered steel bolts and studs with diameters greater than 1½ in. but with similar mechanical properties.

NOTE 2—A complete metric companion to Specification A 325 has been developed—Specification A 325M; therefore, no metric equivalents are presented in this specification.

1.4 This specification is applicable to heavy hex structural bolts only. For bolts of other configurations and thread lengths with similar mechanical properties, see Specification A 449.

1.5 Terms used in this specification are defined in Specification F 1789.

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 10, of this specification: *This*

*standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware<sup>4</sup>
- A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service<sup>5</sup>
- A 449 Specification for Quenched and Tempered Steel Bolts and Studs<sup>6</sup>
- A 490 Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength<sup>6</sup>
- A 563 Specification for Carbon and Alloy Steel Nuts<sup>6</sup>
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>7</sup>
- B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel<sup>8</sup>
- D 3951 Practice for Commercial Packaging<sup>9</sup>
- F 436 Specification for Hardened Steel Washers<sup>6</sup>
- F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets<sup>6</sup>
- F 788/F 788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series<sup>6</sup>
- F 959 Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners<sup>6</sup>
- F 1470 Fastener Sampling for Specified Mechanical Properties and Performance Inspection<sup>6</sup>
- F 1789 Standard Terminology for F16 mechanical Fasteners<sup>6</sup>

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-325 in Section II of that Code.

<sup>3</sup> Published by American Institute of Steel Construction, One East Wacker Dr., Ste. 3100, Chicago, IL 60601-2001.

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.06.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>6</sup> Annual Book of ASTM Standards, Vol 01.08.

<sup>7</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>8</sup> Annual Book of ASTM Standards, Vol 02.05.

<sup>9</sup> Annual Book of ASTM Standards, Vol 15.09.

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



G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels<sup>10</sup>

2.2 *ASME Standards:*<sup>11</sup>

B 1.1 Unified Screw Threads

B 18.2.6 Fasteners for Use in Structural Applications

B 18.24.1 Part Identifying Number (PIN) Code System

2.3 *Military Standard:*<sup>12</sup>

MIL-STD-105 Sampling Procedure and Tables for Inspection by Attributes

**3. Ordering Information**

3.1 Orders for heavy hex structural bolts under this specification shall include the following:

3.1.1 Quantity (number of pieces of bolts and accessories).

3.1.2 Size, including nominal bolt diameter, thread pitch, and bolt length.

3.1.3 Name of product, heavy hex structural bolts.

3.1.4 When bolts threaded full length are required, Supplementary Requirement S1 shall be specified.

3.1.5 Type of bolt: Type 1 or 3. When type is not specified, either Type 1 or Type 3 shall be furnished at the supplier's option.

3.1.6 ASTM designation and year of issue.

3.1.7 Other components such as nuts, washers, and compressible washer-type direct-tension indicators, if required.

3.1.7.1 When such other components are specified to be furnished, also state "Nuts, washers, and direct tension indicators, or combination thereof, shall be furnished by lot number."

3.1.8 *Zinc Coating*—Specify the zinc coating process required, for example, hot dip, mechanically deposited, or no preference (see 4.3).

3.1.9 *Other Finishes*—Specify other protective finish, if required.

3.1.10 Test reports, if required (see Section 13).

3.1.11 Supplementary or special requirements, if required.

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

NOTE 3—A typical ordering description follows: 1000 pieces 1½-7 UNC in. dia × 4 in. long heavy hex structural bolt, *Type 1 ASTM A 325-02*, each with one hardened washer, ASTM F 436 Type 1, and one heavy hex nut, ASTM A 563 Grade DH. Each component hot-dip zinc-coated. Nuts lubricated.

3.2 *Recommended Nuts:*

3.2.1 Nuts conforming to the requirements of Specification A 563 are the recommended nuts for use with Specification A 325 heavy hex structural bolts. The nuts shall be of the class and have a surface finish for each type of bolt as follows:

Bolt Type and Finish	Nut Class and Finish
1, plain (noncoated)	A 563-C, C 3, D, DH, DH3, plain
1, zinc coated	A 563-DH, zinc coated
3, plain	A 563-C3, DH3, plain

3.2.2 Alternatively, nuts conforming to Specification A 194/A 194M Gr. 2H are considered a suitable substitute for use with Specification A 325 Type 1 heavy hex structural bolts.

3.2.3 When Specification A 194/A 194M Gr. 2H zinc-coated nuts are supplied, the zinc coating, overtapping, lubrication, and rotational capacity testing shall be in accordance with Specification A 563.

3.3 *Recommended Washers:*

3.3.1 Washers conforming to Specification F 436 are the recommended washers for use with Specification A 325 heavy hex structural bolts. The washers shall have a surface finish for each type of bolt as follows:

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

3.4 *Other Accessories:*

3.4.1 When compressible washer type direct tension indicators are specified to be used with these bolts, they shall conform to Specification F 959 Type 325.

**4. Materials and Manufacture**

4.1 *Heat Treatment:*

4.1.1 Type 1 bolts produced from medium carbon steel shall be quenched in a liquid medium from the austenitizing temperature. Type 1 bolts produced from medium carbon steel to which chromium, nickel, molybdenum, or boron were intentionally added shall be quenched only in oil from the austenitizing temperature.

4.1.2 Type 3 bolts shall be quenched only in oil from the austenitizing temperature.

4.1.3 Type 1 bolts, regardless of the steel used, and Type 3 bolts shall be tempered by reheating to not less than 800°F.

4.2 *Threading*—Threads shall be cut or rolled.

4.3 *Zinc Coatings, Hot-Dip and Mechanically Deposited:*

4.3.1 When zinc-coated fasteners are required, the purchaser shall specify the zinc coating process, for example, hot dip, mechanically deposited, or no preference.

4.3.2 When hot-dip is specified, the fasteners shall be zinc-coated by the hot-dip process and the coating shall conform to the coating weight/thickness and performance requirements of Class C of Specification A 153.

4.3.3 When mechanically deposited is specified, the fasteners shall be zinc-coated by the mechanical deposition process and the coating shall conform to the coating weight/thickness and performance requirements of Class 50 of Specification B 695.

4.3.4 When no preference is specified, the supplier shall furnish either a hot-dip zinc coating in accordance with Specification A 153, Class C, or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. Threaded components (bolts and nuts) shall be coated by the same zinc-coating process and the supplier's option is limited to one process per item with no mixed processes in a lot.

4.4 *Lubrication*—When zinc-coated nuts are ordered with the bolts, the nuts shall be lubricated in accordance with Specification A 563, Supplementary Requirement S1, to minimize galling.

<sup>10</sup> *Annual Book of ASTM Standards*, Vol 03.02.

<sup>11</sup> Available from ASME International, Information Central, 22 Law Dr., PO Box 2300, Fairfield, NJ 07007-2300

<sup>12</sup> Available from USA Information Systems, Inc., 1092 Laskin Rd., Ste. 208, Virginia Beach, VA 23451.

**4.5 Secondary Processing:**

4.5.1 If any processing, which can affect the mechanical properties or performance of the bolts, is performed after the initial testing, the bolts shall be retested for all specified mechanical properties and performance requirements affected by the reprocessing.

4.5.2 When the secondary process is heat treatment, the bolts shall be tested for all specified mechanical properties. Hot dip zinc-coated bolts shall be tested for all specified mechanical properties and rotational capacity. If zinc-coated nuts are relubricated after the initial rotational capacity tests, the assemblies shall be retested for rotational capacity.

**5. Chemical Composition**

5.1 Type 1 bolts shall be plain carbon steel, carbon boron steel, alloy steel or alloy boron steel at the manufacturer’s option, conforming to the chemical composition specified in Table 1.

5.2 Type 3 bolts shall be weathering steel and shall conform to one of the chemical compositions specified in Table 2. The selection of the chemical composition, A, B, C, D, E, or F, shall be at the option of the bolt manufacturer. See Guide G 101 for methods of estimating the atmospheric corrosion resistance of low alloy steels.

5.3 Product analyses made on finished bolts representing each lot shall conform to the product analysis requirements specified in Table 1 and Table 2, as applicable.

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

5.5 Compliance with 5.4 shall be based on certification that heats of steel having any of the listed elements intentionally added were not used to produce the bolts.

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

**6. Mechanical Properties**

6.1 *Hardness*—The bolts shall conform to the hardness specified in Table 3.

**6.2 Tensile Properties:**

6.2.1 Except as permitted in 6.2.2 for long bolts and 6.2.3 for short bolts, sizes 1.00 in. and smaller having a length of  $2\frac{1}{4}D$  and longer, and sizes larger than 1.00 in. having a length of  $3D$  and longer, shall be wedge tested full size and shall conform to the minimum wedge tensile load and proof load or alternative proof load specified in Table 4. The load achieved during proof load testing shall be equal to or greater than the specified proof load.

6.2.2 When the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements specified in Table 5. When bolts are tested by both full-size and machined specimen methods, the full-size test shall take precedence.

6.2.3 Sizes 1.00 in. and smaller having a length shorter than  $2\frac{1}{4}D$  down to  $2D$ , inclusive, that cannot be wedge tensile tested shall be axially tension tested full size and shall conform to the minimum tensile load and proof load or alternate proof load specified in Table 4. Sizes 1.00 in. and smaller having a

**TABLE 1 Chemical Requirements for Type 1 Bolts**

Element	Carbon Steel	
	Heat Analysis	Product Analysis
Carbon	0.30–0.52	0.28–0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.040	0.048
Sulfur, max	0.050	0.058
Silicon	0.15–0.30	0.13–0.32

  

Element	Carbon Boron Steel	
	Heat Analysis	Product Analysis
Carbon	0.30–0.52	0.28–0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.040	0.048
Sulfur, max	0.050	0.058
Silicon	0.10–0.30	0.08–0.32
Boron	0.0005–0.003	0.0005–0.003

  

Element	Alloy Steel	
	Heat Analysis	Product Analysis
Carbon	0.30–0.52	0.28–0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Silicon	0.15–0.35	0.13–0.37
Alloying Elements	<sup>A</sup>	<sup>A</sup>

  

Element	Alloy Boron Steel	
	Heat Analysis	Product Analysis
Carbon	0.30–0.52	0.28–0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Silicon	0.15–0.35	0.13–0.37
Boron	0.0005–0.003	0.0005–0.003
Alloying Elements	<sup>A</sup>	<sup>A</sup>

<sup>A</sup> Steel, as defined by the American Iron and Steel Institute, shall be considered to be alloy when the maximum of the range given for the content of alloying 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.

length shorter than  $2D$  that cannot be axially tensile tested shall be qualified on the basis of hardness.

6.2.4 For bolts on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event of low hardness readings.

**6.3 Rotational Capacity Test:**

6.3.1 *Definition*—The rotational capacity test is intended to evaluate the presence of a lubricant, the efficiency of the lubricant, and the compatibility of assemblies as represented by the components selected for testing.

6.3.2 *Requirement*—Zinc-coated bolts, zinc-coated washers, and zinc-coated and lubricated nuts tested full size in an assembled joint or tension measuring device, in accordance with 10.2, shall not show signs of failure when subjected to the nut rotation in Table 6. The test shall be performed by the



**TABLE 2 Chemical Requirements for Type 3 Heavy Hex Structural Bolts<sup>A</sup>**

Element	Composition, %					
	Type 3 Bolts <sup>A</sup>					
	A	B	C	D	E	F
Carbon:						
Heat analysis	0.33–0.40	0.38–0.48	0.15–0.25	0.15–0.25	0.20–0.25	0.20–0.25
Product analysis	0.31–0.42	0.36–0.50	0.14–0.26	0.14–0.26	0.18–0.27	0.19–0.26
Manganese:						
Heat analysis	0.90–1.20	0.70–0.90	0.80–1.35	0.40–1.20	0.60–1.00	0.90–1.20
Product analysis	0.86–1.24	0.67–0.93	0.76–1.39	0.36–1.24	0.56–1.04	0.86–1.24
Phosphorus:						
Heat analysis	0.035 max	0.06–0.12	0.035 max	0.035 max	0.035 max	0.035 max
Product analysis	0.040 max	0.06–0.125	0.040 max	0.040 max	0.040 max	0.040 max
Sulfur:						
Heat analysis	0.040 max	0.040 max	0.040 max	0.040 max	0.040 max	0.040 max
Product analysis	0.045 max	0.045 max	0.045 max	0.045 max	0.045 max	0.045 max
Silicon:						
Heat analysis	0.15–0.35	0.30–0.50	0.15–0.35	0.25–0.50	0.15–0.35	0.15–0.35
Product analysis	0.13–0.37	0.25–0.55	0.13–0.37	0.20–0.55	0.13–0.37	0.13–0.37
Copper:						
Heat analysis	0.25–0.45	0.20–0.40	0.20–0.50	0.30–0.50	0.30–0.60	0.20–0.40
Product analysis	0.22–0.48	0.17–0.43	0.17–0.53	0.27–0.53	0.27–0.63	0.17–0.43
Nickel:						
Heat analysis	0.25–0.45	0.50–0.80	0.25–0.50	0.50–0.80	0.30–0.60	0.20–0.40
Product analysis	0.22–0.48	0.47–0.83	0.22–0.53	0.47–0.83	0.27–0.63	0.17–0.43
Chromium:						
Heat analysis	0.45–0.65	0.50–0.75	0.30–0.50	0.50–1.00	0.60–0.90	0.45–0.65
Product analysis	0.42–0.68	0.47–0.83	0.27–0.53	0.45–1.05	0.55–0.95	0.42–0.68
Vanadium:						
Heat analysis	<i>B</i>	<i>B</i>	0.020 min	<i>B</i>	<i>B</i>	<i>B</i>
Product analysis	<i>B</i>	<i>B</i>	0.010 min	<i>B</i>	<i>B</i>	<i>B</i>
Molybdenum:						
Heat analysis	<i>B</i>	0.06 max	<i>B</i>	0.10 max	<i>B</i>	<i>B</i>
Product analysis	<i>B</i>	0.07 max	<i>B</i>	0.11 max	<i>B</i>	<i>B</i>
Titanium:						
Heat analysis	<i>B</i>	<i>B</i>	<i>B</i>	0.05 max	<i>B</i>	<i>B</i>
Product analysis	<i>B</i>	<i>B</i>	<i>B</i>	0.06 max	<i>B</i>	<i>B</i>

<sup>A</sup> A, B, C, D, E, and F are classes of material used for Type 3 bolts. Selection of a class shall be at the option of the bolt manufacturer.

<sup>B</sup> These elements are not specified or required.

**TABLE 3 Hardness Requirements for Bolts**

Bolt Size, in.	Bolt Length, in.	Brinell		Rockwell C	
		Min	Max	Min	Max
½ to 1, incl	Less than 2 <i>D</i> <sup>A</sup>	253	319	25	34
	2 <i>D</i> and over	...	319	...	34
1½ to 1½, incl	Less than 3 <i>D</i> <sup>A</sup>	223	286	19	30
	3 <i>D</i> and over	...	286	...	30

<sup>A</sup> Sizes 1.00 in. and smaller having a length shorter than 2*D* and sizes larger than 1.00 in. having a length shorter than 3*D* are subject only to minimum and maximum hardness.

*D* = Nominal diameter or thread size.

responsible party (see Section 14) prior to shipment after zinc coating and lubrication of nuts (see 10.2 and Note 5).

6.3.3 *Acceptance Criterion*—The bolt and nut assembly shall be considered as non-conforming if the assembly fails to pass any one of the following specified requirements:

6.3.3.1 Inability to install the assembly to the nut rotation in Table 6.

6.3.3.2 Inability to remove the nut after installing to the rotation specified in Table 6.

6.3.3.3 Shear failure of the threads as determined by visual examination of bolt and nut threads following removal.

6.3.3.4 Torsional or torsional/tension failure of the bolt. Elongation of the bolt, in the threads between the nut and bolt head, is to be expected at the required rotation and is not to be classified as a failure.

## 7. Dimensions

### 7.1 Head and Body:

7.1.1 The bolts shall conform to the dimensions for heavy hex structural bolts specified in ANSI/ASME B18.2.6.

7.1.2 The thread length shall not be changed except as provided in Supplementary Requirement S1. Bolts with thread lengths other than those required by this specification shall be ordered under Specification A 449.



**TABLE 4 Tensile Load Requirements for Full-Size Bolts**

Bolt Size, Threads per Inch, and Series Designation	Stress Area, <sup>A</sup> in. <sup>2</sup>	Tensile Load, <sup>B</sup> min, lbf	Proof Load, <sup>B</sup> Measurement Method	Alternative Proof Load, <sup>B</sup> Yield Strength Method
Column 1	Column 2	Column 3	Column 4	Column 5
1/2-13 UNC	0.142	17 050	12 050	13 050
5/8-11 UNC	0.226	27 100	19 200	20 800
3/4-10 UNC	0.334	40 100	28 400	30 700
7/8-9 UNC	0.462	55 450	39 250	42 500
1-8 UNC	0.606	72 700	51 500	55 750
1 1/8-7 UNC	0.763	80 100	56 450	61 800
1 1/8-8 UN	0.790	82 950	58 450	64 000
1 1/4-7 UNC	0.969	101 700	71 700	78 500
1 1/4-8 UN	1.000	105 000	74 000	81 000
1 3/8-6 UNC	1.155	121 300	85 450	93 550
1 3/8-8 UN	1.233	129 500	91 250	99 870
1 1/2-6 UNC	1.405	147 500	104 000	113 800
1 1/2-8 UN	1.492	156 700	110 400	120 850

<sup>A</sup> The stress area is calculated as follows:

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

where:

- A<sub>s</sub> = stress area, in.<sup>2</sup>,
- D = nominal bolt size, and
- n = threads per inch.

<sup>B</sup> Loads tabulated are based on the following:

Bolt Size, in.	Column 3	Column 4	Column 5
1/2 to 1, incl	120 000 psi	85 000 psi	92 000 psi
1 1/8 to 1 1/2, incl	105 000 psi	74 000 psi	81 000 psi

### 7.2 Threads:

7.2.1 *Uncoated*—Threads shall be the Unified Coarse Thread Series as specified in ANSI/ASME B1.1, and shall have Class 2A tolerances.

7.2.2 *Coated*—Unless otherwise specified, zinc-coated bolts to be used with zinc-coated nuts or tapped holes that are tapped oversize, in accordance with Specification A 563, shall have Class 2A threads before hot-dip or mechanically deposited zinc coating. After zinc coating, the maximum limits of pitch and major diameter shall not exceed the Class 2A limit by more than the following amounts:

Nominal Bolt Diameter (in.)	Oversize Limit, in. <sup>A</sup>	
	Hot-Dip Zinc	Mechanical Zinc
1/2	0.018	0.012
5/16, 5/8, 3/4	0.020	0.013
7/8	0.022	0.015
1 to 1 1/4	0.024	0.016
1 3/8, 1 1/2	0.027	0.018

<sup>A</sup> Hot-dip zinc nuts are tapped oversize after coating, and mechanical zinc-coated nuts are tapped oversize before coating.

7.2.3 The gaging limit for bolts shall be verified during manufacture. In case of dispute, a calibrated thread ring gage of the same size as the oversize limit in 7.2.2 (Class X tolerance, gage tolerance plus) shall be used to verify compliance. The gage shall assemble with hand effort following application of light machine oil to prevent galling and damage to the gage. These inspections, when performed to resolve controversy, shall be conducted at the frequency specified in the quality assurance provisions of ASME B18.2.6.

## 8. Workmanship

8.1 The allowable limits, inspection, and evaluation of the surface discontinuities, quench cracks, forging cracks, head bursts, shear bursts, seams, folds, thread laps, voids, tool marks, nicks, and gouges shall be in accordance with Specification F 788/F 788M (See Note 4).

NOTE 4—Specification F 788/F 788M nor F 1470 guarantee 100% freedom from head bursts. Sampling is designed to provide a 95% confidence level of freedom from head bursts in any test lot. Head bursts, within the limits in Specification F 788/F 788M, are unsightly but do not affect mechanical properties or functional requirements of the bolt.

## 9. Number of Tests and Retests

### 9.1 Testing Responsibility:

9.1.1 Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot identification control quality assurance plan in 9.2 through 9.5.

9.1.2 When bolts are furnished by a source other than the manufacturer, the Responsible Party as defined in 14 shall be responsible for assuring all tests have been performed and the bolts comply with the requirements of this specification (see 4.5).

9.2 *Purpose of Lot Inspection*—The purpose of a lot inspection program is to ensure that each lot conforms to the requirements of this specification. For such a plan to be fully effective it is essential that secondary processors, distributors, and purchasers maintain the identification and integrity of each lot until the product is installed.

9.3 *Lot Method*—All bolts shall be processed in accordance with a lot identification-control quality assurance plan. The manufacturer, secondary processors, and distributors shall identify and maintain the integrity of each production lot of bolts from raw-material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot-identification number, each lot shall be tested, and the inspection test reports for each lot shall be retained.

9.4 *Lot Definition*—A lot shall be a quantity of uniquely identified heavy hex structural bolts of the same nominal size and length produced consecutively at the initial operation from a single mill heat of material and processed at one time, by the same process, in the same manner so that statistical sampling is valid. The identity of the lot and lot integrity shall be maintained throughout all subsequent operations and packaging.



**TABLE 5 Tensile Strength Requirements for Specimens Machined from Bolts**

Bolt Diameter, in.	Tensile Strength, min, psi (MPa)	Yield Strength, min, psi (MPa)	Elongation, in 4D, min, %	Reduction of Area, min, %
½ to 1, incl.	120 000 (825)	92 000 (635)	14	35
Over 1 to 1½	105 000 (725)	81 000 (560)	1435	

**TABLE 6 Rotational Capacity Test for Zinc-Coated Bolts**

Bolt Length, in.	Nominal Nut Rotation, degrees (turn)
Up to and including 4 × dia	240 (⅔)
Over 4 × dia, but not exceeding 8 × dia	360 (1)
Over 8 × dia, but not exceeding 12 × dia	420 (1⅙)
Over 12 × dia.	Test not applicable

9.5 *Number of Tests*—The minimum number of tests from each lot for the tests specified below shall be as follows:

Tests	Number of Tests in Accordance With
Hardness, tensile strength, proof load, and rotational capacity	Guide F 1470
Coating weight/thickness	The referenced coating specification <sup>A</sup>
Surface discontinuities	Specification F 788/ F 788M
Dimensions and thread fit	ASME B18.2.6

<sup>A</sup> Guide F 1470 applies if the coating specification does not specify a testing frequency.

## 10. Test Methods

### 10.1 *Tensile, Proof Load, and Hardness:*

10.1.1 Tensile, proof load, and hardness tests shall be conducted in accordance with Test Methods F 606.

10.1.2 Tensile strength shall be determined using the Wedge or Axial Tension Testing Method of Full Size Product Method or the Machined Test Specimens Method depending on size and length as specified in 6.2.1-6.2.4. Fracture on full-size tests shall be in the body or threads of the bolt without a fracture at the junction of the head and body.

10.1.3 Proof load shall be determined using Method 1, Length Measurement, or Method 2, Yield Strength, at the option of the manufacturer.

10.2 *Rotational Capacity*—The zinc-coated bolt shall be placed in a steel joint or tension measuring device and assembled with a zinc-coated washer and a zinc-coated and lubricated nut with which the bolt is intended to be used (see Note 5). The nut shall have been provided with the lubricant described in the last paragraph of the Manufacturing Processes section of Specification A 563. The joint shall be one or more flat structural steel plates or fixture stack up with a total thickness, including the washer, such that 3 to 5 full threads of the bolt are located between the bearing surfaces of the bolt head and nut. The hole in the joint shall have the same nominal diameter as the hole in the washer. The initial tightening of the nut shall produce a load in the bolt not less than 10 % of the

specified proof load. After initial tightening, the nut position shall be marked relative to the bolt, and the rotation shown in Table 6 shall be applied. During rotation, the bolt head shall be restrained from turning.

NOTE 5—Rotational capacity tests shall apply only to matched assembly lots that contain on A 325 bolt, one A 563 lubricated nut, and one F 436 washer that have been zinc coated in accordance with either Specifications A 153 or B 695. Both the bolt and nut components of the matched assembly shall be zinc coated using the same process.

## 11. Inspection

11.1 If the inspection described in 11.2 is required by the purchaser, it shall be specified in the inquiry and contract or order.

11.2 The purchaser’s representative shall have free entry to all parts of the manufacturer’s works, or supplier’s place of business, that concern the manufacture or supply of the material ordered. The manufacturer or supplier shall afford the purchaser’s representative all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser’s representative shall be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the manufacturer’s works or supplier’s place of business.

## 12. Rejection and Rehearing

12.1 Disposition of nonconforming bolts shall be in accordance with the Guide F 1470 section titled “Disposition of Nonconforming Lots.”

## 13. Certification

13.1 When specified on the purchase order, the manufacturer or supplier, whichever is the responsible party as defined in Section 14, shall furnish the purchaser a test reports that includes the following:

13.1.1 Heat analysis, heat number, and a statement certifying that heats having the elements listed in 5.4 intentionally added were not used to produce the bolts,

13.1.2 Results of hardness, tensile, and proof load tests,

13.1.3 Results of rotational capacity tests. This shall include the test method used (solid plate or tension measuring device); and the statement “Nuts lubricated” for zinc-coated nuts when shipped with zinc-coated bolts,

13.1.4 Zinc coating measured coating weight/thickness for coated bolts,

13.1.5 Results of visual inspection for head bursts,

13.1.6 Statement of compliance with dimensional and thread fit requirements,

13.1.7 Lot number and purchase order number,

13.1.8 Complete mailing address of responsible party, and

13.1.9 Title and signature of the individual assigned certification responsibility by the company officers.



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13.2 Failure to include all the required information on the test report shall be cause for rejection.

### 14. Responsibility

14.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser and certifies that the fastener was manufactured, sampled, tested and inspected in accordance with this specification and meets all of its requirements.

### 15. Product Marking

15.1 *Manufacturer's Identification*—All Type 1 and 3 bolts shall be marked by the manufacturer with a unique identifier to identify the manufacturer or private label distributor, as appropriate.

15.2 *Grade Identification*:

15.2.1 Type 1 bolts shall be marked "A 325."

15.2.2 Type 3 bolts shall be marked "A 325" with the "A 325" underlined. The use of additional distinguishing marks to indicate that the bolts are weathering steel shall be at the manufacturer's option.

15.3 *Marking Location and Methods*—All marking shall be located on the top of the bolt head and shall be either raised or depressed at the manufacturer's option.

15.4 *Acceptance Criteria*—Bolts which are not marked in accordance with these provisions shall be considered nonconforming and subject to rejection.

15.5 Type and manufacturer's or private label distributor's identification shall be separate and distinct. The two identi-

cations shall preferably be in different locations and, when on the same level, shall be separated by at least two spaces.

### 16. Packaging and Package Marking

16.1 *Packaging*:

16.1.1 Unless otherwise specified, packaging shall be in accordance with Practice D 3951.

16.1.2 When zinc coated nuts are included on the same order as zinc coated bolts, the bolts and nuts shall be shipped in the same container.

16.1.3 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

16.2 *Package Marking*:

16.2.1 Each shipping unit shall include or be plainly marked with the following information:

16.2.1.1 ASTM designation and type,

16.2.1.2 Size,

16.2.1.3 Name and brand or trademark of the manufacturer,

16.2.1.4 Number of pieces,

16.2.1.5 Lot number; when nuts, washers or direct tension indicators, or combination thereof, are ordered with A 325 heavy hex structural bolts, the shipping unit shall be marked with the lot number in addition to the marking required by the applicable product specification,

16.2.1.6 Purchase order number, and

16.2.1.7 Country of origin.

### 17. Keywords

17.1 bolts; carbon steel; steel; structural; weathering steel

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the contract or order. Details of these supplementary requirements shall be agreed upon in writing between the manufacturer and purchaser. Supplementary requirements shall in no way negate any requirement of the specification itself.

### S1. Bolts Threaded Full Length

S1.1 Bolts with nominal lengths equal to or shorter than four times the nominal bolt diameter shall be threaded full length. Bolts need not have a shoulder, and the distance from the underhead bearing surface to the first complete (full form) thread, as measured with a GO thread ring gage, assembled by

hand as far as the thread will permit, shall not exceed the length of  $2\frac{1}{2}$  threads for bolt sizes 1 in. and smaller, and  $3\frac{1}{2}$  threads for bolt sizes larger than 1 in.

S1.2 Bolts shall be marked in accordance with Section 15, except that the symbol shall be "A 325 T" instead of "A 325."



## SUMMARY OF CHANGES

This section identifies the location of selected changes to this standard that have been incorporated since the -01 issue. For the convenience of the user, Committee F16 has highlighted those changes that impact the use of this standard. This section may also include descriptions of the changes or reasons for the changes, or both.

- (1) In 1.4 limited specification to heavy hex structural bolts only.
- (2) In 4.1 revised to require that Type 3 bolts be quenched in oil.
- (3) In 4.5.1 revised to require retesting only for properties affected by the secondary processing.
- (4) In 4.5.2 rephrased to preclude the implication that black bolts require rotational capacity testing.
- (5) In Table 2, reduced the phosphorus limits for compositions A, D, E, and F and the sulfur limits for compositions A, B, and D.
- (6) In 6.2.1 revised the minimum length for full-size wedge testing.
- (7) In 6.2.3 provided for full-size axially tension testing bolts shorter than  $2\frac{1}{4}D$  down to  $2D$ . Also added requirements for qualifying short bolts on the basis of hardness.
- (8) In Table 3, Hardness, changed  $3D$  to  $2D$  for sizes 1.00 in. and smaller
- (9) Added Table 5 specifying tensile, elongation, and reduction in area requirements for machined specimens.
- (10) In 7.1.1 deleted all wording that permitted the purchaser to specify dimensions other than “heavy hex structural.”
- (11) In 7.1.1 changed the dimensional reference from B18.2.1 to B18.2.6.
- (12) 7.2.2 revised to specify maximum pitch and major diameter limits for mechanically coated bolts.
- (13) Deleted Table 7 (formerly Table 6), “Sample Size for Inspection of Hot-Dip or Mechanically Deposited Zinc-Coated Threads” and referenced ASME B18.2.6, which includes references for testing frequency.
- (14) Deleted former section 9, “Head Bursts,” and included the requirements by reference to Specification F 788/F 788M in 8.1.
- (15) In 9.3 and 9.4 changed “Production Lot” to “Lot” and redefined “Lot.”
- (16) 9.5, “Number of Tests,” revised to invoke Specification F 1470 for hardness, tensile, proof load, and rotational capacity tests. Coating weight/thickness and surface discontinuities sampling referenced to the applicable spec. Dimensional and thread compliance sampling referenced to ASME B18.2.6.
- (17) Section 12, “Rejection and Rehearing,” revised to invoke F 1470.
- (18) In 15.2.1 deleted option permitting marking with three radial lines  $120^\circ$  apart.

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