



Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions¹

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1. Scope

1.1 This specification covers chemical, physical and mechanical requirements for quenched and tempered bolts manufactured from steel and alloy steel, in inch and metric dimensions, in two strength grades, two types and two styles.

1.1.1 This specification is a consolidation and replacement of six ASTM standards, including; A325, A325M, A490, A490M, F1852 and F2280.

1.1.2 This consolidated standard is to ensure alignment between standards with the same intended end use and to simplify the use and maintenance of structural bolt specifications.

1.2 Intended Use:

1.2.1 Bolts manufactured under this specification are intended for use in structural connections covered in the Specification for Structural Joints Using High-Strength Bolts, as approved by the Research Council on Structural Connections.

1.2.2 Bolts in this specification are furnished in sizes from ½ to 1-½ in. inclusive and from M12 to M36 inclusive.

1.3 Classification:

1.3.1 Bolts are designated by grade or property class, which indicates inch or metric respectively.

1.3.2 Bolts are designated by type denoting raw material chemical composition.

1.3.3 Bolts are designated by style denoting Heavy Hex bolts or “Twist-Off” Style assemblies.

Grade	Min. Strength	Type	Style
A325	120 ksi	1 3	Heavy Hex Head
A325M	830 MPa	1 3	Heavy Hex Head
F1852	120 ksi	1 3	Twist-Off
A490	150 ksi	1 3	Heavy Hex Head
A490M	1040 MPa	1 3	Heavy Hex Head
F2280	150 ksi	1 3	Twist-Off

Type 1 - 120 ksi (830 MPa) - carbon steel, carbon boron steel, alloy steel or alloy steel with boron addition

Type 3 - 120 ksi (830 MPa) or 150 ksi (1040 MPa) - weathering steel
Type 1 - 150 ksi (1040 MPa) - alloy steel or alloy steel with boron addition

1.4 Terms used in this specification are defined in **F1789**.

1.5 *Units*—The values stated in either SI units or inch pound units are to be regarded separately as standard. 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.

1.6 Table footnotes are requirements. Notes are advisory.

1.7 *The following safety hazard caveat pertains to the test methods portion 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:²

A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A449 Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

A563 Specification for Carbon and Alloy Steel Nuts

A563M Specification for Carbon and Alloy Steel Nuts (Metric)

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

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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.



E709 Guide for Magnetic Particle Testing
 E1444/E1444M Practice for Magnetic Particle Testing
 F436 Specification for Hardened Steel Washers
 F436M Specification for Hardened Steel Washers (Metric)
 F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
 F788 Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
 F1136/F1136M Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
 F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
 F1789 Terminology for F16 Mechanical Fasteners
 F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners
 F2328 Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts
 F2328M Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts (Metric)
 F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
 F2660 Test Method for Qualifying Coatings for Use on A490 Structural Bolts Relative to Environmental Hydrogen Embrittlement
 F2833 Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
 G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels
 2.2 *ASME Standards:*³
 B1.1 Unified Screw Threads
 B1.13M Metric Screw Threads
 B18.18 Quality Assurance for Fasteners
 B18.2.6 Fasteners for Use in Structural Applications
 B18.2.6M Metric Fasteners for Use in Structural Applications
 2.3 *IFI Standard:*⁴
 IFI 144 Test Evaluation Procedures for Coating Qualification
 2.4 *RCSC Standard:*⁵
 Specification for Structural Joints Using High-Strength Bolts

3. Ordering Information

3.1 Orders for bolts under this specification shall include:
 3.1.1 *ASTM designation.*
 3.1.2 *Quantity:* Number of bolts or assemblies, including washers, if required.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁴ Industrial Fasteners Institute (IFI), 6363 Oak Tree Blvd. Independence, OH 44131. <http://www.indfast.org>

⁵ Research Council on Structural Connections (RCSC), <http://boltcouncil.org>

3.1.3 *Size:* Including nominal bolt diameter and bolt length, and thread pitch if other than standard.

3.1.4 *Grade:* A325, A325M, A490, A490M, F1852 or F2280.

3.1.5 *Type:* Type 1 or Type 3. When Type is not specified either Type 1 or Type 3 may be furnished at the supplier's option.

3.1.6 *Style:* Heavy Hex or Twist-Off Style.

3.1.7 *Coatings or finishes:* If other than plain finish, specify the coating process or finish required, see **Annex A1**.

3.2 *Test reports,* see Section 14.

3.3 Additional details of other assembly components such as nuts and washers, if required.

3.4 Rotational capacity testing of matched sets or assemblies in accordance with **Annex A2**, if required by the purchaser.

3.5 Heavy Hex bolts may be ordered individually, packaged with nuts, packaged with nuts and washers, or as assemblies.

3.6 Any special observation or inspection requirements shall be specified at the time of inquiry and at the time of order. See Section 13.2.

3.7 Any supplementary requirements.

3.8 Country of origin requirements, if any.

NOTE 1—A typical description follows: 1000 pieces 3/4" × 3" ASTM F3125–15, Grade A325 heavy hex bolt, Type 1, each with one hardened ASTM F436 Type 1 washer, and one A563 Grade DH heavy hex nut.

NOTE 2—Bolts are sometimes detailed with names such as A325 HS, A325 SC, A325 X or A490 N. These names relate to connection design and bolt installation, but do not change the manufacturing requirements and are preferably not shown on bolt orders.

4. Dimensions

4.1 Head and Body:

4.1.1 Bolts shall conform to the dimensions specified in **Table 1** for Heavy Hex or Twist-Off bolts.

4.1.2 The thread length shall not be changed except as provided in Supplementary Requirement S1 or S2. Other dimensions shall not be changed except in accordance with Supplementary Requirement S2.

4.1.3 Bolts with thread lengths or dimensional requirements which differ from this specification may also be ordered under Specification A449 or A354. Users should note that A449 and A354 are not exact equivalents to the structural grades in this specification.

4.2 Threads:

4.2.1 Uncoated bolt threads shall be as specified in **Table 1**.

4.2.2 Coated bolts shall have threads meeting **Table 1** requirements before coating.

4.3 The gauging limit for coated bolts shall be verified during manufacture. In case of dispute, a calibrated thread ring gauge of the same size as the oversize limit in **Annex A1** (Class X tolerance, gauge tolerance plus) shall be used to verify compliance. The gauge shall assemble with hand effort following application of light machine oil to prevent galling and damage to the gauge. These inspections, when performed to resolve controversy, shall be conducted at the frequency specified in the quality provisions of **Annex A1**.



TABLE 1 Dimensions, Threads, Marking, Matching Components

	Inch		Metric		Inch		Metric	
	120 ksi Min Tensile		830 MPa Min Tensile		150 ksi Min Tensile		1040 MPa Min Tensile	
	Type 1	Type 3	Type 1	Type 3	Type 1	Type 3	Type 1	Type 3
Style - Heavy Hex Bolts								
Dimensions, ASME ^B	B18.2.6	B18.2.6	B18.2.6M	B18.2.6M	B18.2.6	B18.2.6	B18.2.6M	B18.2.6M
Thread Fit, ASME ^B	B1.1 UNC 2A	B1.1 UNC 2A	B1.13M MC 6g	B1.13M MC 6g	B1.1 UNC 2A	B1.1 UNC 2A	B1.13M MC 6g	B1.13M MC 6g
Grade Marking ^{A,D}	A325	A325	A325M	A325M	A490	A490	A490M	A490M
Style - Twist-Off Bolts								
Dimensions, ASME ^B	B18.2.6	B18.2.6	F	F	B18.2.6	B18.2.6	F	F
Thread Fit, ASME ^B	B1.1 UNC 2A	B1.1 UNC 2A	F	F	B1.1 UNC 2A	B1.1 UNC 2A	F	F
Grade Marking ^{A,D}	A325TC	A325TC	F	F	A490TC	A490TC	F	F
Alt. Marking ^{A,C}	A325	A325	F	F	A490	A490	F	F
Recommended Nut and Washer								
Plain Nut	A563 DH	A563 DH3	A563M 10S	A563M 10S3	A563 DH	A563 DH3	A563M 10S	A563M 10S3
Suitable Alternative ^E	DH3, D, C, C3	C3	8S, 8S3, 10S3	8S3			10S3	
Coated Nut	A563 DH	A563 DH3	A563M 10S	A563M 10S3	A563 DH	A563 DH3	A563M 10S	A563M 10S3
Flat, Bevel or								
Thick Washer if used	F436 - 1	F436 - 3	F436M - 1	F436M - 3	F436 - 1	F436 - 3	F436M - 1	F436M - 3

^A A325 and A325M bolts lengths up to 4D which are fully threaded but which are not required to be fully threaded by the relevant ASME standard shall be marked with a “T”, see Supplementary Requirement S1. Bolts with any other non-standard dimensions, including thread length, shall be marked with an “S”, see Supplementary Requirement S2.

^B Manufactured to the latest revision at the time of manufacture, UNC for inch series and Metric Coarse (MC) for Metric Series.

^C Previously used markings may be sold and used indefinitely, bolts must be manufactured to current marking requirements upon initial publication of this standard.

^D Other distinguishing markings for type 3 are permitted at the manufacturers option.

^E ASTM A194/A194M 2H heavy hex inch nuts may be used in place of A563 DH nuts on type 1 A325, A490, F1852 and F2280 bolts. 2H heavy hex metric nuts may be used in place of A563M 10S nuts on type 1 A325M and A490M bolts. When coated 2H nuts are used in place of DH or 10S nuts, the same requirements of A563, A563M, and this specification, including Annex A1, shall apply. These include, but are not limited to, overlap amount, coating grade, lubrication requirements, and proof load testing.

^F Metric dimensions and requirements for this style have not been established.

TABLE 2 Chemical Requirements

Heat Analysis	120 ksi/830 MPa Minimum				150 ksi/1040 MPa Minimum	
	Grade A325, A325M, F1852				Grade A490, A490M, F2280	
	Type 1	Type 3			Type 1	Type 3
	Carbon or Alloy Steel with or without Boron	Composition A	Composition B	Based on Corrosion Index ^C	Alloy Steel with or without Boron	Based on Corrosion Index ^C
Carbon	0.30 - 0.52	0.33 - 0.40	0.38 - 0.48	0.30 - 0.52 max	0.30 - 0.48 ^A	0.30 - 0.53
Manganese	0.60 min	0.90 - 1.20	0.70 - 0.90	0.60 min	0.60 min	0.60 min
Phosphorus, max	0.035	0.035	0.035	0.035	0.035	0.035
Sulfur, max	0.040	0.040	0.040	0.040	0.040	0.040
Silicon	0.15 - 0.30	0.15 - .30	0.30 - 0.50	^B	^B	^B
Boron	0.003 max	^B	^B	^B	0.003 max	^B
Copper	^B	0.25 - 0.45	0.20 - 0.40	0.20 - 0.60	^B	0.20 - 0.60
Nickel	^B	0.25 - 0.45	0.50 - 0.80	0.20 ^D min	^B	0.20 ^D min
Chromium	^B	0.45 - 0.65	0.50 - 0.75	0.45 min	^B	0.45 min
Vanadium	^B	^B	^B	^B	^B	^B
Molybdenum	^B	^B	0.06 max	0.10 ^D min	^B	0.10 ^D min
Titanium	^B	^B	^B	^B	^B	^B

^A Carbon requirement is 0.35-0.53 for 1-½ in. and M36 diameter bolts.

^B Not Specified.

^C See 6.3.

^D Either Nickel or Molybdenum must be present in the amount specified.

NOTE 3—It is the intent of this specification that coated nuts and bolts assemble freely when ordered together. It is recognized that the batch nature of coating process and the cumulative effect of coating thickness may create intermittent assembly problems. Staying within the material limits is important for assembly strength. Users are encouraged to use the smallest nut overlap which permits consistent free assembly.

5. Product Marking

5.1 At a minimum, all bolts shall be marked as required in Table 1. Marking shall be on the bolt head and may be raised

or depressed at the manufacturer’s option. The marking shall be visible after coating.

5.2 Grade and Type marking, and the manufacturer’s mark shall be in separate and distinct locations on the head. Other markings, if used, such as private label distributor’s mark shall also be separate and distinct.

6. Chemical Composition

6.1 120ksi/830MPa Type 1 bolts shall be carbon steel, carbon boron steel, alloy steel or alloy steel with boron addition at the manufacturer's option, conforming to the chemical composition specified in [Table 2](#).

6.2 150ksi/1040MPa bolts Type 1 shall be alloy steel or alloy steel with boron addition at the manufacturer's option, conforming to the chemical composition specified in [Table 2](#). Alloy Steel is defined in Terminology [F1789](#).

6.3 Type 3 bolts shall be weathering steel and shall conform to the chemical compositions specified in [Table 2](#). Optionally, a chemical composition based on a corrosion index may be used. When qualifying based on the corrosion index the steel shall have a corrosion index of 6 or greater, as calculated from the heat analysis, and as described in Guide [G101](#), using the predictive method based on the data of Larabee and Coburn, or the predictive method based on the data of Townsend. See Guide [G101](#) for methods of estimating the atmospheric corrosion resistance of low alloy steels.

6.4 If performed, product analysis made on finished bolts representing each lot shall be within 10% of the value required of the heat analysis. For example; heat analysis C 0.30–0.52 = product analysis C 0.27–0.57.

6.5 Heats to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

6.6 Chemical analysis shall be performed in accordance with [A751](#).

7. Materials and Manufacture

7.1 Production Method:

7.1.1 Bolts shall be cold formed, warm formed, hot formed, hot forged, machined, or any combination thereof.

7.2 Heat Treatment:

7.2.1 All bolts shall be quenched in oil from the austenitizing temperature.

7.2.2 All bolts shall be tempered by reheating to not less than 800°F/427°C.

7.3 Threads may be rolled or cut.

7.4 Coatings and Other Finishes:

7.4.1 Permitted coatings, including supplementary lubrication and nut oversize requirements, are provided in [Annex A1](#).

7.4.2 When coated fasteners are required, the purchaser shall specify the process and any additional special requirements.

7.4.3 Threaded components (bolts and nuts) shall be coated by the same process, limited to one process per item with no mixed processes in a lot.

7.5 Secondary Processing:

7.5.1 Lot control and full traceability shall be maintained throughout all outside or secondary processes.

7.5.2 Lots to which secondary processing has been performed by any party after sale from the manufacturer must be traceable using a lot number which differs from the manufacturer's original lot number.

7.5.3 If processing that can affect mechanical properties is performed after initial testing, the bolts shall be retested for all specified mechanical properties and performance requirements affected by the processing. This processing includes heat treatment, hot-dip zinc coating and other processing that could affect mechanical properties.

7.5.4 Secondary processing, including lubrication, by any party other than that which certified the assembly lot shall not be permitted on a Twist-Off style bolt assembly lot unless under the direction of the manufacturer.

NOTE 4—Twist-Off Style bolt performance is dependent on the torque/tension relationship and alteration of this relationship may have an adverse effect on performance.

8. Test Methods

8.1 Tensile strength, proof load, surface discontinuities, hardness, micro-hardness, carburization/decarburization, coating thickness, magnetic particle, rotational capacity, assembly tension testing and coating thickness tests, as applicable, shall be in accordance with [Table 3](#).

8.1.1 Tensile strength shall be determined using the [F606/F606M](#) Wedge or Axial Tension Testing of Full Size Product Method or the Machined Test Specimens Method depending on size and nominal length as specified in [10.1](#).

8.1.2 Proof load shall be determined using [F606/F606M](#) Method 1, Length Measurement, or Method 2, Yield Strength, at the option of the manufacturer.

8.1.3 Magnetic Particle Inspection shall be conducted on 150 ksi (1040 MPa) bolts, in accordance with [Table 3](#) and [12.1](#).

8.1.4 Carburization/Decarburization Inspection shall be conducted on 150 ksi (1040 MPa) bolts, in accordance with [12.2](#).

9. Testing and Lot Control

9.1 Testing Responsibility:

9.1.1 Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot control and identification quality assurance plan in Sections [9.2](#) through [9.5](#).

9.1.2 When supplied by a source other than the manufacturer, the responsible party shall assure all tests have been performed and the bolts conform to this specification.

9.2 Bolts shall be processed in accordance with a lot control and identification quality assurance plan. The manufacturer, secondary processors, and distributors shall identify and maintain the integrity of each production lot from raw material through all processing operations to final packing and shipment. Each lot shall be assigned a unique lot identification number, each lot shall be tested, and the lot inspection test reports retained.

9.3 Secondary processing shall be processed in accordance with a lot control and identification quality assurance plan.

9.4 A lot shall be a quantity of uniquely identified 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.