



Designation: F3125 – 15

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

This standard is issued under the fixed designation F3125; 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.

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 1/2 to 1-1/2 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 and Alloy 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
- E709 Guide for Magnetic Particle Testing

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 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.

- F1136/F1136M** Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
- 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
- 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
- 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.
- 3.1.3 *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 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>

3.1.5 *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 ¾" × 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 ASME B18.18.

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

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 nuts may be used in place of A563 DH nuts on type 1 A325, A490, F1852 and F2280 bolts. When coated, the same requirements of A563 and this specification, and Annex A1, including overlap, coating, rotational capacity and proof load testing apply.

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

limits is important for assembly strength and 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, 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. The steel shall be qualified as alloy steel, per Table 2 Footnote D.

6.3 Type 3 bolts shall be weathering steel and shall conform to the chemical compositions specified in Table 2. Optionally, the chemical composition may have a Corrosion Index of 6 or greater, as calculated from the Heat Analysis, and as described in Guide G101 Predictive Method, based on the data of Larabee and Coburn. 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 conform to the product analysis requirements specified in Table 2 Footnote C.

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.

7.4.4 Other coatings are not permitted for 150 ksi/1040 MPa minimum strength level fasteners.

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

TABLE 2 Chemical Requirements^C

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 ^D with or without Boron	Composition A	Composition B	Based on Corrosion Index ^E	Alloy ^D Steel with or without Boron	Based on Corrosion Index ^E	
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 - 0.60B	^B	0.20 - 0.60 ^E
Nickel	^B	0.25 - 0.45	0.50 - 0.80	0.20B,C min	^B	0.20 ^{E,F} min
Chromium	^B	0.45 - 0.65	0.50 - 0.75	0.45B min	^B	0.45 ^E min
Vanadium	^B	^B	^B	^B	^B	^B
Molybdenum	^B	^B	0.06 max	0.10B,C min	^B	0.10 ^{E,F} min
Titanium	^B	^B	^B	^B	^B	^B

^A Carbon requirement is increased to 0.35-0.53 Heat analysis for 1-1/2 in. and M36 diameter bolts.

^B Not Specified.

^C Product analysis that is outside the specified range is permitted provided it is 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 or Phosphorus max Heat analysis 0.040 = Product analysis 0.044.

^D 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.

^E Type 3 bolts conforming to Table 2, or Type 3 bolts which have a copper minimum Heat Analysis of 0.20% and a Corrosion Index of 6 or higher as calculated from the Heat Analysis as described in Guide G101 Predictive method based on the data of Larabee and and Coburn shall be accepted:

$$I = 26.01 (\% \text{ Cu}) + 3.88 (\% \text{ Ni}) + 1.20 (\% \text{ Cr}) + 1.49 (\% \text{ Si}) + 17.28 (\% \text{ P}) - 7.29 (\% \text{ Cu}) (\% \text{ Ni}) - 9.10 (\% \text{ Ni}) (\% \text{ P}) - 33.39 (\% \text{ Cu})^2$$

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

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.

9.5 Additional testing for fastener assemblies, such as fastener tension testing and rotational capacity testing also

TABLE 3 Number of Tests and Test Method or Criteria

	Sample Size (Per Lot)	Test Method Inch	Test Method Metric	Notes
All grades, types, styles				
Tensile Strength	F1470	F606/F606M	F606/F606M	Wedge or axial Full size. Machined. See 8.1.1
Proof Load	F1470	F606/F606M	F606/F606M	Method 1 or 2 optional. See 8.1.2
Hardness	F1470	F606/F606M	F606/F606M	
Dimensions and Thread Fit	ASME B18.18	ASME B18.2.6 B1.1 2A	ASME B18.2.6M B1.13M 6g	
Surface Discontinuities	F1470	F788	F788	
Coating Weight/Thickness	F1470 ^B	Product Specification	Product Specification	
150 ksi grades all types and styles				
Magnetic Particle	F1470	F788	F788	Guide E709 or Practice E1444/E1444M
Carburization/Decarburization	At least 1	F2328	F2328M	
All Twist Off assemblies				
Fastener Tension	F1470	This standard		
Rotational Capacity^A				
	F1470	Annex A2	Annex A2	

^A Galvanized assemblies shall be rotational capacity tested by the responsible party using the component lot numbers of the actual assembly. Plain assemblies shall be rotational capacity tested by the responsible party when specified on the inquiry and order. Other coated assemblies shall be rotational capacity tested when specified on the inquiry and order.

^B Use F1470 for sampling if sample requirements are not in the coating specification.

require that the manufacturer or responsible party maintain assembly lot traceability. A unique assembly or rotational capacity lot number shall be created for each change in assembly component lot number, such as nuts or washers.

NOTE 5—The purpose of a lot inspection and control program is to ensure that each lot conforms to this specification and that lot integrity is maintained to the point of use. It is essential that secondary processors, distributors, and users maintain lot identification and integrity until installation.

9.6 Number of Tests:

9.6.1 The minimum number of tests required from each lot or each assembly lot shall be according to F1470 and ASME B18.18. These tests and sample numbers are for final inspection only and shall be in addition to the manufacturer's established internal quality control system and in-process inspection procedures.

9.6.2 Disposition of non-conforming product shall be in accordance with F1470 Section 8.

NOTE 6—Section 9.6.1 is intended to identify a statistically large number of non-conformances but does not assure 100% freedom from non-conforming product.

10. Mechanical Properties

10.1 Tensile Properties:

10.1.1 Except as permitted in 10.1.2 and 10.1.3, diameters 1 in./M24 and smaller having a nominal length of 2 ¼ D and longer, and sizes over 1 in./M24 having a nominal length of 3D and longer, shall be wedge tested full size to F606/F606M and shall conform to the minimum wedge tensile load and proof load or alternative proof load specified in Table 4.

10.1.2 Sizes 1 in./M24 and smaller having a nominal length shorter than 2 ¼ D down to 2D, inclusive, that cannot be wedge tensile tested, shall be axially tension tested full size to F606/F606M and shall conform to the minimum tensile load and proof load or alternate proof load specified in Table 4.

10.1.3 Sizes 1 in./M24 and smaller having a nominal length shorter than 2D and sizes larger than 1 in./M24 with nominal lengths shorter than 3D that cannot be axially tensile tested shall be qualified on the basis of hardness.

10.1.4 Fracture on full-size tests shall be in the threads of the bolt without fracture at the junction of the head and body.

10.1.5 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.

10.2 Hardness:

10.2.1 Bolts shall conform to the hardness in Table 6. For lots on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event of low hardness readings.

11. Requirements Specific to Twist-Off style bolts

11.1 Assembly Installation Tension Test (Fastener Tension):

11.1.1 The assembly lot tension test shall be performed on twist-off style fastener assemblies to determine the ability of the assembly to provide the required minimum tension.

11.1.2 Twist-Off style bolt assembly lots shall be tested by the manufacturer or responsible party to verify conformance to installation tension requirements.

11.1.3 The test assemblies shall consist of one tension control bolt, one nut and at least one washer.

11.1.4 Full size assemblies shall develop a bolt tension when the spline end is separated from the bolt conforming to the minimum requirements in Table 7.

11.2 Lubrication:

11.2.1 Assemblies shall have at least one component lubricated by the manufacturer or responsible party to meet the assembly lot tension requirements.

TABLE 4 Tensile Strength Requirements for Bolts Tested Full Size

		120 ksi - A325, F1852			150 ksi - A490, F2280			
Stress Area ^A		Tensile min	Proof Load ^C min	Proof Load ^D min	Tensile min	Tensile max.	Proof Load ^C min	Proof Load ^D min
in.	in ²	lbf	lbf	lbf	lbf	lbf	lbf	
1/2-13 UNC	0.142	17050	12050	13050	21300	24600	17050	18500
5/8-11 UNC	0.226	27100	19200	20800	33900	39100	27100	29400
3/4-10 UNC	0.334	40100	28400	30700	50100	57800	40100	43400
7/8-9 UNC	0.462	55450	39250	42500	69300	79950	55450	60100
1-8 UNC	0.606	72700	51500	55750	90900	104850	72700	78800
1 1/8-7 UNC	0.763	91600 ^B	64900 ^B	70250 ^B	114450	132000	91550	99200
1 1/4-7 UNC	0.969	116300 ^B	82400 ^B	89200 ^B	145350	167650	116300	126000
1 3/8-6 UNC	1.155	138600 ^B	98200 ^B	106300 ^B	173250	199850	138600	150200
1 1/2-6 UNC	1.405	168600 ^B	119500 ^B	129300 ^B	210750	243100	168600	182600
Above values based on		120000 psi	85000 psi	92000 psi	150000 psi	173000 psi	120000 psi	130000 psi
		830 MPa - A325M			1040 MPa - A490M			
Stress Area ^A		Tensile min.	Proof Load ^C min	Proof Load ^D min	Tensile min.	Tensile max.	Proof Load ^C min	Proof Load ^D min
mm	mm ²	kN	kN	kN	kN	kN	kN	kN
M12 x 1.75 MC	84.3	70	50.6	55.6	87.7	103	70	79.2
M16 x 2.0 MC	157	130	94.2	104	163	190	130	148
M20 x 2.5 MC	245	203	147	162	255	296	203	230
M22 x 2.5 MC	303	251	182	200	315	366	251	285
M24 x 3.0 MC	353	293	212	233	367	427	293	332
M27 x 3.0 MC	459	381	275	303	477	555	381	431
M30 x 3.5 MC	561	466	337	370	583	679	466	527
M36 x 4.0 MC	817	678	490	539	850	989	678	768
Above values based on		830 MPa	600 MPa	660 MPa	1040 MPa	1210 MPa	830 MPa	940 MPa

^A The stress area is calculated as follows for inch: $A_S = 0.7854 [D - (0.9743/P)]^2$; for Metric: $A_S = 0.7854 (D - 0.9382P)^2$; where A_S = Stress Area, D = Nominal Bolt Size, and P = thread pitch.

^B Previous versions of A325 and F1852 required tensile testing based on 105 ksi min. tensile strength for larger diameters, and proof load testing of 74 ksi (length measurement method) and 81 ksi (yield strength method). This specification was changed to align with AISC/RCSC design and installation values and metric equivalent strength levels.

^C Proof load length measurement.

^D Alternative Proof load Yield Strength Method.

TABLE 5 Tensile Strength Requirements for Specimens Machined from Bolts

	Tensile min.	Tensile max.	Yield min.	Elongation in 4D, min. %	Reduction of Area, min. %
Inch 120 ksi, Grade A325, F1852	120000 psi	...	92000 psi	14	35
Inch 150 ksi, Grade A490, F2280	150000 psi	173000 psi	130000 psi	14	40
Metric 830 MPa, Grade A325M	830 MPa	...	660 MPa	14	35
Metric 1040 MPa, Grade A490M	1040 MPa	1210 MPa	940 MPa	14	40

TABLE 6 Hardness Requirements for Bolts

		120 ksi/830 MPa Tensile, Grade A325, A325M, F1852				150 ksi/1040 MPa Tensile, Grade A490, A490M, F2280			
		Brinell HB		Rockwell HRC		Brinell HB		Rockwell HRC	
		Min	Max	Min	Max	Min	Max	Min	Max
Up to 1 in., M24 Inclusive	Less than 2D	253	319	25	34	311	352	33	38
Up to 1 in., M24 Inclusive	2D and longer	...	319	...	34	...	352	...	38
Over 1 in., M24	Less than 3D	253	319	25	34	311	352	33	38
Over 1 in., M24	3D and longer	...	319	...	34	...	352	...	38

TABLE 7 Twist-Off Style Assembly Installation Tension Test (Minimum Tension, lbf)

Bolt Diameter, in.	F1852	F2280
1/2-13 UNC	12550	15650
5/8-11 UNC	19900	24900
3/4-10 UNC	29450	36800
7/8-9 UNC	40750	50950
1-8 UNC	53450	66800
1 1/8-7 UNC	67350	84100
1 1/4-7 UNC	85500	106850

11.3 Secondary processing of Twist-Off style bolts, including coatings and lubrication shall not be permitted to an assembly lot after final assembly lot installation tension testing. See 7.5.4.

11.4 Test Requirements:

11.4.1 Tests shall be conducted at an ambient temperature between 50° and 90° F (10 and 32°C).