



Designation: F2280 – 11

Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength¹

This standard is issued under the fixed designation F2280; 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 two types of heat treated, steel, tension control bolt-nut-washer assemblies, also referred to as “sets,” having a tensile strength of 150 to 173 ksi. These assemblies are capable of developing a minimum predetermined tension when installed by applying torque to the nut, while at the same time applying a counter torque to separate the spline end from the body of the bolt using an appropriate spline drive installation tool.

1.2 An assembly consists of a tension control bolt with spline end (covered by this specification) and a suitable nut and washer covered by reference to applicable ASTM specifications.

1.3 The fastener assemblies are intended for use in structural connections. These connections, installation procedures, and the use of alternate design structural bolts are covered under the requirements of the “Specification for Structural Joints Using ASTM or A490 Bolts”, approved by the Research Council on Structural Connections.

1.4 The assemblies are available with either round (button or dome) heads, heavy hex structural heads, or alternate design heads described in Section 11, in sizes $\frac{1}{2}$ to $1\frac{1}{8}$ in. inclusive, in two types specified in Section 4.

1.5 Tension control bolts manufactured and marked in accordance with the requirements of Specification A490, and conforming to the dimensional and other requirements of this specification, will be considered an acceptable alternate under this specification for two years following initial publication.

1.6 *The following precautionary statement pertains only to the test method portions, Sections 15 and 16, 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 appro-*

priate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:²

- A490 Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
- A563 Specification for Carbon and Alloy Steel Nuts
- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- E709 Guide for Magnetic Particle Testing
- E1444 Practice for Magnetic Particle Testing
- F436 Specification for Hardened Steel Washers
- F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
- F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
- 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 and Studs
- G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 ASME Standards:³

- B1.1 Unified Inch Screw Threads
- B1.3M Screw Threads Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads
- B18.2.6 Fasteners for Use in Structural Applications

2.3 Research Council on Structural Connections:⁴

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.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

⁴ Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

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

Specification for Structural Joints Using ASTM A325 or A490 Bolts

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

The definition of terms used in this specification shall be as specified in Terminology F1789, unless otherwise defined herein.

3.1.1 *component lot*—component lot, for the purpose of assigning an identification number and from which test samples shall be selected, shall consist of all tension control bolts, all nuts or all washers processed essentially together through all operations to the shipping container, of which each component has the following common characteristics: heat number (mill heat); ASTM designation and grade or type, as applicable; nominal dimensions (size) and head style; and heat treatment lot.

3.1.2 *manufacturer*—entity that assembles, lubricates, tests, and certifies compliance with this specification.

3.1.3 *secondary processing*—any processing performed by any entity on the assemblies or individual components after initial testing.

4. Classification

4.1 The tension control bolts are designated by type denoting chemical composition as follows:

4.1.1 *Type 1*—Alloy steel, and

4.1.2 *Type 3*—Weathering steel.

5. Ordering Information

5.1 Orders for assemblies shall include the items of information below. Optional items not on the purchase order shall be considered as not being required (see Note 1):

5.1.1 Quantity of assemblies,

5.1.2 Size, include nominal tension control bolt diameter and length (without the spline end),

5.1.3 Name of product, that is, twist off type tension control bolt/nut/washer assemblies,

5.1.4 Head style (see 11.1.1),

5.1.5 Type of assembly, that is, Type 1 or Type 3,

5.1.6 ASTM designation and year of publication, and

5.1.7 Special requirements, if required.

NOTE 1—A typical order description follows: 2520 assemblies, 1½–7 UNC in. diameter by 3 in. long Tension Control Bolt/Nut/Washer Assemblies, Round Heads, Type 1 ASTM F2280.

6. Materials and Manufacture

6.1 Heat Treatment:

6.1.1 Tension control bolts shall be heat treated by quenching in oil from the austenitizing temperature and then tempering by reheating to a temperature not less than 800°F.

6.2 *Thread*—The threads of tension control bolts shall be rolled.

6.3 Lubrication:

6.3.1 The assemblies shall be lubricated by the manufacturer to meet the Assembly Lot Tension requirements in Section 9.

6.3.2 Lubrication other than that applied by the manufacturer shall not be permitted, as the type and amount of lubrication is critical to meeting the minimum clamping forces specified.

6.4 *Secondary Processing*—Secondary processing shall not be permitted to an assembly lot.

6.5 Assembly:

6.5.1 The assemblies shall be of the type specified by the purchaser.

6.5.2 The assemblies shall consist of one tension control bolt, with one nut and one or more washer(s) assembled on the bolt and the nut threaded on the bolt a minimum of one turn.

6.5.3 Nuts and washers used on the assemblies shall conform to the requirements of the specifications below:

Assembly Type and Finish	Nut Specification, Class and Finish	Washer Specification, Type and Finish
Type 1 Plain	Specification A563 DH plain	Specification F436 Type 1plain
Type 3 Weathering Steel	Specification A563 DH3 plain	Specification F436 Type 3 plain weathering steel

6.5.4 All nuts shall be heavy hex. All washers used in the assembly shall be circular and through hardened.

6.6 *Protective Coatings*—The bolts, nuts and washers shall not be coated by hot dip zinc coating, mechanical deposition or electroplating with zinc or other metallic coatings

7. Chemical Composition

7.1 Tension Control Bolts:

7.1.1 Type 1 tension control bolts shall be alloy steel conforming to the chemical composition in Table 1. The steel

TABLE 1 Chemical Requirements for Type 1 Alloy Steel Tension Control Bolts

Element	Alloy Steel	
	Composition %	
	Heat Analysis, %	Product Analysis, %
Carbon	0.30–0.48	0.28–0.50
Phosphorus, max	0.040	0.045
Manganese, min	0.60	0.57
Sulfur, max	0.040	0.045
Alloying Elements	A	A
Alloy Steel with Boron Addition		
Element	Composition %	
	Heat Analysis, %	Product Analysis, %
Carbon	0.30–0.48	0.28–0.50
Manganese, min	0.60	0.57
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Boron	0.0005–0.003	0.0005–0.003
Alloying Elements	A	A

^A 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.

shall contain sufficient alloying elements to qualify it as an alloy steel.

7.1.2 Type 3 tension control bolts shall be weathering steel and shall conform to the chemical compositions specified in **Table 2**. See Guide **G101** for method of estimating the atmospheric corrosion resistance of low alloy steels.

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

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

7.1.5 For Type 1 bolts heats of steel, with intentionally added boron, or boron heat analysis exceeding 0.0035 %, shall not be permitted.

7.1.6 Compliance with **7.1.4** and **7.1.5** shall be based on certification that heats of steel having any of the listed elements intentionally added were not used to produce the bolts.

7.1.7 Chemical analysis shall be performed in accordance with Test Methods, Practices, and Terminology **A751**.

7.2 *Nuts and Washers*—Chemical requirements for nuts and washers shall be in accordance with the applicable specification specified in **6.5.3**.

8. Mechanical Property Requirements for Tension Control Bolts

8.1 *Hardness*: The bolts shall conform to the hardness specified in **Table 3**.

8.2 *Tensile Properties*:

8.2.1 Except as permitted in **8.2.2** for long bolts, and **8.2.3** for short bolts, sizes 1.0 in. and smaller having a length of $2\frac{1}{4}$ in. D and longer; and sizes larger than 1.0 in. having a length of 3D and longer; shall be wedge tested full size and shall conform to the minimum and maximum 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.

8.2.2 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.

8.2.3 Sizes 1.0 in. and smaller having a length shorter than $2\frac{1}{4}$ D down to 2D inclusive, which 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 1.0 in. and smaller having a length shorter than 2D, which cannot axially tensile tested shall be qualified on the basis of hardness.

8.2.4 Size $1\frac{1}{8}$ in. having a length shorter than 3D shall be qualified on the basis of hardness.

8.2.5 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.

8.3 *Nuts and Washers*—Mechanical properties for nuts and washers shall be in accordance with the applicable specification in **6.5.3**.

9. Assembly Lot Tension Test

9.1 *Purpose*—The assembly lot tension test shall be performed on fastener assemblies to determine the ability of the assembly to provide the required minimum tension.

9.2 *Requirement*—Full size completed assemblies tested in accordance with **14.4** shall develop a bolt tension when the spline end is separated from the bolt conforming to the requirements in **Table 5**, Column 1.

10. Carburization/Decarburization

10.1 This test is intended to evaluate the presence or absence of carburization and decarburization as determined by the difference in microhardness near the surface and core.

10.2 *Requirements*:

10.2.1 *Carburization*—The assemblies shall show no evidence of a carburized surface when evaluated in accordance with **15.5**.

10.2.2 *Decarburization*—Hardness value differences shall not exceed the requirements set forth for decarburization in Test Method **F2328** for class 2/3H materials when evaluated in accordance with **15.5**.

11. Dimensions

11.1 *Tension Control Bolts*:

11.1.1 Tension control bolts shall be furnished with either round (button or dome), heavy hex structural or alternate design heads as specified by the purchaser.

11.1.2 The head, body and spline dimensions shall conform to the requirements in ASME **B18.2.6** for tension control bolts.

11.1.3 Head designs as specified in **11.1.1** shall have a bearing surface area and head height equal to or larger than required for heavy hex structural bolts in ASME **B18.2.6**.

11.1.4 The thread length shall be as specified in ASME **B18.2.6** for heavy hex structural bolts.

11.2 *Nuts and Washers*—The dimensions for nuts and washers shall be in accordance with the applicable specification specified in **6.5.3**.

11.3 *Threads*:

11.3.1 Threads on tension control bolts shall be the Unified Coarse Thread Series as specified in ASME **B1.1**, and shall have Class 2A tolerances.

11.3.2 The gauging limit for bolts shall be verified during manufacture. In case of purchaser/supplier controversy over thread compliance, System 21 of ASME **B1.3M** shall be used for referee purposes.

TABLE 2 Chemical Requirements for Type 3 Weathering Steel Tension Control Bolts

Element	Composition, %	
	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes $\frac{3}{4}$ in. and smaller	0.20-0.53	0.19-0.55
Sizes $\frac{7}{8}$ to $1\frac{1}{8}$ in. incl.	0.30-0.53	0.28-0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.035	0.040
Sulfur	0.040	0.045
Copper	0.20-0.60	0.17-0.63
Chromium	0.45-0.90	0.42-0.93
Nickel or	0.20-0.60	0.17-0.63
Molybdenum	0.15-0.25	0.14-0.26