Designation: ~~F3043 – 14~~ F3043 – 14$^{\varepsilon 1}$

Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Alloy Steel, Heat Treated, 200 ksi Minimum Tensile Strength[1,2]

This standard is issued under the fixed designation F3043; 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.

ε[1] NOTE—Section 1.7 and the title of Annex A1 were editorially corrected in February 2015.

1. Scope

1.1 This specification covers one style of heat treated, alloy steel, tension control bolt-nut-washer assemblies, also referred to as "sets," having a tensile strength of 200 to 215 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, nut and washer covered by this specification.

1.3 The assemblies are available with round heads described in Section 10, in sizes 1 in. to 1¼ in. inclusive.

1.4 The fastener assemblies are intended for use in structural connections in the following environmental conditions:

1.4.1 Interiors, normally dry, including interiors where structural steel is embedded in concrete, encased in masonry or protected by membrane or noncorrosive contact type fireproofing.

1.4.2 Interiors and exteriors, normally dry, under roof, where the installed assemblies are soundly protected by a shop-applied or field-applied coating to the structural steel system.

1.5 The fastener assemblies are not intended for use in structural connections in the following environments, with or without protection by a shop-applied or field-applied coating to the structural steel system:

1.5.1 Exteriors not under roof.

1.5.2 Chemical environments in which strong concentrations of highly corrosive gases, fumes, or chemicals, either in solution or as concentrated liquids or solids, contact the fasteners or their protective coating.

1.5.3 Heavy industrial environments severe enough to be classified as a chemical environment as described in 1.5.2.

1.5.4 Condensation and high humidity environments maintaining almost continuous condensation, including submerged in water and soil.

1.5.5 Cathodically protected environments, in which current is applied to the structural steel system by the sacrificial anode method or the DC power method.

1.6 *Units*—The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 The following precautionary statement pertains only to the test method portions, Section ~~15~~13, Section ~~16~~14 and Annex A2 of this ~~Specification:~~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.*

[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.

Current edition approved Oct. 1, 2014. Published December 2014. DOI: ~~10.1520/F3043-14.~~10.1520/F3043-14E01.

[2] The "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Alloy Steel, Heat Treated, 200 ksi Minimum Tensile Strength of Grade 2 is covered by US patent number 7 070 664, July 4, 2006. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
E709 Guide for Magnetic Particle Testing
E1444 Practice for Magnetic Particle Testing
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
F812/F812M Specification for Surface Discontinuities of Nuts, 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, Studs, and Nuts

2.2 *ASME Standards:*[4]

B1.3 Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)
B1.15 Unified Inch Screw Threads (UNJ Thread Form)
B18.2.6 Fasteners for Use in Structural Applications

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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

3.1.2 *component lot, n*—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); nominal dimensions (size), grade, and heat treatment lot.

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

4. Ordering Information

4.1 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):

4.1.1 Quantity of assemblies,
4.1.2 Size, including nominal tension control bolt diameter, bolt length (without the spline end), and thread pitch,
4.1.3 Grade, that is, Grade 1 or Grade 2,
4.1.4 Name of product, that is, twist off type tension control bolt/nut/washer assemblies[2],
4.1.5 ASTM designation and year of publication, and
4.1.6 Special requirements, if required.

NOTE 1—A typical order description follows: 1000 assemblies, 1¼ diameter by 4 in. long with 7 threads per in., Grade 2, Tension Control Bolt/Nut/Washer Assemblies, Round Heads, ASTM F3043.

5. Materials and Manufacture

5.1 *Tension Control Bolt/Nut/Washer Assemblies:*

5.1.1 The assemblies shall be of the round head style.

5.1.2 The assemblies shall consist of one tension control bolt, with one nut and one washer assembled on the bolt and the nut threaded on the bolt a minimum of one turn.

5.1.3 All nuts shall be heavy hex.

5.1.4 All washers used in the assembly shall be circular and through hardened.

5.1.5 *Protective Coatings*—The bolts, nuts and washers shall not be coated by hot dip zinc coating, mechanical deposition, electroplating, dip-spin, dip-drain, or spray methods with zinc or other metallic coatings.

NOTE 2—Protective coatings may be shop-applied or field-applied to installed assemblies.

5.1.6 *Lubrication:*

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

[3] 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.

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

5.1.6.2 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.

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

5.2 *Tension Control Bolts:*

5.2.1 *Heat Treatment:*

5.2.1.1 If phosphate coating has been applied to the raw material, the residual phosphate shall be removed prior to heat treatment, and a record of the application of this processing step shall be maintained by the processor.

5.2.1.2 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 1000°F.

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

5.3 *Nuts:*

5.3.1 Nuts shall be made by hot forming.

5.3.2 Nuts shall be heat treated by quenching in a liquid medium from a temperature above the transformation temperature and tempering at a temperature of at least 850°F.

5.3.3 Threads shall be formed by tapping.

5.4 *Washers:*

5.4.1 Washers shall be through hardened.

6. Chemical Composition

6.1 *Tension Control Bolts:*

6.1.1 Steel for tension control bolts shall be made by the basic oxygen process.

6.1.2 Bolts shall be alloy steel conforming to the chemical composition in Table 1.

6.1.3 Product analysis may be made by the purchaser on finished bolts representing each lot. The chemical composition shall conform to the requirements in Table 1, Product Analysis.

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

6.1.5 Compliance with 6.1.4 shall be based on certification that heats of steel having any of the listed elements intentionally added were not used to produce the bolts.

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

6.2 *Nuts:*

6.2.1 Steel for nuts shall be made by the basic oxygen or electric-furnace process.

6.2.2 Nuts shall conform to the chemical composition in Table 2.

6.2.3 Product analysis may be made by the purchaser on finished nuts representing each lot. The chemical composition shall conform to the requirements in Table 2, Product Analysis.

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

6.3 *Washers:*

6.3.1 Steel used in the manufacture of washers shall be produced by the basic-oxygen or electric-furnace process.

6.3.2 Washers shall conform to the chemical composition specified in Table 3.

6.3.3 Product analysis may be made by the purchaser on finished washers representing each lot. The chemical composition shall conform to the requirements in Table 3, Product Analysis.

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

TABLE 1 Chemical Requirements for Tension Control Bolts[A]

Element	Composition, %			
	Heat Analysis, %		Product Analysis, %	
	min	max	min	max
Carbon	0.38	0.42	0.36	0.44
Manganese	0.40	0.60	0.37	0.63
Phosphorus	. . .	0.01	. . .	0.015
Sulfur	. . .	0.01	. . .	0.015
Silicon	. . .	0.10	. . .	0.12
Chromium	1.20	1.40	1.15	1.45
Molybdenum	0.60	0.80	0.57	0.83
Vanadium	0.30	0.40	0.27	0.43

[A] Aluminum, cobalt, niobium / columbium, nickel, titanium, tungsten, zirconium, or any other alloying elements may be added to obtain the desired alloying effect.

TABLE 2 Chemical Requirements for Nuts

Element	Composition, %			
	Heat Analysis, %		Product Analysis, %	
	min	max	min	max
Carbon	0.30	0.48	0.28	0.50
Manganese	0.60	0.90	0.57	0.93
Silicon	0.15	0.35	0.13	0.37
Phosphorus	. . .	0.050	. . .	0.055
Sulfur	. . .	0.050	. . .	0.055

TABLE 3 Chemical Requirements for Washers

Element	Composition, %			
	Heat Analysis, %		Product Analysis, %	
	min	max	min	max
Carbon	0.42	0.48	0.40	0.50
Manganese	0.60	0.90	0.57	0.93
Silicon	0.15	0.35	0.13	0.37
Phosphorus	. . .	0.030	. . .	0.035
Sulfur	. . .	0.030	. . .	0.035

7. Mechanical Property Requirements for Tension Control Bolts, Nuts and Washers

7.1 *Tension Control Bolts:*

7.1.1 *Hardness*—Bolts shall conform to the hardness specified in Table 4.

7.1.2 *Tensile Properties:*

7.1.2.1 Bolts 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 5. The load achieved during proof load testing shall be equal to or greater than the specified proof load.

7.1.2.2 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 6. When bolts are tested by both full size and machined specimen methods, the full size test shall take precedence.

7.1.2.3 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.

7.1.2.4 Sample bolts shall be used to verify that the alloy steel material and heat treatment provides resistance to Environmental Hydrogen Embrittlement (EHE), in accordance with the requirements of Annex A2.

7.2 *Nuts:*

7.2.1 Nuts shall conform to the surface hardness specified in Table 7.

7.2.2 Nuts shall withstand the proof load stress specified in Table 8.

7.3 *Washers:*

7.3.1 Washers shall conform to the core hardness specified in Table 9.

8. Assembly Lot Tension Test

8.1 *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.

8.2 *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 10, Column 1.

9. Carburization/Decarburization of Bolts

9.1 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.

9.2 *Requirements:*

9.2.1 *Carburization*—The assemblies shall show no evidence of a carburized surface when evaluated in accordance with 14.1.4.

TABLE 4 Hardness Requirements for Tension Control Bolts

Bolt Size, in.	Bolt Length, in.	Rockwell C	
		min	max
1 to 1¼, incl	all	38	45

TABLE 5 Tensile Requirements for Full Size Tension Control Bolts

Bolt Size, Threads per in.	Stress Area, in.^{2} [A,B]	Tensile Load, lbf[C]	
		min	max
Column 1	Column 2	Column 3	Column 4
Grade 1			
1 in. - 8	0.615	123 100	132 300
1⅛ in. - 7	0.776	155 200	166 800
1¼ in. - 7	0.983	196 700	211 400
Grade 2			
1 in. - 8	0.640	128 000	137 700
1⅛ in. - 7	0.808	161 600	173 600
1¼ in. - 7	1.019	203 800	219 100

[A] The stress area for Grade 1 is calculated as:

$$A_s = 0.7854\ [0.5\ (d_{3\ max} + d_{2\ max})]^2$$

[B] The stress area for Grade 2 is calculated in accordance with Annex A1.

[C] Loads tabulated are based on the following:

Bolt Size, in.	Column 3	Column 4
1 to 1¼	200 000 psi	215 000 psi

TABLE 6 Tensile Strength Requirements for Specimens Machined from Bolts

Nominal Bolt Diameter, in.	Tensile Strength, ksi		Yield Strength (0.2 % offset), min, ksi	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %
	min	max			
1 to 1¼, incl	200	215	180	14	40

TABLE 7 Hardness Requirements for Nuts

Bolt Size, in.	Surface Hardness, Rockwell C	
	min	max
1 to 1¼, incl	30	40

TABLE 8 Proof Load Requirements for Nuts

Nominal Size - Threads per in.	Stress Area, A_s, in.^{2} [A,B]	Proof Load Stress, ksi	Nut Proof Load, lbf[C]
Grade 1			
1 in. - 8	0.615	200	123 100
1⅛ in. - 7	0.776	200	155 200
1¼ in. - 7	0.983	200	196 700
Grade 2			
1 in. - 8	0.640	200	128 000
1⅛ in. - 7	0.808	200	161 600
1¼ in. - 7	1.019	200	203 800

[A] The stress area for Grade 1 is calculated as:

$$A_s = 0.7854\ [0.5\ (d_{3\ max} + d_{2\ max})]^2$$

[B] The stress area for Grade 2 is calculated in accordance with Annex A1.

[C] To determine nut proof load in pounds, multiply the appropriate nut proof load stress by the tensile stress area of the thread.

TABLE 9 Core Hardness Requirements for Washers

Rockwell C	
Min 40	Max 45

9.2.2 *Decarburization*—Hardness value differences shall not exceed the requirements set forth for decarburization in Test Method F2328 for class ¾ H materials when evaluated in accordance with 14.1.4.

10. Dimensions of Tension Control Bolts, Nuts, and Washers

10.1 *Tension Control Bolts:*

10.1.1 Tension control bolts shall be furnished with round heads.

TABLE 10 Assembly Lot Tension Test Requirements

Bolt Size, in.	Grade 1		Grade 2	
	Manufacturers Acceptance Test Tension, lbs, min[A]	Tension lbs, min (for information only)[B]	Manufacturers Acceptance Test Tension, lbs, min[A]	Tension lbs, min (for information only)[B]
	Column 1	Column 2	Column 1	Column 2
1	90 000	86 000	94 000	90 000
1⅛	114 000	109 000	119 000	113 000
1¼	145 000	138 000	150 000	143 000

[A] The manufacturer's acceptance test tension values are 5 % higher than the tension in Column 2 and are rounded to the nearest 1000 lbs (kip).
[B] The values in Column 2 are equal to 70 % of the specified minimum tensile strength for tests of full size F3043 bolts tested in axial tension and are rounded to the nearest 1000 lbs (kip).

10.1.2 The head, body and spline dimensions shall conform to the dimensional requirements in Table 11, and ASME B18.2.6 section 6.5 for straightness, 6.6 for true position of head, and 6.11 for incomplete thread diameter.

10.1.3 *Threads:*

10.1.3.1 The thread length shall be as specified in Table 11.

10.1.3.2 Threads for Grade 1 shall have the coarse series, class 2A UNJ thread as specified in ASME B1.15.

10.1.3.3 Threads for Grade 2 shall be as specified in Annex A1, and shall have Class 2A tolerances as calculated in section 4.3.3 of ASME B1.15.

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

10.2 *Nuts:*

10.2.1 The dimensions for nuts shall conform to the dimensional requirements in Table 12, and ASME B18.2.6, sections 3.1.4, 3.1.5 and 3.1.6.

10.2.2 Threads for nuts for Grade 1 shall be coarse series, class 2B UNJ thread as specified in ASME B1.15.

10.2.3 Threads for nuts for Grade 2 shall be as specified in Annex A1, with UNJ thread and without root radius, and shall have Class 2B tolerances as calculated in section 4.3.4 of ASME B1.15.

10.3 *Washers:*

10.3.1 All circular washers shall conform to the dimensions shown in Table 13.

10.3.2 The deviation from flatness shall not exceed 0.010 in. per inch as the maximum deviation from a straight edge placed on the cut side.

10.3.3 Circular runout of the outside diameter with respect to the hole shall not exceed 0.030 FIM.

10.3.4 Burrs shall not project above the immediately adjacent washer surface more than 0.010 in.

11. Workmanship, Finish, and Appearance

11.1 For tension control bolts, 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 F788/F788M.

11.2 For the nut component, the allowable limits, inspection, and evaluation of surface discontinuities, quench cracks, forging cracks, inclusion cracks, bursts, shear bursts, seams, voids, tool marks, nicks and gouges shall be in accordance with Specification F812/F812M.

11.3 Washers shall be free of excess mill scale and foreign material on bearing surfaces.

12. Magnetic Particle Inspection for Tension Control Bolt Longitudinal Discontinuities and Transverse Cracks

12.1 *Requirements:*

12.1.1 Each sample representative of the bolt lot shall be magnetic particle inspected for longitudinal discontinuities and transverse cracks.

12.1.2 The lot, as represented by the sample, shall be free from nonconforming bolts, as defined in Specification F788/F788M, when inspected in accordance with Section 12.2.

12.2 *Inspection Procedure:*

12.2.1 The inspection sample shall be selected at random from each bolt lot in accordance with 13.4.2.4 and examined for longitudinal discontinuities and transverse cracks in the threads, body, fillet, and underside of the head.