

TECHNICAL REVIEW

TENSION CONTROL BOLTS COATED WITH INF3013™

March 2023

OVERVIEW

This technical review is intended to streamline and clarify the requirements of the specifications and to provide test data indicating compliance to the requirements of these specs. This review is not intended as a deep dive into all areas of the specification(s) but more to provide key information specific to the functionality of coated Tension Control (TC) bolts.

Since TC bolts have a unique method of tightening the critical factors affecting installation are different from a more conventionally installed fastener. TC bolts use a shear wrench for tightening. The wrench has an inner socket which retains the tip of the bolt from rotation while the outer socket rotates the nut. Once the correct tension (torque) has been achieved the tip shears from the bolt.

In effect the bolts are calibrated to shear the tip at a targeted tension. Critical factors to control the targeted tension are in order of priority; friction, shear tip groove diameter, and hardness/chemistry.

These three factors are what will be the focus of this technical review.



SPECIFICATIONS

The bolt specification for structural fasteners is ASTM F3125 (22) (Figure 1). This spec was created in 2015 and has had several revisions with the latest and current revision occurring in 2022. This specification is the “recipe” for manufacturing and testing structural fasteners. The F3125 spec also includes several other ASTM specifications (Figure 2) that detail exactly how to test these fasteners for several different factors such as hardness, coating thickness, and details the applicable plating specification. With the latest release of F3125 (22) the permitted zinc flake coating specification changed from F1136/F1136M (Geomet), F2833 (Magni), and F3019/F3019M (Doerken) to ASTM F3393 (20) (Figure 3). With this change the spec went from a “Brand” to more of a performance specification. The above-named Brands are the only coatings approved to the specification.



Designation: F3125/F3125M – 22

Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength1

Figure 1 - Source ASTM F3125/F3125M-22

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/A563M Specification for Carbon and Alloy Steel Nuts \(Inch and Metric\)](#)

Figure 2 - Source ASTM F3125/F3125M-22

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F3125/F3125M-22
TABLE A1.1 Permitted Coatings

120 ksi & 830 MPa Bolt Assemblies ^A			150 ksi & 1040 MPa Bolt Assemblies ^A		Classification Codes	
Commonly Applied Coatings	Grade or Class		Qualified Coatings	Corrosion	Appearance	Coefficient of Friction
F2329	Hot Dip Galvanized / 50 µm		F3393	D	1	R _B
B695	Class 55		...	...	...	...
	Classification Codes		...	...	...	...
Other Coatings	Corrosion	Appearance	Coefficient of Friction	...	...	...
F3393	D	1	R _B	...	...	...

^A Coatings for Twist-off style bolt assemblies shall be agreed upon between the producer, supplier and user, and are not permitted except when applied under the Direction of the manufacturer. The coefficient of friction classification code does not apply to Twist-off style bolt assemblies.

^B Specification F3393 is a consolidation and replacement of three ASTM standards which included qualified coatings F1136/F1136M Bolt & Washer Grade 3, Nut Grade 5, F2833 Grade 1, and F3019/F3019M Grade 4.

Figure 3 - Source ASTM F3125/F3125M-22

SPECIFICATION CONTROLS VERSUS INFASCO DATA

With a coated TC bolt, you are looking for two primary characteristics: long corrosion resistance and repeatable shear of the tip providing a consistent targeted tension. The plating spec and the general bolt spec have controls in place to ensure these characteristics are met. The Material Test Reports (MTR) detail the values achieved against the specification requirements.

ASSEMBLY TENSION TEST

Test conducted in a hydraulic load cell device (Skidmore tester) per ASTM F3125-22 (Figure 4).

11. Requirements Specific to Twist-Off style bolts

11.1 Assembly 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 Test assemblies shall develop a bolt tension to

the minimum requirements in **Table 8** when the spline end is separated from the bolt.

TABLE 8 Twist-Off Style Assembly Installation Tension Test (Minimum Tension, lbf)

Bolt Diameter, in.	F1852	F2280
½-13 UNC	12550	15650
⅝-11 UNC	19900	24900
¾-10 UNC	29450	36800
⅞-9 UNC	40750	50950
1-8 UNC	53450	66800
1⅛-7 UNC	67350	84100
1¼-7 UNC	85500	106850

Figure 4 - Source ASTM F3125/F3125M-22

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The Infasco test values for Assembly Tension are recorded in the MTR (Appendix 1) and are the mean value of 3 individual tension tests (Figure 5).

ASSEMBLY TENSION (F1952)	29,000 lbf
MEAN VALUE	35,000

INFASCO

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03_LAB_010 Rev.01

Figure 5 - Infasco Test

COATING REQUIREMENTS AND VALUES

The selected coating requirements provide three significant contributions to the effectiveness of this bolting system: corrosion resistance, frictional properties (for repeatable tension), and reduction in variation from environmental changes.

Per coating specification ASTM 3393-20 the correct coating code would be D1N.

D for the corrosion resistance level and minimum coating thickness to achieve 720 hours minimum (Figure 6). The 1 in D1N represents the color of the coating, in this case grey. And the N represents the friction requirement of the coating which is total coefficient of friction of 0.12+/-0.03. Per the spec this is not relevant for twist off style bolts (TC) as the more prominent factor is the Tension Test results. However, using this value ensures that the coating supplier understands and can provide a consistent friction.

TABLE 1 Minimum Corrosion Resistance, Minimum Coating Thickness, or Minimum Coating Weight

Classification Code	Minimum Corrosion Resistance	Minimum Coating Thickness	Minimum Coating Weight
A	240h	0.00016 in. - 4µm	0.0430oz/ft2 – 13g/m2
B	480h	0.00020 in. - 5µm	0.0524oz/ft2 – 16g/m2
C	600h	0.00025 in. - 6µm	0.0688oz/ft2 – 21g/m2
D	720h	0.00030 in. - 8µm	0.0754oz/ft2 – 23g/m2
E	960h	0.00050 in. - 12µm	0.0800oz/ft2 – 24g/m2
F	1200h	0.00060 in. - 15µm	0.1180oz/ft2 – 36g/m2
G	As Agreed Upon	As Agreed Upon	As Agreed Upon

Figure 6 –Source ASTM 3393-20

Since this is a very extended salt spray test (30 days) it is not practical to use salt spray testing as an ongoing conformance test. Instead, we use salt spray testing as an audit method and use coating thickness testing as the ongoing quality test. Our plating thickness measuring device outputs a value that must have a multiplier factor assigned to compare to the thickness allowable by the spec. As above the minimum thickness for D is 0.0003. Our outputs are multiplied by a factor of 0.001. For example, 0.53 times 0.001 equals 0.00053 exceeding the minimum required above. The converted spec value for our device is 0.30.

The Infasco test values (Figure 7) for the coating thickness are shown in the MTR (Appendix 2).

Figure 7- Infasco Test

ASTM E376
COATING THICKNESS (0.01 in)
0.30
0.53
0.55
0.33
0.38
0.33
0.38
0.44
0.41
0.45
0.49
0.47
0.50
0.33
0.62
0.47

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A recent audit for salt spray hours has produced a test result that at time of this report has exceeded 6000 hours. (Figure 8). For comparison purposes only salt spray testing on samples coated with Mechanical Galv failed at 433 hours due to red corrosion and high levels of white corrosion (Figure 9).



Figure 8 - Infasco Test



Figure 9 - Infasco Test

Although the full MTR package from Infasco will cover other aspects of the fastener's compliance to the specification the purpose of this report makes that information irrelevant and was therefore not included in this review. Full MTR package is available upon request.

Rick Brown

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COATED WITH INF3013™

MTR PAGE 1 Appendix 1



ISO 9001, IATF 16949
ISO / IEC 17025
ISO 14001

SET NO.: 2022-40284

FASTENER TEST REPORT

(THIS DOCUMENT MAY ONLY BE REPRODUCED IN ITS ENTIRETY, WITH PRIOR WRITTEN APPROVAL BY THE INFASCO LABORATORY)

(THE INFASCO LABORATORY IS ACCREDITED BY THE CCN FOR THE TESTS LISTED AT WWW.CCN.CA)

COMPLIES WITH EN10204:2004 INSPECTION CERTIFICATE 3.1

DATE: 2022-12-16

DESCRIPTION	A F1852-1TC+A563-DH NA+F436-1 UNC N 3/4-10 X 2 1/2
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BOLT F1852-1TC ROUND HD BOLT UNC N ZAFINF3013
MARKING : HOLLOW TRIANGLE & "A325TC"

LOT NO. 2207-59741 1313D	MANUFACTURED BY INFASCO			HARDNESS (ROCKWELL) HRC 25.0 - HRC 34.0	PROOF LOAD (LB) MIN: 28,400	TENSILE STRENGTH (LB) MIN: 40,100	
MEAN VALUE				30.9	PASS	49,363	
HEAT NO.	C %	Mn %	P %	S %	Si %	B %	
A57540	0.34	0.79	0.011	0.004	0.21	0.002	

NUT HVY HEX NUT A563-DH FNA UNC N ZAFINF3013
MARKING : TRIANGLE & "DH"

LOT NO. 2202-51584 5950D	MANUFACTURED BY INFASCO			HARDNESS (ROCKWELL) HRC 24.0 - HRC 38.0	PROOF LOAD (LB) MIN: 58,450		
MEAN VALUE				33.6	PASS		
HEAT NO.	C %	Mn %	P %	S %	Si %	Cu %	Ni %
C148283	0.44	0.78	0.004	0.013	0.20	0.04	0.02

WASHER F436-1 STRUCTURAL WASHER FNA STD ZAFINF3013
MARKING : MANUFACTURER'S ID & "F436"

LOT NO. 08-20560 7494D	MANUFACTURED BY TECHNICAL STAMPING INC USA			HARDNESS (ROCKWELL) HRC 38.0 - HRC 45.0			
MEAN VALUE				38.7			
HEAT NO.	C %	Mn %	P %	S %	Si %		
12012250	0.35	0.87	0.009	0.001	0.19		

HEAT CHEMICAL ANALYSIS PROVIDED BY STEEL SUPPLIER.

ASSEMBLY TENSION (F1852) MINIMUM	29,000 lbf
MEAN VALUE	35,000

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Christian Raymond
Quality Assurance Supervisor

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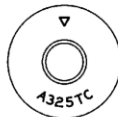
COATED WITH INF3013™

MTR PAGE 2 Appendix 2



ISO 9001, IATF 16949
ISO / IEC 17025
ISO 14001

LOT NO.: 2207-59741
1313D



FASTENER TEST REPORT

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(THE INFASCO LABORATORY IS ACCREDITED BY THE CCN FOR THE TESTS LISTED AT WWW.CCN.CA)
COMPLIES WITH EN10204:2004 INSPECTION CERTIFICATE 3.1

DATE 2022-11-19

DESCRIPTION AND MARKING	F1852-1TC ROUND HD BOLT UNC N ZAFINF3013 HOLLOW TRIANGLE & "A325TC"				
SIZE	3/4-10 X 2 1/2	GRADE	10B35M	QUANTITY	56,756

HEAT CHEMICAL ANALYSIS (provided by steel supplier)

HEAT NO.	C %	Mn %	P %	S %	Si %	B %
A57540	0.34	0.79	0.011	0.004	0.21	0.002

METHOD	ASTM F606 PROOF LOAD (psi)	ASTM F606 WEDGE TENSILE STRENGTH (psi)	SHEAR STRENGTH	SURFACE HARDNESS (HR 30N)	ASTM F606 CORE HARDNESS (ROCKWELL)	MICRO HARDNESS	ASTM E376 COATING THICKNESS (0.001 in)
SPEC. MIN.	85,000	120,000			HRC 25.0 HRC 34.0		0.30
SPEC. MAX:							
S NO. 1	PASS	149,000			HRC 31.2		0.53
A NO. 2	PASS	148,000			30.4		0.55
M NO. 3	PASS	147,000			30.4		0.33
P NO. 4					31.6		0.38
L NO. 5					30.7		0.33
E NO. 6							0.38
							0.44
							0.41
							0.45
							0.49
							0.47
							0.50
							0.33
							0.62
							0.47

THE ABOVE TESTED SAMPLES HAVE BEEN INSPECTED FOR VISUAL DISCONTINUITIES AND FOUND ACCEPTABLE. THEY COMPLY IN ALL RESPECTS WITH THE LATEST EDITION OF THE FOLLOWING SPECS:
ASTM F3125 GRADE 1852 TYPE 1, ASME B18.2.6, THREADS PER ASME B1.1 CLASS 2A UNLESS OTHERWISE SPECIFIED. NO BISMUTH, SELENIUM, TELLURIUM, LEAD HAVE BEEN INTENTIONALLY ADDED COATING AS PER F3393 DIN.

MANUFACTURED IN: CANADA
The steel was melted and rolled
in North America and is mercury and asbestos-free.

Gabriel Landry, eng.
Senior Metallurgical Engineer

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