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Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners[1]

This standard is issued under the fixed designation F 959; 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 the requirements for compressible-washer-type direct tension indicators capable of indicating the achievement of a specified minimum bolt tension in a structural bolt.

1.2 Four types of direct tension indicators in nominal diameter sizes ½ through 1½ in. are covered:

1.2.1 *Type 325*—direct tension indicators for use with Specification A 325 ~~or F1852 Type I bolts, nuts, and washers.~~ Type 1 bolts or F or F 1852 assemblies.

1.2.2 *Type 325–3*— direct tension indicators for use with Specification A 325 ~~Type 3 bolts, nuts, and washers.~~ Type 3 or F 1852 Type 3 assemblies.

1.2.3 *Type 490*—direct tension indicators for use with Specification A 490 ~~or F2280 bolts, nuts, and washers.~~ Type 1 bolts or F 2280 assemblies.

1.2.4 *Type 490–3*— direct tension indicators for use with Specification A 490 ~~Type 3 bolts, nuts, and washers.~~ Type 3 F 2280 Type 3 assemblies.

1.3 Direct tension indicators are intended for installation under either a bolt head or a hardened washer. (See Research Council on Structural Connections: Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.)

~~1.4~~

1.4 This specification provides for furnishing Types 325–3 and 490–3 to a Chemical Composition Requirement or a Corrosion Resistance Index (CRI) at the suppliers option.

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

1.6 The following precautionary statement pertains only to the test method portions, Section 12 and Appendix X1 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]

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A 490 Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

D 3951 Practice for Commercial Packaging

F 436 Specification for Hardened Steel Washers

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F 1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F 1852 Specification for Twist Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

F 2280 Specification for Twist Off ~~Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi~~

[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.

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

~~Minimum Tensile Strength~~ Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength

G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 *Research Council on Structural Connections:*[3]

~~Specification~~ Specification for Structural Joints Using ASTM A 325 or A 490 Bolts

2.3 *ASME Standard:*[4]

ASME B18.2.6 Fasteners for Use in Structural Applications

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *compressible-washer-type direct tension indicator*, *n*—washer-type element inserted under the bolt head or hardened washer, having the capability of indicating the achievement of a required minimum bolt tension by the degree of direct tension indicator plastic deformation. Hereafter referred to as *direct tension indicator*.

4. Ordering Information

4.1 Orders for direct tension indicators under this specification shall include the following:

4.1.1 Quantity (number of pieces);

4.1.2 Name of product (direct tension indicator);

4.1.3 Size, that is, nominal diameter;

4.1.4 ASTM designation and year of issue (if not specified, current issue shall be used);

~~4.1.5Type~~4.1.5 Type required, 325, 325-3, 490, 490-3 (see 1.2);

4.1.6 Coating type, if required (5.4);

4.1.7 Source inspection, if required (Section 13);

4.1.8 Certificates of compliance or test reports, if required (Section 15); and

4.1.9 Any special requirements.

5. Materials and Manufacture

5.1 Steel used in the manufacture of direct tension indicators shall be produced by the basic-oxygen or electric-furnace process.

5.2 *Design*:

5.2.1 Direct tension indicators shall have a configuration produced by extrusion, punching, pressing, or similar forming, to permit a measurable decrease in thickness when placed in compression.

5.2.2 The design shall be such that the degree of plastic deformation shall indicate the tension in a tightened structural bolt.

5.3 *Heat Treatment*— The process used for heat treatment of DTIs shall be through-hardening by heating to a temperature above the upper transformation temperature, quenching in a liquid medium, and then retempering by reheating to a suitable temperature to attain desired mechanical/performance properties.

5.4 *Protective Coatings*:

5.4.1 Unless otherwise specified, the direct tension indicators shall be furnished "plain" with the "as fabricated" surface finish without protective coatings.

5.4.2 When "zinc coated" is specified, the direct tension indicators shall be zinc coated by the mechanical deposition process in accordance with the requirements of Class 55 of Specification B 695.

5.4.3 When "baked epoxy" is specified, the epoxy shall be 0.001 to 0.002 in. thick applied over the zinc coating specified in 5.4.2. The epoxy shall not flake off exposed surfaces during installation.

5.4.4 Other coatings are to be used only when approved by the direct tension indicator manufacturer.

6. Chemical Composition

~~6.1The direct tension indicators shall conform in chemical composition to the limits given in~~

6.1 Direct tension indicators furnished to Chemical Composition Requirements shall conform to the full Heat Analysis specified in Table 1.

~~6.2Product analysis may be made by the purchaser from finished direct tension indicators representing each lot. The chemical composition shall conform to the requirements given in~~

6.2 In addition to the compositions in Table 1, weathering steels type 325–3 and Type 490–3 having Copper, Phosphorus, and Sulfur conforming to Table 1 and a Corrosion Resistance Index of 6 or higher calculated on the basis of the Heat Analysis as described in Guide G 101 Predictive Method based on the data of Larabee and Coburn shall be considered acceptable. See Note 1.

[3] Available from Research Council on Structural Connections at www.boltcouncil.org.

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

TABLE 1 Chemical Composition Requirements

Element	Composition, %			
	Heat Analysis		Product Analysis	
	Type 325 and Type 490	Type 325-3 and Type 490-3[A]	Type 325 and Type 490	Type 325-3 and Type 490-3[A]
Carbon	0.30–0.55		0.27–0.58	
Manganese	0.50–0.90		0.47–0.93	
Phosphorus, Max	0.04	0.040	0.048	0.045
Sulfur, Max	0.045	0.050	0.053	0.055
Silicon	0.15–0.35	0.15–0.35	0.13–0.37	0.13–0.37
Chromium		0.45–0.65		0.42–0.68
Nickel		0.25–0.45		0.22–0.48
Copper		0.25–0.45		0.22–0.48

[A] Weathering steel DTIs are also permitted to be manufactured from any of the Type 3 steels in the chemical composition sections of Specifications A 325 and F 436.

NOTE 1—The user is cautioned that the Guide G 101 predictive equation (Predictive Method Based on the Data of Larabee and Coburn) for calculation of an atmospheric corrosion index has been verified only for the composition limits stated in that guide.

6.3 For all types furnished to the chemical compositions in Table 1, Product Analysis may be made by the purchaser from finished direct tension indicators representing each lot. The chemical composition shall conform to the requirements given in Table 1, Product Analysis.

6.4 Product Analyses are not applicable to Type 325–3 and Type 490–3 indicators furnished to a CRI of 6 or higher. Acceptance shall be based on the CRI of 6 or higher calculated from the Heat Analysis. Other weathering Steels with Copper, Phosphorus, and Sulfur conforming to the specified limits and a Corrosion Resistance of 6 or higher, are acceptable in lieu of compliance with the full specified Chemical Compositions.

7. Performance Requirements

7.1 *Compression Loads*—When compressed to the gap specified in Table 2, the compression load shall conform to the requirements specified in Table 3.

8. Dimensions

8.1 The direct tension indicators shall conform to the dimensional and related requirements of ASME B18.2.6.

9. Workmanship, Finish, and Appearance

9.1 The direct tension indicators shall be commercially smooth and free of injurious material or manufacturing defects that would affect their performance.

10. Number of Tests and Retests

10.1 *Responsibility*:

10.1.1 The direct tension indicator manufacturer shall inspect each lot of direct tension indicators prior to shipment in accordance with the quality assurance procedures described in 10.2.

10.1.2 The purpose of a lot inspection testing program is to ensure that each lot conforms to the requirements of this specification. For such a plan to be fully effective, it is essential that the purchaser continue to maintain the identification and integrity of each lot following delivery until the product is installed in its service application.

10.2 *Production Lot Method*:

10.2.1 All direct tension indicators shall be processed in accordance with a lot identification control–quality assurance plan. The manufacturer shall identify and maintain the integrity of each production lot of direct tension indicators from raw material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot-identification number, each lot shall be tested, and the inspection test reports for each lot shall be retained.

TABLE 2 Direct Tension Indicator Gap for Compression Load Testing

Direct Tension Indicator Finish	Gap, in.	
	Specification A 325	Specification A 490
Plain finish	0.015	0.015
Mechanically galvanized	0.015	. . .
Baked epoxy coating on mechanically deposited zinc	0.015	. . .