



Designation: F959 – 13

Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners¹

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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 $\frac{1}{2}$ through $1\frac{1}{2}$ in. are covered:

1.2.1 *Type 325*—direct tension indicators for use with Specification **A325** Type 1 bolts or **F** or **F1852** assemblies.

1.2.2 *Type 325–3*—direct tension indicators for use with Specification **A325** Type 3 or **F1852** Type 3 assemblies.

1.2.3 *Type 490*—direct tension indicators for use with Specification **A490** Type 1 bolts or **F2280** assemblies.

1.2.4 *Type 490–3*—direct tension indicators for use with Specification **A490** Type 3 **F2280** 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 **A325** or **A490** Bolts.)

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.*

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. Referenced Documents

2.1 ASTM Standards:²

A325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A490 Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

D3951 Practice for Commercial Packaging

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

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F1852 Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

F2280 Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength

G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 Research Council on Structural Connections:³

Specification for Structural Joints Using ASTM **A325** or **A490** 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:

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 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>.

*A Summary of Changes section appears at the end of 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);
- 4.1.5 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:

5.3.1 The heat treatment of DTIs is optional at the manufacturer's discretion, provided the DTIs meet all of the mechanical and performance requirements.

5.3.2 If heat treatment is performed, the process shall be through-hardening by heating to a temperature above the upper transformation temperature, quenching in a liquid medium, and tempering by heating to a suitable temperature.

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 B695.

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

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

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 G101 Predictive Method based on the data of Larabee and Coburn shall be considered acceptable. See Note 1.

NOTE 1—The user is cautioned that the Guide G101 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.

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 A325 and F436.