



Designation: F959 – 15

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

This standard is issued under the fixed designation F959; 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, (DTIs) capable of indicating the achievement of a specified minimum bolt tension in a structural bolt.

1.2 Eight types of DTIs in nominal diameter sizes $\frac{1}{2}$ through $1\frac{1}{2}$ in. as well as M16 through M36 are covered:

1.2.1 *Type 325-1*—DTIs for use with Specification **A325** Type 1 bolts or **F** or **F1852** assemblies.

1.2.2 *Type 325-3*—DTIs for use with Specification **A325** Type 3 bolts or **F1852** Type 3 assemblies.

1.2.3 *Type 490-1*—DTIs for use with Specification **A490** Type 1 bolts or **F2280** assemblies.

1.2.4 *Type 490-3*—DTIs for use with Specification **A490** Type 3 **F2280** Type 3 assemblies.

1.2.5 *Type 8.8-1*—DTIs for use with Specification **A325M** Type 1 bolts.

1.2.6 *Type 8.8-3*—DTIs for use with Specification **A325M** Type 3 bolts.

1.2.7 *Type 10.9-1*—DTIs for use with Specification **A490M** Type 1 bolts.

1.2.8 *Type 10.9-3*—DTIs for use with Specification **A490M** Type 3 bolts.

1.3 DTIs are intended for installation under either a bolt head or a hardened washer. (See Research Council on Structural Connections: Specification for Structural Joints Using High-Strength Bolts.)

1.4 This specification provides for furnishing Type 3 DTIs to a Chemical Composition Requirement or a Corrosion Resistance Index (CRI) at the manufacturer's discretion.

1.5 Terms used in this specification are defined in Terminology **F1789** unless otherwise specified.

1.6 The following precautionary statement pertains only to the test method portions, Section 10 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

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

A325M Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric)

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

A490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)

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

F436 Specification for Hardened Steel Washers

F436M Specification for Hardened Steel Washers (Metric)

F606/F606M 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

F1789 Terminology for F16 Mechanical Fasteners

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 High-Strength Bolts

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 May 1, 2015. Published October 2015. Originally approved in 1985. Last previous edition approved in 2013 as F959 – 13. DOI: 10.1520/F0959-15.

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.

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

2.3 *ASME Standard*.⁴

ASME B18.2.6 Fasteners for Use in Structural Applications
ASME B18.2.6M Fasteners for Use in Structural Applications

3. Ordering Information

3.1 Orders for DTIs under this specification shall include the following:

- 3.1.1 Quantity (number of pieces);
- 3.1.2 Name of product (DTI);
- 3.1.3 Size, that is, nominal diameter;
- 3.1.4 ASTM designation and year of issue (if not specified, current issue shall be used);
- 3.1.5 Type required, 325-1, 325-3, 490-1, 490-3, 8.8-1, 8.8-3, 10.9-1, 10.9-3 (see 1.2);
- 3.1.6 Coating type, if required (4.4);
- 3.1.7 Source inspection, if required (Section 11);
- 3.1.8 Certificates of compliance or test reports, if required (Section 13); and
- 3.1.9 Any special requirements.

4. Materials and Manufacture

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

4.2 Design:

4.2.1 DTIs shall have a configuration produced by extrusion, punching, pressing, or similar forming, to permit a measurable decrease in thickness when placed in compression.

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

4.3 Heat Treatment:

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

4.3.2 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.

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

4.4 Protective Coatings:

4.4.1 Unless otherwise specified, the DTIs shall be furnished "plain" with the "as fabricated" surface finish without protective coatings.

4.4.2 When zinc coated is specified, the DTIs shall be zinc coated by the mechanical deposition process in accordance with the requirements of Class 55 of Specification B695.

4.4.3 Other coatings are to be used only when approved by the DTI manufacturer.

5. Chemical Composition

5.1 DTIs shall conform to the full Heat Analysis specified in Table 1 or the requirements of 5.2.

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

5.2 Type 3 products 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 shall be considered acceptable. See Note 1.

NOTE 1—The user is cautioned that the Guide G101 predictive equation for calculation of an atmospheric corrosion index has been verified only for the composition limits stated in that guide.

5.2.1 Product Analyses are not applicable to Type 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 specified Type 3 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.

6. Performance Requirements

6.1 *Compression Loads*—When the gap of inch series DTIs are compressed to 0.015 in. or metric series DTIs to 0.4 mm, the compression load shall conform to the requirements specified in Table 2.

TABLE 1 Chemical Composition Requirements

Element	Composition, %			
	Heat Analysis		Product Analysis	
	Type 1 Series	Type 3 Series ^A	Type 1 Series	Type 3 Series ^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 Type 3 DTIs are also permitted to be manufactured from any of the Type 3 steels in the chemical composition sections of Specifications A325 and F436 or A325M and F436M.