



Designation: F 959 – 05a

# Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners<sup>1</sup>

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 ( $\epsilon$ ) 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 Two 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 A 325 bolts, and

1.2.2 *Type 490*—direct tension indicators for use with Specification A 490 bolts.

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 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*:<sup>2</sup>

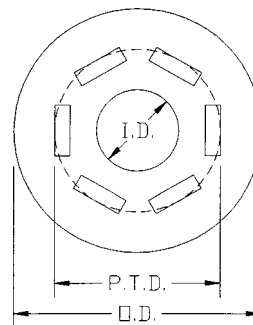
A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

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 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners,



DIRECT TENSION INDICATOR

FIG. 1 Direct Tension Indicator Protrusion Tangential Diameter (PTD)

Washers, and Rivets

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

2.2 *Research Council on Structural Connections*:<sup>3</sup>  
Specification for Structural Joints Using ASTM A 325 or A 490 Bolts

## 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);

4.1.5 Type required, 325 or 490 (1.2);

<sup>3</sup> Available from Research Council on Structural Connections at www.boltcouncil.org.

<sup>1</sup> 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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<sup>2</sup> 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.

- 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 50 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

6.1 The direct tension indicators shall conform in chemical composition to the limits given in Table 1.

6.2 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.

## 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 dimensions specified in Table 4.

## 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.

10.2.2 For purposes of assigning an identification number and from which test samples shall be selected, a production lot shall consist of all direct tension indicators processed essentially together through all operations to placing in the shipping container that are of the same nominal size, produced from the same mill heat of steel, and heat treated in the same heat treatment cycle.

**TABLE 1 Chemical Composition Requirements**

Element	Composition, <sup>A</sup> %			
	Heat Analysis		Product Analysis	
	Type 325 and Type 490	Type 325-3 and Type 490-3	Type 325 and Type 490	Type 325-3 and Type 490-3
Carbon	0.30–0.50		0.27–0.53	
Manganese	0.50–0.90		0.47–0.93	
Phosphorus, Max	0.035	0.040	0.043	0.045
Sulfur, Max	0.040	0.050	0.048	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

<sup>A</sup> Weathering steel DTIs may also be manufactured from any of the steels listed in Table 2 of Specification A 325.