



Designation: F2482/F2482M – 21

## Standard Specification for Load-Indicating Externally Threaded Fasteners<sup>1</sup>

This standard is issued under the fixed designation F2482/F2482M; 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 externally threaded bolts, studs, and cap screws, herein called fasteners, capable of indicating clamping forces up to yield strength during the tightening process or post installation residual tension, or both. Load-indicating fasteners utilize a variety of sensor types to indicate fastener tension. This specification outlines the various types of load indication technologies available and defines their performance requirements.

1.2 This specification covers fastener diameters  $\frac{1}{4}$  to 7 in. [M6 to M180] inclusive. Fasteners are manufactured from a variety of material types and grades. All fastener materials shall be defined by a governing engineering standard or specification for strength and performance values (see 6.1). Fasteners governed by this specification shall maintain traceability of material test records throughout the manufacturing process to verify conformance with the applicable fastener standards.

1.3 These fasteners provide a means to verify the desired clamp load in critical applications upon installation and in service.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5 The following precautionary statement pertains only to the test method portion, Section 11, of the 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standard-*

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

E4 Practices for Force Calibration and Verification of Testing Machines

E1685 Practice for Measuring the Change in Length of Bolts Using the Ultrasonic Pulse-Echo Technique

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

F1789 Terminology for F16 Mechanical Fasteners

2.2 *ASME Standard:*<sup>3</sup>

B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

2.3 *ISO Standard:*<sup>4</sup>

ISO 898-1 Mechanical Properties of fasteners made of carbon or alloy steel Part -1

### 3. Terminology

3.1 Terms used in this specification are defined in Terminology F1789, unless otherwise specified herein.

3.2 *Definitions:*

3.2.1 *calibration of accuracy lot*—lot shall consist of all load-indicating fasteners processed essentially together through all operations to the shipping container that are of the same nominal size, the same nominal length, and manufactured/calibrated from the same mill heat of steel. This lot is used for the purpose of assigning an identification number and from which calibrated samples shall be selected.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>4</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.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.

Current edition approved Dec. 1, 2021. Published January 2022. Originally approved in 2005. Last previous edition approved in 2015 as F2482–08(2015). DOI: 10.1520/F2482\_F2482M-21.

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

3.2.2 *load-indicating fastener*—externally threaded fastener equipped with a load indicating device capable of measuring fastener tension during the tightening process or residual tension after tightening, or both.

## 4. Classification

4.1 This specification covers the following types of load-indicating fasteners:

4.1.1 *Mechanical Dial Type (MT)*—This type of fastener incorporates a dial on the head of the bolt or end of the stud that continuously displays the tension in the fastener.

4.1.2 *Electronic Type (ET)*—This type of fastener employs an electronic measuring device attached to the head or end to obtain readings indicating the tension in the fastener.

4.1.3 *Strain Gauge Type (ST)*—This type of fastener incorporates a bonded device wired in a wheatstone bridge configuration which, through changes in relative resistance, reports tension in the fastener.

4.1.4 *Ultrasonic Type (UT)*—This type of fastener incorporates an acoustic coupling device using pulse-echo technique capable of converting time-of-flight (TOF) measurements into existing fastener tension.

4.1.5 *Optical Type (OT)*—This type of fastener incorporates an optical indicator in the head of the bolt that can indicate tension visually and/or by fiber optic sensor measurement.

4.1.6 *Electronic Wireless (EW)*—This type of fastener employs an electronic measuring device attached to the head or end that can indicate and transmit fastener tension wirelessly.

## 5. Ordering Information

5.1 Orders for load indicating fasteners shall include the following:

- 5.1.1 Quantity;
- 5.1.2 Size, including nominal diameter, thread pitch and length;
- 5.1.3 Head style of fastener component;
- 5.1.4 ASTM F2482/F2482M designation, Type XX (Section 4), full-scale load value (6.2), and load tolerance (8.2);
- 5.1.5 Material Grade or Engineering Specification, as applicable for fastener component;
- 5.1.6 Coating or finish, if required;
- 5.1.7 Test report(s) or certificate(s) (Section 14), if required; and
- 5.1.8 Special requirements, if required.

NOTE 1—A typical ordering information follows: 1000 pieces, 1 in.-8 in. × 8 in. Heavy Hex Structural Bolt ASTM F2482/F2482M Type MT, Proof Load, LT1, Grade A325-1, ASTM F1941 Fe/Zn, 5C Coating. Calibration Accuracy Test Report required.

## 6. Materials and Manufacture

6.1 All load-indicating fasteners shall be manufactured or processed to ensure no degradation of the mechanical properties of the fastener component from which the load-indicating fastener is derived (see Section 7).

6.1.1 *Reduced Loadability*—Where applicable, if due to geometric modification, the fasteners no longer conform to the specified material standard's stated tensile load (klbf, kN) but

do conform (see 6.1) to the stated material strengths (psi, MPa), a reduced loadability designation shall be used to mark the product.

6.1.1.1 For inch product, an asterisk, \*, may be used to designate the reduced loadability.

6.1.1.2 For metric product, a leading "0" in front of the class marking is acceptable per ISO 898-1.

6.1.1.3 The material test records for the modified product shall reflect the magnitude of reduced loadability.

6.1.1.4 Other marking methods that adequately convey the reduced loadability designation to the end user will be acceptable.

6.1.1.5 Refer to ISO 898-1 for a more complete definition of reduced loadability.

6.2 Load-indicating fasteners are capable of displaying load up to their full-scale specifications. Common full-scale load specifications are Design Load, Proof Load, and Yield Load.

(1) Design Load is defined as a tensile load value set as a percentage of the fastener's proof or yield strength.

(2) Proof Load is the tensile load value equal to the fastener's proof strength.

(3) Yield Load is the tensile load value equal to the fastener's yield strength.

6.2.1 Type MT load-indicating fasteners shall incorporate a calibrated dial capable of displaying fastener tension readings up to the yield strength of the fastener.

6.2.2 Type ET load-indicating fasteners shall incorporate a measuring device capable of displaying load indications up to the yield strength on a digital readout.

6.2.3 Type ST load-indicating fasteners shall incorporate permanently bonded electronic-resistance devices configured in a Wheatstone Bridge configuration. The fastener shall then be capable of being connected to an electronic unit to measure installed tension between 0 and 100 % of the proof strength of the fastener.

6.2.4 Type UT load-indicating fasteners shall incorporate an acoustic coupling device to the end of the fastener, using a pulse-echo technique capable of converting time-of-flight (TOF) measurements into existing fastener tension up to the yield strength of the fastener. (See Practice E1685.)

6.2.5 Type OT load-indicating fasteners shall incorporate an optical sensor capable of signaling fastener tension visually and/or be capable of connecting to a fiber optic coupling device that measures the fastener load up to the yield strength of the fastener.

6.2.6 Type EW load indicating fasteners shall incorporate an electronic measuring device capable of measuring, converting, and wirelessly transmitting fastener tension up to the yield strength to a receiving device.

## 7. Chemical and Mechanical Properties

7.1 The chemical and mechanical properties shall be dictated by the associated ASTM or other governing engineering specification to which the load-indicating features are being added. See 1.2 for additional information.