INTERNATIONAL

Designation: E83 – 23

Standard Practice for Verification and Classification of Extensometer Systems[1]

This standard is issued under the fixed designation E83; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers procedures for the verification and classification of extensometer systems, but it is not intended to be a complete purchase specification. The practice is applicable only to instruments that indicate or record values that are proportional to changes in length corresponding to either tensile or compressive strain. Extensometer systems are classified on the basis of the magnitude of their errors.

1.2 Because strain is a dimensionless quantity, this document can be used for extensometers based on either SI or US customary units of displacement.

NOTE 1—Bonded resistance strain gauges directly bonded to a specimen cannot be calibrated or verified with the apparatus described in this practice for the verification of extensometers having definite gauge points. (See procedures as described in Test Methods E251.)

1.3 *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.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization 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:*[2]

E6 Terminology Relating to Methods of Mechanical Testing

E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials

E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages

2.2 *Other Standards:*[3]

JCGM 100:2008 Evaluation of measurement data – Guide to the expression of uncertainty in measurement

3. Terminology

3.1 *Definitions:*

3.1.1 In addition to the terms listed, see Terminology E6.

3.1.2 *calibration*—a determination of the calibration factor for a system using established procedures.

3.1.3 *calibration factor*—the factor by which the change in extensometer reading must be multiplied to obtain the equivalent strain.

3.1.3.1 *Discussion*—For any extensometer, the calibration factor is equal to the ratio of change in length to the product of the gauge length and the change in the extensometer reading. For direct-reading extensometers the calibration factor is unity.

3.1.4 *compressometer*—a specialized extensometer used for sensing negative or compressive strain.

3.1.5 *deflectometer*—a specialized extensometer used for sensing of extension or motion, usually without reference to a specific gauge length.

3.1.6 *dot/line tracking optical extensometer system (DLT), n*—an optical extensometer system that uses marks at an initially known distance, physically placed on a specimen or calibration fixture, to establish the gauge length value for determination of strain.

3.1.7 *error, in extensometer systems*—the value obtained by subtracting the correct value of the strain from the indicated value given by the extensometer system.

3.1.8 *extensometer, n*—a device for sensing strain.

3.1.9 *extensometer systems*—a system for sensing and indicating strain.

3.1.9.1 *Discussion*—The system will normally include an extensometer, conditioning electronics and auxiliary device

[1] This practice is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.01 on Calibration of Mechanical Testing Machines and Apparatus.

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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.

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

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

(recorder, digital readout, computer, etc.). However, completely self-contained mechanical devices are permitted. An extensometer system may be one of three types.

3.1.10 *Type 1 extensometer system, n*—an extensometer system which both defines gauge length and senses extension, for example, a clip-on strain gauge type with conditioning electronics.

3.1.11 *Type 2 extensometer system, n*—an extensometer which senses extension and the gauge length is defined by specimen geometry or specimen features such as ridges or notches.

3.1.11.1 *Discussion*—A Type 2 extensometer is used where the extensometer gauge length is determined by features on the specimen, for example, ridges, notches, or overall height (in case of compression test piece). The precision associated with gauge length setting for a Type 2 extensometer should be specified in relevant test method or product standard. The position readout on a testing machine is not recommended for use in a Type 2 extensometer system.

3.1.12 *Type 3 extensometer system, n*—an extensometer system which intrinsically senses strain (ratiometric principle), for example, video camera system.

3.1.13 *gauge length (L), n*—the original length of that portion of the specimen over which strain or change of length is determined.

3.1.13.1 *Discussion*—If the device is used for sensing extension or motion, and gauge length is predetermined by the specimen geometry or specific test method, then only resolution and strain error for a specified gauge length should determine the class of extensometer system.

3.1.14 *laser optical extensometer system, n*—an optical extensometer system that uses a laser to track and measure the extension/strain.

3.1.15 *resolution of the strain indicator*—the smallest change in strain that can be estimated or ascertained on the strain indicating apparatus of the testing system, at any applied strain.

3.1.16 *resolution of the digital type strain indicators (numeric displays, printouts, and so forth)*—the resolution is the smallest change in strain that can be displayed on the strain indicator (may be a single digit or a combination of digits) at any applied strain.

3.1.16.1 *Discussion*—If the strain indication, for either type of strain indicator, fluctuates more than twice the resolution, as described in 3.1.15 or 3.1.16, the resolution expressed as a strain shall be equal to one-half the range of fluctuation.

3.1.17 *verification*—a determination that a system meets the requirements of a given classification after calibration according to established procedures.

3.1.18 *verification apparatus*—a device for verifying extensometer systems.

3.1.18.1 *Discussion*—This device is used to simulate the change in length experienced by a test specimen as a result of the applied force. The extensometer may either be attached directly to the mechanism or interfaced with it in a manner similar to normal operation (that is, possibly without contact for some optical extensometers).

3.2 *virtual optical extensometer system, n*—an optical extensometer system in which the initial datum points used to establish the gauge length value for determination of strain are chosen by the user based on a location in the image in software – the gauge length is not defined by discrete marks on the specimen.

3.3 *working distance, (WD), n*—the physical distance that the optical extensometer system is from the surface of the specimen or verification apparatus, the distance is measured from the front of the optical extensometer system.

3.3.1 *Discussion*—The WD measurement can be made from the camera body to the front of the specimen or verification apparatus. While it is not important where the physical distance is measured from it is important to measure the distance and report where the measurements were made. Doing this will enable the user to recreate the conditions under which the optical extensometer system was verified.

4. Verification Apparatus

4.1 The apparatus for verifying extensometer systems shall provide a means for applying controlled displacements to a simulated specimen and for measuring these displacements accurately. It may consist of a rigid frame, suitable coaxial spindles, or other fixtures to accommodate the extensometer being verified, a mechanism for moving one spindle or fixture axially with respect to the other, and a means for measuring accurately the change in length so produced,[4] or any other device or mechanism that will accomplish the purpose equally well. The mechanism provided for moving one spindle relative to the other shall permit sensitive adjustments. The changes in length shall be measured, for example, by means of an interferometer, calibrated standard gauge blocks and an indicator, a calibrated micrometer screw, or a calibrated laser measurement system. If standard gauge blocks and an indicator, or a micrometer screw, are used, they shall be calibrated and their limits of accuracy and sensitivity stated. The errors of the verification apparatus shall not exceed one third of the permissible error of the extensometer.

4.2 The verification apparatus shall be calibrated at intervals not to exceed two years.

NOTE 2—He-Ne laser interferometer measurement systems based on the 0.633 μm wavelength line are considered to be primary-based displacement standards and do not require recalibration.[5]

4.3 If the verification apparatus is to be used to verify extensometers used for bidirectional tests, the errors of the verification apparatus should be measured in both directions of travel so as to include any backlash present.

[4] A review of some past, current, and possible future methods for calibrating strain measuring devices is given in the paper by Watson, R. B., "Calibration Techniques for Extensometry: Possible Standards of Strain Measurement," *Journal of Testing and Evaluation*, JTEVA, Vol. 21, No. 6, November 1993, pp. 515–521.

[5] A letter from NIST (National Institute of Standards and Technology) has been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: E28-1013.