Designation: E2428 – 22

Standard Practice for Calibration and Verification of Elastic Torque Measurement Standards[1]

This standard is issued under the fixed designation E2428; 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 The purpose of this practice is to specify the procedure for the calibration and verification of elastic torque measurement standards.

1.2 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 This practice is intended for the calibration of static elastic torque measurement standards. The practice is not applicable for dynamic or high-speed torque calibrations or measurements, nor can the results of calibrations performed in accordance with this practice be assumed valid for dynamic or high-speed torque measurements.

1.4 *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.*

1.5 *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

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E2624 Practice for Torque Calibration of Testing Machines

2.2 *ASME Standard:*[3]

B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

2.3 *BIPM Standard:*[4]

JCGM 200 International vocabulary of metrology–Basic and general concepts and associated terms (VIM)

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology E6 for the definitions of calibration, metrological traceability, resolution, and verification.

3.1.2 *primary torque measurement standard, n*—A deadweight force applied through a moment arm, all with metrological traceability to the International System of Units (SI).

3.1.3 *secondary torque measurement standard, n*—An instrument or mechanism, the calibration of which has been established by a comparison with primary torque measurement standard(s).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration equation, n*—A mathematical relationship between deflection and torque established from the calibration data for use with the elastic torque measurement standard in service.

3.2.2 *creep, n*—The change in indication of the elastic torque measurement standard under constant applied torque.

3.2.2.1 *Discussion*—Creep is expressed as a percentage of the indicated change at a constant applied torque from an initial time following the achievement of mechanical and electrical stability and the time at which the test is concluded. The stabilities of secondary torque measurement standards and primary torque measurement standards are usually adequate to measure creep during the test time interval. Creep results from a time-dependent, elastic deformation of the elastic member of the elastic torque measurement standard. In the case of elastic torque measurement standards, creep is minimized by strain

[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 American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from BIPM, Pavillon de Breteuil, F-92312 Sèvres Cedex. http://www.bipm.org

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

gage design and process modifications to reduce the strain gage response to the inherent time-dependent elastic deformation.

3.2.3 *creep recovery, n*—The change of indicated from the elastic torque measurement standard at zero torque after the removal of the maximum applied calibration torque and initial zero-torque indication.

3.2.3.1 *Discussion*—The zero-torque indication is taken at a time following the achievement of mechanical and electrical stability and a time equal to the time at the calibration torque. For many elastic torque measurement standards, the creep characteristic and the creep recovery characteristic are approximate mirror images.

3.2.4 *deflection, n*—The difference between the indication of the elastic torque measurement standard under applied torque and the indication with zero applied torque.

3.2.5 *elastic torque measurement standard, n*—A system consisting of an elastic member combined with an electronic-indicating measurement instrument for measuring the strain of the elastic member under an applied torque.

3.2.5.1 *Discussion*—An elastic torque measurement standard is a specific "measurement standard" as defined in JCGM 200.

3.2.5.2 *Discussion*—An elastic torque measurement standard is commonly referred to as a torque transducer, torque-measuring transducer, or torque cell.

3.2.6 *lower limit factor, LLF, n*—A statistical estimate of the measurement error in torque computed from the calibration equation of the elastic torque measurement standard when the elastic torque measurement standard is calibrated in accordance with this practice.

3.2.6.1 *Discussion*—The lower limit factor is used to calculate the lower torque limit of the verified range of torques. Other factors evaluated in establishing the lower torque limit of the verified range of torques are the resolution of the elastic torque measurement standard and the lowest non-zero torque applied in the calibration torque sequence. The lower limit factor is one component of the measurement uncertainty. As a component of measurement uncertainty, the lower limit factor is often described as the relative reproducibility error with rotation. Other measurement uncertainty components should be included in a comprehensive measurement uncertainty analysis.

3.2.6.2 *Discussion*—The lower limit factor was termed uncertainty in revisions prior to E2428-15a.

3.2.7 *mode, n*—The direction of torque, either clockwise or counter-clockwise.

3.2.8 *moment arm, n*—The component that couples the perpendicular line of action of the force and the center of moments to create a torque and whose length or radius length displays metrological traceability to the International System of Units (SI)

3.2.8.1 *Discussion*—The center of moments may be the actual point about which the force causes rotation. It may also be a reference point or axis about which the force may be considered as causing rotation.

3.2.8.2 *Discussion*—Moment arm is synonymous with calibration beam (radius, single- or double-ended), torque arm, wheel, or lever unless specifically referenced otherwise.

3.2.9 *verified range of torques, n*—The range of indicated torque for which the elastic torque measurement standard gives results within permissible variations specified.

3.3 Refer to JCGM 200 International vocabulary of metrology- Basic and general concepts and associated terms (VIM) for definitions of the terms coverage factor, expanded measurement uncertainty, indication, maximum permissible measurement error, measurement error, measurement uncertainty, measurement repeatability, measurement reproducibility, reference measurement standard, and sensitivity.

4. Significance and Use

4.1 Testing machines that apply and indicate torque are in general use in many industries. Practice E2624 has been written to provide a practice for the torque calibration and verification of these testing machines. A necessary element in Practice E2624 is the use of elastic torque measurement standards whose torque characteristics are known to be metrologically traceable to the International System of Units (SI). Practice E2428 describes how these elastic torque measurement standards are to be calibrated. The procedures are useful to users of testing machines, manufacturers and providers of elastic torque measurement standards, calibration laboratories that provide calibration services and documents of metrological traceability, service organizations using elastic torque measurement standards to calibrate and verify testing machines, and testing laboratories performing general structural test measurements.

5. Reference Measurement Standards

5.1 Elastic torque measurement standards used for the calibration and verification of the torque-measuring systems of testing machines may be calibrated by either primary or secondary torque measurement standards.

5.2 Elastic torque measurement standards used as secondary torque measurement standards for the calibration of other elastic torque measurement standards shall be calibrated by primary torque measurement standards.

5.3 *Primary Torque Measurement Standard*—Weights used as primary force measurement standards shall be made of rolled, forged, or cast metal. Adjustment cavities shall be closed by threaded plugs or suitable seals. External surfaces of weights shall have a surface roughness average of 3.2 μm or less as specified in ASME B46.1.