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Low Torque Calibrations

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Torque Calibrations

- Overview
  - Current Capabilities
    - Calibration Process for Cell / Transducer
  - New Demands
  - Current Process
  - New Capabilities

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Reference Standards

Designation: E 2428 – 08

Standard Practice for Calibration of Torque-Measuring Instruments for Verifying the Torque Indication of Torque Testing Machines[1]

This standard is issued under the fixed designation E 2428; 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 practice is to specify procedure for the calibration of elastic torque-measuring instruments.

NOTE 1—Verification by deadweight and a lever arm is an acceptable method of verifying the torque indication of a torque testing machine. Tolerances for weights used are tabulated in Practice E 2624; methods for calibration of the weights are given in NIST Technical Note 577, Methods of Calibrating Weights for Piston Gages.[2]

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 This practice is intended for the calibration of static or quasi-static torque measuring instruments. The practice is not applicable for high speed torque calibrations or 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 2624 Practice for Torque Calibration of Testing Machines and Devices

2.2 *American National Standard:*

B46.1 Surface Texture[4]

ELASTIC TORQUE-MEASURING INSTRUMENTS

3. Terminology

3.1 *Definitions:*

3.1.1 *elastic torque-measuring device*—a device or system consisting of an elastic member combined with a device for indicating the measured values (or a quantity proportional to the measured value) of deformation of the member under an applied torque.

3.1.2 *primary torque standards*—a deadweight force applied through a lever arm or wheel, with a calibrated length or radius of a known uncertainty, that is traceable to national standards.

3.1.3 *secondary torque standard*—an instrument or mechanism, that has been calibrated by a comparison with a primary torque standard(s).

3.1.4 *torque*—a vector product of force and length, expressed in terms of N-m, lbf-in., etc.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration equation*—a mathematical relationship between output of the unit under test and the applied standard torque, sometimes referred to as the calibration curve.

3.2.2 *continuous-reading device*—a class of instruments whose characteristics permit interpolation of torque values between calibrated torque values.

3.2.2.1 *Discussion*—Such instruments usually have torque-to-deflection relationships that can be fitted to polynomial equations. Departures from the fitted curve are reflected in the uncertainty (see 8.4).

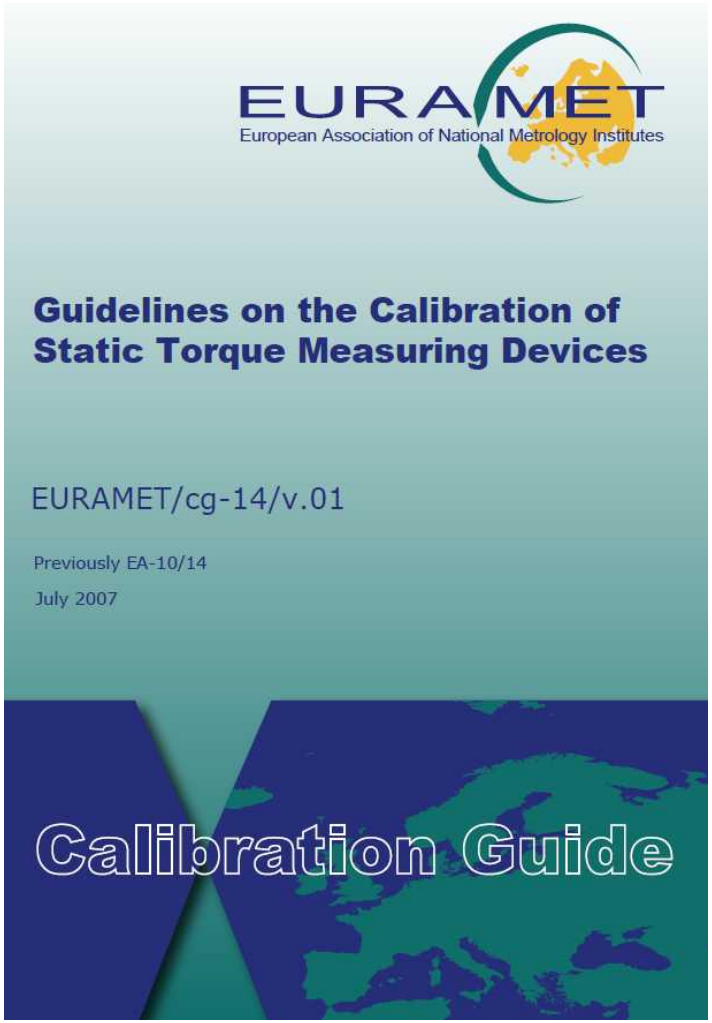
3.2.3 *deflection*—the difference between the readings of an instrument under applied torque and the reading with no applied torque. The definition of deflection applies to output readings in electrical units as well as readings in units of torque.

[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.
Current edition approved Feb. 15, 2008. Published March 2008.

[2] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[3] 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.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.



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Torque Calibrations

- **Current System (mfg. AKO)**
  - **Current Uncertainty Provided For Torque Devices**
    - **+/- 0.4 % of indicated value**

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Torque Cell / Transducer Calibrations

- Calibration Process (CW & CCW)
  - First calibration check point at 10% of range
  - Increment increased in 10% steps to 100% capacity
  - Readings must be within 0.1% of indicated value
  - Current system only allows only a single calibration point adjustment (@ 100% capacity)
    - Linearity accuracy of transducer significant as there is no correction for non-linear errors

Torque Cell / Transducer Capabilities

Asset Number	Torque Cell Maximum Capacity	Torque Cell Resolution	Minimum Calibration Point Permitted
SNL-1053	320 oz-in / 20 lb-in	0.04 oz-in / 0.0025 lb-in	16 oz-in / 1 lb-in
SNL-1000	100 lb-in / 1600 oz-in	0.01 lb-in / 0.10 oz-in	4 lb-in / 64 oz-in
SNL-1351	600 lb-in / 50 lb-ft	0.05 lb-in / 0.005 lb-ft	20 lb-in / 1.6 lb-ft
SNL-1002	1,000 lb-ft / 12,000 lb-in	0.1 lb-ft / 1.0 lb-in	40 lb-ft / 480 lb-in

Note - If a calibration point is required that is below the minimum calibration point permitted value, the metrologist must consult with the project lead to determine an acceptable method

[1] Value listed is derived by multiplying the torque cell resolution by 400. The multiplier value of 400 is referenced from ASTM E 2428-08 "Standard Practice for Calibration of Torque-Measuring Instruments for Verifying the Torque Indication of Torque Testing Machines", Section 8.5.2.2. This process was provided and approved by Project Lead of Primary Physical Standards.

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Determination of Minimum Calibration Point

Value listed is derived by multiplying the torque cell resolution by 400. The multiplier value of 400 is referenced from ASTM E 2428-08 “Standard Practice for Calibration of Torque-Measuring Instruments for Verifying the Torque Indication of Torque Testing Machines”, Section 8.5.2.2. This process was provided and approved by Project Lead of Primary Physical Standards.

8.5.2.2 *Class A—For instruments used to verify torque* testing machines in accordance with Practice E 2624, the uncertainty of the instrument must not exceed 0.25 % of the torque. The lower torque limit of the instrument is 400 times the uncertainty, in torque units, obtained from the calibration data.

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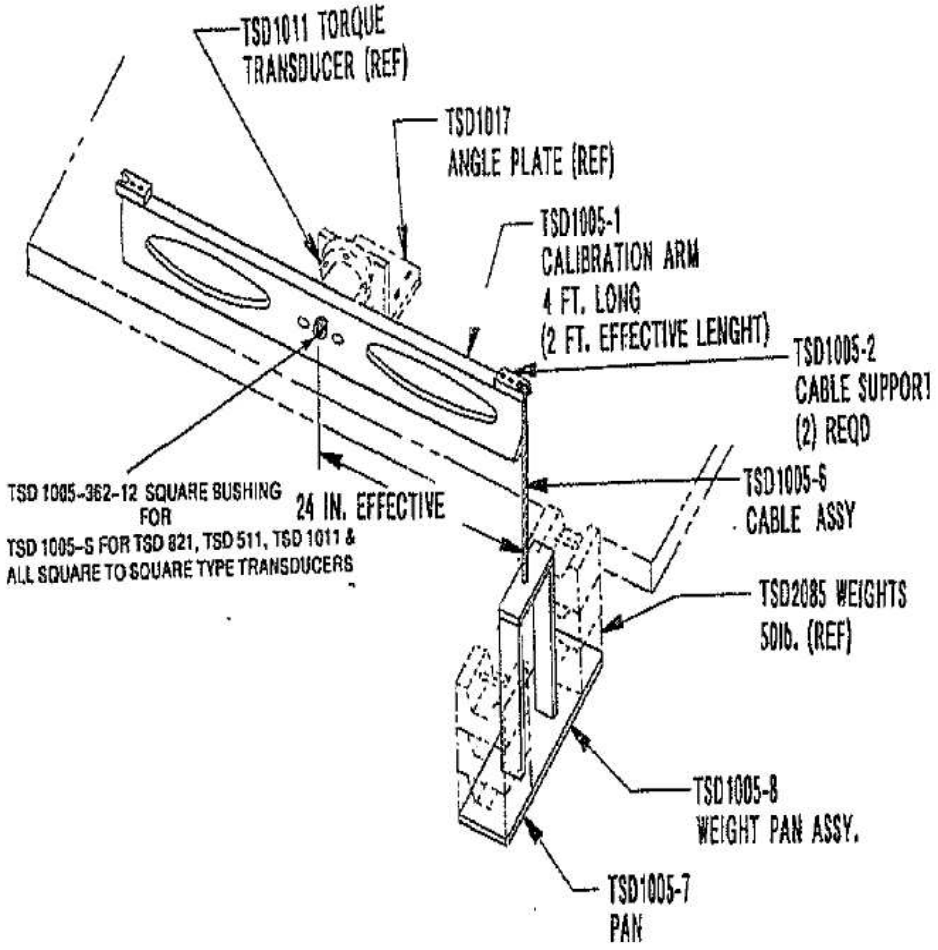
Torque Cell / Transducer Calibration



Typical Torque Calibration Setup

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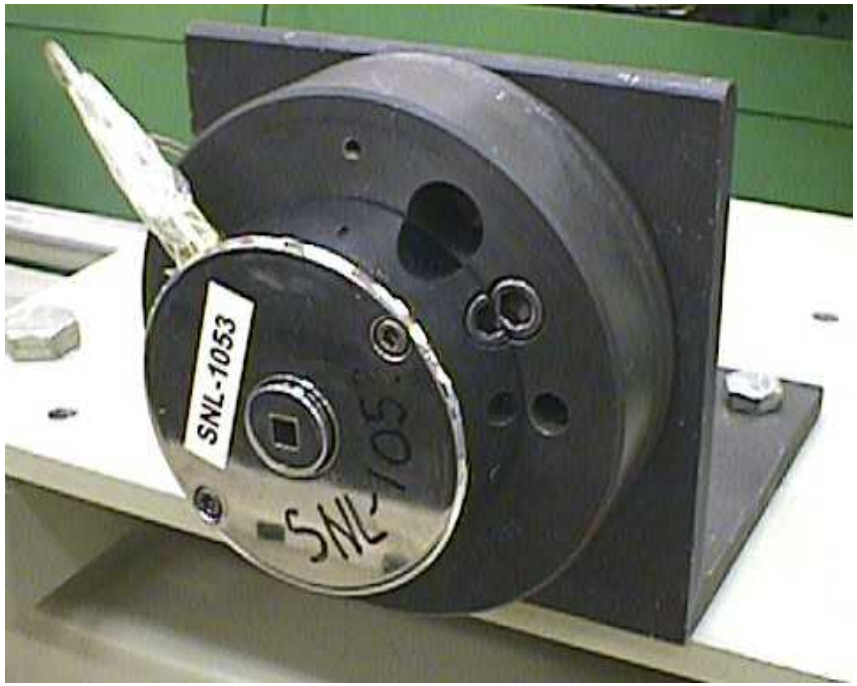
Torque Cell / Transducer Calibration

- **Calibration Process**
  - **Transducer mounted for calibration**



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Torque Cell / Transducer Calibrations

- **Moment arm and weights**
  - **Depending on the capacity of the transducer, moment arms of 5 inch, 10 inch and 24 inch are used**

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Torque Cell / Transducer Limitations

- **Overlap of ranges requires multiple cells / transducers for some torque M&TE**

Asset Number	Torque Cell Maximum Capacity	Minimum Calibration Point Permitted
SNL-1053	320 oz-in / 20 lb-in	16 oz-in / 1 lb-in
SNL-1000	100 lb-in / 1600 oz-in	4 lb-in / 64 oz-in
SNL-1351	600 lb-in / 50 lb-ft	20 lb-in / 1.6 lb-ft
SNL-1002	1,000 lb-ft / 12,000 lb-in	40 lb-ft / 480 lb-in

New Demands

- Increasing demand for torque calibrations below current capability of 16 oz-in / 1 lb-in
- Torque Watches and Preset Drivers

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Current Process For Low Torque Calibration

- Past practice for low torque calibrations developed due to uncertainty issues when using cell / transducer at less than 10% of range
  - Mount transducer in calibration position and test two points
    - One test point above and one below UUT
  - Fixturing of UUT issues
    - Proper orientation
    - Manual application of force
    - Time consuming
  - Alternative method
    - Preload cell / transducer into it's calibrated range

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Low Torque Calibrations

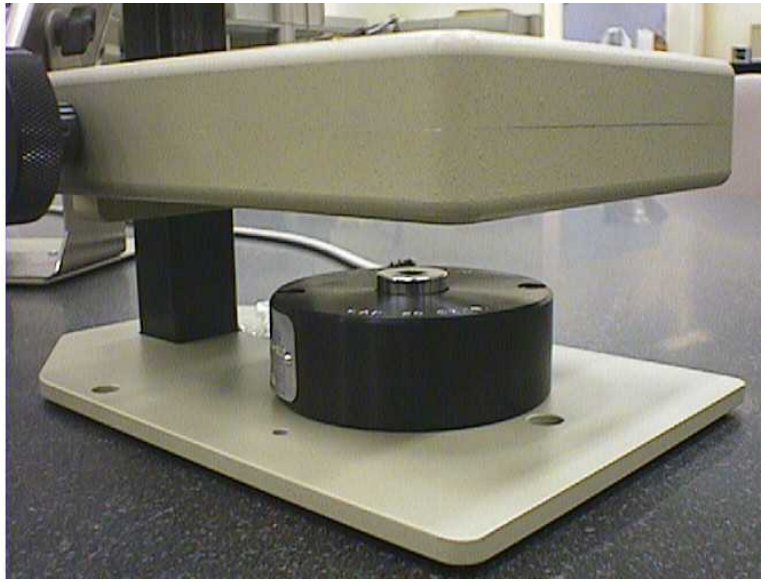
- **Preloaded Transducer**
  - **Incremental weight(s) added**

Low Torque Calibrations

- Both methods present issues
  - Uncertainty
  - Side loading of transducer
  - Orientation and testing of UUT
- Acquired new system
  - AKO
  - Non-linear error correction capability
  - Approximately $11K
    - Transducer, stand and all mounting accessories

Low Torque Calibrations

- Transducer with stand



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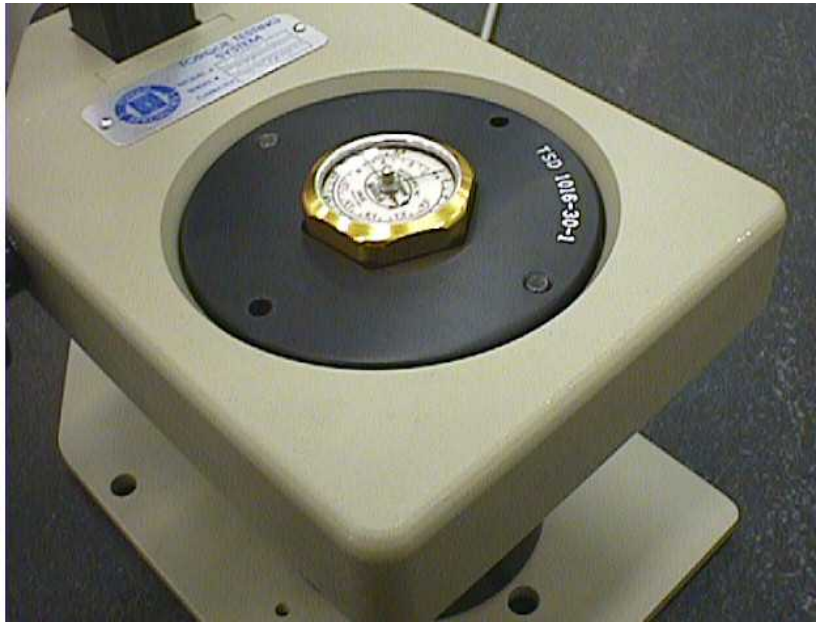
Low Torque Calibrations

- Orientation and rotation of UUT



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Low Torque Calibrations

- **Various Mounting Adaptor Plates**
  - **Most common shapes should be covered**

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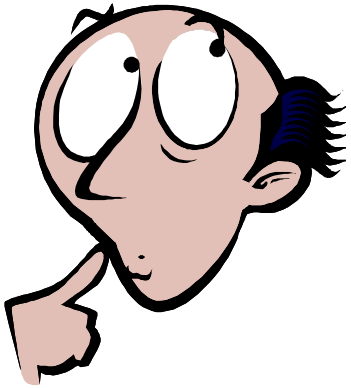
Low Torque Calibrations

- Calibration of system
  - Use standard moment arm (5 inch) and weights
    - Dedicated weights to be purchased
  - Five point non-linear calibration / adjustment
    - Programmable readout
    - Ten point test (5 additional test points)
  - System was ordered with calibration range of:
    - 0 – 20 oz-in
    - Allows slight overlap (4 oz-in) with current cell / transducer
  - New system will allow calibrations from 1 oz-in to 20 oz-in
    - Per pending approval by PSL LM&F Lead

Questions?



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