Designation: E6 – 15$^{\varepsilon 3}$

Standard Terminology Relating to Methods of Mechanical Testing[1]

This standard is issued under the fixed designation E6; 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.

ε[1] NOTE—Editorial changes were made throughout in May 2017.
ε[2] NOTE—Editorial changes were made throughout in April 2019.
ε[3] NOTE—Editorial changes were made throughout in May 2020.

1. Scope

1.1 This terminology covers the principal terms relating to methods of mechanical testing of solids. The general definitions are restricted and interpreted, when necessary, to make them particularly applicable and practicable for use in standards requiring or relating to mechanical tests. These definitions are published to encourage uniformity of terminology in product specifications.

1.2 Terms relating to fatigue and fracture testing are defined in Terminology E1823.

1.3 *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]

E8/E8M Test Methods for Tension Testing of Metallic Materials

E796 Test Method for Ductility Testing of Metallic Foil (Withdrawn 2009)[3]

E1823 Terminology Relating to Fatigue and Fracture Testing

2.2 *ISO Standard:*[4]

ISO/IEC Guide 99:2007 International Vocabulary of metrology—Basic and general concepts and terms (VIM)

2.3 *NIST Technical Notes:*

NIST Technical Note 1297 Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results[5]

2.4 *BIPM Standard:*[6]

JCGM 200 : International vocabulary of metrology — Basic and general concepts and associated terms (VIM).

3. Index of Cross-References and Associated Definitions

3.1 The terms listed below are associated with terminology that is fundamental or commonly used. The definition for the term of interest is related to or is given below the definition for the fundamental term cited.

Term	
angular strain	see **strain**
axial strain	see **strain**
bending strain	see **strain**
chord modulus	see **modulus of elasticity**
direct verification	see **verification**
compressive stress	see **stress**
elastic constants	see **modulus of elasticity** and **Poisson's ratio**
elastic modulus	see **modulus of elasticity**
engineering strain	see **strain**
engineering stress	see **stress**
fracture stress	see **stress**
indirect verification	see **verification**
linear (tensile or compressive) strain	see **strain**
macrostrain	see **strain**
malleability	see **ductility**
microstrain	see **strain**
modulus of rigidity	see **modulus of elasticity**
nominal stress	see **stress**
normal stress	see **stress**

[1] This terminology is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.91 on Terminology except where designated otherwise. A subcommittee designation in parentheses following a definition indicates the subcommittee with responsibility for that definition.

Current edition approved Dec. 1, 2015. Published March 2016. Originally approved in 1923. Last previous edition approved in 2009 as E6 – 09b$^{\varepsilon 1}$. DOI: 10.1520/E0006-15E03.

[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

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

[6] Available from BIPM - Pavillon de Breteuil F-92312 Sèvres Cedex FRANCE. this document is available free-of-charge at https://www.bipm.org/en/publications/guides/vim.html

physical properties	see **mechanical properties**
pin	see **mandrel (in bend testing)**
plunger	see **mandrel (in bend testing)**
principal stress	see **stress**
residual strain	see **strain**
residual stress	see **stress**
Rockwell superficial hardness number	see **Rockwell hardness number**
secant modulus	see **modulus of elasticity**
shear strain	see **strain**
shear stress	see **stress**
static fatigue strength	see **creep rupture strength**
stress-rupture strength	see **creep rupture strength**
tangent modulus	see **modulus of elasticity**
tensile stress	see **stress**
torsional modulus	see **modulus of elasticity**
torsional stress	see **stress**
transverse strain	see **strain**
true strain	see **strain**
true stress	see **stress**
ultimate tensile strength (UTS)	see **tensile strength**
yield strength	see also **upper yield strength** and **lower yield strength**

4. Terminology

4.1 *Terms and Definitions:*

absorbed energy [FL], *n*—work spent to fracture a specimen in a single pendulum swing, as measured by a compensated indicating device **(E28.07)**

accuracy, *n*—the permissible variation from the correct value. **(E28.01)**

adjusted length of the reduced section—the length of the reduced section plus an amount calculated to compensate for strain in the fillet region. **(E28.04)**

alignment, *n*—the condition of a testing machine that influences the introduction of bending moments into a specimen (or alignment transducer) during the application of tensile or compressive forces. **(E28.01)**

angle of bend, *n*—the change in the angle between the two legs of the specimen during a bend test, measured before release of the bending forces.

Discussion—The angle of bend is measured before release of the bending force, unless otherwise specified. **(E28.02)**

angle of twist (torsion test), *n*—the angle of relative rotation measured in a plane normal to the torsion specimen's longitudinal axis over the gauge length. **(E28.04)**

bearing area [L^2], *n*—the product of the pin diameter and specimen thickness. **(E28.04)**

bearing force [F], *n*—a compressive force on an interface. **(E28.04)**

bearing strain, *n*—the ratio of the bearing deformation of the bearing hole, in the direction of the applied force, to the pin diameter. **(E28.04)**

bearing strength [FL^{-2}] **,** *n*—the maximum bearing stress which a material is capable of sustaining. **(E28.04)**

bearing stress [FL^{-2}] **,** *n*—the force per unit of bearing area. **(E28.04)**

bearing yield strength [FL^{-2}], *n*—the bearing stress at which a material exhibits a specified limiting deviation from the proportionality of bearing stress to bearing strain. **(E28.04)**

bend test, *n*—a test for ductility performed by bending or folding a specimen, usually by steadily applied forces but in some instances by blows.

Discussion—The bending may be interrupted to examine the bent surface for cracks.

Discussion—The ductility is usually judged by whether or not the specimen cracks under the specified conditions of the test.

Discussion—There are four general types of bend tests according to the manner in which the forces are applied to the specimen to make the bend. These are as follows:

1. Free Bend
2. Guided Bend
3. Semi-Guided Bend
4. Wrap-Around Bend

Discussion—The specimen has a substantially uniform cross-section and a length several times as great as the largest dimension of the cross-section. **(E28.02)**

biaxial stretching, *n*—a mode of sheet metal forming in which positive strains are observed in all directions at a given location. **(E28.02)**

breaking force[F], *n*—the force at which fracture occurs.

Discussion—When used in connection with tension tests of thin materials or materials of small diameter for which it is often difficult to distinguish between the breaking force and the maximum force developed, the latter is considered to be the breaking force. **(E28.04)**

Brinell hardness number, *n*—a number, which is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation which is assumed to be spherical and of the diameter of the ball. **(E28.06)**

Brinell hardness scale—a designation that identifies the specific combination of ball diameter and applied force used to perform the Brinell hardness test. **(E28.06)**

Brinell hardness test, *n*—an indentation hardness test using a verified machine to force an indenter (tungsten carbide ball with diameter *D*), under specified conditions, into the surface of the material under test. The diameter of the resulting indentation *d* is measured after removal of the force. **(E28.06)**

calibration—determination of the values of the significant parameters by comparison with values indicated by a reference instrument or by a set of reference standards. **(E28.06)**

calibration, *n*—a process that establishes, under specific conditions, the relationship between values indicated by a measuring system and the corresponding values indicated by one or more standards.

Discussion—This definition is intended to meet the principles of the definition of **calibration** provided by the ISO/IEC Guide 99:2007 International Vocabulary of Basic and General Terms in Metrology (VIM). **(E28.91)**

calibration, *n*—operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.

Discussion—A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Discussion—Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with verification of calibration.

Discussion—Often, the first step alone in the above definition is perceived as being calibration. **JCGM 200:2012** [7]

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

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 extensometer reading. For direct-reading extensometers the calibration factor is unity. **(E28.01)**

compressive strength [FL^{-2}], *n*—the maximum compressive stress that a material is capable of sustaining.

Discussion—Compressive strength is calculated by dividing the maximum force during a compression test by the original cross-sectional area of the specimen.

Discussion—In the case of a material which fails in compression by a shattering fracture, the compressive strength has a very definite value. In the case of materials which do not fail in compression by a shattering fracture, the value obtained for compressive strength is an arbitrary value depending upon the degree of distortion which is regarded as indicating complete failure of the material. **(E28.04)**

compressometer, *n*—a specialized extensometer used for sensing negative or compressive strain. **(E28.01)**

constraint, *n*—any restriction to the deformation of a body. **(E28.91)**

creep, *n*—the time-dependent strain that occurs after the application of a force which is thereafter maintained constant.

Discussion—Creep tests are usually made at constant force and temperature. For tests on plastics, the initial strain – however defined– is included; for tests on metals, the initial strain is not included. **(E28.04)**

creep recovery, *n*—the time-dependent decrease in strain in a solid, following the removal of force.

Discussion—Recovery is usually determined at constant temperature.

Discussion—In tests of plastics, the initial recovery is generally included; for metals, it is not. Thermal expansion is excluded. **(E28.04)**

creep rupture strength [FL^{-2}], *n*—the stress causing fracture in a creep test at a given time, in a specified constant environment.

Discussion—This is sometimes referred to as the *stress-rupture strength* or, in glass technology, the *static fatigue strength*. **(E28.04)**

creep strength [FL^{-2}], *n*—the stress that causes a given creep in a creep test at a given time in a specified constant environment. **(E28.04)**

deep drawing, *n*—a metal sheet forming operation in which strains on the sheet surface are positive in the direction of the punch travel and negative at 90° to that direction. **(E28.02)**

deflectometer, *n*—a specialized extensometer used for sensing of extension or motion, usually without reference to a specific gauge length. **(E28.01)**

Demeri Split Ring Test—a test that measures the springback behavior of sheet metal by comparing the diameter of a ring extracted from the wall of a flat bottom cup and the diameter of the same ring split to release residual stresses. **(E28.02)**

discontinuous yielding, *n*—in a uniaxial test, a hesitation or fluctuation of force observed at the onset of plastic deformation, due to localized yielding.

Discussion—The stress-strain curve need not appear to be discontinuous. **(E28.04)**

discontinuous yielding stress, σ_i, *n*—the peak stress at the initiation of the first measurable serration on the curve of stress-versus-strain.

Discussion—The parameter σ_i is a function of test variables and is not a material constant. **(E28.04)**

ductility, *n*—the ability of a material to deform plastically before fracturing.

Discussion—Ductility is usually evaluated by measuring (*1*) the elongation or reduction of area from a tension test, (*2*) the depth of cup from a cupping test, (*3*) the radius or angle of bend from the bend test, or (*4*) the fatigue ductility from the fatigue ductility test (see Test Method E796).

Discussion—Malleability is the ability to deform plastically under repetitive compressive forces. **(E28.02)**

dynamic mechanical measurement, *n*—a technique in which either the modulus or damping, or both, of a substance under oscillatory applied force or displacement is measured as a function of temperature, frequency, or time, or a combination thereof. **(E28.04)**

eccentricity, *n*—the distance between the line of action of the applied force and the axis of symmetry of the specimen in a plane perpendicular to the longitudinal axis of the specimen. **(E28.01)**

edge distance [L], *n*—the distance from the edge of a bearing specimen to the center of the hole in the direction of applied force. **(E28.04)**

edge distance ratio, *n*—the ratio of the edge distance to the pin diameter. **(E28.04)**

elastic limit [FL^{-2}], *n*—the greatest stress that a material is capable of sustaining without any permanent strain remaining upon complete release of the stress.

Discussion—Due to practical considerations in determining the elastic limit, measurements of strain using a small force, rather than zero force, are usually taken as the initial and final reference. **(E28.04)**

[7] This definition is reproduced here from JCGM 200:2012 International vocabulary of metrology – Basic and general concepts and associated terms (VIM) with permission from the Director of BIPM. The text has been put in ASTM International's form and style.

elastic true strain, ε_e, *n*—elastic component of the true strain. **(E28.02)**

elongation, *El*, *n*—the increase in gauge length of a body subjected to a tension force, referenced to a gauge length on the body.

Discussion—Usually elongation is expressed as a percentage of the original gauge length.

Discussion—The increase in gauge length may be determined either *at* or *after* fracture, as specified for the material under test.

Discussion—The term elongation, when applied to metals, generally means measurement after fracture; when applied to plastics and elastomers, measurement at fracture. Such interpretation is usually applicable to values of elongation reported in the literature when no further qualification is given.

Discussion—In reporting values of elongation, the gauge length shall be stated.

Discussion—Elongation is affected by specimen geometry (area and shape of cross section, parallel length, parallelism, fillet radii, etc.), preparation (degree to which surfaces within the reduced section are smooth and free of cold work), and test procedure (alignment and test speed, for example). **(E28.04)**

elongation after fracture, *n*—the elongation measured by fitting the two halves of the broken specimen together. **(E28.04)**

elongation at fracture, *n*—the elongation measured just prior to the sudden decrease in force associated with fracture. **(E28.04)**

error, *n*—for a measurement or reading, the amount it deviates from a known or reference value represented by a measurement standard.

Discussion—Mathematically, the error is calculated by subtracting the accepted value from the measurement or reading. (See also **percent error**.) **(E28.91)**

expanded uncertainty—a statistical measurement of the probable limits of error of a measurement.

Discussion—NIST Technical Note 1297 treats the statistical approach including the expanded uncertainty. **(E28.91)**

extensometer, *n*—a device for sensing strain. **(E28.01)**

extensometer system, *n*—a system for sensing and indicating strain.

Discussion—The system will normally include an extensometer, conditioning electronics, and auxiliary device (recorder, digital readout, computer, etc.). However, completely self-contained mechanical devices are permitted. An extensometer system may be one of three types. **(E28.01)**

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. **(E28.01)**

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.

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. **(E28.01)**

Type 3 extensometer system, n—an extensometer system which intrinsically senses strain (ratiometric principle), for example, video camera system. **(E28.01)**

exercise, *v*—apply the maximum force to be used in the verification to either a force-measuring instrument or the force-sensing device of a testing machine or to both, to reestablish the hysteresis pattern that tends to disappear during periods of disuse, or with the change of mode of force application, as from compression to tension. **(E28.01)**

fatigue ductility, D_f —the ability of a material to deform plastically before fracturing, determined from a constant-strain amplitude, low-cycle fatigue test.

Discussion—Fatigue ductility is usually expressed in percent in direct analogy with elongation and reduction of area ductility measures.

Discussion—The fatigue ductility corresponds to the fracture ductility, the true tensile strain at fracture. Elongation and reduction of area represent the engineering tensile strain after fracture.

Discussion—For the purpose of this definition the fatigue ductility exponent, *c*, is defined as $c = -0.60$. **(E28.02)**

fatigue life, N_f, *n*—the numbers of cycles of stress or strain of a specified character that a given specimen sustains before failure of a specified nature occurs. **(E28.01)**

force-measuring instrument—a system consisting of an elastic member combined with an appropriate instrument for indicating the magnitude (or a quantity proportional to the magnitude) of deformation of the member under an applied force. **(E28.01)**

forming limit curve, (FLC), *n*—an empirically derived curve showing the biaxial strain levels beyond which localized through-thickness thinning (necking) and subsequent failure occur during the forming of a metallic sheet. **(E28.02)**

forming limit diagram, (FLD), *n*—a graph on which the measured major and associated minor strain combinations are plotted to develop a forming limit curve. **(E28.02)**

fracture ductility, ε_f, *n*—the true plastic strain at fracture.

fracture strength, S_f [FL^{-2}], *n*—the normal stress at the beginning of fracture.

Discussion—Fracture strength is calculated by dividing the force at the beginning of fracture during a tension test by the original cross-sectional area of the specimen. **(E28.04)**

free bend, *n*—the bend obtained by applying forces to the ends of a specimen without the application of force at the point of maximum bending.

Discussion—In making a free bend, lateral forces first are applied to produce a small amount of bending at two points. The two bends, each a suitable distance from the center, are both in the same direction. **(E28.02)**

force [F], *n*—in mechanical testing, a vector quantity of fundamental nature characterized by a magnitude, a direction, a sense, and a discrete point of application, that acts externally upon a test object and creates stresses in it.

DISCUSSION—Force is a derived unit of the SI system. Units of force in the SI system are newtons (N).

DISCUSSION—Where applicable, the noun **force** is preferred to **load** in terminology for mechanical testing. **(E28.91)**

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

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. **(E28.01)**

gauge length, *n*—the original length of that portion of the specimen over which strain, elongation, or change of length are determined.

DISCUSSION—Typically, this length is also the distance between gauge marks, if gauge marking is used to facilitate measurement of the elongation after fracture.

DISCUSSION—When sensing extension or motion with a gauge length that is predetermined by the specimen geometry or specific test method, then only resolution and strain error for the specified gauge length should determine the class of the extensometer system. **(E28.04)**

guided bend, *n*—the bend obtained by using a mandrel to guide and force the portion of the specimen being bent between two faces of a die. **(E28.02)**

hardness, *n*—the resistance of a material to deformation, particularly permanent deformation, indentation, or scratching.

DISCUSSION—Different methods of evaluating hardness give different ratings because they are measuring somewhat different quantities and characteristics of the material. There is no absolute scale for hardness; therefore, to express hardness quantitatively, each type of test has its own scale of arbitrarily defined hardness. **(E28.06)**

indentation hardness, *n*—the hardness as evaluated from measurements of area or depth of the indentation made by pressing a specified indenter into the surface of a material under specified static loading conditions. **(E28.06)**

initial recovery, *n*—the decrease in strain in a specimen resulting from the removal of force, before creep recovery takes place.

DISCUSSION—This is sometimes referred to as instantaneous recovery.

DISCUSSION—Recovery is usually determined at constant temperature. Thermal expansion is excluded.

DISCUSSION—For tests on plastics, the initial recovery is generally included as part of creep recovery.

DISCUSSION—This definition describes a quantity which is difficult to measure accurately. The values obtained may vary greatly with the sensitivity and accuracy of the test equipment. When determining this quantity, the procedure and characteristics of the test equipment should be reported. **(E28.04)**

initial strain, *n*—the strain introduced into a specimen by the given loading conditions, before creep takes place.

DISCUSSION—This is sometimes referred to as instantaneous strain. **(E28.04)**

initial stress, *n*—the stress introduced into a specimen by imposing the given constraint conditions before stress relaxation begins.

DISCUSSION—This is sometimes referred to as instantaneous stress. **(E28.11)**

instrumented absorbed energy, W_t[FL], *n*—work spent to fracture a specimen in a single pendulum swing, as calculated by integrating the force-displacement curve. **(E28.07)**

Knoop hardness number, HK, *n*—the calculated result from a Knoop hardness test, which is proportional to the test force applied to the Knoop indenter divided by the projected area of the permanent indentation made by the indenter after removal of the test force.

DISCUSSION—The projected area of the permanent indentation made by the Knoop indenter is calculated based partly on the measured length of the long diagonal of the projected area of the indentation. **(E28.06)**

Knoop hardness test, *n*—an indentation test in which a Knoop rhombic-based pyramidal diamond indenter having specified edge angles, is forced under specified conditions into the surface of the test material, and, after removal of the test force, the length of the long diagonal of the projected area of the indentation is measured to calculate the Knoop hardness number. **(E28.06)**

lateral expansion [L], *n*—the maximum increase in thickness of the specimen as a result of the impact test, expressed in mm.

DISCUSSION—lateral expansion is used as a measure of ductility. **(E28.07)**

lead wire, *n*—an electrical conductor used to connect a sensor to its instrumentation. **(E28.01)**

least count, *n*—the smallest change in indication that can customarily be determined and reported.

DISCUSSION—In machines with close graduations the least count may be the value of a graduation interval; with open graduations or with magnifiers for reading, it may be an estimated fraction, rarely as fine as one tenth, of a graduated interval; and with verniers it is customarily the difference between the scale and vernier graduation measured in terms of scale units. If the indicating mechanism includes a stepped detent, the detent action may determine the least count.

length of the reduced section—the distance between the tangent points of the fillets that bound the reduced section. **(E28.04)**

limiting dome height (LDH) test, *n*—an evaluative test for metal sheet deformation capability employing a hemispherical punch and a circumferential clamping force sufficient to prevent metal in the surrounding flange from being pulled into the die cavity. **(E28.02)**

load [F] **,** *n*—in mechanical testing, an external force or system of forces or pressures, acting upon the test specimen or sample.

DISCUSSION—**Load** is a deprecated term and, where practical, should be replaced by **force**, particularly when used as a noun. For reasons of editorial simplicity or traditional usage, replacement of **load** by **force** may not always be desirable when used as a verb, adjective, or other part of speech. For example, it is appropriate to refer to **loading** a specimen, a **loading** rate, a **load** cell, or a **load**–line displacement. **(E28.91)**

lower yield strength, *LYS* [FL^{-2}], *n*—in a uniaxial test, the minimum stress recorded during discontinuous yielding, ignoring transient effects. **(E28.04)**

mandrel (in bend testing), *n*—the tool used to control the strain on the concave side of a bend in a wrap-around bend test and also to apply the bending force in a semi-guided or guided bend test.

DISCUSSION—The terms "pin" and "plunger" have been used in place of mandrel.

DISCUSSION—In free bends or semi-guided bends to an angle of 180° a shim or block of the proper thickness may be placed between the legs of the specimen as bending is completed. This shim or block is also referred to as a pin or mandrel. **(E28.02)**

measurement accuracy, *n*—closeness of agreement between a measured quantity value and a true quantity value of a measurand

DISCUSSION—The concept 'measurement accuracy' is not a quantity and is not given a numerical quantity value. A measurement is said to be more accurate when it offers a smaller measurement error.

DISCUSSION—The term "measurement accuracy" should not be used for measurement trueness and the term "measurement precision" should not be used for 'measurement accuracy', which, however, is related to both these concepts.

DISCUSSION—'Measurement accuracy' is sometimes understood as closeness of agreement between measured quantity values that are being attributed to the measurand. **JCGM 200:2012** [7]

mechanical hysteresis, *n*—the energy absorbed in a complete cycle of loading and unloading.

DISCUSSION—A complete cycle of loading and unloading includes any stress cycle regardless of the mean stress or range of stress. **(E28.04)**

mechanical properties, *n*—those properties of a material that are associated with elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain.

DISCUSSION—These properties have often been referred to as "physical properties," but the term "mechanical properties" is preferred. **(E28.91)**

mechanical testing, *n*—determination of the properties or the mechanical states of a material that are associated with elastic and inelastic reactions to force or that involve relationships between stress and strain. **(E28.91)**

metrological traceability, *n*—property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.

DISCUSSION—For this definition, a 'reference' can be a definition of a measurement unit through its practical realization, or a measurement procedure including the measurement unit for a non-ordinal quantity, or a measurement standard.

DISCUSSION—Metrological traceability requires an established calibration hierarchy.

DISCUSSION—Specification of the reference must include the time at which this reference was used in establishing the calibration hierarchy, along with any other relevant metrological information about the reference, such as when the first calibration in the calibration hierarchy was performed.

DISCUSSION—For measurements with more than one input quantity in the measurement model, each of the input quantity values should itself be metrologically traceable and the calibration hierarchy involved may form a branched structure or a network. The effort involved in establishing metrological traceability for each input quantity value should be commensurate with its relative contribution to the measurement result.

DISCUSSION—Metrological traceability of a measurement result does not ensure that the measurement uncertainty is adequate for a given purpose or that there is an absence of mistakes.

DISCUSSION—A comparison between two measurement standards may be viewed as a calibration if the comparison is used to check and, if necessary, correct the quantity value and measurement uncertainty attributed to one of the measurement standards. **JCGM 200:2012**[7]

modulus of elasticity [FL^{-2}], *n*—the ratio of stress to corresponding strain below the proportional limit.

DISCUSSION—The stress-strain relationships of many materials do not conform to Hooke's law throughout the elastic range, but deviate therefrom even at stresses well below the elastic limit. For such materials, the slope of either the tangent to the stress-strain curve at the origin or at a low stress, the secant drawn from the origin to any specified point on the stress-strain curve, or the chord connecting any two specified points on the stress-strain curve is usually taken to be the "modulus of elasticity." In these cases, the modulus should be designated as the "tangent modulus," the "secant modulus," or the "chord modulus," and the point or points on the stress-strain curve described. Thus, for materials where the stress-strain relationship is curvilinear rather than linear, one of the four following terms may be used:

(a) initial tangent modulus [FL^{-2}], *n*—the slope of the stress-strain curve at the origin.

(b) tangent modulus [FL^{-2}], *n*—the slope of the stress-strain curve at any specified stress or strain.

(c) secant modulus [FL^{-2}], *n*—the slope of the secant drawn from the origin to any specified point on the stress-strain curve.

(d) chord modulus [FL^{-2}], *n*—the slope of the chord drawn between any two specified points on the stress-strain curve below the elastic limit of the material.

DISCUSSION—Modulus of elasticity, like stress, is expressed in force per unit of area (pounds per square inch, etc.). **(E28.04)**

modulus of rupture in bending [FL^{-2}], *n*—the value of maximum tensile or compressive stress (whichever causes failure) in the extreme fiber of a beam loaded to failure in bending, computed from the flexure equation:

$$S_b = Mc/I \quad (1)$$

where:

M = maximum bending moment, computed from the maximum force and the original moment arm,

c = initial distance from the neutral axis to the extreme fiber where failure occurs, and