Designation: E344 – 18

Terminology Relating to Thermometry and Hydrometry[1]

This standard is issued under the fixed designation E344; 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 terminology is a compilation of definitions of terms used by ASTM Committee E20 on Temperature Measurement.

1.2 Terms with definitions generally applicable to the fields of thermometry and hydrometry are listed in 3.1.

1.3 Terms with definitions applicable only to the indicated standards in which they appear are listed in 3.2.

1.4 Information about the International Temperature Scale of 1990 is given in Appendix X1.

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]

E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
E100 Specification for ASTM Hydrometers
E126 Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers
E207 Test Method for Thermal EMF Test of Single Thermoelement Materials by Comparison with a Reference Thermoelement of Similar EMF-Temperature Properties
E220 Test Method for Calibration of Thermocouples By Comparison Techniques
E230/E230M Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
E452 Test Method for Calibration of Refractory Metal Thermocouples Using a Radiation Thermometer
E574 Specification for Duplex, Base Metal Thermocouple Wire With Glass Fiber or Silica Fiber Insulation
E585/E585M Specification for Compacted Mineral-Insulated, Metal-Sheathed, Base Metal Thermocouple Cable
E601 Guide for Measuring Electromotive Force (emf) Stability of Base-Metal Thermoelement Materials with Time in Air
E608/E608M Specification for Mineral-Insulated, Metal-Sheathed Base Metal Thermocouples
E644 Test Methods for Testing Industrial Resistance Thermometers
E667 Specification for Mercury-in-Glass, Maximum Self-Registering Clinical Thermometers
E696 Specification for Tungsten-Rhenium Alloy Thermocouple Wire
E710 Test Method for Comparing EMF Stabilities of Base-Metal Thermoelements in Air Using Dual, Simultaneous, Thermal-EMF Indicators (Withdrawn 2006)[3]
E780 Test Method for Measuring the Insulation Resistance of Mineral-Insulated, Metal-Sheathed Thermocouples and Mineral-Insulated, Metal-Sheathed Cable at Room Temperature
E825 Specification for Phase Change-Type Disposable Fever Thermometer for Intermittent Determination of Human Temperature
E839 Test Methods for Sheathed Thermocouples and Sheathed Thermocouple Cable
E879 Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
E1061 Specification for Direct-Reading Liquid Crystal Forehead Thermometers
E1104 Specification for Clinical Thermometer Probe Covers and Sheaths
E1112 Specification for Electronic Thermometer for Intermittent Determination of Patient Temperature
E1129/E1129M Specification for Thermocouple Connectors
E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
E1159 Specification for Thermocouple Materials, Platinum-Rhodium Alloys, and Platinum

[1] This terminology is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.91 on Editorial and Terminology.

Current edition approved April 1, 2018. Published May 2018. Originally approved in 1968. Last previous edition approved in 2016 as E344 – 16. DOI: 10.1520/E0344-18.

[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.

E1256 Test Methods for Radiation Thermometers (Single Waveband Type)
E1299 Specification for Reusable Phase-Change-Type Fever Thermometer for Intermittent Determination of Human Temperature
E1350 Guide for Testing Sheathed Thermocouples, Thermocouples Assemblies, and Connecting Wires Prior to, and After Installation or Service
E1502 Guide for Use of Fixed-Point Cells for Reference Temperatures
E1594 Guide for Expression of Temperature
E1684/E1684M Specification for Miniature Thermocouple Connectors
E1750 Guide for Use of Water Triple Point Cells
E1751/E1751M Guide for Temperature Electromotive Force (emf) Tables for Non-Letter Designated Thermocouple Combinations
E1965 Specification for Infrared Thermometers for Intermittent Determination of Patient Temperature

2.2 *Other Standards, Supplementary Vocabularies, and Sources:*[4]

International Vocabulary of Basic and General Terms in Metrology (VIM) 1993
Guide to the Expression of Uncertainty in Measurement (GUM) 1995
IEC 61298-1 Process Measurement and Control Devices General Methods and Procedures for Evaluating Performance- Part 1: General Considerations[5]

3. Terminology

3.1 *Definitions:*

accuracy, *n—of a temperature measurement*, closeness of agreement between the result of a temperature measurement and a true value of the temperature.

DISCUSSION—Accuracy is a qualitative concept.

base metal thermocouple, *n*—thermocouple whose thermoelements are composed primarily of base metals and their alloys. (See also **noble metal thermocouple; refractory metal thermocouple**.)

DISCUSSION—Base metals used in thermoelements include nickel, iron, chromium, copper, aluminum. Letter-designated types E, J, K, T, and N are considered base metal thermocouples.

bias, *n*—the scatter between the mean values of subsets of data, from each other or from the accepted value.

blackbody, *n*—the perfect or ideal source of thermal radiant power having a spectral distribution described by the Planck equation.

DISCUSSION—The term blackbody is often used to describe a furnace or other source of radiant power which approximates the ideal.

bulb, *n—of a liquid-in-glass thermometer*, reservoir for the thermometric liquid.

calibration, *n—of a thermometer or thermometric system*, the set of operations that establishes the relationship between the indications of a thermometer or thermometric system and the corresponding reference standard at discrete temperature values. The operations are performed under specified conditions. The calibration results are often used to establish this relationship at other temperature values. The communicated results shall include a statement of the measurement uncertainty for each measurement result.

DISCUSSION—(1) The result of a calibration permits either the assignment of values of temperature to indicated values of thermometric quantity, or the determination of additive or multiplicative corrections with respect to indications, or both. (2) A calibration may also determine other metrological properties such as the effect of influence quantities. (3) The result of a calibration may be communicated in a document such as a calibration certificate, calibration report, calibration function, calibration diagram, calibration curve, or calibration table. (4) The term calibration has also been used in standards under E20 jurisdiction to refer to the result of the operations, to representations of the result, and to the actual relationship between values of the thermometric quantity and temperature.

calibration point, *n*—a specific value, established by a reference, at which the indication or output of a measuring device is determined.

Celsius, *adj*—pertaining to or denoting something related to the expression of temperature in degrees Celsius.

DISCUSSION—For example, "A **Celsius** thermometer has a scale marked in degrees Celsius."

center wavelength, *n*—a wavelength, usually near the middle of the band of radiant power over which a radiation thermometer responds, that is used to characterize its performance.

DISCUSSION—The value of the center wavelength is usually specified by the manufacturer of the instrument.

clinical thermometer, *n*—thermometer of any type designed to measure human body temperature.

DISCUSSION—Some clinical thermometers may be designed to measure the body temperature of animals.

coaxial thermocouple, *n*—a thermocouple consisting of a thermoelement in wire form within a thermoelement in tube form with the wire being electrically insulated from the tube except at the measuring junction.

compensating extension wires, *n*—those extension wires fabricated from materials basically different in composition from the thermocouple.

DISCUSSION—They have similar thermoelectric properties and within a stated temperature range effectively transfer the reference junction to the other end of the wires.

complete immersion thermometer, *n*—a liquid-in-glass thermometer designed to indicate temperatures correctly when the entire thermometer is exposed to the temperature being measured. (Compare **total immersion thermometer** and **partial immersion thermometer.**)

connection head, *n*—a housing enclosing a terminal block for an electrical temperature-sensing device and usually provided with threaded openings for attachment to a protecting tube and for attachment of conduit.

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

[5] Available from International Electrotechnical Commission (IEC), 3 rue de Varembé, Case postale 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

defining fixed point, *n*—thermometric fixed point of an idealized system, to which a numerical value has been assigned, used in defining a temperature scale.

degree Celsius, °C, *n*—derived unit of temperature in the International System of Units (SI). (See **kelvin**.)

DISCUSSION—At any temperature, an interval of one degree Celsius is the same as an interval of one kelvin, by definition. For information about the relation between units and values of temperature expressed in different units, see Guide E1594.

degree centigrade, *n*—obsolete term. Use **degree Celsius.**

degree Fahrenheit, °F, *n*—non-SI unit of temperature commonly used in the United States of America.

DISCUSSION—At any temperature, an interval of one degree Fahrenheit is the same as an interval of 5/9 kelvin (or 5/9 degree Celsius). For information about the relation between units and values of temperature expressed in different units, see Guide E1594.

electromotive force (emf), *n*—the electrical potential difference which produces or tends to produce an electric current.

error, *n—of a temperature measurement*, result of a temperature measurement minus a true value of temperature.

extension wires, *n*—those having temperature-emf characteristics that when connected to a thermocouple effectively transfer the reference junction to the other end of the wires. (Compare **compensating wires).**

Fahrenheit, *adj*—pertaining to or denoting something related to the expression of temperature in degrees Fahrenheit.

DISCUSSION—For example, "A **Fahrenheit** thermometer has a scale marked in degrees Fahrenheit."

fixed point, *n— in thermometry*, reproducible temperature of equilibrium of a system of two or more phases under specified conditions.

freezing point, *n*—fixed point of a single component system in which liquid and solid phases are in equilibrium at a specified pressure, usually 101 325 Pa, and the system is losing heat slowly. (Compare **melting point**.)

grounded junction, *n*—A measuring junction of a thermocouple assembly that is electrically and physically connected to its sheath. See also **Style G**.

DISCUSSION—The term "grounded" has been historically accepted in the field of thermometry to indicate the electrical connectivity of a thermocouple's measuring junction to its sheath; the term does not indicate whether or not the measuring junction is electrically connected to earth or circuit ground.

hysteresis, *n*—The property of a device or instrument whereby it gives different output values in relation to its input values depending upon the directional sequence in which the input values have been applied. **IEC 61298-1**

ice point, *n*—thermometric fixed point of ice and water saturated with air at a pressure of 101 325 Pa.

industrial platinum resistance thermometer (IPRT), *n*—a rugged platinum resistance thermometer suitable for temperature measurements in harsh industrial environments over all or part of the temperature range -200°C to 650°C.

DISCUSSION—(1) The sensing element is made from platinum wire or film and packaged in a rugged housing to withstand harsh operating conditions. The sheath material is usually stainless steel or Inconel; however, other materials may be used for special applications. (2) The resistance-temperature relationship is usually defined by a specified nominal equation and interchangeability tolerances over a specified temperature range. (3) IPRTs have ice-point resistance values of at least 100 ohms, and are available with two-wire, three-wire or four-wire terminations. (4) IPRTs are the most rugged and lowest cost platinum resistance thermometers.

International Practical Temperature Scale (IPTS-48), *n*—the temperature scale adopted by the 11th General Conference on Weights and Measures in 1960 and replaced in 1968 by the International Practical Temperature Scale of 1968.

International Practical Temperature Scale of 1968 (IPTS-68), *n*—the temperature scale adopted by the 13th General Conference on Weights and Measures in 1968.

DISCUSSION—The IPTS-68 was superseded in 1990 by the International Temperature Scale of 1990.

International Temperature Scale of 1990 (ITS-90), *n*—the temperature scale prepared in accordance with instructions of the 18th General Conference on Weights and Measures, and adopted on January 1, 1990.

kelvin, K, *n*—base unit of temperature in the International System of Units (SI).

liquid-in-glass thermometer, *n*—a temperature-measuring instrument whose indications are based on the temperature coefficient of expansion of a liquid relative to that of its containing glass bulb.

lower range value, *n*—the lowest quantity that an instrument is adjusted to measure.

maximum permissible errors, *n—of a thermometer or thermometric system*, extreme values permitted by regulation or specification of the difference between the indication of a thermometer or thermometeric system and the true value of temperature.

DISCUSSION—The term *tolerance* is sometimes used in ASTM standards to represent this concept.

maximum self-registering clinical thermometer, *n*—clinical thermometer designed to retain the indication of its maximum measured temperature until reset.

measuring junction, *n*—that junction of a thermocouple which is subjected to the temperature to be measured.

melting point, *n*—fixed point of a single component system in which liquid and solid phases are in equilibrium at a specified pressure, usually 101 325 Pa, and the system is gaining heat slowly. (Compare **freezing point**.)

noble metal thermocouple, *n*—thermocouple whose thermoelements are composed primarily of noble metals and their alloys. (See also **base metal thermocouple; refractory metal thermocouple**.)

DISCUSSION—Noble metals used in thermoelements include platinum, rhodium, gold, palladium, iridium. Letter designated types B, R, and S are considered noble metal thermocouples.

partial immersion thermometer, *n*—a liquid-in-glass thermometer designed to indicate temperatures correctly when the bulb and a specified part of the stem are exposed to the temperatures being measured. (Compare **complete immersion thermometer** and **total immersion thermometer.**)

Peltier coefficient, *n*—the reversible heat which is absorbed or evolved at a thermocouple junction when unit current passes in unit time.

platinum 27 (Pt-27), *n*—the platinum standard to which the National Bureau of Standards referred thermoelectric measurements prior to 1973.

platinum 67 (Pt-67), *n*—the platinum standard used by the National Bureau of Standards after 1972 as the reference to which thermoelectric measurements are referred.

platinum resistance thermometer (PRT), *n*—a resistance thermometer with the resistance element constructed from platinum or platinum alloy.

Discussion—Platinum resistance thermometers are available in a variety of designs for use over the general temperature range of -259°C to 962°C or portions thereof. The construction details of each PRT design (type of element, connecting wire construction, insulation, sealing, and mounting) are tailored to maximize the performance of the thermometer for the intended application and temperature range. See also **Standard Platinum Resistance Thermometer** (SPRT), **Industrial Platinum Resistance Thermometer** (IPRT) and **Secondary Reference PRT Thermometer**.

precision, *n*—the scatter between individual values of test data within the subset, normally computed with respect to the mean of the subset. (See **bias**.)

probe cover and sheath, *n*—a device provided for the purpose of preventing biological contact between the patient and the probe or thermometer.

protecting tube, *n*—a tube designed to enclose a temperature-sensing device and protect it from the deleterious effects of the environment.

Discussion—It may provide for attachment to a connection head but is not primarily designed for pressure-tight attachment to a vessel. (See also **thermowell**.)

radiation thermometer, *n*—a radiometer calibrated to indicate the temperature of a blackbody.

radiometer, *n*—a device for measuring radiant power that has an output proportional to the intensity of the input power.

range, *n—of a thermometer of thermometric system*, a set of temperatures within specified lower and upper tempurature limits.

Discussion—The "operating range," "measuring range," working range," or "scale range" is the set of exposure temperatures for the sensing portion of a thermometer or thermometric system that permits temperature measurements to be made with specified uncertainty. With certain liquid-in-glass thermometers, an auxiliary scale or reference scale is provided. The "range" of such liquid-in-glass thermometers includes only the "working range" or "measuring range" and does not include the auxiliary scale or reference scale (when applicable).

Discussion—The "storage temperature range" or "non-operating temperature range" is set of exposer temperatures that the thermometer or thermometric system can endure without adversely affecting the ability to make temperature measurements with specified uncertainty when subsequently placed into service. Some specifications provide for a maximum increase in specified uncertainty after exposer to the storage temperature range for a specified period of time.

Discussion—The "ambient temperature range" is the set of exposure temperatures that the indication or display portion of the thermometer or thermometric system can endure during the measurement process without adversely affecting the ability to make temperature measurements.

Discussion—See also **span**.

reference junction, *n*—that junction of a thermocouple which is at a known temperature.

reference temperature, *n*—that temperature, however determined, whose value and accompanying uncertainty, are taken to be known in the calibration of thermometers or for other purposes.

Discussion—This temperature can be determined through measurement using a calibrated thermometer such as a Standard Platinum Resistance Thermometer (SPRT), or through the realization of a thermometric fixed point cell with an assigned value. Examples of fixed point cells include the triple point of water cell and the freezing point of zinc cell, among others.

refractory metal thermocouple, *n—(1)* one whose thermoelements have melting points above 1935°C (3515°F).*(2)* thermocouple whose thermoelements are composed primarily of refractory metals and their alloys. (See also **base metal thermocouple; noble metal thermocouple**.)

Discussion—Refractory metals used in thermoelements include tungsten, rhenium, and molybdenum.

repeatability, *n—of results of temperature measurements*, closeness of agreement between the results of successive measurements of the same temperature carried out under the same conditions of measurement.

Discussion—(1) Repeatability conditions include the same measurement procedure; the same observer; the same thermometer or thermometeric system, used under the same conditions; the same location; and repetition over a short interval of time. (2) Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results such as the mean value and standard deviation.

reproducibility, *n—of results of temperature measurements*, closeness of agreement between the results of measurements of the same temperature carried out under changed conditions of measurement.

Discussion—(1) A valid statement of reproducibility requires specification of the conditions changed. (2) The changed conditions may include principle of measurement, method of measurement, observer, thermometer or thermometric system, reference standard(s), location, conditions of use, and time. For ASTM standard test methods, the method is not changed. (3) Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results such as the mean value and standard deviation. (4) Results are here usually understood to be corrected results.

resistance thermometer, *n*—a temperature-measuring device comprised of a resistance thermometer element, internal connecting wires, a protective shell with or without means for mounting, a connection head, or connecting wire or other fittings, or both.

resistance thermometer element, *n*—the temperature-sensitive portion of the thermometer composed of resistance wire, film or semiconductor material, its supporting structure, and means for attaching connecting wires.

secondary reference PRT thermometers, *n*—a general purpose laboratory reference thermometer (also referred to as "Secondary SPRT" and "Secondary Reference PRT") designed to be a suitable standard for routine temperature measurement over all or part of the range -200°C to 650°C.

DISCUSSION—(1) Secondary reference PRT thermometers have a sensing element made from strain-free platinum wire such that the finished thermometer meets the specified stability and repeatability requirements but not necessarily the acceptance criteria defined by the ITS-90. (2) Secondary reference PRT thermometers are typically configured with a long-stem metal sheath, have nominal ice-point resistance values between 25 ohms and 100 ohms, and feature four-wire terminations. (3) The resistance-temperature relationship is usually defined by a thermometer-specific calibration and uncertainty applicable over a specified temperature range. (4) Secondary reference PRT thermometers have greater uncertainty than SPRTs but are generally more rugged and less costly

secondary standard thermocouple, *n*—a thermocouple that has had its temperature-emf relationship determined by reference to a primary standard of temperature.

Seebeck coefficient, *n*—the change in thermoelectric emf per unit change of temperature at a given temperature for a thermoelement exposed to a thermal gradient.

DISCUSSION—The units of the Seebeck coefficent are volts per kelvin (V/K), although it is often expressed as microvolts per kelvin (μV/K). (See also **thermoelectric power**.)

Seebeck effect, *n*—a phenomenon in which a temperature-dependent electromotive force is generated between two points of a thermoelement that are at different temperatures. The Seebeck effect provides the physical basis for thermocouples.

Seebeck emf, *n*—an electrical potential difference between two points in a region of electrically conducting material that exists solely because of temperature gradients between those two points in the material.

sensor, *n—of a thermometer or thermometric system*, element of the thermometer or thermometric system that is directly affected by the temperature to be measured.

sheath-enclosed-scale thermometer, *n*—the cylindrical glass envelope which encloses the scale and capillary tube.

sheathed thermocouple, *n*—a thermocouple having its thermoelements, and sometimes its measuring junction, embedded in ceramic insulation compacted within a metal protecting tube.

sheathed thermocouple wire, *n*—one or more pairs of thermoelements (without measuring junction(s)) embedded in ceramic insulation compacted within a metal protecting tube.

sheathed thermoelement, *n*—a thermoelement embedded in ceramic insulation compacted within a metal protecting tube.

span, *n—of a thermometer or thermometric system,* the absolute value of the difference between the specified lower and upper temperature limits within a range.

standard platinum resistance thermometer (SPRT), *n*—a precision laboratory reference thermometer and defining interpolating instrument on the ITS-90 from approximately -259°C to 962°C or portions thereof.

DISCUSSION—(1) Standard platinum resistance thermometers have a sensing element made from strain-free platinum wire with sufficient purity such that the finished thermometer meets the acceptance criteria defined by the ITS-90. (2) Common SPRT configurations include the Capsule type (CSPRT), the Long-stem type (LSPRT), and the High Temperature type (HTSPRT). These configurations have nominal icepoint resistance values between 0.25 ohms and 25 ohms, four-wire terminations, and are optimized to cover portions of the temperature range above. (3) The resistance-temperature relationship is defined by a thermometer-specific calibration and uncertainty applicable over a specified temperature range. (4) SPRTs are capable of achieving the lowest calibration uncertainty of any reference thermometer, but are relatively delicate and require careful handling to avoid damage caused by mechanical shock.

standard thermoelement, *n*—a thermoelement that has been calibrated with reference to platinum 67 (Pt-67).

stem, *n—of a liquid-in-glass thermometer*, capillary tube through which the meniscus of the thermometric liquid moves with change of temperature.

Style CU, *n*—designation for a common ungrounded measuring junction in a thermocouple assembly.

Style G, *n*—designation for a grounded measuring junction in a thermocouple assembly.

Style IU, *n*—designation for an isolated ungrounded measuring junction in a thermocouple assembly.

Style U, *n*—designation for an ungrounded measuring junction in a thermocouple assembly.

target plane, *n*—the plane, perpendicular to the line of sight of a radiation thermometer, that is in focus for that instrument.

temperature coefficient of resistance, α, *n*—the ratio of the fractional change in electrical resistance of a substance to a corresponding change in temperature of that substance.

DISCUSSION—(1) The temperature coefficient of resistance is given by $\alpha\ (T) = (1/R)\ (dR/dT)$, where α is the symbol representing the temperature coefficient of resistance, R is the resistance of the thermometer resistor at temperature T, and (dR/dT) is the first derivative of R with respect to T. (2) The dimension of α is reciprocal temperature. In general, $\alpha = \alpha\ (T)$ is a function of temperature. (3) For platinum resistance thermometers, over the temperature interval 0°C to 100°C, the platinum resistor has been characterized historically by an average temperature coefficient of resistance using $\alpha = (R_{100} - R_0)/100R_0$, where R_0 is the resistance at 0°C and R_{100} is the resistance at 100°C. The value of α for industrial platinum resistance thermometers specified in Specification E1137/E1137M can be derived from the coefficients A and B given in that standard using $\alpha = A + 100B$.

test thermoelement, *n*—a thermoelement that is to be calibrated with reference to platinum 67 (Pt-67) by comparing its thermal emf with that of a standard thermoelement.

thermal electromotive force (thermal emf), *n*—the net emf set up in a thermocouple under conditions of zero current. (Same as **Seebeck emf**).

thermistor, *n*—a temperature sensor employing a semiconductor that exhibits a continuous change in electrical resistance

with a change in sensor temperature (that is, a semiconductor for which the temperature coefficient of resistance over a specified temperature range is either negative or positive and exhibits no discontinuities).

DISCUSSION—(1) A negative temperature coefficient thermistor (NTC) is a ceramic semiconductor that exhibits a monotonic decrease in electrical resistance with an increase in sensor temperatures and exhibits no changes in sign. (2) A positive temperature coefficient thermistor (PTC) is a semiconductor that exhibits an increase in electrical resistance with an increase in sensor temperature when used within its normal operating range. One type of PTC thermistor exhibits a monotonic increase in electrical resistance with increasing temperature and exhibits no changes in sign. Another type of PTC thermistor has a transition or switching temperature that is determined by its physical composition. The temperature coefficient of resistance for this switching type device exhibits a slight negative value at temperatures below the transition temperature, becomes zero in the region of the transition temperature and then exhibits a large positive value at temperatures above the transition temperature. The electrical resistance of these switching PTC devices is a relatively low value at low body temperatures, decreases to a minimum value in the region of the transition temperature and then rapidly increases to an extremely high value as the device is heated above the transition temperature.

thermocouple, *n—in thermometry*, the sensor of a thermoelectric thermometer, consisting of electrically conducting circuit elements of two different thermoelectric characteristics joined at a junction.

thermocouple assembly, *n*—an assembly consisting of two thermocouple elements and one or more associated parts such as terminal block, connection head, and protecting tube.

thermocouple calibration, *n*—the process of determining the emf developed by a thermocouple with respect to temperature established by a standard.

thermocouple electromotive force (emf), *n*—the electrical potential difference between the open ends of the thermocouple's positive and negative thermoelements at the reference junction.

DISCUSSION—Thermocouple emf is dependent on the temperature difference between the thermocouple's measuring junction and reference junction.

thermocouple inhomogeneity, *n*—the variation of the thermoelectric properties of a thermocouple's thermoelements along their length.

DISCUSSION—This variation may exist in a new thermocouple, but it also may be due to the exposure of certain segments of the thermocouple to hot temperatures or harsh chemical environments. Inhomogeneity results in the deviation of a thermocouple's Seebeck coefficient at a given temperature from its normal Seebeck coefficient at that temperature. Thermocouple inhomogeneity is often reported as a fractional variation in the Seebeck coefficient.

thermoelectric power, *n*—(See **Seebeck coefficient**.)

thermoelectric properties, *n*—electrical properties of a material related to the electric potential gradient generated in the material by a temperature gradient in the material.

thermoelectric thermometer, *n*—thermometer for which the thermometric quantity is an emf produced by the Seebeck effect.

thermoelement, *n—in thermometry*, each of the materially dissimilar electrical conductors or circuit elements that comprise a thermocouple.

thermometric fixed point, *n*—fixed point useful in the practice of thermometry.

thermopile, *n*—a number of similar thermocouples connected in series, arranged so that alternate junctions are at the reference temperature and at the measured temperature, to increase the output for a given temperature difference between reference and measuring junctions.

thermowell, *n*—a closed-end reentrant tube designed for the insertion of a temperature-sensing element, and provided with means for pressure-tight attachment to a vessel. (See also **protecting tube**.)

tolerance, *n*—the defined limits of allowable deviation from a standard in a measured quantity or other value such as temperature, relative humidity, resistance, and so forth. When the term is used for a measurement instrument or system, it refers to the permitted variation of a measured value from the correct value. See also **error** and **maximum permissible error**.

DISCUSSION—The tolerance may be specified as a factor or percentage of the nominal value; a maximum deviation from a nominal value; an explicit range of allowed values; or, be implied by the numeric accuracy of the nominal value. Tolerance can be symmetrical or asymmetrical. When the term is used in quality control, it refers to the limiting values between which measurements must lie if an article is to be acceptable, as distinct from confidence limits. The term "tolerance" should not be used to designate "maximum permissible error".

total immersion thermometer, *n*—a liquid-in-glass thermometer designed to indicate temperatures correctly when just that portion of the thermometer containing the liquid is exposed to the temperature being measured. (Compare **complete immersion thermometer** and **partial immersion thermometer.**)

traceability, *n—of a temperature measurement*, the ability to relate, with scientific credibility, the result of a temperature measurement and its associated uncertainty to a stated temperature scale through a sequence of comparisons with references, usually national or international standards, whose values have been determined on the scale with stated uncertainty.

triple point, *n*—fixed point of a system in which three phases are in equilibrium.

triple point of water, *n*—triple point of the liquid, solid, and vapor phases of water.

DISCUSSION—The idealized triple point of water, to which a value of 273.16 K (0.01°C) is assigned, is a defining fixed point for both the Kelvin Thermodynamic Temperature Scale (KTTS) and the International Temperature Scale of 1990 (ITS-90).

true value, *n—of a temperature*, value attributed to a particular temperature and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose.

DISCUSSION—(1) For example, in a given situation, the value assigned to a temperature determined by measurement with a reference standard