



Terminology Relating to Thermometry and Hydrometry¹

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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.

2. Referenced Documents

2.1 ASTM Standards:²

E 1 Specification for ASTM Liquid-in-Glass Thermometers

E 77 Test Method for Inspection and Verification of Thermometers

E 100 Specification for ASTM Hydrometers

E 126 Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers

E 207 Test Method for Thermal EMF Test of Single Thermo-element Materials by Comparison with a Reference Thermo-element of Similar EMF-Temperature Properties

E 220 Test Method for Calibration of Thermocouples By Comparison Techniques

E 230 Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples

E 452 Test Method for Calibration of Refractory Metal Thermocouples Using a Radiation Thermometer

E 574 Specification for Duplex, Base Metal Thermocouple Wire With Glass Fiber or Silica Fiber Insulation

E 585/E 585M Specification for Compacted Mineral-Insulated, Metal-Sheathed, Base Metal Thermocouple Cable

E 601 Test Method for Measuring Electromotive Force (emf) Stability of Base-Metal Thermo-element Materials with Time in Air

E 608/E 608M Specification for Mineral-Insulated, Metal-Sheathed Base Metal Thermocouples

E 644 Test Methods for Testing Industrial Resistance Thermometers

E 667 Specification for Mercury-in-Glass, Maximum Self-Registering Clinical Thermometers

E 696 Specification for Tungsten-Rhenium Alloy Thermocouple Wire

E 710 Test Method for Comparing EMF Stabilities of Base-Metal Thermo-elements in Air Using Dual, Simultaneous, Thermal-EMF Indicators³

E 780 Test Method for Measuring the Insulation Resistance of Mineral-Insulated, Metal-Sheathed Thermocouples and Thermocouple Cable at Room Temperature

E 825 Specification for Phase Change-Type Disposable Fever Thermometer for Intermittent Determination of Human Temperature

E 839 Test Methods for Sheathed Thermocouples and Sheathed Thermocouple Material

E 879 Specification for Thermistor Sensors for Clinical Laboratory Temperature Measurements

E 1061 Specification for Direct-Reading Liquid Crystal Forehead Thermometers

E 1104 Specification for Clinical Thermometer Probe Covers and Sheaths

E 1112 Specification for Electronic Thermometer for Intermittent Determination of Patient Temperature

E 1129/E 1129M Specification for Thermocouple Connectors

E 1137/E 1137M Specification for Industrial Platinum Resistance Thermometers

E 1159 Specification for Thermocouple Materials, Platinum-Rhodium Alloys, and Platinum

E 1256 Test Methods for Radiation Thermometers (Single Waveband Type)

E 1299 Specification for Reusable Phase-Change-Type Fever Thermometer for Intermittent Determination of Human Temperature

E 1350 Guide for Testing Sheathed Thermocouples, Thermocouples Assemblies, and Connecting Wires Prior to, and After Installation or Service

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.

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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 Withdrawn.

E 1502 Guide for Use of Freezing-Point Cells for Reference Temperatures

E 1594 Guide for Expression of Temperature

E 1684 Specification for Miniature Thermocouple Connectors

E 1750 Guide for Use of Water Triple Point Cells

E 1751 Guide for Temperature Electromotive Force (EMF) Tables for Non-Letter Designated Thermocouple Combinations

E 1965 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

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 establish, under specified conditions, the relationship between the values of a thermometric quantity indicated by a thermometer or thermometric system and the corresponding values of temperature realized by standards.

DISCUSSION—(1) The result of a calibration permits either the assignment of values of temperature to indicated values of thermometric quantity or determination of corrections with respect to indications. (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 or a

calibration report. (4) The term *calibration* has also been used 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—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.

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 E 1594.

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

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

information about the relation between units and values of temperature expressed in different units, see Guide E 1594.

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**.)

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

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 thermometric 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.

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 temperature 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