This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases only the current version of the standard as published by ASTM is to be considered the official document.

INTERNATIONAL

Designation: ~~E1594 – 11~~ E1594 – 16

Standard Guide for Expression of Temperature[1]

This standard is issued under the fixed designation E1594; 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 guide covers uniform methods for expressing temperature, temperature values, and temperature differences.

1.2 This guide is intended as a supplement to IEEE/ASTM SI-10.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E344 Terminology Relating to Thermometry and Hydrometry

IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System

3. Terminology

3.1 *General*—Standard terms used in this guide are defined in Terminology E344 and in IEEE/ASTM SI-10.

4. Basic Concepts

4.1 Temperature is a fundamental measurable quantity designated by the symbol T or the symbol t (see 5.1). ~~In expressions of dimensions the symbol θ is sometimes used to indicate the dimension temperature.~~

4.2 A temperature value is expressed in terms of a temperature scale. The complete description consists of a numerical value designating the magnitude, a unit, and, where appropriate, a tolerance or uncertainty. Both the numerical value and the unit depend upon the scale.

4.3 A unit of temperature is understood to mean an interval on a temperature scale.

4.4 A temperature difference, interval, or increment is also described by a numerical value designating the magnitude, a unit, and, where appropriate, a tolerance or uncertainty.

iTeh Standards (https://standards.iteh.ai) Document Preview ASTM E1594-16 https://standards.iteh.ai/catalog/standards/sist/282db304-9e52-46f7-91c9-ef1d25d7acec/astm-e1594-16

5. Temperature Scales

5.1 *Thermodynamic Temperature Scales:*

5.1.1 By international agreement, the theoretical temperature scale to which all temperature values should be ultimately referable is the Kelvin Thermodynamic Temperature Scale (KTTS). A value of temperature expressed on the KTTS is known as a thermodynamic temperature, symbol T.

5.1.2 The unit of thermodynamic temperature is the kelvin, symbol K. The kelvin is a base unit in the International System of Units (SI). Note that the symbol for the kelvin is the capital letter K only; the degree sign (°) is not used.

5.1.3 The expression of a value of thermodynamic temperature is written:

$$T = n_k \text{ K} \tag{1}$$

where:

n_k = a numerical value designating the magnitude,
K = the symbol for the unit kelvin.

The magnitude may also be represented by the notation T/K.

[1] This guide 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 ~~Nov. 1, 2011~~May 15, 2016. Published ~~December 2011~~May 2016. Originally approved in 1994. Last previous edition approved in ~~2006~~2011 as ~~E1594 – 06.~~E1594 – 11. DOI: ~~10.1520/E1594-11.~~10.1520/E1594-16.

[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.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

5.1.4 A thermodynamic temperature may be expressed as a Celsius temperature. The symbol t is to be used to designate a Celsius temperature, but if this symbol leads to a conflict in notation in a given context, it is acceptable to use the symbol T instead to designate a Celsius temperature.

5.1.5 The unit of Celsius temperature is the degree Celsius, symbol °C. The degree Celsius is a derived SI unit. Note that the symbol for the degree Celsius consists of the degree sign (°) followed by the capital letter C. Neither the degree sign nor the letter C alone represents the degree Celsius. The Unicode value for the degree sign is 176 (00B0 in hexadecimal). The symbol may be represented by the two separate Unicode characters, the degree sign (°) followed by the capital letter C. The Unicode character "°C" with the value 8451 (2103 in hexadecimal) may also be used as the degree Celsius symbol.

5.1.6 The expression of a value of Celsius temperature is written:

$$t = n_c \,°\mathrm{C} \tag{2}$$

where:

n_c = a numerical value designating the magnitude,
°C = the symbol for the unit degree Celsius.

The magnitude may also be represented by the notation t/°C.

5.1.7 By definition, at any temperature, a temperature increment of one degree Celsius is equal to a temperature increment of one kelvin.

5.1.8 By definition, the Celsius temperature $t = 0$ °C is the same as the thermodynamic temperature $T = 273.15$ K. The relation between numerical values associated with both expressions of a temperature is therefore given by:

$$n_c = n_k - 273.15 \tag{3}$$

where:

t = n_c °C is the same temperature as $T = n_k$ K.

5.2 *Practical Temperature Scales:*

~~5.2.1 Practical temperature scales have been established by international agreement for the practice of temperature measurement. Among them are the International Practical Temperature Scale of 1968, the International Practical Temperature Scale of 1948, and the International Temperature Scale of 1927.[3]~~

5.2.1 Practical ~~scales~~ temperature scales have been established by international agreement for the practice of temperature measurement. Practical scales are designed so that a numerical value of temperature expressed on the scale is close to the numerical value of thermodynamic temperature. Because the KTTS is difficult to implement, the vast majority of temperature measurements are based on a practical scale.

5.2.2 There are two practical temperature scales now in use, superseding all others. The International Temperature Scale of 1990[3] defines temperatures above 0.65 K. The Provisional Low-Temperature Scale from 0.9 mK to 1 K[4] defines temperatures between 0.0009 K and 1 K.

5.2.3 Examples of previously used practical temperature scales are the International Practical Temperature Scale of 1968, the International Practical Temperature Scale of 1948, and the International Temperature Scale of 1927.[5]

5.2.4 A value of temperature on a practical temperature scale may be expressed either in kelvins or in degrees Celsius using the designations, symbols, and relations given in 5.1.

iTeh Standards (https://standards.iteh.ai) Document Preview
ASTM E1594-16
https://standards.iteh.ai/catalog/standards/sist/282db304-9e52-46f7-91c0-ef1d25d7acec/astm-e1594-16

6. Expression of Values of Temperature

6.1 *Temperature Scale Identification :*

6.1.1 ~~It~~ In a document containing temperature values, it is important that the temperature scale upon which those values ~~of temperature~~ are expressed be ~~identified in a document.~~ identified. When reference to more than one scale is made in a document, or when critical data are presented, scale identification is essential.

6.1.2 Thermodynamic temperatures may be identified as such, or with reference to the KTTS. If values of temperature are expressed on a practical temperature scale, the scale should be identified. The identification may be an abbreviation, as defined in the text of the scale; for example, the International Temperature Scale of 1990 is abbreviated ITS-90 and the Provisional Low-Temperature Scale from 0.9 mK to 1 K is abbreviated PLTS-2000.

6.1.3 Scale identification may be placed in text, in footnotes, in table headings, or in figures, as appropriate.

6.1.4 A scale may also be identified by a subscript associated with a quantity symbol; for example, T_{Th} and t_{Th} for thermodynamic temperatures, T_{90} and t_{90} for temperature values on ITS-90, and T_{2000} for temperature values on PLTS-2000.

---

[5] *Evolution of the International Practical Temperature Scale of 1968, ASTM STP 565*, ASTM, 1974.

~~[3] *Evolution of the International Practical Temperature Scale of 1968, ASTM STP 565*, ASTM, 1974.~~

[3] Preston-Thomas, H., "The International Temperature Scale of 1990 (ITS-90)," Metrologia, Vol 27, No. 1, 1990, pp. 3–10. For errata see ibid, Vol 27, No. 2, 1990, p. 107.

[4] Rusby, R. L., Durieux, M., Reesink, A. L, Hudson, R. P., Schuster, G., Kühne, M., Fogle, W. E., Soulen, R. J., and Adams, E. D., "The Provisional Low Temperature Scale from 0.9 mK to 1 K, PLTS-2000." J. Low Temp. Physics Vol 126, 2002, pp. 633–642.