Designation: E1256 – 17 (Reapproved 2022)

Standard Test Methods for Radiation Thermometers (Single Waveband Type)[1]

This standard is issued under the fixed designation E1256; 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 The test methods described in these test methods can be utilized to evaluate the following six basic operational parameters of a radiation thermometer (single waveband type):

	Section
Calibration Accuracy	8
Repeatability	9
Field-of-View	10
Response Time	11
Warm-Up Time	12
Long-Term Stability	13

1.2 The term single waveband refers to radiation thermometers that operate in a single band of spectral radiation. This term is used to differentiate single waveband radiation thermometers from those termed as ratio radiation thermometers, two channel radiation thermometers, two color radiation thermometers, multiwavelength radiation thermometers, multichannel radiation thermometers, or multicolor radiation thermometers. The term single waveband does not preclude wideband radiation thermometers such as those operating in the 8–14 μm band.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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:*

E2758 Guide for Selection and Use of Wideband, Low Temperature Infrared Thermometers

2.2 *IEC Documents*

IEC/TS 62492-1 ed 1.0 TS Industrial Process Control Devices—Radiation Thermometers—Part 1: Technical Data for Radiation Thermometers

3. Terminology

3.1 *Definitions:*

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

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

3.1.2 *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.

3.1.2.1 *Discussion*—The value of the center wavelength is usually specified by the manufacturer of the instrument.

3.1.3 *field-of-view, n*—a usually circular, flat surface of a measured object from which the radiation thermometer receives radiation.[2]

NOTE 1—*Field-of-view* traditionally has been referred to as *target size*.

3.1.4 *measuring distance, n*—distance or distance range between the radiation thermometer and the target (measured object) for which the radiation thermometer is designed.[2]

NOTE 2—*Measuring distance* traditionally has been referred to as *target distance*.

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

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

3.1.7 *target distance, n*—see *measuring distance*.

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

3.1.9 *target size, n*—see *field-of-view*.

[1] These test methods are under the jurisdiction of ASTM Committee E20 on Temperature Measurement and are the direct responsibility of Subcommittee E20.02 on Radiation Thermometry.

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[2] IEC 62492-1.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *reference temperature source, n*—a source of thermal radiant power of known temperature or emissivity, or both, used in the testing of radiation thermometers.

3.2.2 *temperature resolution, n*—the minimum simulated or actual change in target temperature that gives a usable change in output or indication, or both.

4. Significance and Use

4.1 The purpose of these test methods is to establish consensus test methods by which both manufacturers and end users may perform tests to establish the validity of the readings of their radiation thermometers. The test results can also serve as standard performance criteria for instrument evaluation or selection, or both.

4.2 The goal is to provide test methods that are reliable and can be performed by a sufficiently skilled end user or manufacturer. It is hoped that it will result in a better understanding of the operation of radiation thermometers and also promote improved communication between the manufacturers and the end users. A user without sufficient knowledge and experience should seek assistance from the equipment makers or other expert sources, such as those found at the National Institute of Standards and Technology in Gaithersburg, Maryland.

4.3 These test methods should be used with the awareness that there are other parameters, particularly spectral range limits and temperature resolution, which impact the use and characterization of radiation thermometers and for which test methods have not yet been developed.

4.3.1 Temperature resolution is the minimum simulated or actual change in target temperature that results in a usable change in output or indication, or both. It is usually expressed as a temperature differential or a percent of full-scale value, or both, and usually applies to value measured. The magnitude of the temperature resolution depends upon a combination of four factors: detector noise equivalent temperature difference (NETD), electronic signal processing, signal-to-noise characteristics (including amplification noise), and analog-to-digital conversion "granularity."

4.3.2 Spectral range limits are the upper and lower limits to the wavelength band of radiant energy to which the instrument responds. These limits are generally expressed in micrometers (μm) and include the effects of all elements in the measuring optical path. At the spectral response limits, the transmission of the measuring optics is 5 % of peak transmission. (See Fig. 1.)

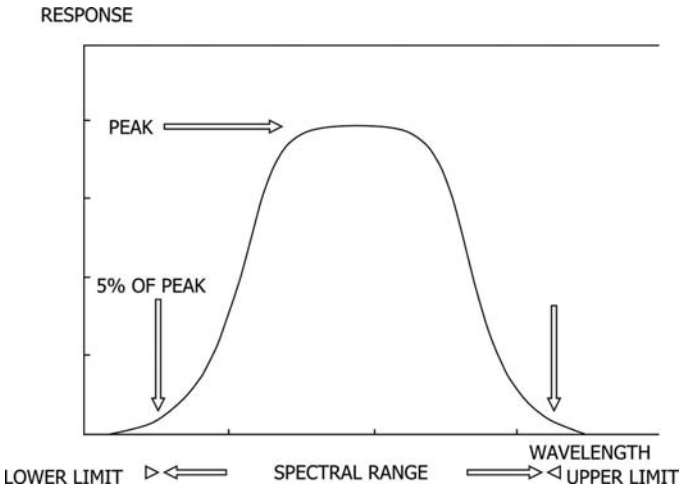

FIG. 1 Spectral Range Limits

5. Apparatus

5.1 The following apparatus, set up as illustrated in Fig. 2, can be used to perform the standard tests for all six parameters.

5.1.1 *Reference Temperature Source*—A blackbody (or other stable isothermal radiant source of high and known emissivity) with an opening diameter at least as large as that specified in these test methods.

NOTE 3—Typical examples include nearly isothermal furnaces with internal geometries, such as a sphere with an opening small relative to its radius, or a right circular cylinder with one end closed having a radius small relative to its length.[3]

5.1.2 *Temperature Indicator*—Either contact or radiometric, which accurately displays the temperature of the reference temperature source.

5.1.3 *Shutter Mechanism*—Of sufficient size so as to completely block the opening of the reference temperature source from the field-of-view of the test instrument. The shutter mechanism shall activate within a time interval that is short when compared with the response time of the test instrument.

5.1.4 *Iris Diaphragm*—Of sufficient size so that when fully open the iris diameter is greater than the opening of the reference temperature source. It shall be located with its opening concentric with and perpendicular to the line of sight of the radiation thermometer.

5.1.4.1 The side of the diaphragm facing the radiation thermometer should be blackened (nearly nonreflective) so as to minimize the effect of radiation reflected from the surrounding environment. In addition the iris should be shaded from sources of intense extraneous radiation. (See Note 11.)

5.1.5 *Aperture Set*—If an iris diaphragm is not available, an aperture disc set of appropriate diameters can be used. Each aperture should be blackened and also mounted and protected from extraneous sources of radiation as discussed in 5.1.4.1.

5.1.6 *Data Acquisition Systems*—Of appropriate speed and storage capacity to measure and record the output signal of the radiation thermometer in Section 10 ("Response Time Test Method").

5.1.7 *Power Supply*—Capable of supplying the proper voltage and frequency, if necessary, to the radiation thermometer.

6. Calibration Accuracy Test Method

6.1 *Summary*—This test method outlines the procedure to be used to evaluate the maximum deviation between the temperature indicated by the radiation thermometer and the known temperature of a reference temperature source, including the uncertainty of the reference temperature source relative to the current International Temperature Scale.

[3] DeWitt, D. P., and Nutter, G. D., eds., "Theory and Practice of Radiation Thermometry," John Wiley and Sons, New York, NY.