Designation: E1897 – 14 (Reapproved 2022)

Standard Practice for Measuring and Compensating for Transmittance of an Attenuating Medium Using Infrared Imaging Radiometers[1]

This standard is issued under the fixed designation E1897; 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 practice covers procedures for measuring and compensating for transmittance when using an infrared imaging radiometer to measure the temperature of a specimen through an attenuating medium, such as a window, filter, or atmosphere.[2]

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *These procedures may involve use of equipment and materials in the presence of heated or electrically-energized equipment, or both.*

1.4 *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.*

1.5 *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:*[3]

E1316 Terminology for Nondestructive Examinations

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *attenuating medium*—a semi-transparent solid, liquid, or gas, such as a window, filter, external optics or an atmosphere that attenuates radiation.

3.1.2 *blackbody simulator*—a device with an emissivity close to 1.00 that can be heated or cooled to a stable temperature.

3.1.3 *filter*—a semi-transparent material that attenuates certain wavelengths of radiation.

3.1.4 *infrared thermographer*—the person using an infrared imaging radiometer.

3.1.5 *reflected temperature*—the temperature of the energy incident upon and reflected by the measurement surface of the specimen.

3.1.6 *window*—a semi-transparent material that separates conditioned and unconditioned atmospheres and attenuates certain wavelengths of radiation.

3.2 See also Terminology E1316.

4. Summary of Practice

4.1 Using the computer built into an infrared imaging radiometer, a method is given for measuring the transmittance of an attenuating medium.

4.2 Using the computer built into an infrared imaging radiometer, a method is given for compensating for errors when measuring the temperature of a specimen through an attenuating medium when the emissivity of the specimen and the transmittance of the attenuating medium are known.

4.3 Using the computer built into an infrared imaging radiometer, a method is given for measuring and compensating for unknown transmittance and emissivity errors when the specimen temperature is known.

5. Significance and Use

5.1 The transmittance of an attenuating medium can cause errors for an infrared thermographer using an infrared imaging radiometer to measure the temperature of a specimen through the medium. Three test methods are given for measuring and compensating for this error source.

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.10 on Specialized NDT Methods.

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[2] This practice was originally adapted in 1997, by agreement, from the *Guideline for Measuring and Compensating for Reflected Temperature, Emittance and Transmittance* developed by Infraspection Institute, 425 Ellis Street, Burlington, NJ 08016.

[3] 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.

5.1.1 A procedure is given for measuring the transmittance of an attenuating medium.

5.1.2 A procedure is given for compensating for errors when measuring the temperature of a specimen having a known emissivity through an attenuating medium with a known transmittance.

5.1.3 A procedure is given for measuring and compensating for transmittance and emissivity errors when the specimen temperature is known.

5.2 These procedures can be used in the field or laboratory using commonly available materials.

5.3 These procedures can be used with any infrared radiometers that have the required computer capabilities.

5.4 The values of transmittance are defined only in terms of the procedure for the purpose of process control and nondestructive evaluation of materials.

6. Interferences

6.1 *Practice for Measuring the Transmittance of an Attenuating Medium:*

6.1.1 This practice requires a blackbody simulator with an emissivity of 0.95 or greater that is at least 20 °C warmer than ambient temperature. Potential errors can be minimized by ensuring the stability of the temperature difference between the source and the ambient temperature during the procedure. Also, the transmittance measurement accuracy can be increased by increasing this temperature difference.

6.1.2 Errors can be minimized by ensuring that the temperature of the attenuating medium is as close as possible to the reflected temperature incident upon the specimen.

6.1.3 The compositions and thicknesses of attenuating media can vary within the same specimen. Errors can be minimized by measuring through the same portion of the specimen every time.

6.2 *Practice for Compensating for Unknown Errors When Measuring the Temperature of a Specimen With a Known Emissivity Through an Attenuating Medium Having a Known Transmittance:*

6.2.1 Errors can be minimized by ensuring that the temperature of the attenuating medium is as close as possible to the reflected temperature incident upon the specimen.

6.3 The transmittance of an attenuating medium may be specific to the temperature of the medium and the spectral waveband of the radiometer used to make the measurement. Therefore, the temperature of the measured specimen and the spectral waveband of the radiometer used should be noted with the measured transmittance value.

6.4 The use of these test methods to compensate for the transmittance of an attenuating medium is valid only when measuring the temperatures of specimens that are opaque in the waveband of the infrared imaging radiometer.

7. Apparatus

7.1 A calibrated infrared imaging radiometer with a built-in computer that allows the infrared thermographer to input reflected temperatures and emissivity values.

7.2 The procedure for measuring the transmittance of an attenuating medium requires a tripod or device to support the infrared imaging radiometer.

7.3 The procedure for measuring the transmittance of an attenuating medium requires a high-emissivity source that is heated to a stable temperature at least 20 °C above ambient temperature.

7.4 The procedure for measuring and compensating for unknown transmittance and emissivity errors when the specimen temperature is known requires a calibrated thermometer to measure the temperature of the specimen.

8. Procedure

8.1 To measure the transmittance of an attenuating medium, use the following sequential steps:

8.1.1 Place the infrared imaging radiometer on the tripod or support device at the desired location and distance from the blackbody simulator.

8.1.2 Point the infrared imaging radiometer at the blackbody simulator and focus on a portion that has an emissivity of 0.95 or greater. Make sure that the blackbody simulator is at a stable temperature at least 20 °C above the ambient temperature.

8.1.3 Use an appropriate infrared imaging radiometer measurement function (such as spot temperature, crosshairs, or isotherm) to measure and compensate for the reflected temperature error incident upon the blackbody simulator.

8.1.4 With the imager's computer emittance control still set to 1.00, measure and record the apparent temperature of this same portion of the blackbody simulator.

8.1.5 Position the attenuating medium between the imager's detector or lens and the blackbody simulator.

8.1.6 Without moving the imager, adjust its computer's emissivity control until the imager's computer indicates the same temperature recorded in 8.1.4. The indicated "emissivity" value is the transmittance of the attenuating medium, at this blackbody simulator temperature and radiometer's spectral waveband.

8.1.7 Repeat 8.1.1 through 8.1.6 a minimum of three times and average the transmittance values to yield an average transmittance.

8.2 To measure the temperature of a specimen having a known emissivity through an attenuating medium having a known transmittance, use the following sequential steps.

8.2.1 Point the infrared imaging radiometer at the specimen and focus on the portion where the temperature is to be measured. Place the attenuating medium having a known transmittance between the imager's detector or lens and the specimen.

8.2.2 Instead of 1.00, enter the measured transmittance percentage of the attenuating medium under the imager's emissivity input (sometime referred to as "emittance" or "E"). Use an appropriate infrared imaging radiometer function (such as spot temperature, crosshairs, or isotherm) to measure and compensate for the reflected temperature error incident upon the specimen.