Designation: E1543 – 00 (Reapproved 2006)

Standard Test Method for Noise Equivalent Temperature Difference of Thermal Imaging Systems[1]

This standard is issued under the fixed designation E1543; 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 test method covers the determination of the noise equivalent temperature difference (NETD; NEΔT) of thermal imaging systems of the conventional forward-looking infrared (FLIR) or other types that utilize an optical-mechanical scanner; it does not include charge-coupled devices or pyroelectric vidicons.

1.2 Parts of this test method have been formulated under the assumption of a photonic detector(s) at a standard background temperature of 295°K (22°C). Besides nonuniformity, tests made at other background temperatures may result in impairment of precision and bias.

1.3 The values stated in SI units are to be regarded as standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1213 Test Method for Minimum Resolvable Temperature Difference for Thermal Imaging Systems

E1316 Terminology for Nondestructive Examinations

3. Terminology

3.1 *Definitions:*

3.1.1 *blackbody simulator*—a device that produces an emission spectrum closely approximating that emitted by a blackbody (surface with emissivity of 1.0), usually a cavity or a flat plate with a structured or coated surface having a stable and uniform temperature.

3.1.2 *dwell time*—the time spent, during one frame, in scanning one angular dimension of a single pixel (picture element) of the image within the instantaneous field of view (IFOV) of a detector. Thus, for example, if a single pixel is scanned n times during one frame, the dwell time is given by n times the duration of a single scan of the pixel.

3.1.3 *FLIR*—an acronym for forward-looking infrared, originally implying airborne, now denoting any fast-frame thermal imaging system comparable to that of television and yielding real-time displays. Generally, these systems employ optical-mechanical scanning mechanisms.

3.1.4 See also Section J: Infrared Examination, of Terminology E1316.

4. Summary of Test Method

4.1 The target is a blackbody source of uniform temperature that is viewed by the infrared thermal imaging system through an aperture of prescribed size. A specified temperature difference is established between the target and its background. Measurements are made of the peak-to-peak signal voltage from the target and the RMS noise voltage from the background, both across a standard reference filter, and of the target and background temperatures. From these measured values, the NETD is calculated.

5. Significance and Use

5.1 This test method gives an objective measure of the temperature sensitivity of a thermal imaging system (relative to a standard reference filter) exclusive of a monitor, with emphasis on the detector(s) and preamplifier.

NOTE 1—Test values obtained under idealized laboratory conditions may or may not correlate directly with service performance.

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

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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.

5.2 This test method affords a convenient means for periodically monitoring the performance of a given thermal imaging system.

5.3 NETD relates to minimum resolvable temperature difference as described in Test Method E1213. Thus, an increase in NETD may be manifest as a loss of detail in imagery.

5.4 Intercomparisons based solely on NETD figures may be misleading.

NOTE 2—NETD depends on various factors such as spectral bandwidth and background temperature.

6. Apparatus

6.1 The apparatus, as shown in Fig. 1, consists of the following:

6.1.1 *Blackbody Simulator*, temporally stable and controllable to within 0.1°C.

6.1.2 *Target Plate*, containing an aperture several times larger dimensionally than the IFOV. The target plate should be at least ten times the dimension of the aperture in both the height and width. (The plate forms the target background; the aperture, in effect, becomes the target as the blackbody simulator is viewed through it.) The material and surface conditions of the target plate must be carefully considered. It is helpful for the back side of the target plate to be a highly reflective metallic surface to minimize the influence of the blackbody simulator on the temperature of the target background. The front surface of the target plate should appear to the infrared imaging system to have a high emissivity. One possibility would be to coat the viewed surface with a high emissivity paint or coating.

6.1.3 *Target Cover*, used to block completely the radiation emanating from the target. The target cover should have front and back surface properties similar to those of the target plate.

6.1.4 *Standard Reference Filter*, consisting of a single RC low-pass filter whose product *RC* is equal to twice the dwell time; see Fig. 2.

NOTE 3—If the resistance, *R*, is in ohms and the capacitance, *C*, is in farads, *RC* is in seconds.

NOTE 4—The purpose of the filter is to standardize and define a reference noise bandwidth, upon which the noise measurement depends in part.

NOTE 5—If convenient, the filter may be a self-contained unit for external connection.

6.1.5 *Infrared Spot Radiometer* or equivalent radiometric instrument, calibrated with the aid of a blackbody source to an accuracy within 0.1°C.

6.1.6 *Digital Oscilloscope*.

6.1.7 *Digital True RMS Voltmeter*, with high crest factor (peak voltage/RMS voltage) so as not to attenuate any noise peaks, and bandwidth from approximately zero to at least 1.6/*RC*. See 6.1.4 and X1.1.

7. Procedure

7.1 Mount the target plate at the blackbody simulator, with its aperture oriented the same as the IFOV of the imaging system and centered with the blackbody source, see Fig. 1(*a*).

7.2 Connect the standard reference filter (input) to a point beyond the preamplifier and before any multiplexor, video sync pulse generator or pulse-width modulator.

7.3 The thermal imaging system, including the scanner, shall be in operation. (The monitor need not be connected.)

7.4 Set the blackbody simulator target temperature to roughly 7 or 8°C above the ambient temperature; the recommended ambient temperature is 22°C, controlled within ±1°C.

7.5 With the spot radiometer at a normal distance of 1 m to the target, measure and record the target temperature, *T*.

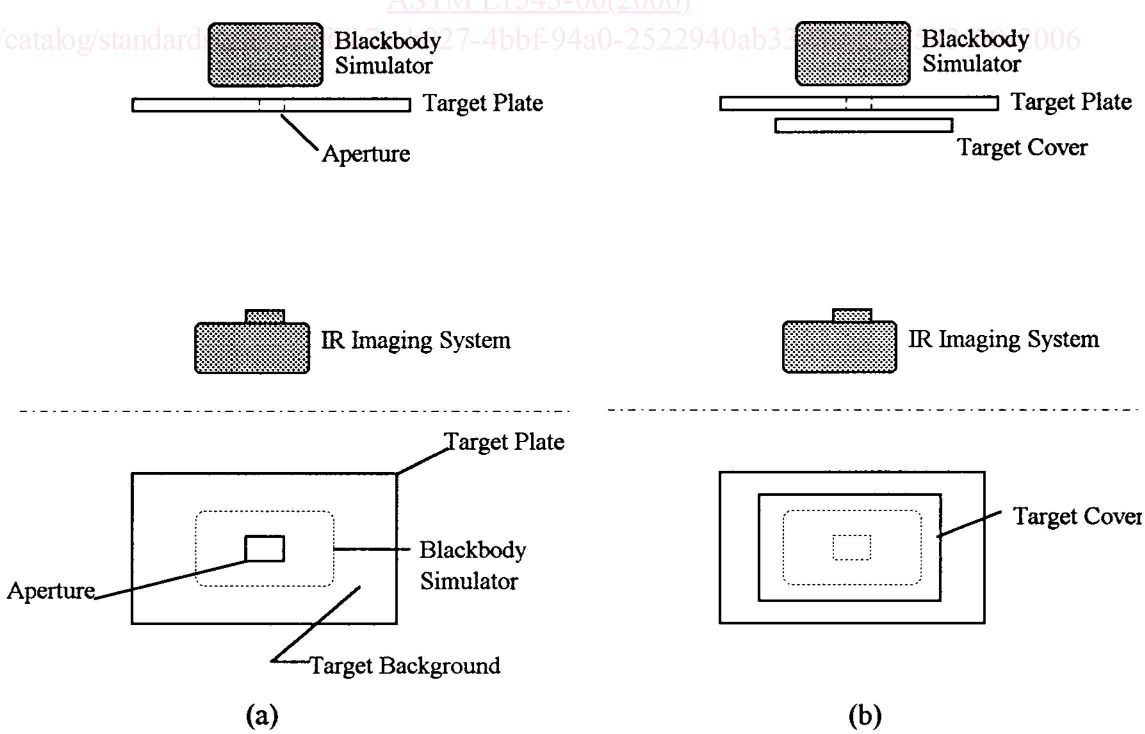

FIG. 1 Schematic of NETD Test Configuration; (*a*) When Measuring Signal and (*b*) When Measuring Noise