Designation: E 668 – 00

Standard Practice for Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices[1]

This standard is issued under the fixed designation E 668; 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 the use of thermoluminescence dosimeters (TLDs) to determine the absorbed dose in a material irradiated by ionizing radiation. Although some elements of the procedures have broader application, the specific area of concern is radiation-hardness testing of electronic devices. This practice is applicable to the measurement of absorbed dose in materials irradiated by gamma rays, X rays, and electrons of energies from 12 to 60 MeV. Specific energy limits are covered in appropriate sections describing specific applications of the procedures. The range of absorbed dose covered is approximately from 10^{-2} to 10^{4} Gy (1 to 10^{6} rad), and the range of absorbed dose rates is approximately from 10^{-2} to 10^{10} Gy/s (1 to 10^{12} rad/s). Absorbed dose and absorbed dose-rate measurements in materials subjected to neutron irradiation are not covered in this practice. Further, the portion of these procedures that deal with electron irradiation are primarily intended for use in parts testing. Testing of devices as a part of more massive components such as electronics boards or boxes may require techniques outside the scope of this practice.

NOTE 1—The purpose of the upper and lower limits on the energy for electron irradiation is to approach a limiting case where dosimetry is simplified. Specifically, the dosimetry methodology specified requires that the following three limiting conditions be approached: (*a*) energy loss of the primary electrons is small, (*b*) secondary electrons are largely stopped within the dosimeter, and (*c*) bremsstrahlung radiation generated by the primary electrons is largely lost.

1.2 *This standard dose 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:*

E 170 Terminology Relating to Radiation Measurements and Dosimetry[2]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[3]

E 665 Practice for Determining Absorbed Dose Versus Depth in Materials Exposed to the X-ray Output of Flash X-Ray Machines[2]

E 666 Practice for Calculating Absorbed Dose from Gamma or X Radiation[2]

2.2 *International Commission on Radiation Units and Measurements (ICRU) Reports:*

ICRU Report 14—Radiation Dosimetry: X Rays and Gamma Rays with Maximum Photon Energies Between 0.6 and 50 MeV[4]

ICRU Report 17—Radiation Dosimetry: X Rays Generated at Potentials of 5 to 150 keV[4]

ICRU Report 21—Radiation Dosimetry: Electrons with Initial Energies Between 1 and 50 MeV[4]

ICRU Report 31—Average Energy Required to Produce an Ion Pair[4]

ICRU Report 33—Radiation Quantities and Units[4]

ICRU Report 34—The Dosimetry of Pulsed Radiation[4]

ICRU Report 37—Stopping Powers for Electrons and Positrons[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *absorbed dose, D*—the quotient of $d\bar{\epsilon}$ by dm, where $d\bar{\epsilon}$ is the mean energy imparted by ionizing radiation to the matter in a volume element and dm is the mass of matter in that volume element.

$$D = \frac{d\bar{\epsilon}}{dm} \tag{1}$$

Previously, the special unit of absorbed dose was the rad; however, the gray (Gy) has been adopted as the official SI unit (see Practice E 380).

$$1\ \text{Gy} = 1\ \text{J} \cdot \text{kg}^{-1} = 10^{2}\ \text{rad} \tag{2}$$

[1] This practice is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.07 on Radiation Dosimetry for Radiation Effects on Materials and Devices.

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[2] *Annual Book of ASTM Standards,* Vol 12.02.

[3] *Annual Book of ASTM Standards,* Vol 14.02.

[4] Available from International Commission on Radiation Units and Measurements, 7910, Woodmont Ave., Suite 800, Bethesda, MD 20814.

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