Designation: E 666 – 03

Standard Practice for Calculating Absorbed Dose From Gamma or X Radiation[1]

This standard is issued under the fixed designation E 666; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice presents a technique for calculating the absorbed dose in a material from knowledge of the radiation field, the composition of the material, **(1-5)**[2,3] and a related measurement. The procedure is applicable for X and gamma radiation provided the energy of the photons fall within the range from 0.01 to 20 MeV.

1.2 A method is given for calculating the absorbed dose in a material from the knowledge of the absorbed dose in another material exposed to the same radiation field. The procedure is restricted to homogeneous materials composed of the elements for which absorption coefficients have been tabulated **(2).** It also requires some knowledge of the energy spectrum of the radiation field produced by the source under consideration. Generally, the accuracy of this method is limited by the accuracy to which the energy spectrum of the radiation field is known.

1.3 The results of this practice are only valid if charged particle equilibrium exists in the material and at the depth of interest. Thus, this practice is not applicable for determining absorbed dose in the immediate vicinity of boundaries between materials of widely differing atomic numbers. For more information on this topic, see Practice E 1249.

1.4 Energy transport computer codes[4] exist that are formulated to calculate absorbed dose in materials more precisely than this method. To use these codes, more effort, time, and expense are required. If the situation warrants, such calculations should be used rather than the method described here.

1.5 *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:*

E 170 Terminology Relating to Radiation Measurements and Dosimetry[5]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[6]

E 665 Practice for Determining Absorbed Dose Versus Depth in Materials Exposed to the X-Ray Output of Flash X-Ray Machines[5]

E 668 Practice for Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices[5]

E 1249 Practice for Minimizing Dosimetry Errors in Radiation Hardness Testing of Silicon Electronic Devices Using Co-60 Sources[5]

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 60 MeV[7]

ICRU Report 18—Specification of High Activity Gamma-Ray Sources[7]

ICRU Report 21—Radiation Dosimetry: Electrons with Initial Energies Between 1 and 50 MeV[7]

ICRU Report 33—Radiation Quantities and Units[7]

ICRU Report 34—The Dosimetry of Pulsed Radiation[7]

3. Significance and Use

3.1 The absorbed dose is a more meaningful parameter than exposure for use in relating the effects of radiation on materials. It expresses the energy absorbed by the irradiated material per unit mass, whereas exposure is related to the amount of charge produced in air per unit mass. Absorbed dose, as referred to here, implies that the measurement is made under

[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.

Current edition approved July 10, 2003. Published August 2003. Originally approved in 1997. Last previous edition approved in 1997 as E 666–97.

[2] The boldface numbers in parentheses refer to the list of references appended to this practice.

[3] For calculation of absorbed dose in biological materials such as tissue or bone, etc., ICRU Report 14 provides more information and procedures for a more accurate calculation than this practice.

[4] Information on and packages of computer codes can be obtained from The Radiation Safety Information Computational Center, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6362. This information center collects, organizes, evaluates, and disseminates shielding information related to radiation from reactors, weapons, and accelerators and to radiation occurring in space.

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

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

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

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