



Designation: E2232 – 16

Standard Guide for Selection and Use of Mathematical Methods for Calculating Absorbed Dose in Radiation Processing Applications¹

This standard is issued under the fixed designation E2232; 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 guide describes different mathematical methods that may be used to calculate absorbed dose and criteria for their selection. Absorbed-dose calculations can determine the effectiveness of the radiation process, estimate the absorbed-dose distribution in product, or supplement or complement, or both, the measurement of absorbed dose.

1.2 Radiation processing is an evolving field and annotated examples are provided in [Annex A6](#) to illustrate the applications where mathematical methods have been successfully applied. While not limited by the applications cited in these examples, applications specific to neutron transport, radiation therapy and shielding design are not addressed in this document.

1.3 This guide covers the calculation of radiation transport of electrons and photons with energies up to 25 MeV.

1.4 The mathematical methods described include Monte Carlo, point kernel, discrete ordinate, semi-empirical and empirical methods.

1.5 This guide is limited to the use of general purpose software packages for the calculation of the transport of charged or uncharged particles and photons, or both, from various types of sources of ionizing radiation. This standard is limited to the use of these software packages or other mathematical methods for the determination of spatial dose distributions for photons emitted following the decay of ^{137}Cs or ^{60}Co , for energetic electrons from particle accelerators, or for X-rays generated by electron accelerators.

1.6 This guide assists the user in determining if mathematical methods are a useful tool. This guide may assist the user in selecting an appropriate method for calculating absorbed dose. The user must determine whether any of these mathematical methods are appropriate for the solution to their specific application and what, if any, software to apply.

¹ This guide is under the jurisdiction of ASTM Committee E61 on Radiation Processing and is the direct responsibility of Subcommittee E61.04 on Specialty Application.

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NOTE 1—The user is urged to apply these predictive techniques while being aware of the need for experience and also the inherent limitations of both the method and the available software. Information pertaining to availability and updates to codes for modeling radiation transport, courses, workshops and meetings can be found in [Annex A1](#). For a basic understanding of radiation physics and a brief overview of method selection, refer to [Annex A3](#).

1.7 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 requirements prior to use.

2. Referenced Documents

2.1 *ASTM Standards:*²

[E170 Terminology Relating to Radiation Measurements and Dosimetry](#)

[E482 Guide for Application of Neutron Transport Methods for Reactor Vessel Surveillance](#)

2.2 *ISO/ASTM Standards:*²

[51707 Guide for Estimating Uncertainties in Dosimetry for Radiation Processing](#)

2.3 *International Commission on Radiation Units and Measurements Reports:*³

[ICRU Report 85a Fundamental Quantities and Units for Ionizing Radiation](#)

2.4 *United States National Institute of Standards and Technology:*⁴

[NIST Technical Note 1297 \(1994 edition\) Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results](#)

3. Terminology

3.1 *Definitions:*

² For referenced ASTM and ISO/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.

³ Available from International Commission on Radiation Units and Measurements, 7910 Woodmont Ave., Suite 800, Bethesda, MD 20815 USA.

⁴ Available as a download from the NIST web site at: <http://physics.nist.gov/Pubs/guidelines/TN1297/tn1297s.pdf>.