

Practice for dosimetry in an electron-beam facility for radiation processing at energies between 300 keV and 25 MeV

ICS 17.240

National foreword

This British Standard reproduces verbatim ISO 15569:1998 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Health physics instrumentation, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii and iii, a blank page, pages 1 to 19 and a back cover.

The BSI copyright notice displayed throughout this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 August 1999

© BSI 08-1999

ISBN 0 580 32907 0

Amendments issued since publication

Amd. No.	Date	Comments

INTERNATIONAL STANDARD

**ISO
15569**

First edition
1998-12-15

Practice for dosimetry in an electron-beam facility for radiation processing at energies between 300 keV and 25 MeV

*Pratique de la dosimétrie utilisant des faisceaux d'énergie comprise entre
300 keV et 25 MeV*



Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 15569 was prepared by the American Society for Testing and Materials (ASTM) Subcommittee E10.01 (as E 1649-94) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 85, *Nuclear energy*, in parallel with its approval by the ISO member bodies.

A new ISO/TC 85 Working Group WG 3, *High-level dosimetry for radiation processing*, was formed to review the voting comments from the ISO "Fast-track procedure" and to maintain these standards. The USA holds the convenership of this working group.

International Standard ISO 15569 is one of 20 standards developed and published by ASTM. The 20 fast-tracked standards and their associated ASTM designations are listed below:

ISO Designation	ASTM Designation	Title
15554	E 1204-93	<i>Practice for dosimetry in gamma irradiation facilities for food processing</i>
15555	E 1205-93	<i>Practice for use of a ceric-cerous sulfate dosimetry system</i>
15556	E 1261-94	<i>Guide for selection and calibration of dosimetry systems for radiation processing</i>
15557	E 1275-93	<i>Practice for use of a radiochromic film dosimetry system</i>
15558	E 1276-96	<i>Practice for use of a polymethylmethacrylate dosimetry system</i>
15559	E 1310-94	<i>Practice for use of a radiochromic optical waveguide dosimetry system</i>
15560	E 1400-95a	<i>Practice for characterization and performance of a high-dose radiation dosimetry calibration laboratory</i>
15561	E 1401-96	<i>Practice for use of a dichromate dosimetry system</i>

15562	E 1431-91	<i>Practice for dosimetry in electron and bremsstrahlung irradiation facilities for food processing</i>
15563	E 1538-93	<i>Practice for use of the ethanol-chlorobenzene dosimetry system</i>
15564	E 1539-93	<i>Guide for use of radiation-sensitive indicators</i>
15565	E 1540-93	<i>Practice for use of a radiochromic liquid dosimetry system</i>
15566	E 1607-94	<i>Practice for use of the alanine-EPR dosimetry system</i>
15567	E 1608-94	<i>Practice for dosimetry in an X-ray (bremsstrahlung) facility for radiation processing</i>
15568	E 1631-96	<i>Practice for use of calorimetric dosimetry systems for electron beam dose measurements and dosimeter calibrations</i>
15569	E 1649-94	<i>Practice for dosimetry in an electron-beam facility for radiation processing at energies between 300 keV and 25 MeV</i>
15570	E 1650-94	<i>Practice for use of cellulose acetate dosimetry system</i>
15571	E 1702-95	<i>Practice for dosimetry in a gamma irradiation facility for radiation processing</i>
15572	E 1707-95	<i>Guide for estimating uncertainties in dosimetry for radiation processing</i>
15573	E 1818-96	<i>Practice for dosimetry in an electron-beam facility for radiation processing at energies between 80 keV and 300 keV</i>

For the purposes of this International Standard, the following amendments to the ASTM text apply.

Page 1, subclause 1.2, note 2, and subclause 1.3

Replace note 2 and subclause 1.3 by the following.

1.3 Dosimetry is only one component of a total quality assurance program for an irradiation facility. Other controls besides dosimetry may be required for specific applications such as medical device sterilization and food preservation.

1.4 For the irradiation of food and the radiation sterilization of health care products, other specific ISO standards exist. For food irradiation, see ISO 15562:1998, *Practice for dosimetry in electron and bremsstrahlung irradiation facilities for food processing* (ASTM Practice E 1431). For the radiation sterilization of health care products, see ISO 11137:1995, *Sterilization of health care products — Requirements for validation and routine control — Radiation sterilization*. In those areas covered by ISO 11137, that standard takes precedence.

Page 1, subclause 1.4

Renumber this subclause as 1.5.



Designation: E 1649 – 94

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St. Philadelphia, Pa 19103
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM
If not listed in the current combined index, will appear in the next edition.

Standard Practice for Dosimetry in an Electron Beam Facility for Radiation Processing at Energies Between 300 keV and 25 MeV¹

This standard is issued under the fixed designation E 1649; 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 dosimetric procedures to be followed in facility characterization, process qualification, and routine processing using electron beam radiation to ensure that the entire product has been treated with an acceptable range of absorbed doses. Other procedures related to facility characterization (including equipment documentation), process qualification, and routine product processing that may influence and may be used to monitor absorbed dose in the product are also discussed.

NOTE 1—For guidance in the selection and calibration of dosimeters, see Guide E 1261. For further guidance in the selection, calibration, and use of specific dosimeters, and interpretation of absorbed dose in the product from dosimetry, also see Practices E 668, E 1275, E 1276, E 1431, E 1607, E 1631, and E 1650. For use with electron energies above 5 MeV, see Practices E 1026, E 1205, E 1401, E 1538, and E 1540 for discussions of specific large volume dosimeters. For discussion of radiation dosimetry for pulsed radiation, see ICRU Report 34. When considering a dosimeter type, be cautious of influences from dose rates and accelerator pulse rates and widths (if applicable).

1.2 The electron energy range covered in this practice is between 300 keV and 25 MeV, although there are some discussions for other energies.

NOTE 2—For application of dosimetry in the characterization and operation of electron beam and X-ray (bremsstrahlung) irradiation facilities for food processing, see Practice E 1431. For application of dosimetry in the characterization and operation of irradiation facilities using X-ray radiation (bremsstrahlung), see Practice E 1608.

1.3 Dosimetry is one component of a total quality assurance program for adherence to good manufacturing practices. Specific applications of electron beam radiation processing may require additional controls.

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:

- E 170 Terminology Relating to Radiation Measurements and Dosimetry²
- E 668 Practice for the Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining

Absorbed Dose in Radiation-Hardness Testing of Electronic Devices²

E 1026 Practice for Using the Fricke Reference Standard Dosimetry System²

E 1205 Practice for Use of a Ceric-Cerous Sulfate Dosimetry System²

E 1261 Guide for Selection and Calibration of Dosimetry Systems for Radiation Processing²

E 1275 Practice for Use of a Radiochromic Film Dosimetry System²

E 1276 Practice for Use of a Polymethylmethacrylate Dosimetry System²

E 1401 Practice for Use of a Dichromate Dosimetry System²

E 1431 Practice for Dosimetry in Electron and Bremsstrahlung Irradiation Facilities for Food Processing²

E 1538 Practice for Use of an Ethanol-Chlorobenzene Dosimetry System²

E 1539 Guide for the Use of Radiation-Sensitive Indicators²

E 1540 Practice for Use of a Radiochromic Liquid Solution Dosimetry System²

E 1607 Practice for Use of the Alanine-EPR Dosimetry System²

E 1608 Practice for Dosimetry in an X-Ray (Bremsstrahlung) Irradiation Facility for Radiation Processing²

E 1631 Practice for Use of Calorimetric Dosimetry Systems for Electron Beam Measurements and Dosimeter Calibrations²

E 1650 Practice for Use of a Cellulose Acetate Dosimetry System²

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

ICRU Report 33 Radiation Quantities and Units³

ICRU Report 34 The Dosimetry of Pulsed Radiation³

ICRU Report 35 Radiation Dosimetry: Electron Beams with Energies Between 1 and 50 MeV³

ICRU Report 37 Stopping Powers for Electrons and Positrons³

3. Terminology

3.1 *Definitions*—Other terms used in this practice may be found in Terminology E 170 and ICRU Report 33.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *absorbed dose, D*—the quotient of $d\bar{e}$ by dm , where $d\bar{e}$ is the mean energy imparted by ionizing radiation to the

¹ This practice is under the jurisdiction of ASTM Committee E-10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.01 on Dosimetry for Radiation Processing.

Current edition approved Nov. 15, 1994. Published February 1995.

² Annual Book of ASTM Standards, Vol 12.02.

³ Available from International Commission on Radiation Units and Measurements, 7910 Woodmont Ave., Suite 800, Bethesda, MD 20814.

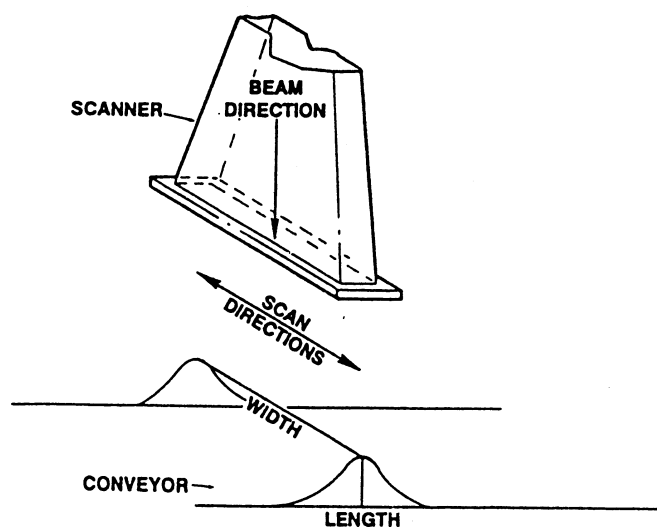


FIG. 1 Diagram Showing Beam Length and Width for a Scanned Beam Using a Conveyor Material Handling System

matter of mass dm (see ICRU Report 33).

$$D = \frac{d\bar{e}}{dm}$$

The special name of the unit for absorbed dose is the gray (Gy):

$$1 \text{ Gy} = 1 \text{ J} \cdot \text{kg}^{-1}$$

Formerly, the special unit for absorbed dose was the rad:

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

and:

$$1 \text{ Mrad} = 10 \text{ kGy}$$

3.2.2 average beam current—time-averaged electron

beam current; for a pulsed machine, the averaging shall be done over a large number of pulses.

3.2.3 beam length—dimension of the irradiation zone perpendicular to the beam width and direction of the electron beam specified at a specified distance from the accelerator window.

DISCUSSION—See Fig. 1.

3.2.4 beam power—product of the average electron energy and the average beam current.

3.2.5 beam width—dimension of the irradiation zone perpendicular to the beam length and direction of the electron beam specified at a specific distance from where the beam exits the accelerator.

DISCUSSION—For a radiation processing facility with a conveyor system, the beam width is usually perpendicular to the flow of motion of the conveyor (see Fig. 1). Beam width is the distance between the points along the dose profile which are at a defined level from the maximum dose region in the profile (see Fig. 2). Various techniques may be employed to produce an electron beam width adequate to cover the processing zone, for example, use of electromagnetic scanning of pencil beam (in which case beam width is also referred to as scan width), defocussing elements, and scattering foils.

3.2.6 compensating dummy—simulated product used during routine production runs with irradiation units containing less product than specified in the product loading configuration or at the beginning and end of a production run to compensate for the absence of product.

3.2.7 depth-dose distribution—variation of absorbed dose with depth from the incident surface of a material exposed to radiation.

DISCUSSION—A typical distribution in homogeneous material produced by an electron beam along the beam axis is shown in Fig. 3. See

⁴ McKeown, J., AECL Accelerators, private communication, 1993. Example of a beam width profile of an AECL Impela accelerator.

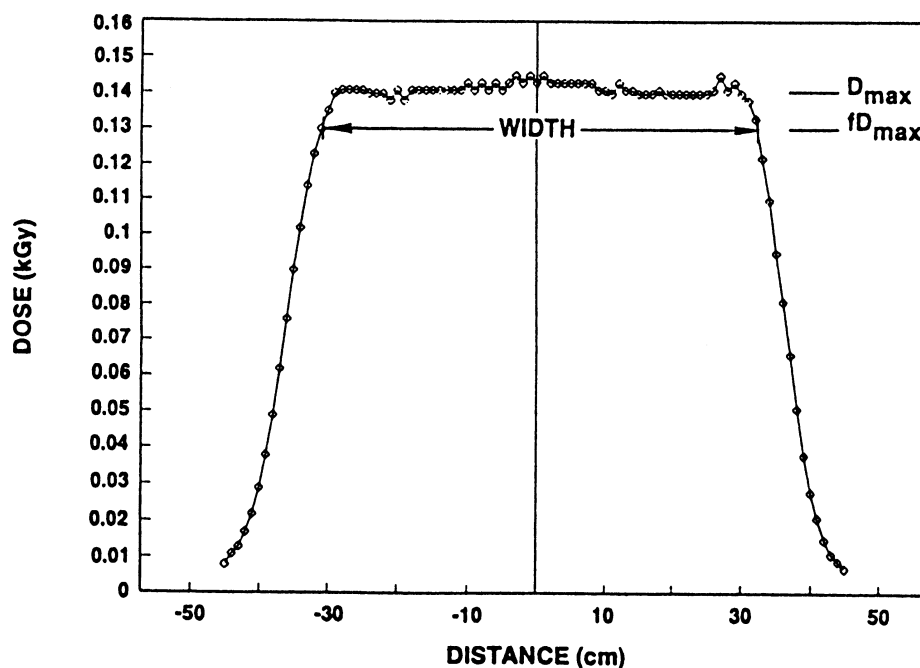


FIG. 2 Example of Electron-beam Dose Distribution Along the Beam Width⁴ with the Width Noted at Some Defined Fractional Level f of the Average Maximum Dose $D_{\max}$