This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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Standard Practice for Dosimetry for a Self-Contained Dry-Storage Gamma Irradiator[1]

This standard is issued under the fixed designation 52116; 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 outlines dosimetric procedures to be followed with self-contained dry-storage gamma irradiators. For irradiators used for routine processing, procedures are given to ensure that product processed will receive absorbed doses within prescribed limits.

1.2 This practice covers dosimetry in the use of dry-storage gamma irradiators, namely self-contained dry-storage ^{137}Cs or ^{60}Co irradiators (shielded freestanding irradiators). It does not cover underwater pool sources, panoramic gamma sources, nor does it cover self-contained bremsstrahlung X-ray units.

1.3 The absorbed-dose range for the use of the dry-storage self-contained gamma irradiators covered by this practice is typically 1 to 10^5 Gy, depending on the application. The absorbed-dose rate range typically is from 10^{-2} to 10^3 Gy/min.

1.4 For irradiators supplied for specific applications, specific ASTM practices and guides provide dosimetric procedures for the application. For procedures specific to dosimetry in blood irradiation, see ASTM Practice 51939. For procedures specific to dosimetry in radiation research on food and agricultural products, see ASTM Guide 51900. For procedures specific to radiation hardness testing, see ASTM Practice E1249. For procedures specific to the dosimetry in the irradiation of insects for sterile release programs, see ASTM Guide 51940. In those cases covered by ASTM 51939, 51900, 51940, or E1249, those standards take precedence.

1.5 This document is one of a set of standards that provides recommendations for properly implementing and utilizing dosimetry in radiation processing. It is intended to be read in conjunction with ASTM 52628, "Practice for Dosimetry in Radiation Processing."

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

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced documents

2.1 *ASTM Standards:*[2]

E1249 Practice for Minimizing Dosimetry Errors in Radiation Hardness Testing of Silicon Electronic Devices Using Co-60 Sources

E3083 Terminology Relating to Radiation Processing: Dosimetry and Applications

51026 Practice for Using the Fricke Dosimetry System

51261 Practice for Calibration of Routine Dosimetry Systems for Radiation Processing

51539 Guide for Use of Radiation-Sensitive Indicators

51607 Practice for Use of an Alanine-EPR Dosimetry System

51707 Guide for Estimating Uncertainties in Dosimetry for Radiation Processing

51900 Guide for Dosimetry in Radiation Research on Food and Agricultural Products

51939 Practice for Blood Irradiation Dosimetry

51940 Guide for Dosimetry for Sterile Insects Release Programs

52628 Practice for Dosimetry in Radiation Processing

52701 Guide for Performance Characterization of Dosimeters and Dosimetry Systems for Use in Radiation Processing

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[1] This practice is under the jurisdiction of ASTM Committee E61 on Radiation Processing and is the direct responsibility of Subcommittee E61.04 on Specialty Application. Originally developed as a joint ASTM/ISO standard in conjunction with ISO/TC 85/WG 3.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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2.2 *International Commission on Radiation Units and Measurements (ICRU) Reports:*[3]

ICRU 85a Fundamental Quantities and Units for Ionizing Radiation

2.3 *ANSI Standards:*[4]

ANSI/HPS N43.7 Safe Design and Use of Self-Contained, Dry Source Storage Gamma Irradiators (Category I)

2.4 *Joint Committee for Guides in Metrology (JCGM) Reports:*

JCGM 100:2008, GUM 1995, with minor corrections Evaluation of measurement data – Guide to the Expression of Uncertainty in Measurement[5]

JCGM 200:2008, VIM International vocabulary of metrology – Basis and general concepts and associated terms[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *absorbed-dose mapping*—measurement of absorbed dose within an irradiated product to produce a one-, two-, or three-dimensional distribution of absorbed dose, thus rendering a map of absorbed-dose values.

3.1.2 *calibration*—set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realised by standards.

3.1.2.1 *Discussion*—Calibration conditions include environmental and irradiation conditions present during irradiation, storage, and measurement of the dosimeters that are used for the generation of a calibration curve.

3.1.3 *dose uniformity ratio*—ratio of the maximum to the minimum absorbed dose within the irradiated product.

3.1.4 *measurement management system*—set of interrelated or interacting elements necessary to achieve metrological confirmation and continual control of measurement processes.

3.1.5 *transit dose*—absorbed dose delivered to a product (or a dosimeter) while it travels between the non-irradiation position and the irradiation position, or in the case of a movable source, while the source moves into and out of its irradiation position.

3.2 Definitions of other terms used in this standard that pertain to radiation measurement and dosimetry may be found in ASTM Practice 52628. Other terms that pertain to radiation measurement and dosimetry may be found in ASTM Terminology E3083. Where appropriate, definitions used in these standards have been derived from and are consistent with definitions in ICRU 85a and general metrological definitions given in the VIM.

4. Significance and use

4.1 The design and operation of a self-contained irradiator should ensure that reproducible absorbed doses are obtained when the same irradiation parameters are used. Dosimetry is performed to determine the relationship between the irradiation parameters and the absorbed dose.

4.1.1 For most applications, the absorbed dose is expressed as absorbed dose to water (see ASTM Practice 51261). For conversion of absorbed dose to water to that to other materials, for example, silicon, see Annex A1 of ASTM Practice 51261.

4.2 Self-contained dry-storage gamma irradiators contain properly shielded radioactive sources, namely ^{137}Cs or ^{60}Co, that emit ionizing electromagnetic radiation (gamma radiation). These irradiators have an enclosed, accessible irradiator sample chamber connected with a sample positioning system, for example, irradiator drawer, rotor, or irradiator turntable, as part of the irradiation device.

4.3 Self-contained dry-storage gamma irradiators can be used for many radiation processing applications, including the calibration irradiation of dosimeters; studies of dosimeter influence quantities; radiation effects studies, and irradiation of materials or biological samples for process compatibility studies; batch irradiations of microbiological, botanical, or *in vitro* samples; irradiation of small animals; radiation "hardness" testing of electronics components and other materials; and batch radiation processing of containers of samples.

NOTE 1—Self-contained dry-storage gamma irradiators contain a sealed radiation source, or an array of sealed radiation sources securely held in a dry container constructed of solid materials. The sealed radiation sources are shielded at all times, and human access to the chamber undergoing irradiation is not physically possible due to the irradiator's design configuration (see ANSI/HPS N43.7).

NOTE 2—For reference-standard dosimetry, the absorbed dose and absorbed-dose rate can be expressed in water or other material which has similar radiation absorption properties to those of the samples or dosimeters being irradiated. In some cases, the reference-standard dosimetry may be performed using ionization chambers, and may be calibrated in terms of exposure (C kg^{-1}), or absorbed dose to air, water, or tissue (Gy). Measurements performed in terms of exposure apply to ionization in air, and care should be taken to apply that measurement to the sample being irradiated.

5. Types of facilities and modes of operation

5.1 *Facility Types*—Typical self-contained dry-storage gamma irradiators are illustrated in Annex A1. These irradiators house the radiation source(s) in a protective lead shield (or other appropriate material), and usually have a sample positioning mechanism tied to an accurate calibrated reset timer to lower or rotate the sample holder from the load/unload position to the irradiation position and back to the load/unload position. Details on the calibration of dosimetry systems and dose mapping in such irradiators may be found, respectively in ASTM Practice 51261 and in this practice. Details on the designs of such irradiators and on safety considerations in the use of such irradiators may be found in ANSI/HPS N43.7.

5.2 *Modes of Operation*—Three common modes of operation are described. This does not purport to include all modes of operation.

[3] International Commission on Radiation Units and Measurements (ICRU), 7910 Woodmont Ave., Suite 800, Bethesda, MD 20810, U.S.A.

[4] Available from the Health Physics Society, http://hps.org.

[5] Document produced by Working Group 1 of the Joint Committee for Guides in Metrology (JCGM/WG 1). Available free of charge at the BIPM website (http://www.bipm.org).

[6] Document produced by Working Group 2 of the Joint Committee for Guides in Metrology (JCGM/WG 2). Available free of charge at the BIPM website (http://www.bipm.org).