ISO/ASTM 51204:2004(E)

Standard Practice for Dosimetry in Gamma Irradiation Facilities for Food Processing[1]

This standard is issued under the fixed designation ISO/ASTM 51204; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision.

1. Scope

1.1 This practice outlines the installation qualification program for an irradiator and the dosimetric procedures to be followed during operational qualification, performance qualification, and routine processing in facilities that process food with ionizing radiation from radionuclide gamma sources to ensure that product has been treated within a predetermined range of absorbed dose. Other procedures related to operational qualification, performance qualification, and routine processing that may influence absorbed dose in the product are also discussed. Information about effective or regulatory dose limits for food products is not within the scope of this practice (see ASTM Guides F 1355, F 1356, F 1736, and F 1885).

NOTE 1—Dosimetry is only one component of a total quality assurance program for adherence to good manufacturing practices used in the production of safe and wholesome food.

NOTE 2—ISO/ASTM Practice 51431 describes dosimetric procedures for electron beam and X-ray (bremsstrahlung) irradiation facilities for food processing.

1.2 For guidance in the selection and calibration of dosimetry systems, and interpretation of measured absorbed dose in the product, see ISO/ASTM Guide 51261 and ASTM Practice E 666. For the use of specific dosimetry systems, see ASTM Practices E 1026 and E 2304, and ISO/ASTM Practices 51205, 51275, 51276, 51310, 51401, 51538, 51540, 51607, 51650, and 51956. For discussion of radiation dosimetry for gamma-rays and X-rays also see ICRU Report 14.

1.3 *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:* [2]

E 170 Terminology Relating to Radiation Measurements and Dosimetry

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

E 1026 Practice for Using the Fricke Reference Standard Dosimetry System

E 2232 Guide for Selection and Use of Mathematical Models for Calculating Absorbed Dose in Radiation-Processing Applications

E 2304 Practice for Use of a LiF Photo-Fluorescent Film Dosimetry System

F 1355 Guide for the Irradiation of Fresh Fruits as a Phytosanitary Treatment

F 1356 Guide for the Irradiation of Fresh and Frozen Red Meats and Poultry to Control Pathogens and Other Microorganisms

F 1736 Guide for the Irradiation of Finfish and Shellfish to Control Pathogens and Spoilage Microorganisms

F 1885 Guide for Irradiation of Dried Spices, Herbs, and Vegetable Seasonings to Control Pathogens and Other Microorganisms

2.2 *ISO/ASTM Standards:*[2]

51205 Practice for Use of a Ceric-Cerous Sulfate Dosimetry System

51261 Guide for Selection and Calibration of Dosimetry Systems for Radiation Processing

51275 Practice for Use of a Radiochromic Film Dosimetry System

51276 Practice for Use of a Polymethylmethacrylate Dosimetry System

51310 Practice for Use of a Radiochromic Optical Waveguide Dosimetry System

51400 Practice for Characterization and Performance of a High-Dose Radiation Dosimetry Calibration Laboratory

51401 Practice for Use of a Dichromate Dosimetry System

51431 Practice for Dosimetry in Electron Beam and X-ray bremsstrahlung Irradiation Facilities for Food Processing

51538 Practice for Use of an Ethanol-Chlorobenzene Dosimetry System

[1] This practice is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.01 on Dosimetry for Radiation Processing and is also under the jurisdiction of ISO/TC 85/WG 3.

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[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.

51539 Guide for the Use of Radiation-Sensitive Indicators
51540 Practice for the Use of a Radiochromic Liquid Dosimetry System
51607 Practice for the Use of the Alanine-EPR Dosimetry System
51650 Practice for the Use of a Cellulose Acetate Dosimetry System
51707 Guide for Estimating Uncertainties in Dosimetry for Radiation Processing
51956 Practice for Use of Thermoluminescence-Dosimetry (TLD) Systems for Radiation Processing

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

ICRU Report 14 Radiation Dosimetry: X-Rays and Gamma Rays with Maximum Photon Energies Between 0.6 and 50 MeV
ICRU Report 60 Fundamental Quantities and Units for Ionizing Radiation

3. Terminology

3.1 *Definitions:*

3.1.1 *absorbed dose, D*—quantity of ionizing radiation energy imparted per unit mass of a specified material. The SI unit of absorbed dose is the gray (Gy), where 1 gray is equivalent to the absorption of 1 joule per kilogram of the specified material (1 Gy = 1 J/kg). The mathematical relationship is the quotient of $d\bar{\epsilon}$ by d*m*, where $d\bar{\epsilon}$ is the mean incremental energy imparted by ionizing radiation to matter of incremental mass d*m* (see ICRU Report 60).

$$D = d\bar{\epsilon}/dm \quad (1)$$

3.1.2 *absorbed-dose mapping*—measurement of absorbed dose within a process load using dosimeters placed at specified locations to produce a one-, two- or three-dimensional distribution of absorbed dose, thus rendering a map of absorbed-dose values.

3.1.3 *calibration facility*—combination of an ionizing radiation source and its associated instrumentation that provides, at a specified location and within a specific material, a uniform and reproducible absorbed dose, or absorbed-dose rate, traceable to national or international standards and that may be used to derive the dosimetry system's response function or calibration curve.

3.1.4 *compensating dummy*—simulated product used during routine production runs in process loads that contain less product than specified in the product loading configuration, or simulated product used at the beginning or end of a production run, to compensate for the absence of product. Also see 3.1.18.

3.1.4.1 *Discussion*—Simulated product or phantom material may be used during operational qualification as a substitute for the actual product, material, or substance to be irradiated.

3.1.5 *dosimeter response*—reproducible, quantifiable radiation effect produced in the dosimeter by a given absorbed dose.

3.1.6 *dosimeter set*—one or more dosimeters used to measure the absorbed dose at a location and whose average reading is used as the absorbed-dose measurement at that location.

3.1.7 *dosimetry system*—system used for determining absorbed dose consisting of dosimeters, measurement instruments and their associated reference standards, and procedures for the system's use.

3.1.8 *installation qualification*—obtaining and documenting evidence that the irradiator, with all its associated equipment and instrumentation, has been provided and installed in accordance with specifications.

3.1.9 *irradiation time*—total time during which a process load is exposed to radiation.

3.1.10 *operational qualification*—obtaining and documenting evidence that installed equipment and instrumentation operate within predetermined limits when used in accordance with operational procedures.

3.1.11 *performance qualification*—obtaining and documenting evidence that the equipment and instrumentation, as installed and operated in accordance with operational procedures, consistently perform according to predetermined criteria and thereby yield product that meets specifications.

3.1.12 *primary–standard dosimeter*—dosimeter of the highest metrological quality, established and maintained as an absorbed-dose standard by a national or international standards organization (see ISO/ASTM Guide 51261).

3.1.13 *process load*—volume of material with a specified loading configuration irradiated as a single entity.

3.1.14 *production run* (applicable to continuous-flow and shuffle-dwell irradiations)—a series of process loads consisting of materials or products having similar radiation-absorption characteristics that are irradiated sequentially to a specified range of absorbed dose.

3.1.15 *reference-standard dosimeter*—dosimeter of high metrological quality, used as a standard to provide measurements traceable to and consistent with measurements made using primary-standard dosimeters (see ISO/ASTM Guide 51261).

3.1.16 *response function*—mathematical representation of the relationship between dosimeter response and absorbed dose for a given dosimetry system.

3.1.17 *routine dosimeter*—dosimeter calibrated against a primary-, reference-, or transfer-standard dosimeter and used for routine absorbed-dose measurements (see ISO/ASTM Guide 51261).

3.1.18 *simulated product*—material with attenuation and scattering properties similar to those of the product, material, or substance to be irradiated.

3.1.18.1 *Discussion*—Simulated product is used during operational qualification as a substitution for the actual product, material, or substance to be irradiated. When used in routine production runs, it is sometimes referred to as "compensating dummy." When used for absorbed-dose mapping, simulated product is sometimes referred to as "phantom material."

3.1.19 *transfer-standard dosimeter*—dosimeter, often a reference-standard dosimeter, suitable for transport between

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