INTERNATIONAL STANDARD

**ISO/ASTM 51956**

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# Practice for use of a thermoluminescence-dosimetry system (TLD system) for radiation processing

*Pratique pour l'utilisation d'un système de dosimêtrie par thermoluminescence (système TLD) pour le traitement par irradiation*



Reference number
ISO/ASTM 51956:2013(E)

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## Contents

## 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.

ASTM International is one of the world's largest voluntary standards development organizations with global participation from affected stakeholders. ASTM technical committees follow rigorous due process balloting procedures.

A pilot project between ISO and ASTM International has been formed to develop and maintain a group of ISO/ASTM radiation processing dosimetry standards. Under this pilot project, ASTM Committee E61, Radiation Processing, is responsible for the development and maintenance of these dosimetry standards with unrestricted participation and input from appropriate ISO member bodies.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. Neither ISO nor ASTM International shall be held responsible for identifying any or all such patent rights.

International Standard ISO/ASTM 51956 was developed by ASTM Committee E61, Radiation Processing, through Subcommittee E61.02, Dosimetry Systems, and by Technical Committee ISO/TC 85, Nuclear energy, nuclear technologies and radiological protection.

This third edition cancels and replaces the second edition (ISO/ASTM 51956:2005), which has been technically revised.

ISO/ASTM 51956:2013(E)

An American National Standard

# Standard Practice for Use of a Thermoluminescence-Dosimetry System (TLD System) for Radiation Processing[1]

This standard is issued under the fixed designation ISO/ASTM 51956; 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 covers procedures for the use of thermoluminescence dosimeters (TLDs) to measure the absorbed dose in materials irradiated by photons or electrons in terms of absorbed dose to water. Thermoluminescence-dosimetry systems (TLD systems) are generally used as routine dosimetry systems.

1.2 The thermoluminescence dosimeter (TLD) is classified as a type II dosimeter on the basis of the complex effect of influence quantities on the dosimeter response. See ISO/ASTM Practice 52628.

1.3 This document is one of a set of standards that provides recommendations for properly implementing dosimetry in radiation processing, and describes a means of achieving compliance with the requirements of ISO/ASTM 52628 "Practice for Dosimetry in Radiation Processing" for a TLD system. It is intended to be read in conjunction with ISO/ASTM 52628.

1.4 This practice covers the use of TLD systems under the following conditions:

1.4.1 The absorbed-dose range is from 1 Gy to 10 kGy.

1.4.2 The absorbed-dose rate is between $1 \times 10^{-2}$ and $1 \times 10^{10}$ Gy $s^{-1}$.

1.4.3 The radiation-energy range for photons and electrons is from 0.1 to 50 MeV.

1.5 This practice does not cover measurements of absorbed dose in materials subjected to neutron irradiation.

1.6 This practice does not cover procedures for the use of TLDs for determining absorbed dose in radiation-hardness testing of electronic devices. Procedures for the use of TLDs for radiation-hardness testing are given in ASTM Practice E668.

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 limitations prior to use.*

## 2. Referenced documents

2.1 *ASTM Standards:*[2]

E170 Terminology Relating to Radiation Measurements and Dosimetry

E666 Practice for Calculating Absorbed Dose From Gamma or X Radiation

E668 Practice for Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices

2.2 *ISO/ASTM Standards:*[2]

51261 Practice for Calibration of Routine Dosimetry Systems for Radiation Processing

51608 Practice for Dosimetry in an X-Ray (Bremsstrahlung) Facility for Radiation Processing

51649 Practice for Dosimetry in an Electron-Beam Facility for Radiation Processing at Energies Between 300 keV and 25 MeV

51702 Practice for Dosimetry in Gamma Irradiation Facilities for Radiation Processing

51707 Guide for Estimating Uncertainties in Dosimetry for Radiation Processing

51939 Practice for Blood Irradiation Dosimetry

51940 Guide for Dosimetry for Sterile Insect Release Programs

52628 Practice for Dosimetry in Radiation Processing

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

2.3 *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[3]

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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 E61.02 on Dosimetry Systems, and is also under the jurisdiction of ISO/TC 85/WG 3.

Current edition approved Aug. 1, 2013. Published November 2013. Originally published as ASTM E 1956–98. The present International Standard ISO/ASTM 51956:2013(E) is a major revision of the last previous edition ISO/ASTM 51956:2005(E).

[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] 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.

JCGM 200:2008, VIM, International Vocabulary of Metrology—Basis and general concepts and associated terms[4]

2.4 *ISO Standard:*

ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment[5]

2.5 *International Commission on Radiation Units and Measurements (ICRU) Report:*

ICRU Report 85a Fundamental Quantities and Units for Ionizing Radiation[6]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *annealing*—thermal treatment of a TLD prior to irradiation or prior to readout.

3.1.1.1 *Discussion*—Pre-irradiation annealing of TLDs is usually done to erase the effects of previous irradiation and to readjust the sensitivity of the phosphor; pre-readout annealing usually is done to reduce low-temperature TLD response.

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 realized 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. To achieve stable environmental conditions, it may be necessary to condition the dosimeters before performing the calibration procedure.

3.1.3 *calibration curve*—expression of the relation between indication and corresponding measured quantity value. **(VIM)**

3.1.4 *charged-particle equilibrium*—condition in which the kinetic energy of charged particles (or electrons), excluding rest mass, entering an infinitesimal volume of the irradiated material equals the kinetic energy of charge particles (or electrons) emerging from it.

3.1.4.1 *Discussion*—When electrons are the predominant charged particles, the term "electron equilibrium" is often used to describe charged-particle equilibrium.

3.1.5 *dosimeter batch*—quantity of dosimeters made from a specific mass of material with uniform composition, fabricated in a single production run under controlled, consistent conditions, and having a unique identification code.

3.1.6 *dosimeter stock*—part of a dosimeter batch held by the user.

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

3.1.8 *electron equilibrium*—charged-particle equilibrium for electrons. See *charged-particle equilibrium.*

3.1.9 *measurement management system*—set of interrelated or interacting elements necessary to achieve metrological confirmation and continual control of measurement processes. **(ISO 10012)**

3.1.10 *quality assurance*—all systematic actions necessary to provide adequate confidence that a calibration, measurement, or process is performed to a predefined level of quality.

3.1.11 *reference standard dosimetry system*—dosimetry system, generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived.

3.1.12 *routine dosimetry system*—dosimetry system calibrated against a reference standard dosimetry system and used for routine absorbed dose measurements, including dose mapping and process monitoring.

3.1.13 *thermoluminescence dosimeter (TLD)*—TL phosphor, alone or incorporated in a material, used for determining the absorbed dose to materials.

3.1.13.1 *Discussion*—For example, the TL phosphor is sometimes incorporated in a TFE-fluorocarbon matrix.

3.1.14 *thermoluminescence dosimeter reader (TLD reader)*—instrument used to measure the light emitted from a TLD consisting essentially of a heating element, a light-measuring device, and appropriate electronics.

3.1.15 *thermoluminescence dosimeter response (TLD response)*—light emitted by the TLD and read out during its heating cycle consisting of one of the following: *(a)* the total light output over the entire heating cycle, *(b)* a part of that total light output, or *(c)* the peak amplitude of the light output.

3.1.16 *thermoluminescence phosphor (TL phosphor)*—material that stores, upon irradiation, a fraction of its absorbed dose in various excited energy states and when thermally stimulated, it emits this stored energy as ultraviolet, visible, and infrared lights.

3.1.17 *TLD preparation*—procedure of cleaning, annealing, and encapsulating the TL phosphor prior to irradiation.

3.2 Definitions of other terms used in this standard that pertain to radiation measurement and dosimetry may be found in ASTM Terminology E170. Definitions in ASTM Terminology E170 are compatible with ICRU Report 85a; that document, therefore, may be used as an alternative reference.

## 4. Significance and use

4.1 In radiation processing, TLDs are mainly used in the irradiation of blood products (see ISO/ASTM Practice 51939) and insects for sterile insect release programs (see ISO/ASTM Guide 51940). TLDs may also be used in other radiation processing applications such as the sterilization of medical

[4] 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.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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