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Nuclear energy, nuclear technologies, and radiological protection — Vocabulary —

Part 4: Dosimetry for radiation processing

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Partie 4: Dosimetrie pour processue de radiation

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Foreword

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The committee responsible for this document is ISO/TC85 *Nuclear energy, nuclear technologies, and radiological protection*.

ISO 12749 consists of the following parts, under the general title *Nuclear energy, nuclear technologies, and radiological protection — Vocabulary*:

— *Part 2: Radiological protection*

— *Part 3: Nuclear fuel cycle*

— *Part 4: Dosimetry for radiation processing*

The following part is under preparation:

— *Part 5: Nuclear reactors*

The following part is planned:

— *Part 1: General terminology*

Introduction

This part of ISO 12749 provides terms and definitions for concepts for dosimetry related to radiation processing using gamma radiation, X-radiation, or accelerated electrons. Concepts related to the calibration and use of dosimetry systems for operational qualification and performance qualification of commercial radiation processing facilities and for dose monitoring for quality assurance during the routine processing of products are defined. Terminological data are taken from the ISO/ASTM standards developed by ISO TC 85 and ASTM International Committee E61. Care is taken to ensure definitions are consistent with other technically validated documents such as VIM, ICRU and GUM.

Unambiguous communication of nuclear energy concepts is crucial since serious consequences can arise from misunderstandings with regard to standards related to equipment and materials used in nuclear energy activities. Concepts dealing with dosimetry related to radiation processing and procedures for preparation, testing, and using dosimetry systems to determine the absorbed dose are present in all of the ISO/ASTM standards developed by WG3. To avoid misunderstandings, these concepts need to be designated by common terms and described by harmonized definitions.

Conceptual arrangement of terms and definitions is based on concepts systems that show corresponding relationships among nuclear energy concepts. Such arrangement provides users with a structured view of the nuclear energy sector and will facilitate common understanding of all related concepts. Besides, concepts systems and conceptual arrangement of terminological data will be helpful to any kind of user because it will promote clear, accurate and useful communication.

Nuclear energy, nuclear technologies, and radiological protection — Vocabulary —

Part 4: Dosimetry for radiation processing

1 Scope

This part of ISO 12749 lists unambiguous terms and definitions for concepts for dosimetry related to radiation processing using gamma radiation, X-radiation, or accelerated electrons. It is intended to facilitate communication and promote common understanding.

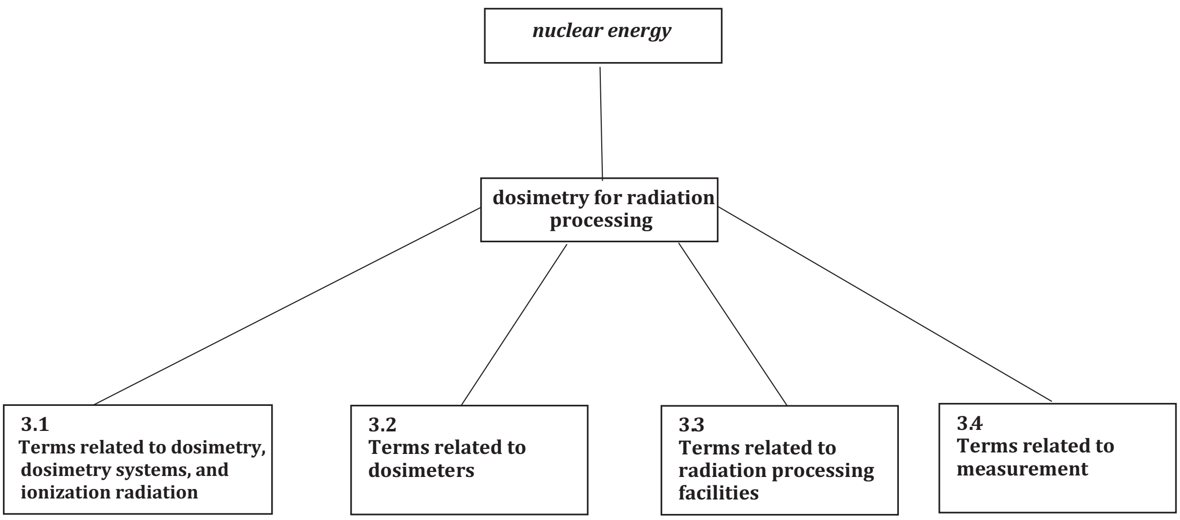
2 Structure of the vocabulary

The terminology entries are presented in the conceptual order of the English preferred terms. Both a systematic index and an alphabetical index are included at the end of the standard. The structure of each entry is in accordance with ISO 10241-1.

All the terms included in this part of ISO 12749 deal exclusively with dosimetry for radiation processing. When selecting terms and definitions, special care has been taken to include the terms that need to be defined, it means, either because the definitions are essential to the correct understanding of the corresponding concepts or because some specific ambiguities need to be addressed.

The notes appended to certain definitions offer clarification or examples to facilitate understanding of the concepts described. In certain cases, miscellaneous information is also included, for example, the units in which a quantity is normally measured, recommended parameter values, references, etc.

According to the title, the vocabulary deals with concepts belonging to the general ***nuclear energy*** field within which concepts in the **dosimetry for radiation processing** subfield are taking into account.



3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Terms related to dosimetry, dosimetry systems and ionizing radiation

3.1.1
dosimetry
measurement of absorbed dose by the use of a dosimetry system

[SOURCE: ISO/ASTM 52628:2013, 3.1.7]

3.1.2
absorbed dose
D
quotient of the $\mathrm{d}\bar{\varepsilon}$ by the dm, where the $\mathrm{d}\bar{\varepsilon}$ is the mean energy imparted by ionization radiation to matter of mass dm

Note 1 to entry: It is expressed as

$$D = \mathrm{d}\bar{\varepsilon} \,/\, \mathrm{d}m$$

Note 2 to entry: The special name for the unit of absorbed dose is gray (Gy), where 1 gray is equivalent to the absorption of 1 J per kilogram of a specified material (1 Gy = 1 J / kg).

[SOURCE: ICRU 85a, 5.2.5, October 2011, modified]

Note 3 to entry: In most radiation processing applications, absorbed dose is in terms of absorbed dose to water.

3.1.3
dosimetry system
used for measuring absorbed dose, consisting of dosimeters, measurement instruments and their associated reference standards, and procedures for the system's use

[SOURCE: ISO/ASTM 52628:2013, 3.1.8, modified]

3.1.3.1
primary standard dosimetry system
designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity

[SOURCE: ISO/ASTM 52628:2013, 3.1.11, modified]

3.1.3.2
reference standard 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

[SOURCE: ISO/ASTM 52628:2013, 3.1.13, modified]

3.1.3.3
routine dosimetry system
calibrated against a reference standard dosimetry system and used for routine absorbed dose measurements, including dose mapping and process monitoring

[SOURCE: ISO/ASTM 52628:2013, 3.1.16, modified]

3.1.3.4
transfer standard dosimetry system
used as an intermediary to calibrate other dosimetry systems, usually routine dosimetry system

[SOURCE: ISO/ASTM 52628:2013, 3.1.18, modified]

3.1.4
ionizing radiation
consists of charged particles or uncharged particles, or both, that as a result of physical interaction, creates ions by primary or secondary processes

Note 1 to entry: Charged particles could be positrons or electrons, and uncharged particles could be X-radiation or gamma radiation.

[SOURCE: ASTM E170, 14a, modified]

3.1.4.1
gamma radiation
electromagnetic radiation emitted in the process of nuclear transition

[SOURCE: IEC 60050, modified]

3.1.4.1.1
activity
A
quotient of −d*N* by d*t*, where d*N* is the mean change in the number of nuclei in that energy state due to spontaneous nuclear transformations in the time interval d*t*

Note 1 to entry: Activity of an amount of radionuclide in a particular energy state at a given time.

Note 2 to entry: It is expressed as

$$A = -\mathrm{d}N/\mathrm{d}t$$

Note 3 to entry: The special name for the unit of activity is becquerel (Bq), where 1 Bq = 1 s^{-1} and 1 Ci = 3,7×10^{10} Bq.

[SOURCE: ICRU 85a, 6.2, October 2011, modified]

3.1.4.1.2
decay constant
λ
quotient of d*N*/*N* by d*t*, where d*N*/*N* is the mean fractional change in the number of nuclei in that energy state due to spontaneous nuclear transformations in the time interval d*t*

Note 1 to entry: Decay constant of a radionuclide in a particular energy state.

Note 2 to entry: It is expressed as

$$\lambda = -\frac{\mathrm{d}N / N}{\mathrm{d}t}$$

[SOURCE: ICRU 85a, 6.1, October 2011, modified]

3.1.4.1.3
half-life
$T_{1/2}$
time taken for the activity of an amount of radionuclide to become half its initial value

Note 1 to entry: Half-life of a radionuclide in a particular energy state.

Note 2 to entry: $T_{1/2} = \ln 2/\lambda$, where λ is the *decay constant* (3.1.4.1.2).

3.1.4.2
X-radiation
X-ray
ionizing electromagnetic radiation, which includes both bremsstrahlung and the characteristic radiation emitted when atomic electrons make transitions to more tightly bound states

Note 1 to entry: In radiation processing applications, the principal X-radiation is bremsstrahlung.

[SOURCE: ISO/ASTM 51608:2015, 3.2.1]

3.1.4.2.1
bremsstrahlung
broad-spectrum electromagnetic radiation emitted when an energetic charged particle is influenced by a strong electric or magnetic field, such as that in the vicinity of an atomic nucleus

[SOURCE: ISO/ASTM 51608:2015, 3.1.4]

3.1.4.3
electron beam
stream of electrons generated by an electron accelerator

3.1.5
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

[SOURCE: ISO/ASTM 52628:2013, 3.1.3]

3.1.5.1
approved laboratory
recognized national metrology institute; or has been formally accredited to ISO/IEC 17025; or has a quality system consistent with the requirements of ISO/IEC 17025

Note 1 to entry: A recognized national metrology institute or other calibration laboratory accredited to ISO/IEC 17025 should be used in order to ensure traceability to a national or international standard. A calibration certificate provided by a laboratory not having formal recognition or accreditation will not necessarily be proof of traceability to a national or international standard.

[SOURCE: ISO/ASTM 51261:2013, 3.1.1, modified]

3.1.5.1.1
accredited dosimetry calibration laboratory
dosimetry laboratory with formal recognition by an accrediting organization that the dosimetry laboratory is competent to carry out specific activities which lead to the calibration or calibration verification of dosimetry systems in accordance with documented requirements of the accrediting organization

[SOURCE: ISO/ASTM 52628:2013, 3.1.2]

3.1.5.2
reference standard radiation field
calibrated radiation field, generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived

[SOURCE: ISO/ASTM 52628:2013, 3.1.14]

3.1.5.3
charged-particle equilibrium
electron equilibrium
condition in which the kinetic energy of charged particles, excluding rest mass, entering an infinitesimal volume of the irradiated material equals the kinetic energy of charge particles emerging from it

Note 1 to entry: This is referred to as electron equilibrium in the case of electrons set in motion by photon irradiation of a material.

[SOURCE: ISO/ASTM 51261:2013, 3.1.4]

3.1.6
calibration curve
expression of the relation between indication and corresponding measured quantity value

Note 1 to entry: In radiation processing standards, term “dosimeter response” is generally used for “indication”.

[SOURCE: VIM:2008, 4.31]

3.1.7
verification
provision of objective evidence that a given item fulfils specified requirements

[SOURCE: VIM: 2008, 2.44]

3.2 Terms related to dosimeters

3.2.1
dosimeter
device that, when irradiated, exhibits a quantifiable change that can be related to absorbed dose in a given material using appropriate measurement instruments and procedures

[SOURCE: ISO/ASTM 52628:2013, 3.1.4]

3.2.2
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

[SOURCE: ISO/ASTM 51276:2012, 3.1.3]

3.2.2.1
dosimeter stock
part of a dosimeter batch held by the user

[SOURCE: ISO/ASTM 51276:2012, 3.1.5]

3.2.3
dosimeter set
one or more dosimeters used to measure the absorbed dose at a location and whose average reading is used to determine absorbed dose at that location

[SOURCE: ISO/ASTM 51940:2013, 3.1.9]

3.2.4
dosimeter response
reproducible, quantifiable effect produced in the dosimeter by ionizing radiation

Note 1 to entry: The response value may be obtained from such measurements as optical absorbance, thickness, mass, peak-to-peak distance in EPR spectra, or electropotential between solutions and thermoluminescent output.

[SOURCE: ISO/ASTM 51276:2012, 3.1.4]

3.2.4.1
radiation chemical yield
$G(\mathrm{x})$
quotient of $n(\mathrm{x})$ by $\bar{\varepsilon}$, where $n(\mathrm{x})$ is the mean amount of substance of that entity produced, destroyed, or changed in a system by the mean energy imparted, $\bar{\varepsilon}$ to the matter of that system

Note 1 to entry: Radiation of chemical yield of an entity x.

Note 2 to entry: It is expressed as

$$G(\mathrm{x}) = n(\mathrm{x})/\bar{\varepsilon}$$

Note 3 to entry: SI unit: mol · J^{-1}

[SOURCE: ICRU-85a, October 2011, 4.6, modified]

3.2.5
influence quantity
quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result

[SOURCE: VIM:2008, 2.52]

Note 1 to entry: In radiation processing dosimetry, this term includes temperature, relative humidity, time intervals, light, radiation energy, absorbed-dose rate, and other factors that might affect dosimeter response, as well as quantities associated with the measurement instrument.

3.2.5.1
absorbed-dose rate
$\dot{D}$
quotient of $\mathrm{d}D$ by $\mathrm{d}t$, where $\mathrm{d}D$ is the increment of absorbed dose in the time interval $\mathrm{d}t$

Note 1 to entry: It is expressed as

$$\dot{D} = \mathrm{d}D/\mathrm{d}t$$

Note 2 to entry: Unit: SI $\mathrm{Gy{\cdot}s^{-1}}$.

[SOURCE: ICRU-85a, October 2011, 5.2.6, modified]

Note 3 to entry: The absorbed-dose rate is often specified in terms of its average value over longer time intervals, for example, in units of $\mathrm{Gy{\cdot}min^{-1}}$ or $\mathrm{Gy{\cdot}h^{-1}}$.

Note 4 to entry: In electron-beam irradiators with pulsed or scanned beam, there are two types of dose rate: average value over several pulses (scans) and instantaneous value within a pulse (scan). These two values can be significantly different.

[SOURCE: ISO/ASTM 51650:2013, 3.1.2]

3.2.6
type 1 dosimeter
dosimeter of high metrological quality, where the response of which is affected by individual influence quantities in a well-defined way that can be expressed in terms of independent correction factors

[SOURCE: ISO/ASTM 52628:2013, 3.1.19, modified]

