भारतीय मानक

Indian Standard

IS 16902 (Part 4) : 2023
ISO 12749-4 : 2015

परमाणु ऊर्जा, परमाणु तकनिकियाँ एवं रेडियोलॉजीकल संरक्षण — शब्दावली

भाग 4 विकिरण प्रसंस्करण के लिए डोसीमेट्री

Nuclear Energy, Nuclear Technologies and Radiological Protection — Vocabulary

Part 4 Dosimetry for Radiation Processing

ICS 01.040.13; 13.280

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August 2023 **Price Group 11**

Nuclear Energy for Peaceful Applications Sectional Committee, CHD 30

NATIONAL FOREWORD

This Indian Standard (Part 4) which is identical with ISO 12749-4 : 2015 'Nuclear energy, nuclear technologies and radiological protection — Vocabulary — Part 4: Dosimetry for radiation processing' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Nuclear Energy for Peaceful Applications Sectional Committee and approval of the Chemical Division Council.

This part of IS 16902 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.

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 Indian Standards. 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.

This Indian Standard is published in several parts. The other parts in this series are:

Part 1 General terminology

Part 2 Radiological protection

Part 3 Nuclear fuel cycle

Part 5 Nuclear reactors

Part 6 Nuclear medicine

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions and terminologies are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words `International Standard' appear referring to this standard, they should be read as `Indian Standard'; and

b) Comma (,) has been used as a decimal marker in the International Standard, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Contents

Page

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.

Indian Standard

NUCLEAR ENERGY, NUCLEAR TECHNOLOGIES AND RADIOLOGICAL PROTCTION — VOCABULAY

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.

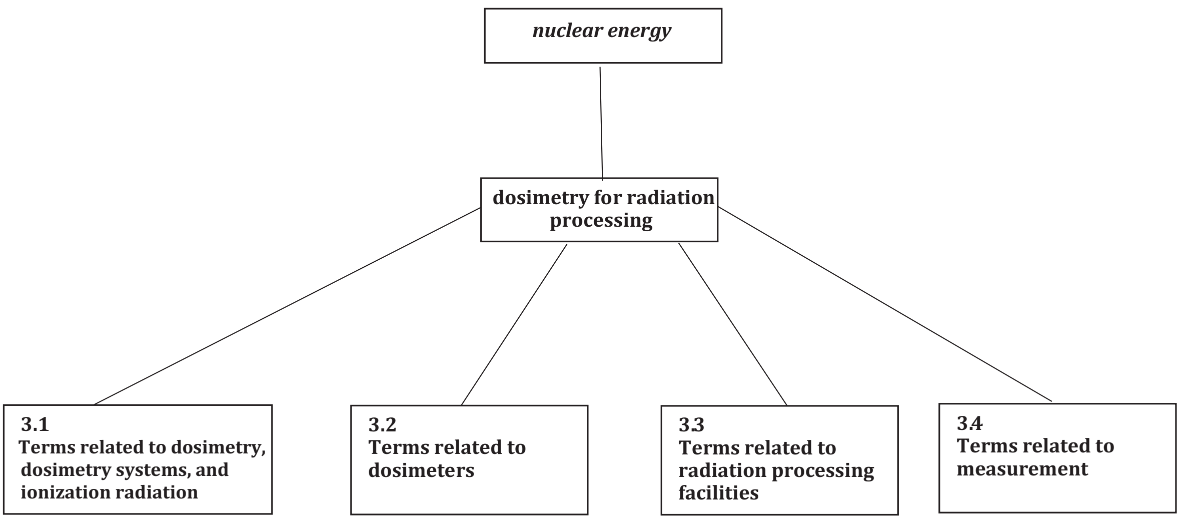
2 Structure of the vocabulary

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 $d\bar{\varepsilon}$ by the dm, where the $d\bar{\varepsilon}$ is the mean energy imparted by ionization radiation to matter of mass dm

Note 1 to entry: It is expressed as

$$D = d\bar{\varepsilon} / dm$$

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 $-\mathrm{d}N$ by $\mathrm{d}t$, where $\mathrm{d}N$ is the mean change in the number of nuclei in that energy state due to spontaneous nuclear transformations in the time interval $\mathrm{d}t$

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 = $3{,}7\times10^{10}$ Bq.

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

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

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(x)
quotient of n(x) by $\bar{\varepsilon}$, where n(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 dD by dt, where dD is the increment of absorbed dose in the time interval dt

Note 1 to entry: It is expressed as

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

Note 2 to entry: Unit: SI Gy·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 Gy·min^{-1} or Gy·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]

3.2.6.1
alanine dosimeter
specified quantity and physical form of the radiation-sensitive material alanine and any added inert substance such as a binder, where the radiation-induced change in specific stable free radicals in alanine is related to absorbed dose

Note 1 to entry: This may be a type 1 dosimeter.

[SOURCE: Adapted from ISO/ASTM 51607:2013, 3.1.2]

3.2.6.2
ceric-cerous dosimeter
specially prepared solution of ceric sulfate and cerous sulfate in sulfuric acid, individually sealed in an appropriate container such as a glass ampoule, where the radiation-induced changes in electropotential or optical absorbance of the solution are related to absorbed dose

[SOURCE: ISO/ASTM 51205:2009, 3.1.3]

Note 1 to entry: This may be a type 1 dosimeter.

3.2.6.3
dichromate dosimeter
solution containing silver and dichromate ions in perchloric acid in an appropriate container such as a sealed glass ampoule that indicates absorbed dose by change (decrease) in absorbance at a specified wavelength

[SOURCE: adapted from ISO/ASTM 51401:2013, 4.2]

Note 1 to entry: This may be a type 1 dosimeter.

3.2.6.4
ethanol chlorobenzene dosimeter
partly deoxygenated solution of chlorobenzene (CB) in 96 volume % ethanol in an appropriate container, such as a flame-sealed glass ampoule, used to indicate absorbed dose by measurement of the amount of HCl formed under irradiation

[SOURCE: ISO/ASTM 51538:2009, 3.1.4]

Note 1 to entry: This is may be a type 1 dosimeter.

3.2.6.5
Fricke dosimeter
air-saturated solution of ferrous sulfate or ferrous ammonium sulfate that indicates absorbed dose by an increase in absorbance at a specified wavelength

[SOURCE: ASTM E1026:2013, 4.2]

Note 1 to entry: This may be a type 1 dosimeter.

3.2.7
type 2 dosimeter
response is affected by influence quantities in a complex way that cannot practically be expressed in terms of independent correction factors

[SOURCE: ISO/ASTM 52628:2013, 3.1.20, modified]

3.2.7.1
calorimeter
assembly consisting of calorimetric body (absorber), thermal insulation, and temperature sensor with wiring, that during exposure to ionizing radiation exhibits a characterizable change in absorber temperature that can be related to absorbed dose

Note 1 to entry: This is a type 2 dosimeter.

[SOURCE: Adapted from ISO/ASTM 51631:2013, 3.2.2]

3.2.7.2
cellulose triacetate dosimeter
piece of CTA film that, during exposure to ionizing radiation, exhibits a quantifiable change in specific net absorbance as a function of absorbed dose

[SOURCE: ISO/ASTM 51650:2013, 3.1.4]

Note 1 to entry: This is a type 2 dosimeter.

3.2.7.3
polymethylmethacrylate dosimeter
PMMA dosimeter
piece of specially selected or developed PMMA material, individually sealed by the manufacturer in an impermeable sachet, that during exposure to ionizing radiation exhibits a characterizable change in specific optical absorbance as a function of absorbed dose

[SOURCE: ISO/ASTM 51276:2012, 3.1.7]

3.2.7.4
radiochromic film dosimeter
specially prepared film containing ingredients that undergo change in optical absorbance under ionizing radiation, which can be related to absorbed dose

[SOURCE: adapted from ISO/ASTM 51275:2013, 3.1.7]

3.2.7.5
radiochromic liquid dosimeter
specially prepared solution containing ingredients that undergo change in optical absorbance under ionizing radiation, which can be related to absorbed dose

[SOURCE: adapted from ISO/ASTM 51540:2004, 3.1.7]

3.2.7.6
radiochromic optical waveguide dosimeter
specially prepared optical waveguide containing ingredients that undergo an ionizing radiation-induced change in photometric absorbance, which can be related to absorbed dose

[SOURCE: adapted from ISO/ASTM 51310:2004, 3.1.8]

3.2.7.7
thermoluminescence dosimeter
TLD
thermoluminescence phosphor, alone or incorporated in a material, used for determining the absorbed dose to materials

[SOURCE: ISO/ASTM 51956:2013, 3.1.13]

3.3 Terms related to radiation processing

3.3.1
radiation processing
intentional irradiation of products or materials to preserve, modify or improve their characteristics

[SOURCE: ISO/ASTM 52628:2013, 3.1.12]

3.3.2
radiation processing facility
establishment that uses ionizing radiation for the purpose of radiation processing

3.3.2.1
gamma facility
gamma-ray irradiation facility
gamma-ray radiation facility
establishment that uses gamma-emitting radionuclide source for the purpose of radiation processing

[SOURCE: ISO/ASTM 51608:2015, 3.2.3]

3.3.2.2
X-ray facility
X-ray (bremsstrahlung) facility
X-ray (bremsstrahlung) irradiation facility
X-ray (bremsstrahlung) radiation facility
establishment that uses X-radiation (bremsstrahlung) for the purpose of radiation processing

3.3.2.2.1
X-ray converter
X-ray (bremsstrahlung) converter
device for generating X-radiation (bremsstrahlung) from an electron beam, consisting of a target, means for cooling the target, and a supporting structure

[SOURCE: ISO/ASTM 51608:2015, 3.1.16]

3.3.2.2.2
X-ray target
component of the X-ray converter that is struck by the electron beam and which produces X-radiation (bremsstrahlung)

Note 1 to entry: X-ray target is usually made of metal with a high atomic number, high melting temperature, and high thermal conductivity.

[SOURCE: adapted from ISO/ASTM 51608:2015, 3.2.4]

3.3.2.3
electron beam facility
establishment that uses electron beam accelerator for the purpose of radiation processing

3.3.3
validation
<process> documented procedure for obtaining, recording and interpreting the results required to establish that a process will consistently yield product complying with predetermined specifications

[SOURCE: ISO 11137-1:2006]

3.3.4
installation qualification
IQ
process of obtaining and documenting evidence that equipment has been provided and installed in accordance with its specifications

[SOURCE: ISO/ASTM 51702:2013, 3.1.8]

3.3.4.1
electron beam spot
cross section of an unscanned beam in the reference plane

3.3.4.1.1
beam length
dimension of the irradiation zone, perpendicular to the beam width and direction of the electron beam at a specified distance from the accelerator window

[SOURCE: ISO/ASTM 51649:2015, 3.1.4]

3.3.4.1.2
beam width
dimension of the irradiation zone perpendicular to the direction of product movement, at a specified distance from the accelerator window

[SOURCE: ISO/ASTM 51649:2015, 3.1.5]

3.3.4.2
electron beam power
product of the average electron beam energy and the average beam current

[SOURCE: ISO/ASTM 51649:2015, 3.1.4]

3.3.4.2.1
average beam current
time-averaged electron beam current; for a pulsed accelerator, the averaging shall be done over a large number of pulses

[SOURCE: ISO/ASTM 51649:2015, 3.1.2]

3.3.4.2.2
electron energy spectrum
particle fluence distribution of electrons as a function of energy

[SOURCE: ISO/ASTM 51649:2015, 3.1.12]

3.3.4.2.3
electron beam energy
kinetic energy of the accelerated electrons in the beam

Note 1 to entry: Unit: J.

Note 2 to entry: Electron volt (eV) is often used as the unit for electron beam energy, where 1 eV = $1{,}602\times10^{-19}$ J.

Note 3 to entry: In radiation processing, where beams with a broad electron energy spectrum are frequently used, the terms *most probable energy* (E_p) and *average energy* (E_a) are common. They are linked to the *practical electron range* R_p and *half-value depth* R_{50} by empirical equations, respectively.

Note 4 to entry: Electron beam energy can be determined using established relationships between electron beam energy and depth-dose distribution parameters. The method used for energy calculation must be specified.

[SOURCE: ISO/ASTM 51649:2015, 3.1.10. modified]

3.3.4.3
electron beam range
penetration distance in a specific, totally absorbing material along the beam axis of the electrons incident on the material, equivalent to practical electron range, R_p

Note 1 to entry: R_p can be measured from experimental depth-dose distributions in a given material.

Note 2 to entry: Other forms of electron range are found in the dosimetry literature, for example, extrapolated range derived from depth-dose data and the continuous-slowing-down-approximation range (the calculated path length traversed by an electron in a material in the course of completely slowing down).

Note 3 to entry: Electron range is usually expressed in terms of mass per unit area (kg·m^{-2}), but sometimes in terms of thickness (m) for a specified material.

[SOURCE: ISO/ASTM 51649:2015, 3.2.5]

3.3.4.3.1
half-entrance depth
R_{50e}
depth in homogeneous material at which the absorbed dose has decreased down to 50 % of the absorbed dose at the surface of the material

[SOURCE: ISO/ASTM 51649:2015, 3.2.7]

3.3.4.3.2
half-value depth
R_{50}
depth in homogeneous material at which the absorbed dose has decreased down to 50 % of its maximum value

[SOURCE: ISO/ASTM 51649:2015, 3.2.8]

3.3.4.3.3
practical electron range
R_p
depth in homogeneous material to the point where the tangent at the steepest point (the inflection point) on the almost straight descending portion of the depth-dose distribution curve meets the extrapolated X-ray background

[SOURCE: ISO/ASTM 51649:2015, 3.2.10]

3.3.4.3.4
extrapolated electron range
R_{ex}
depth in homogeneous material to the point where the tangent at the steepest point (the inflection point) on the almost straight descending portion of the depth-dose distribution curve meets the depth axis

[SOURCE: ISO/ASTM 51649:2015, 3.2.6]

3.3.4.3.5
optimum thickness
R_{opt}
depth in homogeneous material at which the absorbed dose equals the absorbed dose at the surface where the electron beam enters

[SOURCE: ISO/ASTM 51649:2015, 3.2.9]

3.3.4.4
reference material
homogeneous material of known radiation absorption and scattering properties used to establish characteristics of the irradiation process, such as scan uniformity, depth-dose distribution, throughput rate, and reproducibility of dose delivery

[SOURCE: ISO/ASTM 51649:2015, 3.1.18]

3.3.4.4.1
reference plane
selected plane in the radiation zone that is perpendicular to the electron beam axis

[SOURCE: ISO/ASTM 51649:2015, 3.1.19]

3.3.4.4.2
standardized depth
z
thickness of the absorbing material expressed as the mass per unit area, which is equal to the depth t in the material times the density ρ

Note 1 to entry: If m is the mass of the material beneath area A of the material through which the beam passes, then:

$$z = m/A = t\,\rho$$

Note 2 to entry: The SI unit of z is in kg/m^2, where t is in meters and, ρ in kilograms per cubic meter.

Note 3 to entry: It is common practice to express t in centimeters and ρ in grams per cm^3, then z is in grams per square centimeters.

Note 4 to entry: Standardized depth may also be referred to as surface density or area density.

[SOURCE: ISO/ASTM 51649:2015, 3.1.22, modified]

3.3.4.5
scanned beam
electron beam that is swept back and forth with a varying magnetic field

Note 1 to entry: This is most commonly done along one dimension (beam width), although two-dimensional scanning (beam width and length) may be used with high-current electron beams to avoid overheating the beam exit window of the accelerator or product under the scan horn.

[SOURCE: ISO/ASTM 51649:2015, 3.2.14]

3.3.4.5.1
scan frequency
number of complete scanning cycles per second expressed in Hz

[SOURCE: ISO/ASTM 51649:2015, 3.2.15]

3.3.4.5.2
scan uniformity
degree of uniformity of dose measured along the scan direction

[SOURCE: ISO/ASTM 51649:2015, 3.2.16]

3.3.4.6
pulsed electron beam
electron beam consisting of pulses of electrons rather than a continuous stream of electrons

Note 1 to entry: Beam is produced by a pulsed electron accelerator, typically a linear accelerator.

Note 2 to entry: Pulsed beams are characterized by pulse peak current, pulse width and pulse rate.

3.3.4.6.1
pulse beam current
<for a pulsed accelerator> beam current averaged over the top ripples (aberrations) of the pulse current waveform, equal to I_{avg}/wf, where I_{avg} is the average beam current, w is the pulse width, and f is the pulse rate

[SOURCE: ISO/ASTM 51649:2015, 3.2.11]

3.3.4.6.2
pulse rate
<for a pulsed accelerator> pulse repetition frequency in hertz, or pulses per second

Note 1 to entry: Pulse rate is also referred to as the repetition (rep) rate.

[SOURCE: ISO/ASTM 51649:2015, 3.2.12]

3.3.4.6.3
pulse width
<for a pulsed accelerator> time interval between two points on the leading and trailing edges of the pulse current waveform where the current is 50 % of its pulse beam current value

[SOURCE: ISO/ASTM 51649:2015, 3.2.13]

3.3.4.6.4
duty cycle
<for a pulsed accelerator> fraction of time the beam is effectively on

Note 1 to entry: Duty cycle is the product of the pulse width in seconds and the pulse rate in pulses per second.

[SOURCE: ISO/ASTM 51649:2015, 3.2.4]

3.3.5
operational qualification
OQ
process of obtaining and documenting evidence that installed equipment operates within predetermined limits when used in accordance with its operational procedures

[SOURCE: ISO/ASTM 51702:2013, 3.1.10]

3.3.5.1
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

[SOURCE: ISO/ASTM 51900:2009, 3.1.19]

3.3.5.2
depth-dose distribution
variation of absorbed dose with depth from the incident surface of a material exposed to a given ionizing radiation

[SOURCE: ISO/ASTM 51818:2013, 3.1.5]

3.3.6
performance qualification
PQ
process of obtaining and documenting evidence that the equipment, as installed and operated in accordance with operational procedures, consistently performs in accordance with predetermined criteria and thereby yields product meeting its specification

[SOURCE: ISO/ASTM 51702:2013, 3.1.11]

3.3.7
absorbed-dose mapping
measurement of absorbed dose within an irradiated product to produce a one-dimensional, two-dimensional or three-dimensional distribution of absorbed dose, thus, rendering a map of absorbed-dose values

[SOURCE: ISO/ASTM 51702:2013, 3.1.2, modified]

3.3.7.1
dose uniformity ratio
ratio of the maximum to the minimum absorbed dose within the irradiated product

Note 1 to entry: The concept is also referred to as the max/min dose ratio.

[SOURCE: ISO/ASTM 51940:2013, 3.1.6]

3.3.7.2
routine monitoring position
position where absorbed dose is monitored during routine processing to ensure that the product is receiving the absorbed dose specified for the process

Note 1 to entry: This position may be a location of minimum or maximum dose in the process load or it may be an alternate convenient location in, on or near the process load where the relationship of the dose at this position with the minimum and maximum dose has been established.

[SOURCE: ASTM E2303:2011, 3.1.13]

3.3.7.3
isodose curves
lines or surfaces of constant absorbed dose through a specified medium

[SOURCE: ISO/ASTM 51939:2013, 3.1.16]

3.3.7.4
simulated product
compensating dummy material with absorption and scattering properties similar to those of the product, material or substance to be irradiated

Note 1 to entry: Simulated product is used during irradiator characterization as a substitute for the actual product, material or substance to be irradiated.

Note 2 to entry: When used in routine production runs in order to compensate for the absence of product, simulated product is sometimes referred to as compensating dummy.

Note 3 to entry: When used for absorbed-dose mapping, simulated product is sometimes referred to as phantom material.

[SOURCE: Adapted from ISO/ASTM 51702:2013, 3.1.13]

3.3.7.5
process load
volume of material with a specified product loading configuration irradiated as a single entity

[SOURCE: ASTM E2303:2011, 3.1.10]

3.3.8
routine product processing
treatment of product or material to specified absorbed dose requirements using validated process specification obtained through absorbed-dose mapping and confirmed by routine dosimetry

3.3.8.1
timer setting
defined time interval during which product is exposed to ionizing radiation

Note 1 to entry: For a shuffle-dwell irradiator, the timer setting is the time interval from the start of one shuffle-dwell cycle to the start of the next shuffle-dwell cycle. For a stationary irradiator, the timer setting is the total irradiation time.

[SOURCE: ISO/ASTM 51702:2013, 3.1.14]

3.3.8.2
production run
<for continuous-flow and shuffle-dwell irradiation> series of irradiation containers consisting of materials or products having similar radiation-absorption characteristics, that are irradiated sequentially to a specified range of absorbed dose

[SOURCE: ISO/ASTM 51702:2013, 3.1.12]

3.3.8.2.1
irradiation container
holder in which product is placed during the irradiation process

[SOURCE: ISO/ASTM 51702:2013, 3.1.9]

3.3.8.3
radiation indicator
radiation-sensitive indicator
material such as coated or impregnated adhesive-backed substrate, ink, coating or other materials which may be affixed to or printed on the process loads, and which undergoes a visual change when exposed to ionizing radiation

[SOURCE: ISO/ASTM 51539:2013, 3.1.4]

3.3.8.4
routine dosimetry
dosimetry performed at a radiation processing facility for various routine activities, including absorbed-dose mapping, process control and quality assurance

3.4 Terms related to measurement

3.4.1
measurement
process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity

[SOURCE: ISO/IEC Guide 99:2007/BIPM:2008, 2.1, 2.1]

3.4.2
measurand
quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007/BIPM:2008, 2.3, 2.3]

3.4.3
measurement uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Note 1 to entry: Measurement uncertainty includes components arising from systematic effects, such as components associated with corrections and the assigned quantity values of measurement standards, as well as the definitional uncertainty. Sometimes, estimated systematic effects are not corrected for but, instead, associated measurement uncertainty components are incorporated.

Note 2 to entry: The parameter may be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 3 to entry: Measurement uncertainty comprises, in general, many components. Some of these may be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which may be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

Note 4 to entry: In general, for a given set of information, it is understood that the measurement uncertainty is associated with a stated quantity value attributed to the measurand. A modification of this value results in a modification of the associated uncertainty.

[SOURCE: VIM:2008, 2.26]

3.4.4
metrological traceability
traceability
property of a measurement result whereby result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

Note 1 to entry: The unbroken chain of calibrations is referred to as "traceability chain".

Note 2 to entry: Metrological traceability of a measurement result does not ensure that the measurement uncertainty is adequate for a given purpose or that there is an absence of mistakes.

Note 3 to entry: The abbreviated term "traceability" is sometimes used to mean "metrological traceability" as well as other concepts, such as "sample traceability" or "document traceability" or "instrument traceability" or "material traceability", where the history ("trace") of an item is meant. Therefore, the full term of "metrological traceability" is preferred if there is any risk of confusion.

[SOURCE: VIM:2008, 4.41]

3.4.5
uncertainty budget
statement of a measurement uncertainty, of the components of that measurement uncertainty, and of their calculation and combination

Note 1 to entry: An uncertainty budget should include the measurement model, estimates, and measurement uncertainties associated with the quantities in the measurement model, covariances, type of applied probability density functions, degrees of freedom, type of evaluation of measurement uncertainty, and any coverage factor.

[SOURCE: VIM:2008, 2.33]

3.4.6
standard measurement uncertainty
measurement uncertainty expressed as a standard deviation

Note 1 to entry: Standard measurement uncertainty is also referred to as "standard uncertainty of measurement" or "standard uncertainty".

[SOURCE: VIM:2012, 2.30]

3.4.7
Type A evaluation of measurement uncertainty
evaluation of a component of measurement uncertainty by a statistical analysis of measured quantity values obtained under defined measurement conditions

[SOURCE: VIM:2012, 2.28]

3.4.7.1
repeatability
<results of measurements> closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement

Note 1 to entry: These conditions are called "repeatability conditions".

Note 2 to entry: Repeatability conditions include the same measurement procedure, the same observer, the same measuring instrument used under the same conditions, the same location and repetition over a short period of time.

Note 3 to entry: Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results, such as standard deviation.

[SOURCE: GUM:1995, B.2.15]

3.4.7.2
reproducibility
<results of measurements> closeness of the agreement between the results of measurements of the same measurand carried out under changed conditions of measurements

Note 1 to entry: A valid statement of reproducibility requires specification of the conditions changed.

Note 2 to entry: The changed conditions may include principle of measurements, method of measurement, observer, measuring instrument, reference standard, location, conditions of use and time.

Note 3 to entry: Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results, such as standard deviation.

[SOURCE: GUM:1995, B.2.16]

3.4.8
Type B evaluation of measurement uncertainty
evaluation of a component of measurement uncertainty determined by means other than a Type A evaluation of measurement uncertainty

Note 1 to entry: Evaluation based on information, for example

— associated with authoritative published quantity values,

— associated with the quantity value of a certified reference material,

— obtained from a calibration certificate,

— related to drift,

— obtained from the accuracy class of a verified measuring instrument, and

— obtained from limits deduced through personal experience.

[SOURCE: VIM:2012, 2.29]

3.4.9
coefficient of variation
sample standard deviation expressed as a percentage of sample mean value

[SOURCE: ISO/ASTM 51707:2015, 3.1.4]

3.4.10
combined standard measurement uncertainty
standard measurement uncertainty that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model

Note 1 to entry: It is also referred to as "combined standard uncertainty".

Note 2 to entry: In case of correlations of input quantities in a measurement model, covariances must also be taken into account when calculating the combined standard measurement uncertainty.

[SOURCE: VIM:2012, 2.31]

3.4.11
coverage factor
k
number larger than one by which a combined standard measurement uncertainty is multiplied to obtain an expanded measurement uncertainty

[SOURCE: VIM:2012, 2.38]

3.4.12
expanded uncertainty
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

[SOURCE: GUM:2008, 2.3.5]

Annex A
(informative)

Methodology used in the development of the vocabulary

A.1 General

The specific character of the dosimetry for radiation processing concepts contained in this part of ISO 12749 requires the use of

— clear technical descriptions, and

— a coherent and harmonized vocabulary that is easily understandable by all potential users.

Concepts are not independent of one another, and an analysis of the relationships between concepts within the field of dosimetry for radiation processing and the arrangement of them into concept systems is a prerequisite of a coherent vocabulary. Such an analysis was used in the development of the vocabulary specified in this part of ISO 12749. Since the concept diagrams employed during the development process can be helpful in an informative sense, they are reproduced in A.3.

A.2 Concept relationships and their graphical representation

A.2.1 General

In terminology work, the relationships between concepts are based on the three primary forms of concept relationships indicated in this annex: the hierarchical generic (A.2.2), and partitive (A.2.3) and the non-hierarchical associative (A.2.4).

A.2.2 Generic relation

Subordinate concepts within the hierarchy inherit all the characteristics of the superordinate concept and contain descriptions of these characteristics which distinguish them from the superordinate (parent) and coordinate (sibling) concepts, e.g. the relation of mechanical mouse, optomechanical mouse and optical mouse to computer mouse.

Generic relations are depicted by a fan or tree diagram without arrows (see Figure A.1).

Example from ISO 704:2009, (5.5.2.2.1)

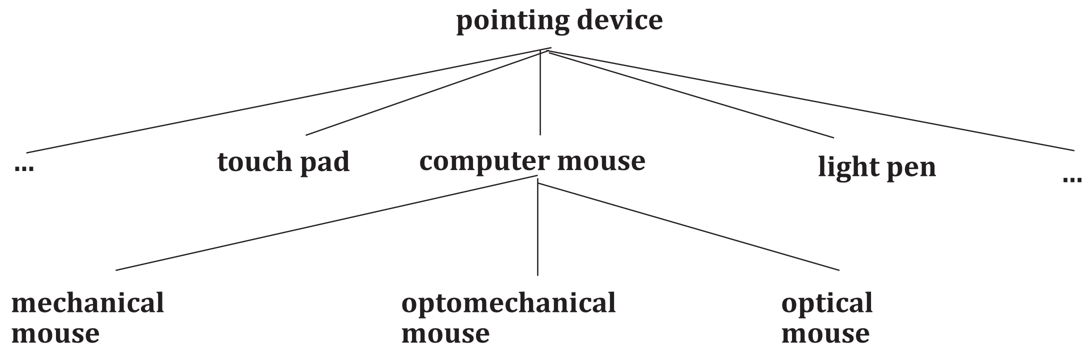


Figure A.1 — Graphical representation of a generic relation

A.2.3 Partitive relation

Subordinate concepts within the hierarchy form constituent parts of the superordinate concept, e.g. mouse button, mouse cord, infrared emitter and mouse wheel can be defined as parts of the concept optomechanical mouse. In comparison, it is inappropriate to define red cord (one possible characteristic of mouse cord) as part of an optomechanical mouse.

Partitive relations are depicted by a rake without arrows (see Figure A.2). Singular parts are depicted by one line, multiple parts by double lines.

Example from ISO 704:2009, (5.5.2.3.1)

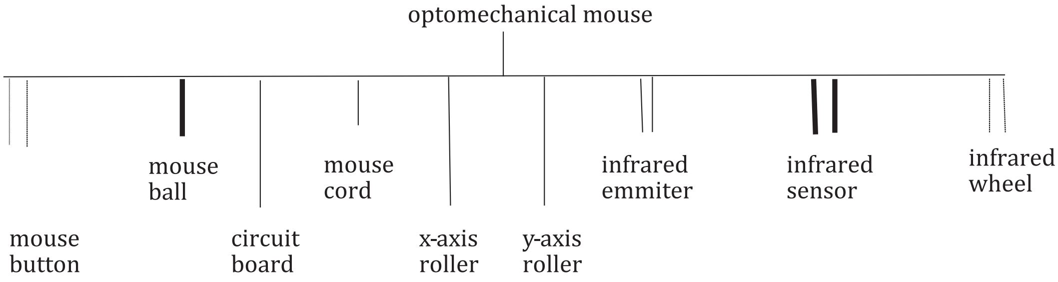


Figure A.2 — Graphical representation of a partitive relation

A.2.4 Associative relation

Associative relations cannot provide the economies in description that are present in generic and partitive relations but are helpful in identifying the nature of the relationship between one concept and another within a concept system, e.g. cause and effect, activity and location, activity and result, tool and function, material and product. Besides, associative relations are the most commonly encountered in terminology practical work, as they correspond to the concepts relations established in the real world.

Associative relations are depicted by a line with arrowheads at each end (see Figure A.3).

Example from ISO 704:2009, (5.6.2)

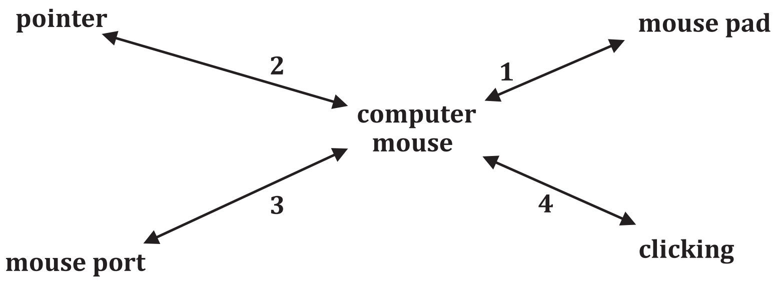


Figure A.3 — Graphical representation of an associative relation

A.3 Concept diagrams

Figure A.4 to Figure A.7 show the concept diagrams on which the thematic groups of the dosimetry for radiation processing vocabulary are based.

Notations in following diagrams show the position of each concept according to generic, partitive and associative relationships.

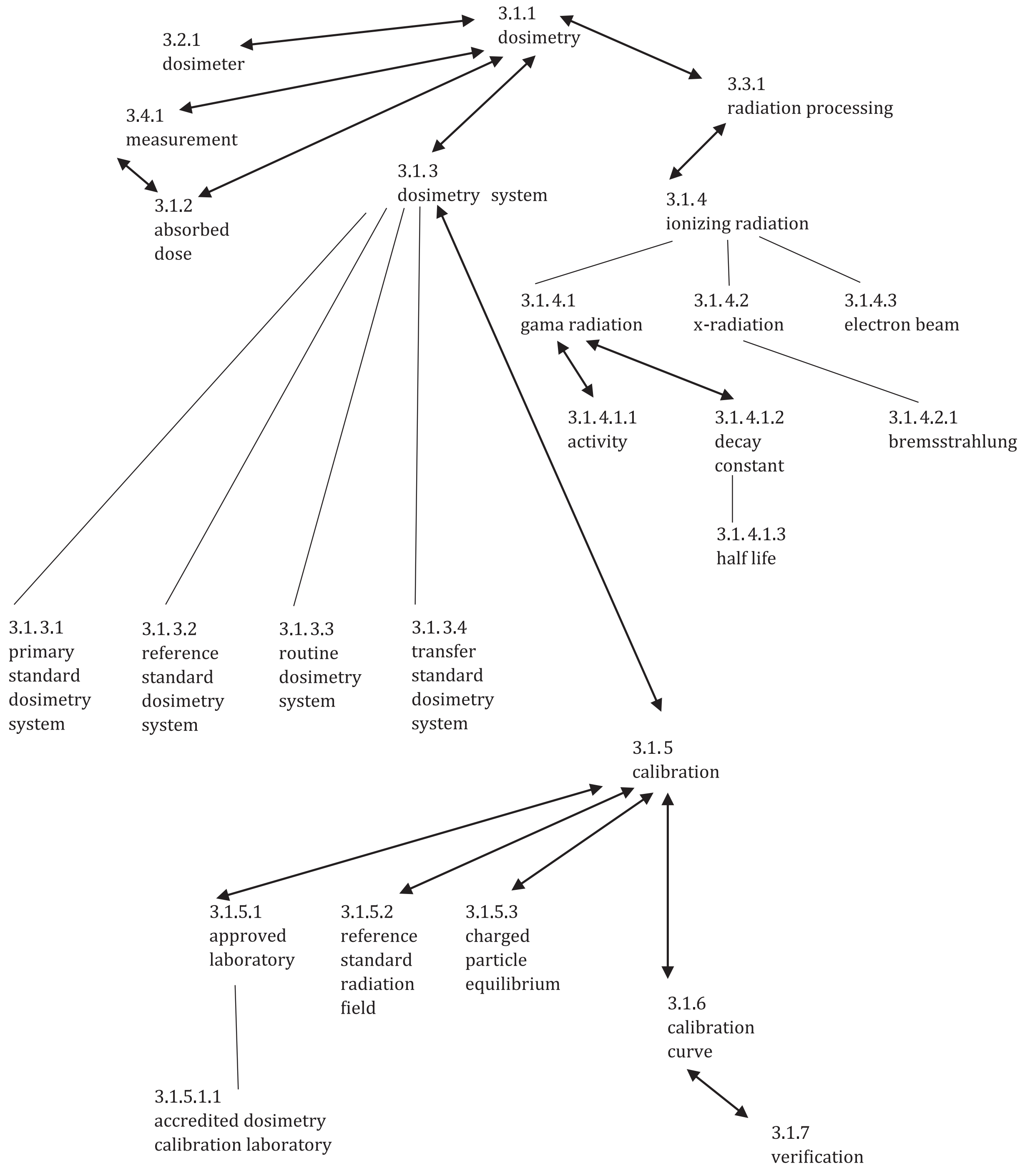


Figure A.4 — 3.1 Terms related to dosimetry, dosimetry systems and ionizing radiation

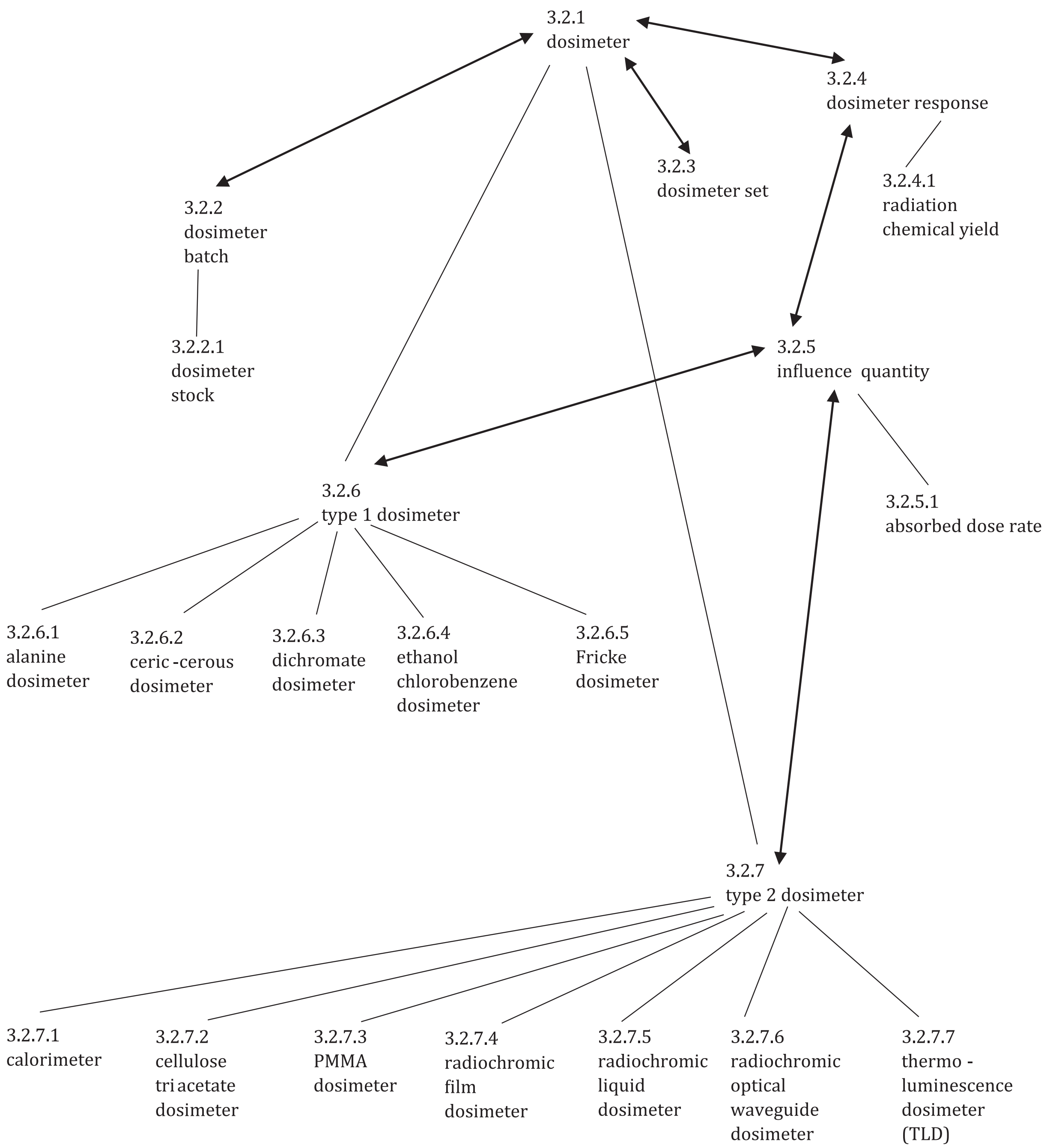


Figure A.5 — 3.2 Terms related to dosimeters

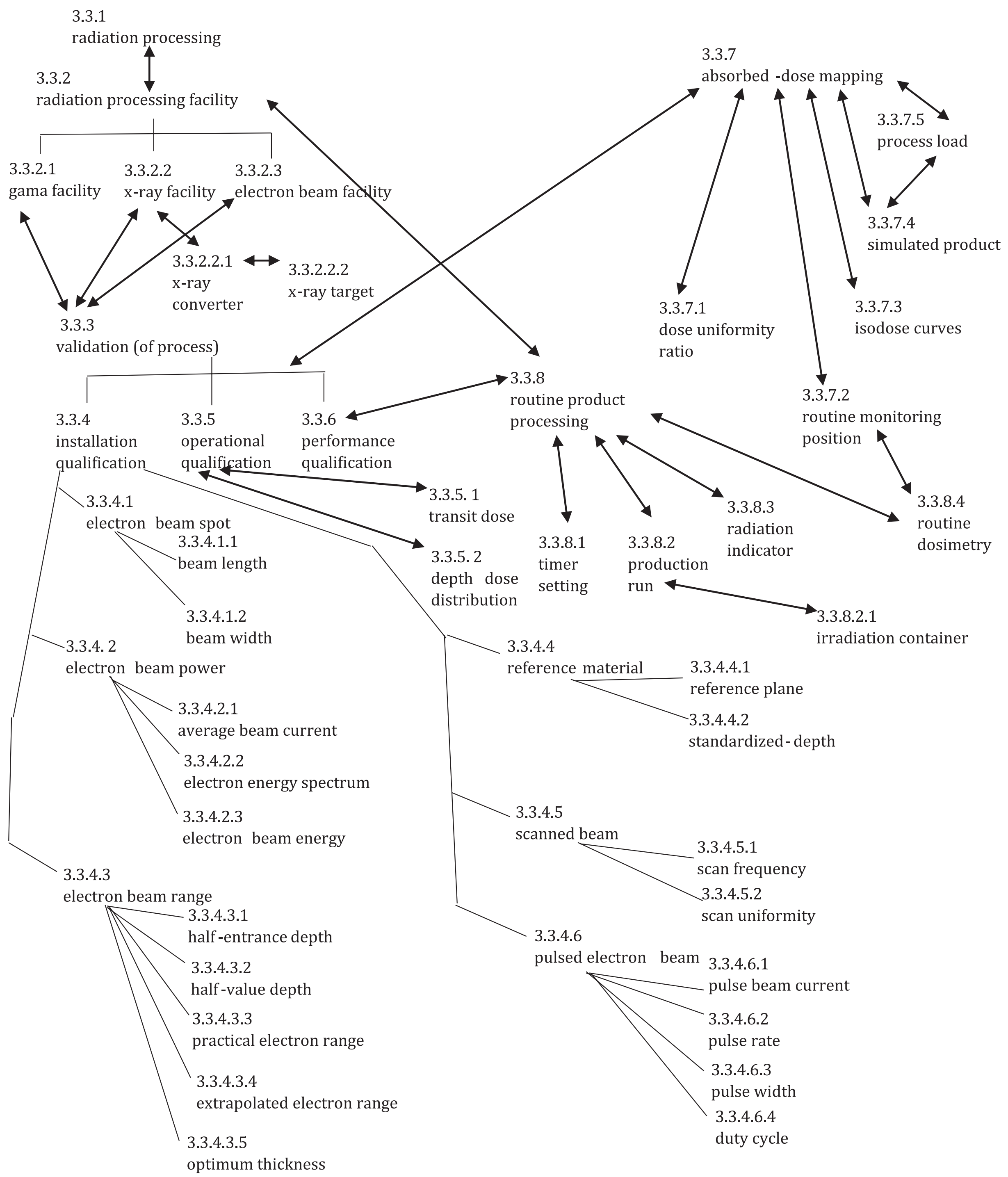


Figure A.6 — 3.3 Terms related to radiation processing

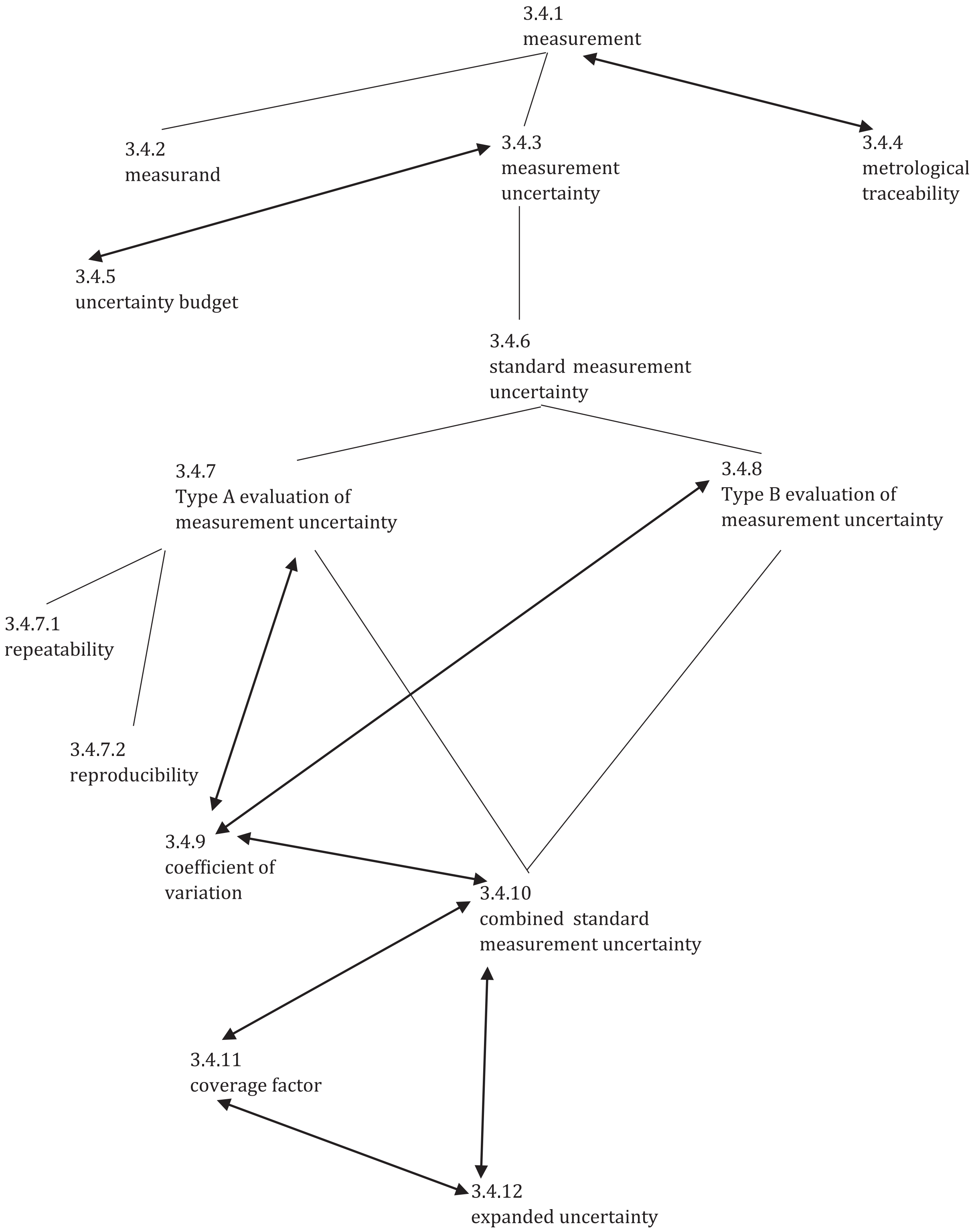


Figure A.7 — 3.4 Terms related to measurement

Bibliography

[1] ISO 704, *Terminology work — Principles and methods*

[2] ISO 921[1)], *Nuclear Energy – Vocabulary*

[3] ISO 1087-1, *Terminology work — Vocabulary — Part 1: Theory and application*

[4] ISO 10241-1, *Terminological entries in standards — Part 1: General requirements and examples of presentation*

[5] ISO/ASTM 51205:2009, *Practice for use of a ceric-cerous sulfate dosimetry system*

[6] ISO/ASTM 51261:2013, *Practice for calibration of routine dosimetry systems for radiation processing*

[7] ISO/ASTM 51275:2013, *Practice for use of a radiochromic film dosimetry system*

[8] ISO/ASTM 51276:2012, *Practice for use of a polymethylmethacrylate dosimetry system*

[9] ISO/ASTM 51310:2004, *Practice for use of a radiochromic optical waveguide dosimetry system*

[10] ISO/ASTM 51401:2013, *Practice for use of a dichromate dosimetry system*

[11] ISO/ASTM 51431:2005, *Practice for dosimetry in electron beam and X-ray (bremsstrahlung) irradiation facilities for food processing*

[12] ISO/ASTM 51538:2009, *Practice for use of the ethanol-chlorobenzene dosimetry system*

[13] ISO/ASTM 51539:2013, *Guide for use of radiation-sensitive indicators*

[14] ISO/ASTM 51540:2004, *Practice for use of a radiochromic liquid dosimetry system*

[15] ISO/ASTM 51607:2013, *Practice for use of the alanine-EPR dosimetry system*

[16] ISO/ASTM 51608:2015, *Practice for dosimetry in an X-ray (bremsstrahlung) facility for radiation processing at energies between 50 keV and 7.5 MeV*

[17] ISO/ASTM 51631:2013, *Practice for use of calorimetric dosimetry systems for electron beam dose measurements and dosimetery system calibrations*

[18] ISO/ASTM 51649:2015, *Practice for dosimetry in an electron beam facility for radiation processing at energies between 300 keV and 25 MeV*

[19] ISO/ASTM 51650:2013, *Practice for use of a cellulose triacetate dosimetry system*

[20] ISO/ASTM 51702:2013, *Practice for dosimetry in a gamma facility for radiation processing*

[21] ISO/ASTM 51707:2015, *Guide for estimation of measurement uncertainty in dosimetry for radiation processing*

[22] ISO/ASTM 51818:2013, *Practice for dosimetry in an electron beam facility for radiation processing at energies between 80 and 300 keV*

[23] ISO/ASTM 51900:2009, *Guide for dosimetry in radiation research on food and agricultural products*

[24] ISO/ASTM 51939:2013, *Practice for blood irradiation dosimetry*

[25] ISO/ASTM 51940:2013, *Guide for dosimetry for sterile insects release programs*

[26] ISO/ASTM 51956:2013, *Practice for use of a thermoluminescence-dosimetry system (TLD system) for radiation processing*

[27] ISO/ASTM 52116:2013, *Practice for dosimetry for a self-contained dry-storage gamma irradiator*

[28] JCGM 100:2008, GUM 1995, with minor corrections, Evaluation of measurement data – Guide to the expression of uncertainty in measurement

[29] JGCM 200:2012, VIM 2008, with minor corrections, International Vocabulary of Metrology – Bases and general concepts and associated terms

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

[31] ASTM E 1026:2013, *Practice for using the Fricke reference standard dosimetry system*

Alphabetical Index

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This Indian Standard has been developed from Doc No: CHD 30 (21927).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi