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

Part 2: Radiological protection

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Énergie nucléaire, technologies nucléaires et protection radiologique — Vocabulaire —

Partie 2: Radioprotection

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection.*

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This second edition cancels and replaces the first edition (ISO 12749-2:2013), which has been technically revised.

The main changes are as follows:

— Merging of the headings “Terms related to radiological monitoring” and “Terms related to measurement”.

— Addition of the heading “Terms related to emergency”.

A list of all parts in the ISO 12749 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document will provide terms and definitions for general nuclear energy concepts dealing with radiological protection and other related concepts. These concepts include protection for human health and the environment; radiation measurement methods and instruments; and the prevision or direct determination of the effect of ionizing radiation on the body.

Terminological data are taken from ISO standards developed and revised by ISO/TC 85/SC 2 and other technically validated documents such as the IAEA Basic Safety Standards, ISO/IEC 80000-10, ICRP, ICRU 51, ICRU 85a, VIM and BIPM.

Unambiguous communication of radiological protection concepts is crucial taking into account the relevant implications that may arise from misunderstandings with regard to equipment and materials involved in the standards dealing with this subject. The market of radiological protection is a heterogeneous one because it comprises equipment designed, built and operated along the safe practices defined by the radiological protection specialists. This market also includes nuclear reactors, nuclear fuel cycle, cosmic radiation, scientific research industrial applications, nuclear medicine and radiotherapy, and instruments to monitor both personnel and facilities and sites. In view of the foregoing, and the large number of people involved who have different levels of scientific and technical knowledge, there can be widely divergent understandings and assumptions about concepts. The results are poor communication, high risk of accidents and duplication of effort as different groups are going to define concepts according to their perspectives.

Conceptual arrangement of terms and definitions is based on concepts systems that show corresponding relationships among radiological protection concepts. In Annex A there is a detailed explanation of this subject. Such arrangement provides users with a structured view of this special sub domain within the nuclear energy sector and will facilitate common understanding of radiological protection 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. At the end of this document an alphabetical index shows the terms followed by their corresponding notation.

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

Part 2: Radiological protection

1 Scope

This document defines terms and definitions related to radiological protection concepts in the subject field of nuclear energy, nuclear technology and the different nuclear applications. It is intended to facilitate communication and promote common understanding.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 General terms related to radiological protection

3.1.1
radiological protection
radiation protection
protection of people and the environment from the harmful effects of exposure to ionizing radiation and the means for achieving such protection while allowing its beneficial uses

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — "and the environment" and "while allowing its beneficial uses" was added and the demonstrative pronoun "that" was replaced with "such protection".]

Note 1 to entry: People include workers, patients and members of the public.

Note 2 to entry: Environment includes biota, waters, lands, and air.

3.1.2
radiation source
source
apparatus, substance or installation, that can cause *radiation exposure* (3.3.1), by emitting ionizing radiation or releasing radioactive substances or materials

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3.1.3
radioactivity
stochastic process whereby nuclei undergo spontaneous random disintegration, usually accompanied by the emission of subatomic particles, or photons

[SOURCE: ISO 12749-1:2020, 3.1.1, modified — "random" was added in the definition.]

3.1.4
radioactive material
material designated in national law or by a regulatory body as being subject to regulatory control because of its *radioactivity* (3.1.3)

Note 1 to entry: This is the 'regulatory' meaning of radioactive, and should not be confused with the 'scientific' meaning of radioactive.

Note 2 to entry: The term radioactive substance is also used to indicate that the 'scientific' meaning of radioactive is intended, rather than the 'regulatory" meaning of radioactive suggested by the term radioactive material.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

Note 3 to entry: Whenever the term "radioactive substance" is mentioned in any definition or note to entry throughout this document, it covers the concept defined in 3.1.4**.**

3.1.5
radioactive contamination
contamination
radioactive substances on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable, or the process giving rise to their presence in such places

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — The parenthesis was deleted and replaced with commas.]

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3.1.6
airborne radioactive substance
radioactive substance dispersed in the air in the form of dusts, fumes, particulates, mists, vapours, or gases

[SOURCE: ISO 16639:2017, 3.4]

3.1.7
derived air concentration
DAC
derived limit (3.1.15) on the activity concentration in air of a specified radionuclide, calculated such that the reference individual, breathing air with constant contamination at the DAC with the breathing behavior of a reference worker for a working year, would receive an *intake* (3.3.4) corresponding to the annual intake for the radionuclide in question

Note 1 to entry: The parameter values recommended by the International Commission on Radiological Protection for calculating DACs are a breathing rate of 1,2 m^3/h and a working year of 2 000 h.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.1.8
air contamination area
area accessible to individuals where the measured or calculated *radioactivity* (3.1.3) concentrations of an *airborne radioactive substance* (3.1.6) exceeds or is likely to exceed the applicable criteria

[SOURCE: ISO 16639:2017, 3.5, modified — Addition of "or calculated", "activity" was changed to "radioactivity" and deletion of "national" from "to exceed the applicable national criteria".]

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3.1.9
decontamination
complete or partial removal of *radioactive contamination* (3.1.5) by a deliberate physical, chemical or biological process

Note 1 to entry: It is preferred that radioactive decontamination does not significantly change the characteristics of the surface.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — "the" was deleted from the definition and "radioactive" was added in the definition and the Note 1 to entry.]

3.1.10
justification
process of determining for an *emergency exposure situation* (3.3.26) or an *existing exposure situation* (3.3.27) whether a proposed protective action or remedial action is likely to be beneficial, whether the expected benefits to individuals and to society from introducing or continuing the protective action or remedial action outweigh the cost of such action and any harm or damage caused by the action

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — "overall" and "including the reduction in radiation detriment" were deleted.]

3.1.11
optimization (of protection and safety)
process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals, workers and members of the public, subject to exposure and the likelihood of exposure being as low as reasonably achievable, economic and social factors being taken into account (ALARA)

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

Note 1 to entry: For *medical exposures* (3.3.29) of patients, the optimization of protection and safety is the management of the radiation dose to the patient commensurate with the medical purpose.

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3.1.12
dose limit
value of the *effective dose* (3.1.24) or the *equivalent dose* (3.1.22) to individuals from *planned exposure situations* (3.3.21), or *doses* (3.1.16) to biota, that shall not be exceeded

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

3.1.13
dose constraint
prospective and source related value of individual *dose* (3.1.16) that is used in *planned exposure situations* (3.3.21) as a parameter for the *optimization of protection and safety* (3.1.11) for the source, and that serves as a boundary in defining the range of options in optimization

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.1.14
annual limit on intake
ALI
intake (3.3.4) by inhalation or ingestion or through the skin of a given radionuclide in a year by reference individual which would result in a *committed dose* (3.1.17) equal to the relevant *dose limit* (3.1.12)

Note 1 to entry: The annual limit on intake is expressed in units of activity.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

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3.1.15
derived limit
limit on a measurable quantity set, on the basis of a model, such that compliance with the derived limit may be assumed to ensure compliance with a primary limit

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.1.16
dose
measure of the energy deposited by radiation in a target

[SOURCE: IAEA. IAEA safety glossary, 2018 Edition. Vienna: IAEA, 2019. p. 278]

Note 1 to entry: When unspecified, dose refers to quantity of *absorbed dose* (3.1.20), measured in gray (1 Gy = 1 J/kg).

Note 2 to entry: Depending upon the context in which it is used, the generic term dose may also refer to *equivalent dose* (3.1.22), *effective dose* (3.1.24) or other dose-related quantities.

[SOURCE: ISO 12749-1:2020, 3.3.6]

3.1.17
committed dose
lifetime *dose* (3.1.16) expected to result from an *intake* (3.3.4)

[SOURCE: IAEA. Radiation protection and safety of radiation sources: international basic safety Standards. IAEA Safety Standards Series No, GSR Part 3. Vienna: IAEA, 2014. p. 471]

Note 1 to entry: For *radiological protection* (3.1.1) calculational purposes, lifetime is typically taken to be 50 years for adults and the time to the age of 70 years for intakes by children. (That is, for intakes by children, 70 years minus the age in years: so, for example 60 years for 10 years old child).

3.1.18
committed equivalent dose
$H_T(\tau)$
quantity $H_T(\tau)$, defined as:

$$H_T(\tau) = \int_{t_0}^{t_0+\tau} H_T(t)\,\mathrm{d}t$$

where t_0 is the time of *intake* (3.3.4), $H_T(t)$ is the *equivalent dose* (3.1.22) rate at time t in tissue or organ T and τ is the integration time elapsed after an intake of radioactive substances

Note 1 to entry: Where τ is not specified, it is taken to be 50 years for adults and the time to the age of 70 years for intakes by children. (That is, for intakes by children, 70 years minus the age in years: so, for example 60 years for a 10 years old child).

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.1.19
committed effective dose
$E(\tau)$
quantity $E(\tau)$, defined as:

$$E(\tau) = \sum_T w_T\, T_T(\tau)$$

where $H_T(\tau)$ is the *committed equivalent dose* (3.1.18) to tissue or organ T over the integration time τ elapsed after an *intake* (3.3.4) of radioactive substances and w_T is the *tissue weighting factor* (3.1.23) for tissue or organ T.

Note 1 to entry: Where τ is not specified, it will be taken to be 50 years for adults and the time to the age of 70 years for intakes by children.

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[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.1.20
absorbed dose
D
differential quotient of $\bar{\varepsilon}$ with respect to *m*, where $\bar{\varepsilon}$ is the mean energy imparted by ionizing radiation to matter of mass *m*:

$$D = \frac{\mathrm{d}\bar{\varepsilon}}{\mathrm{d}m}$$

[SOURCE: ISO 80000-10:2019, 10.81.1]

Note 1 to entry: The gray is a special name for joule J/kg and is to be used as the coherent SI unit for absorbed dose.

3.1.21
radiation weighting factor
w_R
dimensionless factor by which the organ or tissue *absorbed dose* (3.1.20) is multiplied to reflect the higher biological effectiveness of high-*LET* (3.1.25) radiations compared with low-LET radiations. It is used to derive the *equivalent dose* (3.1.22) from the absorbed dose averaged over a tissue or organ

Note 1 to entry: The radiation weighting factor is used to derive the equivalent dose from the absorbed dose averaged over a tissue or organ.

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4) modified — The definition was split into a definition and a Note to entry.]

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3.1.22
equivalent dose
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quantity $H_{T,R}$ defined as: $H_{T,R} = w_R D_{T,R}$ where $D_{T,R}$ is the *absorbed dose* (3.1.20) delivered by radiation type R averaged over a tissue or organ T and w_R is the *radiation weighting factor* (3.1.21) for radiation type R

Note 1 to entry: When the radiation field is composed of different radiation types with different values of w_R the equivalent dose is:

$$H_T = \sum_R w_R D_{T,R}$$

Note 2 to entry: The unit of equivalent dose is J/kg and its special name is sievert (Sv).

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278. modified — The definition was split into a definition and two Notes to entry.]

3.1.23
tissue weighting factor
w_T
multiplier of the *equivalent dose* (3.1.22) to an organ or tissue used for *radiological protection* (3.1.1) purposes to account for the different sensitivities of different organs or tissues to the induction of *stochastic effects* (3.2.5) of radiation

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

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3.1.24
effective dose
E
tissue-weighted sum of the *equivalent doses* (3.1.22) in all specified tissues and organs of the body, given by the expression:

$$E = \sum_{T} w_T \sum_{R} w_R D_{T,R} \text{ or } E = \sum_{T} w_T H_T$$

where H_T or w_R $D_{T,R}$ is the equivalent dose in a tissue or organ, T, and w_T is the *tissue weighting factor* (3.1.23)

Note 1 to entry: The unit for the effective dose is J/kg, and its special name is sievert (Sv).

Note 2 to entry: In order to evaluate the effective dose different anthropomorphic reference models are used; they can be adapted to sex and age.

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

3.1.25
linear energy transfer
LET
quotient of the mean energy, dE_Δ, lost by the charged particles due to electronic interactions in traversing a distance, d*l*, minus the mean sum of the kinetic energies in excess of Δ of all the electrons released by charged particles and d*l*:

$$L_\Delta = \frac{dE_\Delta}{dl}$$

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[SOURCE: ISO 80000-10:2019, 10.85]

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3.1.26
relative biological effectiveness
RBE
ratio of a dose of a low-*LET* (3.1.25) reference radiation to a dose of the radiation considered that gives an identical *biological effect* (3.2.1)

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

Note 1 to entry: The most used reference radiation is 250 keV x-rays.

3.2 General terms related to biological effect

3.2.1
biological effect
effect of ionizing radiation in living cells

EXAMPLE Erythema, damage to the haemopoietic system, and acute radiation syndrome.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.2.2
deterministic effect
tissue reaction
radiation induced health effect for which generally a threshold level of *dose* (3.1.16) exists above which the severity of the effect is greater for a higher dose

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

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3.2.3
acute radiation syndrome
acute radiation sickness
ARS
acute illness caused by irradiation of the entire body (or most of the body) by a high *dose* (3.1.16) of penetrating radiation in a very short period of time (usually a matter of minutes)

Note 1 to entry: The required conditions for Acute Radiation Syndrome (ARS) are:

— The radiation dose is large (i.e., greater than 0,7 Gy).

— The dose is usually from an external exposure.

— The radiation is penetrating.

— The entire body (or a significant portion of it) has received the dose.

[SOURCE: Brochure for Physicians, Acute Radiation Syndrome, Centers for Disease Control and Prevention, https://www.cdc.gov/nceh/radiation/emergencies/pdf/ars.pdf]

Note 2 to entry: With the assumption of the linear-non-threshold dose response for stochastic radiation effects (*LNT model* (3.2.8)) in the low dose range (< 100 mSv) and, under the conditions of the described concept of calculation, *effective dose* (3.1.24) is an additive quantity. At higher radiation doses, when tissue reactions (*deterministic effects* (3.2.2)) can occur, the *absorbed doses* (3.1.20) in organs and tissues have to be used for risk evaluation.

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

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3.2.4
threshold dose
dose estimated to result in only 1 % incidence of tissue reactions

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[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

3.2.5
stochastic effect
radiation induced health effect, whose probability of occurrence is greater for a higher radiation *dose* (3.1.16) and which severity, if it occurs, is independent of dose

Note 1 to entry: Stochastic effects may be *somatic effects* (3.2.9) or *hereditary effects* (3.2.10), and generally occur without a threshold level of dose. Examples include solid cancers and haematologic cancers (leukaemia and lymphoma).

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — "the probability of occurrence of which" was replaced with "whose probability of occurrence" and "leukemia" was replaced with "haematologic cancers".]

3.2.6
risk coefficient
lifetime risk or *radiation detriment* (3.2.7) assumed to result from exposure to unit *equivalent dose* (3.1.22) or *effective dose* (3.1.24)

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.2.7
radiation detriment
total harm that would eventually be incurred by a group that is subject to exposure and by its descendants as a result of the group's exposure to radiation from a source

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p.278]

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3.2.8
linear-non-threshold model
LNT model
dose-response model, which is based on the assumption that, in the low dose range, radiation *doses* (3.1.16) greater than zero will increase the risk of excess cancer and/or heritable disease in a simple proportionate manner

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4)]

Note 1 to entry: Low doses (below about 100 mSv) and low dose rates.

3.2.9
somatic effect
radiation induced health effect that occurs in the exposed individual

Note 1 to entry: Somatic effect includes effects occurring after birth that are attributable to exposure in uterus.

Note 2 to entry: *Deterministic effects* (3.2.2) are normally also somatic effects.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — The note was split in two and "stochastic effects may be somatic effects or hereditary effects" was deleted in the second one.]

3.2.10
hereditary effect
radiation induced health effect that occurs in a descendant of the exposed individual

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Note 1 to entry: The less precise term 'genetic effect' is also used, but hereditary effect is preferred.

Note 2 to entry: Hereditary effects are usually *stochastic effects* (3.2.5).

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

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3.3 Terms related to radiation exposure

3.3.1
radiation exposure
state or condition of being subject to ionizing radiation

Note 1 to entry: Exposure to ionizing radiation can be broadly divided into categories of exposure according to the status of the individual.

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278, modified — "irradiation" was replaced with "ionizing radiation".]

3.3.2
internal exposure
exposure to radiation from a source within the body

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278]

3.3.3
specific absorbed fraction
SAF
fraction of energy of that emitted as a specified radiation type in a source region, S, that is absorbed per unit mass of a target tissue, T

[SOURCE: 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4) modified — "that is absorbed in 1 kg" was replaced with "that is absorbed per unit mass".]

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3.3.4
intake
act or process of taking radionuclides into the body by inhalation or ingestion or through the skin

[SOURCE: IAEA. IAEA safety glossary: 2018 edition. Vienna: IAEA, 2019. p. 278 modified — The phrase "by the operator" was deleted.]

EXAMPLE Intake by injection of a radiopharmaceutical, via a wound, or any other possible exposure pathway.

3.3.5
absorption
transfer of material to blood regardless of mechanism, generally applied to dissociation of particles and uptake into blood of soluble substances and material dissociated from particles

[SOURCE: ISO 16638-1:2015, 3.1, modified — "movement" was changed to "transfer", "which generally" with "generally" and "the uptake" with "uptake".]

3.3.6
human alimentary tract model
HATM
biokinetic model for describing the movement of ingested materials through the human alimentary tract

[SOURCE: ICRP, 2015. Occupational Intakes of Radionuclides: Part 1. ICRP Publication 130. Ann. ICRP 44 (2), modified by that published in publication 100 (ICRP, 2006)]

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3.3.7
human respiratory tract model
HRTM
biokinetic model for describing the deposition, translocation, and *absorption* (3.3.5) of inhaled materials in the human respiratory tract

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[SOURCE: ICRP, 2015. Occupational Intakes of Radionuclides: Part 1. ICRP Publication 130. Ann. ICRP 44 (2), modified — The definition was split into a definition and a Note to entry. modified by that published in publication 66 (ICRP, 1994a) and updated in this report.]

3.3.8
reference bioassay function
set of tabulated values $m(t)$ predicted by a reference biokinetic model describing the time course of the activity in the body following an acute *intake* (3.3.4), at time t

Note 1 to entry: A retention function $m(t)$ represents the predicted activity of a radionuclide in the body, organ, or tissue at a time t after the intake.

3.3.9
retention fraction
ratio of the activity measured in the body, or in excreta, to the *intake* (3.3.4)

[SOURCE: NCRP Composite glossary. Bethesda: NCRP, 2011. p. 217]

3.3.10
excretion function
set of tabulated values $m(t)$ predicted by a reference biokinetic model describing the time course of the activity excreted in body fluids or waste, e.g., urine or faeces, following an acute *intake* (3.3.4) at time t

Note 1 to entry: An excretion function $m(t)$ represents the predicted activity of a radionuclide in a 24 h excreta sample at a time t after the intake.

[SOURCE: ICRP, 2015. Occupational Intakes of Radionuclides: Part 1. ICRP Publication 130. Ann. ICRP 44 (2), modified — The definition was split into a definition and a Note to entry.]

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