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# Radiological protection — Monitoring and dosimetry for internal exposures due to wound contamination with radionuclides

*Radioprotection — Surveillance et dosimétrie en cas d'exposition interne due à la contamination d'une plaie par radionucléides*

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# 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.

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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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

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# Introduction

In the course of their employment, radiation workers may be exposed to radioactive materials that could be incorporated into the body. Intakes of radionuclides need to be monitored to determine that any exposures are at expected levels. Internal doses resulting from intakes of radionuclides cannot be measured directly. Estimating the dose requires decisions to be made about the monitoring techniques and frequencies along with methodologies for dose assessment. The criteria governing the regimes of such a monitoring programme or for the selection of methods and frequencies of monitoring usually depends upon regulations, the purpose of the radiation protection programme, the probabilities of potential radionuclide intakes, and the characteristics of the materials handled.

For these reasons, ISO standards for monitoring programmes (ISO 20553[1]), laboratory requirements (ISO 28218), and dose assessment (ISO 27048[2]) have been developed and can be applied to many workplaces where internal contamination may occur. Their application for internal exposures due to wound contamination with radionuclides requires account to be taken of special aspects resulting from the type of wound and the associated specific biokinetics of radionuclides at the origin of contamination.

This document offers guidance for the design of a special monitoring programme and for dose assessment in the case of wound contamination with radionuclides. Recommendations of international expert bodies and international experience with the practical application of these recommendations in radiological protection programmes have been considered in the development of this document. Its application facilitates the exchange of information between authorities, supervisory institutions and employers.


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# Radiological protection — Monitoring and dosimetry for internal exposures due to wound contamination with radionuclides

## 1 Scope

This document specifies the requirements for personal contamination monitoring and dose assessment following wounds involving radioactive materials. It includes requirements for the direct monitoring at the wound site, monitoring of uptake of radionuclides into the body and assessment of local and systemic doses following the wound event.

It does not address:

— details of monitoring and assessment methods for specific radionuclides;

— monitoring and dose assessment for materials in contact with intact skin or pre-existing wounds, including hot particles;

— therapeutic protocols. However, the responsible entity needs to address the requirements for decontamination and decorporation treatments if appropriate.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 5725-3, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*

ISO 28218, *Radiation protection — Performance criteria for radiobioassay*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 99, ISO 5725-1, ISO 5725-2, ISO 5725-3 and the following 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 http://www.electropedia.org/

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**3.1**
**absorption**
movement of material into blood regardless of mechanism, generally applied to the *uptake* (3.32) into blood of soluble substances and material dissociated from particles

**3.2**
**activity**
number of spontaneous nuclear disintegrations per unit time

Note 1 to entry: The activity is stated in becquerels (Bq), i.e. the number of disintegrations per second.

**3.3**
**biokinetic model**
model describing the time course of *absorption* (3.1), distribution, metabolism and excretion of a substance introduced into the body of an organism

**3.4**
**clearance**
net effect of the biological processes by which radionuclides are removed from the body or from a tissue, organ or region of the body

**3.5**
**contamination**
*activity* (3.2) of radionuclides present on surfaces, or within solids, liquids or gases (including the human body), where the presence of such radioactive material is unintended or undesirable

**3.6**
**decision threshold**
value of the estimator of the measurand which, when exceeded by the result of an actual measurement using a given measurement procedure of a measurand quantifying a physical effect or quantity, it is decided that the physical effect or quantity is present

Note 1 to entry: Otherwise, this effect is assumed to be absent.

**3.7**
**decontamination**
complete or partial removal of radioactive *contamination* (3.5) by a deliberate physical, chemical, or biological process

**3.8**
**decorporation**
method aiming to accelerate the elimination from the body of an incorporated radionuclide

**3.9**
**detection limit**
smallest true value of the measurand which ensures a specified probability of being detectable by the measurement procedure

Note 1 to entry: With the decision threshold, the detection limit is the smallest true value of the measurand for which the probability of wrongly deciding that the true value of the measurand is zero is equal to a specified value, $\beta$, when, in fact, the true value of the measurand is not zero. The probability of being detectable is consequently $(1 - \beta)$.

Note 2 to entry: The terms detection limit and decision threshold are used in an ambiguous way in different standards (e.g. standards related to chemical analysis or quality assurance). If these terms are referred to one has to state according to which standard they are used.

**3.10**
**dose coefficient**
committed tissue equivalent dose per unit acute intake $h_T(\tau)$ or committed effective dose per unit acute intake $e(\tau)$, where $\tau$ is the time period in years over which the dose is calculated [e.g. $e(50)$]


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**3.11**
**effective dose**
sum of weighted *equivalent doses* (3.13) in all tissues and organs of the body

**3.12**
**committed effective dose**
sum of the products of the committed organ or tissue equivalent doses and the appropriate tissue weighting factors

Note 1 to entry: In the context of this document, the integration time is 50 years following any intake.

**3.13**
**equivalent dose**
product of the absorbed dose and the radiation weighting factor for the specific radiations at this point

**3.14**
**local dose**
*equivalent dose* (3.13) in a defined volume or area at the wound site

**3.15**
**systemic dose**
*committed effective dose* (3.12) excluding the local dose at the wound site

**3.16**
**event**
any unintended occurrence, including operating error, equipment failure or other mishap, the consequences or potential consequences of which are not or suspected not to be negligible from the point of view of protection or safety

**3.17**
**internal exposure**
exposure to radiation from a source inside the body

**3.18**
**intake**
<process> act or process of taking radionuclides into the body by inhalation, ingestion, *absorption* (3.1) through the skin or through wounds

**3.19**
**monitoring**
measurements made for the purpose of assessment or control of exposure to radioactive material and the interpretation of the results of such measurements

**3.20**
**incorporation monitoring**
*monitoring* (3.19) of radionuclides incorporated into the bodies of individual workers by measurement of the quantities of radioactive materials in the bodies of individual workers, or by measurement of radioactive material excreted by individual workers

**3.21**
**individual monitoring**
*monitoring* (3.19) by means of equipment worn by individual workers, by measurement of the quantities of radioactive materials in or on the bodies of individual workers, or by measurement of radioactive material excreted by individual workers

**3.22**
**special monitoring programme**
monitoring programme performed to quantify significant exposures following actual or suspected abnormal *events* (3.16)

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**3.23**
**quality assurance**
planned systematic actions necessary to provide adequate confidence that a process, measurement or service satisfy given requirements for quality such as those specified in a licence

**3.24**
**quality control**
part of *quality assurance* (3.23) intended to verify that systems and components correspond to predetermined requirements

**3.25**
**radiobioassay**
procedure used to determine the nature, *activity* (3.2), location or retention of radionuclides in the body by direct (in vivo) measurement or by indirect (in vitro) analysis of material excreted or otherwise removed from the body

**3.26**
**in vitro radiobioassay measurement**
analyses that include measurements of radioactivity present in biological samples taken from an individual

**3.27**
**in vivo radiobioassay measurement**
measurement of radioactive material in the human body utilizing instrumentation that detects radiation emitted from the radioactive material in the body

Note 1 to entry: Normally, the measurement devices are whole-body or partial-body (e.g., lung, thyroid) counters.

**3.28**
**responsible entity**
person, body or service that is in charge of the *monitoring* (3.19) and dosimetry

**3.29**
**retention function**
function describing the fraction of an intake present in a biological compartment (whole body, tissue, organ or excreta) after a given time has elapsed since the intake occurred

**3.30**
**time of measurement**
<in vitro analysis> time at which the biological sample (e.g. urine, faeces) is taken from the individual concerned

**3.31**
**time of measurement**
<in vivo measurements> time at which the *in vivo* measurement begins

**3.32**
**uptake**
translocation of material from deposition site [*wound* (3.33), lung, etc.] into blood and subsequently to systemic organs and tissues

**3.33**
**wound**
injury to the body in which the skin or other tissue is broken, cut, pierced, torn, scraped, burned, etc.


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