SLOVENSKI STANDARD
oSIST prEN ISO 15382:2024

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Radiološka zaščita - Postopki za nadzorovanje doze za očesne leče, kožo in okončine (ISO/DIS 15382:2024)

Radiological protection - Procedures for monitoring the dose to the lens of the eye, the skin and the extremities (ISO/DIS 15382:2024)

Strahlenschutz - Verfahren für die Überwachung der Dosis von Augenlinse, Haut und Extremitäten (ISO/DIS 15382:2024)

Radioprotection - Procédures pour la surveillance des doses au cristallin, à la peau et aux extrémités (ISO/DIS 15382:2024)

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Radiological protection — Procedures for monitoring the dose to the lens of the eye, the skin and the extremities

Radioprotection — Procédures pour la surveillance des doses au cristallin, à la peau et aux extrémités

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Contents

Page

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 document 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 of 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 www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 15382:2015), which has been technically revised.

The main changes are as follows:

— addition of neutron radiation;

— reference to up-to-date standards on reference radiation fields;

— clarification and extension of several procedures;

— extension of dosimetry procedures at nuclear power plants including indirect eye lens dosimetry.

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.

Introduction

The human body shall be protected from harmful effects of exposure to ionizing radiation, internally and externally. Protection from stochastic effects is provided by dose limits on the effective dose, while protection from tissue reactions (i.e., deterministic effects) is provided by dose limits for specific organs. The human skin shall be protected from external tissue reactions, such as erythema and ulceration. For the lens of the eye, there is the risk of radiation induced opacities and cataract at elevated exposures. To protect the skin of the whole body, the extremities, and the lens of the eye, separate dose limits are recommended by the International Commission on Radiological Protection (ICRP). These separate dose limits are needed because, in case of localized exposures, the organ equivalent doses to the skin and the lens of the eye could exceed these limits even if the effective doses were lower than the limit. Specific dosimetry is needed to monitor these doses and to assess compliance with applicable limits.

There are some situations where the correct assessment of the exposure of the skin, extremities, and lens of the eye can be challenging. In the nuclear sector, there can be exposure due to weakly penetrating radiation caused by unshielded open radioactive sources, or by working in glove boxes. These types of exposure can occur, in particular, in connection with contamination. Exposure to weakly penetrating radiation from radioactive noble gases in room air also shall be considered. In the medical field, doses to extremities and doses to the lens of the eye could occur during interventional procedures and in nuclear medicine.

Monitoring the extremities and the lens of the eye is not always straightforward, and many practical problems can arise for the application of monitoring in the workplace, due to issues such as geometry, resulting in an unsuitable monitoring situation. This document provides guidance on how and when this monitoring should be done, for all the different types of workplace fields. This document is directed to all who are involved in the dosimetry of the skin, extremities, and the lens of the eye; for example: radiation protection officers, regulators, workers, dosimetry services, etc.

Radiological protection — Procedures for monitoring the dose to the lens of the eye, the skin and the extremities

1 Scope

This document provides procedures for monitoring the dose to the skin, the extremities, and the lens of the eye. It gives guidance on how to decide if such dosemeters are needed and to ensure that individual monitoring is appropriate to the nature of the exposure, taking practical considerations into account.

This document specifies procedures for individual monitoring of radiation exposure of the skin of the body, extremities (skin of the hands, fingers, wrists, forearms including elbow, lower leg including patella, feet and ankles), and lens of the eye in planned exposure situations. It covers practices which involve a risk of exposure to photons in the range of 8 keV to 10 MeV, electrons and positrons in the range of 0,07 MeV to 1,2 MeV beta mean energies being equivalent to 0,22 MeV and 3,6 MeV beta maximum energy - in accordance to the ISO 6980 series, and neutrons in the range of thermal to 20 MeV.

This document gives guidance for the design of a monitoring program to ensure compliance with legal individual dose limits. It refers to the appropriate operational dose quantities, and it gives guidance on the type and frequency of individual monitoring and the type and positioning of the dosemeter. Finally, different approaches to assess and analyse skin, extremity, and lens of the eye doses are given.

It is not in the scope of this document to consider exposure due to alpha radiation fields.

NOTE 1 The requirements for the monitoring of the occupational exposure may be given in national regulations.

NOTE 2 Dose to the lens of the eye due to intake of tritium is not in the scope of this document. Moreover, the situation of the workers that work in contaminated atmosphere and can have alpha and/or radon eye lens dose is also not in the scope.

2 Normative references

The following documents are referred to in the text in such a way that some or all 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/TS 18090-1, *Radiological protection — Characteristics of reference pulsed radiation — Part 1: Photon radiation*

IEC 62387, *Radiation protection instrumentation - Dosimetry systems with integrating passive detectors for individual, workplace and environmental monitoring of photon and beta radiation*

IEC 60846-1, *Radiation protection instrumentation — Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation — Part 1: Portable workplace and environmental meters and monitors*

IEC 61526, *Radiation protection instrumentation — Measurement of personal dose equivalents $H_p(10)$ and $H_p(0,07)$ for X, gamma, neutron and beta radiations — Direct reading personal dose equivalent meters*

ISO 14146, *Radiological protection — Criteria and performance limits for the periodic evaluation of dosimetry services for external radiation*

IEC 61331-3, *Protective devices against diagnostic medical X-radiation – Part 3: Protective clothing, eyewear and protective patient shields*

IEC/TS 63050, *Radiation protection instrumentation - Dosemeters for pulsed fields of ionizing radiation*

ISO 4037-1, *Radiological protection — X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy — Part 1: Radiation characteristics and production methods*

ISO 4037-2, *Radiological protection — X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy — Part 2: Dosimetry for radiation protection over the energy ranges from 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

ISO 4037-3, *Radiological protection — X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy — Part 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence*

ISO 4037-4, *Radiological protection — X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy — Part 4: Calibration of area and personal dosemeters in low energy X reference radiation fields*

ISO 6980-1, *Nuclear energy — Reference beta-particle radiation — Part 1: Methods of production*

ISO 6980-2, *Nuclear energy — Reference beta-particle radiation — Part 2: Calibration fundamentals related to basic quantities characterizing the radiation field*

ISO 6980-3, *Nuclear energy — Reference beta-particle radiation — Part 3: Calibration of area and personal dosemeters and the determination of their response as a function of beta radiation energy and angle of incidence*

ISO 8529-1, *Neutron reference radiations fields — Part 1: Characteristics and methods of production*

ISO 8529-2, *Reference neutron radiations — Part 2: Calibration fundamentals of radiation protection devices related to the basic quantities characterizing the radiation field*

ISO 8529-3, *Neutron reference radiation fields — Part 3: Calibration of area and personal dosemeters and determination of their response as a function of neutron energy and angle of incidence*

IEC 61005, *Radiation protection instrumentation - Neutron ambient dose equivalent (rate) meters*

ISO 21909-1, *Passive neutron dosimetry systems — Part 1: Performance and test requirements for personal dosimetry*

ISO 21909-2, *Passive neutron dosimetry systems — Part 2: Methodology and criteria for the qualification of personal dosimetry systems in workplaces*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology 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/

4 Individual monitoring

4.1 Quantities

Skin and extremities monitoring involves the measurement of $H_p(0,07)$, the estimator of the equivalent dose to the skin.

Based on the International Commission on Radiation Units and Measurements (ICRU) definitions, lens of the eye monitoring involves the measurement of $H_p(3)$, the estimator of the equivalent dose to the lens of the eye. If the radiation field is well known, $H_p(3)$ can be estimated by the use of dosemeters type tested and calibrated in terms of other quantities, i.e., $H_p(0,07)$ and $H_p(10)$ (this latest being the estimator of the

personal dose equivalent), as in many cases they can provide an adequate estimate of the dose to the lens of the eye. Technical specifications of dosemeters are provided in Annex A. Guidance on which type of dosemeter can be used for the lens of the eye is provided in Annex B.

4.2 Dose limits and monitoring levels

The dose limits for skin, extremities, and lens of the eye for planned exposure situations are given in national regulations.

ICRP has given more recent recommendations on the dose limits (ICRP 103[1] and ICRP 118[2]) to avoid tissue reactions. Requirements equivalent to these recommendations are given by the International Atomic Energy Agency (IAEA) in the General Safety Requirements.[3] These recommendations from ICRP and IAEA constitute the basis for the recommendations in this document.

The ICRP recommends the following dose limits:

a) an equivalent dose limit to the skin of any extremity or whole body skin of 500 mSv in a year. The equivalent dose limits for the skin apply to the average dose over 1 cm^2 of the most highly irradiated area of the skin. In practice, an estimate of equivalent dose to the skin is a conservative estimate of equivalent dose to the extremities;

b) an equivalent dose limit to the lens of the eye of 20 mSv per year averaged over 5 consecutive years (100 mSv in 5 years) and of 50 mSv in any single year.

Individual monitoring is required to verify compliance with dose limits and area of skin dose averaging described in the national regulations. Extremity, skin, and lens of the eye monitoring should be undertaken for workers who have a reasonable probability of receiving per year an equivalent dose higher than 3/10th of one of the above-mentioned yearly limits[4],[5],[6].

The following monitoring levels are recommended:

a) for the extremities or the skin, monitoring should be undertaken if there is a reasonable probability to receive a dose greater than 150 mSv per year;

b) for the lens of the eye, monitoring should be undertaken if there is a reasonable probability to receive a dose in a single year greater than 15 mSv or in average over 5 consecutive years greater than 6 mSv per year.

NOTE National regulations can require monitoring levels different from the ones recommended in this subclause.

For dose levels expected to be lower than the recommended monitoring levels given above, a survey demonstrating that the levels are not exceeded should be sufficient.

The expected annual dose can be estimated via one or more of the methods given in Clause 5.

4.3 Monitoring period

The choice of the length of the monitoring period is related to the levels of the expected doses and to the relevant dose limit.

For doses above the monitoring level, a monitoring period of one month is recommended. For workers whose doses are likely to stay below the monitoring level, monitoring can be adapted. The monitoring period in the latter case can be longer, e.g. three months. Shorter monitoring periods can be chosen (weekly monitoring or even monitoring per procedure), when setting up new procedures, when optimizing working conditions or when there is a risk of potential high exposure.

Regulatory bodies and/or expert committees also can provide appropriate recommendations for monitoring periods.

4.4 Extremity, skin and lens of the eye monitoring

The dose to the extremities, skin, and the lens of the eye needs to be monitored in situations with non-homogeneous exposure conditions for which the whole-body monitoring does not provide an adequate estimate of the dose to the skin, the dose to the extremities, or the dose to the lens of the eye. Exposures can be significant when weakly penetrating radiation such as low energy photons e.g., below 15 keV, or beta radiation is present.

Hand or finger monitoring shall be considered for workplaces where extremities are particularly close to the radiation emitter or radiation beam, such as situations where radioactive sources are handled in, for example, research, nuclear medicine, and dismantling applications. Other important example where extremity monitoring can be necessary is nuclear medicine workplaces. Skin monitoring shall be considered for workplaces where skin is close to the radiation emitter or the beam. Also when there is a risk for skin contamination, monitoring should be considered. Examples of such situations are handling of contaminated components or unsealed radioactive sources.

Monitoring of the lens of the eye shall be specifically considered for workplaces where the eyes are particularly close to the radiation emitter (which can also be a source of scattered radiation) or the radiation beam (for example in interventional radiology, where monitoring the lens of the eye is necessary due to scatter radiation of the collimated) while the rest of the body can be protected by, e.g. a lead apron. Workers exposed in high energy beta fields can receive significant doses to the lens of the eye.

4.5 Uncertainties

An essential aspect of Quality Assurance (QA) in individual monitoring is assessing the quality of the measurement results. In the evaluation of the uncertainty, all knowledge of the dosemeter and evaluating system should be used, possibly in combination with information from the client/customer such as local exposure and storage conditions. The amount of effort put into the uncertainty should be realistic in view of its purpose in radiation protection.

International Commission on Radiation Units and Measurements (ICRU) also makes recommendations on the acceptable levels for total uncertainty in Report 47[7] which are broadly consistent with the ICRP recommendation in ICRP 75.[8] ICRU recommends for single measurements of the operational quantities that "…. in most cases, an overall uncertainty of one standard deviation of 30 % should be acceptable."

The expanded uncertainty (95 % coverage probability) for values of assessed annual dose values at or near the dose limit should be such that the dosemeter's response does not exceed 0,71 to 1,67-for photon radiation and high-energy beta radiation ($\bar{E}_{\text{beta}}$ > 0,2 MeV) and for neutron radiation for the quantity $H^*(10)$ and it should not exceed 0,5 to 2,0 for low-energy beta radiation ($\bar{E}_{\text{beta}} \leq$ 0,2 MeV) and for neutron radiation for the quantity $H_p(10)$ after all corrections have been made (ISO 14146:2024). This applies to values of effective dose, equivalent dose to a small area of skin, equivalent dose to lens of the eye or extremities, summed for all radiation types of the radiation field. For annual dose values significantly below the dose limit larger uncertainties are inevitable. Thus, the dosemeter's response should not exceed 0,3 to 2,3 (ISO 14146:2024).

For neutron radiations, the expanded uncertainty (95 % coverage probability) for values of assessed annual dose values at or near the dose limit should not exceed 0,5 to 2 (factor 2) after all corrections have been made ICRP 75[8].

It shall be recognized that different requirements on accuracy may be needed for an estimate of the equivalent dose at another part of the body than the position of the dosemeter, for example an estimate of the equivalent dose to the fingertips from a measurement of $H_p(0,07)$ several centimetres away[9].

4.6 Characteristics of radiation fields

Characterization of the radiation fields is a challenging step to determine the need for and the type of monitoring required.

Photon fields (X and gamma radiation) of any energy can interact and be deposited to the extremity tissues, i.e., skin and lens of the eye.