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Radiation protection — Criteria and performance limits for the periodic evaluation of processors of personal dosemeters for X and gamma radiation

Radioprotection — Critères et limites d'habilitation pour l'évaluation périodique des exploitants de dosimètres individuels pour les rayons X et gamma

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14146 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

Radiation protection — Criteria and performance limits for the periodic evaluation of processors of personal dosemeters for X and gamma radiation

1 Scope

The quality of a supplier of a personal-dosimetry service (referred to in this text as a "processor") depends on both the characteristics of the approved (type-tested) dosimetry system[1)] and the training and experience of the staff, together with the calibration procedures and quality assurance programmes.

This International Standard specifies the criteria and the test procedures to be used for the periodic verification of the performance of personal-dosemeter processors.

The performance verification may be carried out as a part of the approval procedure for the personal-dosimetry system or as an independent check to verify that the processor fulfils the performance requirements specified in an International Standard.

This International Standard applies to personal dosemeters for the assessment of external photon radiation with an energy between 10 keV and 9 MeV.

It covers all types of personal dosemeter needing laboratory processing (e.g. photographic-film, thermoluminescent or radiophotoluminescent dosemeters) and involving continuous measurements or measurements repeated regularly at fixed time intervals (e.g. several weeks, one month).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1757, *Personal photographic dosemeters*.

ISO 4037-1, *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 4037-3, *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*.

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1) If this International Standard is applied to a dosimetry system for which no approval (pattern or type test) has been provided, then in the following text approval or type test should be read as the technical data sheet provided by the manufacturer or as the data sheet required by the regulatory authority.

ICRP Publication 75, *General principles for the radiation protection of workers*, International Commission on Radiological Protection, Oxford, 1982.

ICRU Report 47, *Measurement of dose equivalents from external photon and electron radiations*, International Commission on Radiation Units and Measurements, Bethesda, 1992.

ICRU Report 51, *Quantities and units in radiation protection dosimetry*, International Commission on Radiation Units and Measurements, Bethesda, 1993.

IEC 61066:1991, *Thermoluminescence dosimetry systems for personal and environmental monitoring*.

3 Terms and definitions

For the purpose of this International Standard, the terms and definitions in ISO 1757 apply, plus the following:

3.1
approved dosemeter/dosimetry system
the personal dosemeter design and associated processing system that has been approved or authorized for use by the qualification body

3.2
control specimen
a personal dosemeter that will provide an estimate of any radiation dose received by the evaluation sample apart from that given by the irradiating laboratory

NOTE The control specimen provides a means of estimating and eliminating the contribution to the dose from natural background radiation and that received during transportation.

3.3
irradiating laboratory
a laboratory possessing radiation sources, calibration equipment and associated facilities (all traceable to national standards) that is able to irradiate dosemeters from the evaluation sample to a high degree of accuracy

3.4
personal dosemeter
one or more passive radiation detectors in a holder designed to be worn by a person for the purpose of estimating that individual's personal dose equivalent

3.5
processor
an organization that operates a personal-dosimetry system which includes the evaluation of the reading of dosemeters after their use and may include:

— providing the user with dosemeters;

— recording the results;

— reporting the results to the user

3.6
qualification body
an organization empowered by a governmental, regulatory or advisory agency to approve a processor or authorize the use of a dosimetry system

NOTE The qualification body may include the evaluating organization (see 3.8).

3.7
evaluation sample
a randomly or otherwise selected representative group of personal dosemeters used to evaluate the performance of a processor

NOTE The evaluation sample includes dosemeters that will be irradiated, remain unirradiated or serve as control specimens for the evaluation procedure.

3.8
evaluating organization
an organization that administers the performance evaluation of processors and assesses the results

NOTE The evaluating organization may include the irradiating laboratory.

4 Quantity measured

The quantity measured in the evaluation shall be the personal dose equivalent $H_p(d)$ as recommended by the ICRU in Report 47 and all irradiations shall be performed on ISO phantoms in accordance with ISO 4037-3, unless another quantity or other phantoms are specified by the national regulatory authority. Every dosimetry system shall be tested for all quantities — e.g. $H_p(10)$ or $H_p(0,07)$ — for which it is approved.

5 Frequency of evaluation

The performance evaluation is valid for a period stated by the qualification body. As a general rule, performance evaluations should be repeated at regular intervals, e.g. every one or two years. The period shall not be longer than three years.

The qualification body shall be notified of any significant change in the processor and/or in the dosimetry system after approval. The qualification body shall recommend a new evaluation when it believes that the modifications may change the performance of the processor and/or dosimetry system.

6 Test conditions

6.1 Standard test conditions and special handling conditions

The quantities which may influence the result, such as ambient temperature, relative humidity, photon radiation background and contamination by radioactive elements, shall conform to the standard test conditions as given in ISO 4037-3.

During the performance evaluation cycle, the evaluation sample, including the control specimen, shall be stored in environmental conditions that do not affect the measurement results obtained from the dosemeters.

The photon radiation background, expressed in terms of dose equivalent, accumulated during the performance evaluation cycle shall be less than 0,1 mSv.

When the control dosemeters are separated from the test dosemeters, the accumulated photon radiation background, expressed in terms of dose equivalent, shall be less than 0,01 mSv.

6.2 Photon radiation

The radiation sources shall be chosen from those specified in ISO 4037-1. Mixtures may also be used.

Testing shall include the range of photon energies and angles of incidence for which the dosimetry system has been approved. The choice of radiation qualities should be guided by the following considerations:

— attempts should be made to vary the radiation qualities used for repeated performance evaluations of the same dosimetry system or the same processor — one radiation quality should be left unchanged from evaluation to evaluation to assess the calibration control;

— the radiation qualities should be selected from the range of photon energies and angles of incidence for which the dosimetry system has been approved;

— the majority of radiation qualities and angles of incidence should be similar to the conditions found in routine radiation surveillance in order to prevent evaluations from emphasizing performance under extreme conditions.

Radiations of the "wide spectrum" series and the "high air kerma rate" series can be used only when their spectra ensure that most of the photons have energies within the range of photon energies for which the system has been approved.

6.3 Dose range

Testing shall be consistent with the dose range for which the system has been approved. The choice of the dose values should be guided by the following considerations:

— attempts should be made to vary the dose values used for repeated performance evaluations of the same dosimetry system or the same processor;

— the dose values should not exceed 1 Sv in order to ensure proper emphasis of the doses likely to be encountered in radiation protection;

— the dose values should not be less than 0,2 mSv, although a higher minimum dose value may be necessary to limit the error introduced by rounding the dosimetry results.

7 Performance limits

For each irradiated dosemeter, the ratio R between the measured dose value H_s and the conventional true value H_c, given by

$$R = \frac{H_s}{H_c}$$

shall meet the following condition:

$$\frac{1}{F}\left(1 - \frac{2H_0}{H_0 + H_c}\right) \leqslant R \leqslant F\left(1 + \frac{H_0}{2H_0 + H_c}\right)$$

where F is a factor to limit the maximum error of the dosimetry system at high dose values and H_0 is the lower limit of the dose range stated in 6.3. According to ICRP 75, F should be equal to 1,5.

A maximum of one-tenth of the dosemeters irradiated may exceed the above limits.

8 Operational procedures

8.1 Evaluation sample size

For each dosimetry system operated by the processor, at least 13 dosemeters shall be included in the evaluation sample. Three dosemeters shall be left unirradiated: two as control specimens for the measurement of the sum of the background dose and the dose during transport, the other as a spare in case of failure or breakage. The rest of the dosemeters shall be irradiated under the conditions stated in clause 6.

If the performance evaluation is carried out less frequently than once per year, then the minimum number of irradiated dosemeters shall be increased from 10 to 20.

8.2 Evaluation procedure

The processor shall certify that the dosemeters submitted for evaluation are representative of those supplied routinely to users.

To ensure that the processing of the evaluation dosemeters is carried out in exactly the same way as for the processor's normal customers, the evaluating organization may send a representative to select the dosemeters and to observe that no special effort is made in processing them.

The evaluating organization may obtain the dosemeters and communicate with the processor through a "dummy customer" and thus prevent the processor from handling the evaluation sample differently, which could influence the evaluation results.

8.3 Evaluation sequence

Evaluation is normally carried out in the following five steps:

a) the processor orders the evaluation or the evaluating organization initiates the evaluation with or without the processor's knowledge;

b) the evaluating organization prepares the evaluation schedule, obtains the dosemeters from the processor and arranges for irradiation of the dosemeters;

c) the processor processes the dosemeters using normal practices and reports the measured doses to the evaluating organization;

d) the evaluating organization analyses the evaluation results and submits them to the qualification body;

e) the evaluating organization maintains the documentation, which shall include the following information for each dosemeter:

   — a unique identifier for each dosemeter tested;

   — the energy and the angle of incidence of the radiation;

   — the values of the delivered and measured doses.

9 Certification

The qualification body shall inform the processor of the results.

The qualification body shall deem competent each processor which is able to show compliance with the performance limits stated in clause 7 for each dosimetry system examined.

The qualification body shall provide the processor with a certificate which specifies at least the dosimetry system and the period of validity.