INTERNATIONAL STANDARD

ISO 8769-2

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Reference sources for the calibration of surface contamination monitors —

Part 2:
Electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV

Sources de référence destinées à l'étalonnage de contrôleurs de contamination de surface —

Partie 2: Électrons d'énergie inférieure à 0,15 MeV *et photons d'énergie inférieure à* 1,5 MeV

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Contents

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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.

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.

International Standard ISO 8769-2 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

ISO 8769 consists of the following parts, under the general title *Reference sources for the calibration of surface contamination monitors*:

— *Part 1: Tritium sources*

— *Part 2: Electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV*

Annexes A and B are for information only.

Introduction

Radioactive contamination of surfaces may result from spilling, splashing or leakage from unsealed sources. This contamination may give rise to the following hazards to health:

a) external exposure to parts of the body in proximity to the surface;

b) internal exposure due to inhalation, ingestion and absorption or entry into the body, through wounds, of radioactive material released from the surface.

The need for effective monitoring of surface contamination has long been recognized [1, 2]. Surface contamination is quantified in terms of activity per unit surface area. This quantity activity per unit area is used to specify "derived limits", i.e. maximum limits of surface contamination. The principle of derived limits is contained within the recommendations of the International Commission on Radiological Protection (ICRP) [3,4]. The requirement for this part of ISO 8769 originated from the need for standard calibration sources in those International Standards dealing with the calibration of surface contamination monitors; in particular, the use of such calibration sources is called for in ISO 7503-1, ISO 7503-2 and ISO 7503-3.

Although regulatory documents refer to surface contamination in terms of activity per unit surface area, the response of monitoring instruments is related directly to the radiation emitted from the surface rather than to the activity contained upon or within the surface. The relationship between surface emission rate and activity is dependent on the decay scheme of the nuclide concerned, i.e. the number and types of radiation produced per decay or transition. In addition, the emission rate from a surface will depend on the absorptive and scattering properties of that surface and assumptions will need to be made as to the relationship between surface emission rate and activity. This is particularly important in the case of tritium where the nature of the source manufacture can produce emission to activity ratios that differ by one or more orders of magnitude. ISO 7503-1, ISO 7503-2 and ISO 7503-3 suggest factors that may be applied in the measurement of contaminated surfaces in the absence of more precise information.

In this part of ISO 8769, calibration sources are specified in terms of surface emission rate. Traceability of calibration sources to national standards is established by a system of transfer instruments.

Annex A discusses the particular problems associated with the measurement of nuclides decaying by electron capture and by isomeric transitions.

Reference sources for the calibration of surface contamination monitors — Part 2: Electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV

1 Scope

This part of ISO 8769 specifies the characteristics of reference sources for the calibration of surface contamination monitors that are traceable to national measurement standards. It relates to a series of sources emitting electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV for particular use in the efficiency calibration of monitors used for the measurement of radionuclides decaying by electron capture and by isomeric transitions; the electron-emitting sources will be of use for the calibration of monitors used for tritium and other low energy beta-emitters. This part of ISO 8769 does not describe the procedures involved in the use of these reference sources for the calibration of surface contamination monitors. Such procedures are specified in ISO 7503-2 and ISO 7503-3.

This part of ISO 8769 specifies reference radiation for the calibration of surface contamination monitors which take the form of adequately characterized large-area sources specified in terms of photon or electron surface emission rate. The measurement of these quantities shall be traceable to national standards. Since some of the sources proposed in this part of ISO 8769 include filters, they are to be regarded as sources of photons or electrons of a particular energy range and not as sources of a particular radionuclide. For example, a ^{241}Am source with the recommended filtration does not emit the alpha particles or characteristic low-energy L X-rays associated with the decay of the nuclide. A nominal value of the source activity may be required for regulatory purposes and is therefore included in this part of ISO 8769.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8769. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8769 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 921: —[1], *Nuclear energy — Vocabulary*

ISO 7503-1:1988, *Evaluation of surface contamination - Part 1: Beta-emitters (maximum beta energy greater than 0,15 MeV) and alpha-emitters.*

ISO 7503-2:1988, *Evaluation of surface contamination - Part 2: Tritium surface contamination.*

ISO 7503-3:—[2], *Evaluation of surface contamination - Part 3: Pure gamma emitters (isomeric transition and electron capture emitters), low energy beta-emitters (maximum beta energy less than 0,15 MeV).*

1) To be published. (Revision of ISO 921:1972)
2) To be published.

ISO 8769-1:—[2] *Reference sources for the calibration of surface contamination monitors — Part 1: Tritium sources.*

IEC 325:1981, *Alpha, beta and alpha-beta contamination meters and monitors.*

IEC 50(391):1975, *International Electrotechnical Vocabulary - Chapter 391: Detection and measurement of ionizing radiation by electric means.*

IEC 50(392):1976, *International Electrotechnical Vocabulary - Chapter 392: Nuclear Instrumentation - Supplement to Chapter 391.*

3 Definitions

For the purposes of this part of ISO 8769, the definitions given in ISO 921, IEC 50(391), IEC 50(392), and the following definitions apply.

NOTE — All uncertainties quoted in this part of ISO 8769 are at the level of one standard deviation; for overall uncertainty, see [5].

3.1 surface emission rate (of a source): Number of particles or photons of a given type above a given energy emerging from the face of the source or its window per unit time.

3.2 instrument efficiency (of a reference transfer instrument): Ratio between the instrument net reading (counts per unit time) and the surface emission rate of the source (particles or photons emitted per unit time) in a specified geometry relative to the source.

NOTE – The instrument efficiency depends on the energy of the radiations emitted by the source.

3.3 source efficiency: Ratio between the surface emission rate and the number of particles or photons of the same type created or released within the source per unit time.

NOTE- Source efficiency will be affected by self-absorption and backscatter.

3.4 self-absorption (of a source): Absorption of radiation which occurs within the material of the source itself.

3.5 traceability: Concept of establishing a valid calibration of a measuring instrument or measurement standard, by a step-by-step comparison with higher level standards up to an accepted or specified standard. In general, the concept of traceability implies eventual reference to an appropriate national or International Standard. (assuming documentation and use of approved laboratories).

3.6 uniformity: Uniformity of a surface with respect to a given property, expressed as a measured quantity per unit surface area, indicating the reproducibility of that property over the surface.

For the purpose of specifying the uniformity of a source with respect to surface emission rate per unit area, the source shall be considered as comprising a number of portions of equal area. The uniformity shall then be specified as the estimated standard deviation of measurements of the individual portions about the mean value for the whole surface expressed as a percentage of the mean. The area of the portions shall be 10 cm^2 or less.

Uniformity may be measured by inserting a masking plate between the source and the counter. The masking plate should have an aperture of appropriate size and should be thick enough to absorb particles and photons of the maximum energy emitted. Care should be taken to always use the same portion of the counter to minimize effects due its possible non-uniform response.

4 Traceability of reference sources

The following scheme is proposed to ensure that standards used in the calibration of surface contamination monitors shall be related to national measurement standards via a clearly defined traceability chain using reference sources and transfer instruments.

Reference sources are of two types:

Class 1 : Reference sources which shall have been calibrated directly in terms of surface emission rate at a national standards laboratory.

Class 2 : Reference sources which shall have been calibrated at an approved laboratory in terms of surface emission rate on a reference transfer instrument, the efficiency of which has been measured by calibration with a Class 1 reference source of the same radionuclide and of the same general construction using the same geometry.

National standards laboratories shall at their discretion provide the means whereby Class 1 reference sources of a specified range of radionuclides may be certified by them[3]. The surface emission rate of Class 1 reference sources shall be measured by absolute methods, or by using an instrument that has been calibrated using sources that have been measured absolutely. The activity of a Class 1 reference source shall have been measured by the manufacturer in a manner acceptable to the national standards laboratory.

Organizations with a requirement to type test surface contamination instruments need to have access to suitable Class 1 or 2 reference sources. Those with a requirement to calibrate such instruments shall have access to similar reference sources or to working sources. The purpose of a working source is to calibrate surface contamination monitors in the field; they are not to be confused with check sources which are only intended to test that a monitor is operating.

Organizations with a requirement to provide working sources for the routine calibration of their surface contamination monitoring instruments require access to a reference transfer instrument with which to calibrate such sources in terms of surface emission rate against a Class 1 or 2 reference source. Where the working source will be used either in a jig or under a particular geometry, the reference transfer instrument on which its emission rate is measured shall have been calibrated using a reference source under identical conditions and geometry; alternatively, the working source shall be removable from the jig so that it can be measured in the usual way. If only a few monitors need calibration or a high degree of accuracy is required, Class 1 or 2 reference sources may be used as working sources.

5 Specification of sources

5.1 General

It is recommended that sources be plane sources comprising a backing material with a given radionuclide permanently deposited on or incorporated into one face only. Photon-emitting sources shall incorporate filters in accordance with table 2.

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3) It is likely that some countries would accept as valid a Class 1 reference source that has been certified by the national standards laboratory of another country.

5.2 Class 1 reference sources

5.2.1 General requirements

In order to comply with the requirements specified in this part of ISO 8769, Class 1 reference sources shall be plane sources comprising conducting backing material with radioactivity deposited upon or incorporated into one face in such a manner as to minimize source self-absorption[4]. The active area shall be at least 10^4 mm^2; a recommended size is 100 mm x 100 mm.

Photon-emitting sources shall include the filtration specified in table 2. The filters should normally be an integral part of the source; they should not be removable. The area of the filter should be such that it extends for at least 10 mm beyond the active area of the source. The mass per unit area of the filter shall be within ± 10% of the specified value in table 2. The uniformity of the mass per unit area of the filter shall be better than ± 3%.

The backing material should be such as to minimize the contribution from backscattered photon radiation. The recommended backing material is aluminium of 3 mm thickness. The mass per unit area of the backing material shall be within ± 10% of the value detailed in the certificate. The uniformity of mass per unit area of the backing material shall be better than ± 3%. The backing material should extend beyond the active area to such an extent that the backscattering effect is uniform over the whole of the active area. It is recommended that the backing material should extend at least 10 mm beyond the active area of the source.

Sources shall be accompanied by a calibration certificate from a national standards laboratory giving the following information:

a) radionuclide and half-life;

b) construction of source assembly, with details of materials and thicknesses of the filter and the backing material;

c) the nature and thickness of the substrate on which the source was placed during the measurement of the surface emission rate and the depth of any intervening air gap;

d) surface emission rate, its uncertainty, uniformity and the reference date;

e) the nature of the emissions (e.g. electrons or photons);

f) active area of source;

g) for beta-emitters, the maximum beta particle energy, $E_{\beta max}$, of the radionuclide;

h) for photon-emitters, the approximate mean photon energy (see table 2) for which the surface emission rate applies (this must include the total Compton contribution),

i) source identification number;

j) class of source;

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4) Beta sources are intended to approximate as closely as practically possible to an ideal "thin" source [2] with respect to the activity itself. However it is acknowledged that for the low-energy beta-emitters proposed in [2] self-absorption will be far from negligible.

k) nominal activity.

NOTE — The certificating organization may not be able to measure or verify some of the information required above but can only repeat statements made by the manufacturer of the source. For example, if the filter cannot be detached from the source, the certificating organization cannot check the thickness and nature of the filter. The certificate therefore shall indicate that information which has been determined by the certificating organization and the source of the information which it has not directly determined.

The following information shall be clearly given on the source:

a) the radionuclide;

b) the source identification number;

c) nominal activity.

Manufacturers may give additional information.

5.2.2 Surface emission rate

The activity level of a Class 1 reference source of the preferred size shall be such as to give a surface emission rate of 2 000 s^{-1} to 10 000 s^{-1} in order to optimize between background, statistical and dead-time errors. The surface emission rate shall be determined by the national standards laboratory with an uncertainty which shall not exceed ± 5 % for beta-emitting sources and which shall not exceed ± 10% for photon-emitting sources.

NOTE — All uncertainties quoted in this part of ISO 8769 are at the level of one standard deviation; for overall uncertainty, see [5].

5.2.3 Uniformity

The uniformity of a Class 1 reference source with respect to surface emission rate shall be better than ± 10 %.

5.2.4 Recommended sources

Class 1 beta-emitting reference sources shall be prepared using the radionuclides listed in table 1. Class 1 photon-emitting reference sources shall be prepared using the radionuclides and filters listed in table 2. The filters specified are essential components of the sources; their purpose is described in annex A.