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Decontamination of radioactively contaminated surfaces — Testing of decontamination agents for textiles

Décontamination des surfaces contaminées par la radioactivité — Essai des agents de décontamination pour les textiles

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Contents

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~~www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see ~~www.iso.org/patents~~www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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~~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*.

This second edition cancels and replaces the first edition (ISO 9271:1992), which has been technically revised.

The main changes are as follows:

— the scope was rephrased and specified;

— opening to further applications;

— adding of symbols of the used measurands;

— improvement of structure;

— improvement in readability;

— adaption to current standards;

— adding a new form in the Annex with description the properties of the agents to be tested.

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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~~www.iso.org/members.html.

Introduction

Wherever radioactivity is used, there is a risk that textiles can become contaminated through contact with radioactivity in solution or airborne radioactivity.

It is normally necessary to remove this contamination to reduce the risk to staff from accidental intake of the radioactivity on the surface. The ease of decontaminating textiles is therefore an important parameter to consider when selecting materials to use, e.g., for facilities in the nuclear industry, in radionuclide laboratories or nuclear medicine facilities.

This document defines a quantitative method under objective conditions for testing the ease of decontamination of textile fabric. The method enables the comparison of different textile materials to support decisions on textiles for use in different applications.

For the test, radioactive solutions are deposited onto a sample of the material to being studied. The solutions contain radionuclides commonly found in nuclear industry (^{60}Co, ^{137}Cs or ^{134}Cs) and are in aqueous form. The textiles are then cleaned with detergents or cleansing agent, to be tested, and the residual activity on the textiles is measured to give a quantitative measure of the ease of decontamination.

Information obtained from the test method will enable the optimization of the choice of decontamination agents for textiles. This should result in lower demands for materials and water in laundry systems, with consequent savings in the cost of radioactive waste processing operations such as filtration, evaporation, solidification and disposal.

If the customer desires that suitability of their decontamination agents is to be tested with other radiochemicals containing alpha- and beta- emitting radionuclides, then other procedures and measurement techniques (like liquid-scintillation-counting) are to be used, which are not described in this document.

Comparative tests can be carried out with all possible combinations of textile materials and radionuclides in homogeneous solutions. lnorganic or organic solutions can be used and they should be based on a solvent which evaporates at room temperature. An assessment of the results of a series of comparative tests is made on the basis of the mean residual pulse rates.

In order to permit the general qualification of a decontamination agent as a single product, this document specifies a test and assessment method based on ^{60}Co and ^{137}Cs applied to internationally standardized cotton fabric. These two radionuclides were selected because they are the most important sources of contamination in the nuclear industry. The cotton fabric selected is the only reference material available in this field. The assessment of the result of a single test is made using an assessment table of final residual pulse rates based on inter-laboratory experiments.

Decontamination of radioactively contaminated surfaces — Testing of decontamination agents for textiles

1 Scope

This document applies to the testing of the decontamination of textiles, which are contaminated by radioactive materials.

The test method describes the technique to assess the efficiency of decontamination agents (see ISO 7503-~~[6,7]~~~~),~~-1 and ISO 7503-3).

This document applies to the testing of detergents, which may be used in aqueous solutions for the purpose of cleaning radioactively contaminated textiles.

The radionuclides used in this test are those commonly found in the nuclear industry (^{137}Cs, ^{134}Cs and ^{60}Co) in aqueous form. The test can also be adapted for use with other radionuclides and other chemical forms, depending on the customer requirements, if the solutions are chemically stable and do not damage the test specimen.

The test method is not suitable if the radionuclide emits low energy gamma rays, like ^{55}Fe, or low energy beta or alpha particles that are readily attenuated in the textile fabrics, or if the nuclide has a chemical or isotopic interaction with the detergent used in the method (e.g~~.~~, tritium which could be in several chemical forms).

The test method does not apply to the testing of the ability of detergents to remove non-radioactive dirt.

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.

~~<std>ISO 2174, *Surface active agents — Preparation of water with known calcium hardness*</std>~~

~~<std>~~ISO 2174, *Surface active agents — Preparation of water with known calcium hardness*

ISO 2267, *Surface active agents — Evaluation of certain effects of laundering — Methods of preparation and use of unsoiled cotton control cloth*~~</std>~~

~~<std>ISO 3819, *Laboratory glassware — Beakers*</std>~~

~~<std>ISO 6330, *Textiles — Domestic washing and drying procedures for textile testing*</std>~~

~~<std>ISO 11074, *Soil quality — Vocabulary*</std>~~

~~<std>ISO 80000-10, *Quantities and units — Part 10: Atomic and nuclear physics*</std>~~

~~<std>ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*</std>~~

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

ISO 3819, *Laboratory glassware — Beakers*

ISO 6330, *Textiles — Domestic washing and drying procedures for textile testing*

ISO 11074, *Soil quality — Vocabulary*

ISO 80000-10, *Quantities and units — Part 10: Atomic and nuclear physics*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 11074, ISO 80000-10, ISO/IEC Guide 98-3, ISO/IEC Guide 99 and the following apply.

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~~https://www.iso.org/obp

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

3.1 Terms and definitions

3.1.1
contamination
radioactive substances deposited on textiles

3.1.2
contaminated textile specimen
pieces of textile reference materials which are contaminated in a specified manner and which are used to determine the efficiency of decontamination agents

3.1.3
decontamination
complete or partial removal of radioactive *contamination* (3.1.1) by a deliberate physical, chemical, or biological process

[SOURCE: ISO 12749-3:2015, 3.7.11.2]

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

3.1.4
specific pulse rate
I_s
pulse rate caused in the measuring apparatus under given geometrical conditions by 1 ml of a contaminant solution

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Note 1 to entry: It is expressed in pulses per minute standardized on 1 ml of the contaminant solution. Pulse rates are derived from count rates applying dead time and background corrections.

3.1.5
residual pulse rate
I_r
pulse rate caused in the measuring apparatus under given geometrical conditions by the residual radionuclide on the tested side of the specimen after *decontamination* (3.1.3)

Note 1 to entry: I_r is expressed in pulses per minute.

3.1.6
mean residual pulse rate
$\overline{I_r}$
arithmetic mean of the residual pulse rate values obtained for the five test specimens contaminated by the same radionuclide

Note 1 to entry: It is expressed in pulses per minute.

3.1.7
standardized mean residual pulse rate
corrected value of the *mean residual pulse rate* (3.1.6)

Note 1 to entry: The correction factor is obtained by dividing a reference value of the specific pulse rate by the pulse rate of a contaminant solution used in the test.

Note 2 to entry: It is expressed in pulses per minute.

Note 3 to entry: The purpose of the correction factor is to compensate for variations in specific pulse rates of contaminant solutions used in different test laboratories.

3.1.8
final residual pulse rate
$I_{r,fin}$
arithmetic mean of the *standardized mean residual pulse rate* (3.1.7) obtained for ^{60}Co and ^{134}Cs or ^{137}Cs

Note 1 to entry: It is expressed in pulses per minute.

Note 2 to entry: is the pulse rate caused in the measuring apparatus under given geometrical conditions by the residual radionuclide on the tested side of the specimen after *decontamination* (3.1.3).

3.2 Symbols

For the purposes of this document, the following symbols apply.

A	Activity of the radionuclide [Bq]
A_S	Specific activity of the radionuclide [Bq·g^{-1}]
A_E	Activity of the radionuclide in the contaminant solution [Bq]
D_{min}	Distance between the centre point of the contaminated area and the edge of the sensitive detector cross-section [mm]

h	Distance of the contaminated test surface from the detector surface [mm]
m	Mass [g]
M	Molar mass [kg·mol^{-1}]
r	Final volume of contaminant solution [ml]
s	Activity concentration of stock solution [MBq·ml^{-1}]
q	Carrier concentration [mol·l^{-1}]
τ	Carrier concentration of the initial radionuclide solution [mol·l^{-1}]
t	Time [s]
$t_{1/2}$	Half-life [years]
u	Carrier concentration, in moles per litre [mol·l^{-1}]
V	Volume [l]

4 Principle

A specimen of the textile material is contaminated using a solution containing ^{60}Co and ^{137}Cs or ^{134}Cs. The emission from the specimen is measured using a detector. The specimen made from textile reference material is decontaminated using a solution of the decontamination agent under test. The emission is measured again and the result is compared to the result of the first measurement to quantify the ease of decontamination.

Separate contaminant solutions containing ^{60}Co and ^{137}Cs or ^{134}Cs (carrier concentration: 10^{-5} mol·l^{-1}; pH 4) are prepared. 100 µl samples of these solutions are counted using a large area radiation detector. The specific pulse rates of contaminant solutions are calculated using the results from the count.

Specimens of the material under test are first treated with the contaminant solutions over a defined area and subsequently decontaminated with demineralized water. The residual pulse rate, I_r, is determined by measuring the contaminated samples.

The standardized mean residual pulse rates $\overline{I_{r,n}}$ for each radionuclide are calculated. The arithmetic mean of the respective values for ^{60}Co and ^{137}Cs or ^{134}Cs (final residual pulse rate, $I_{r,fin}$) is used to assess the ease of decontamination by means of a classification which has been compiled empirically.

5 Apparatus

In addition to ordinary laboratory apparatus, the following equipment shall be used for testing the ease of decontamination of textiles.

5.1 Beakers

Two beakers, of the low-form type, having a capacity of 2 000 ml and in accordance with requirements given in ISO 3819.

5.2 Radiation detector

A detector and associated electronics are required for determining the pulse rate. Suitable detectors are solid scintillation (e.g. NaI(Tl), $LaBr_3$(Ce), $CeBr_3$) and semi-conductor types selective for gamma-ray (see Reference [8]).

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