IEC 62618

Edition 2.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radiation protection instrumentation – Spectroscopy-based alarming personal radiation detectors (SPRD) for the detection of illicit trafficking of radioactive material

Instrumentation pour la radioprotection – Détecteurs individuels spectroscopiques d'alarme aux rayonnements (SPRD) pour la détection du trafic illicite de matières radioactives

IEC 62618:2022-11(en-fr)

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

AVA Documents
Document Sharing Hub

Full document details: IEC 62618-2022

IEC 62618

Edition 2.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radiation protection instrumentation – Spectroscopy-based alarming personal radiation detectors (SPRD) for the detection of illicit trafficking of radioactive material

Instrumentation pour la radioprotection – Détecteurs individuels spectroscopiques d'alarme aux rayonnements (SPRD) pour la détection du trafic illicite de matières radioactives

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 13.280

ISBN 978-2-8322-6050-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

Documents
Document Sharing Hub

Full document details: IEC 62618-2022

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions, abbreviated terms and symbols, quantities and units 8
3.1 Terms and definitions 8
3.2 Abbreviated terms and symbols 10
3.3 Quantities and units 10
4 General test procedure 11
4.1 Standard test conditions 11
4.2 Uncertainties 11
4.3 Statistical fluctuations 11
4.4 Background radiation during testing 12
4.5 Operating parameters and set up 12
4.6 Radiation sources 12
4.7 Special nuclear material (SNM) and depleted uranium (DU) sources 12
4.8 Speed of moving sources including scaling 12
4.9 Functionality test and test acceptance range requirements 13
4.10 Neutron measurement requirements 15
5 General requirements 16
5.1 Basic information 16
5.2 Mechanical characteristics 16
5.3 Data output 17
5.4 User indications 17
5.5 Markings 17
5.6 Alarms 18
6 Radiation detection requirements 18
6.1 False alarm rate 18
6.2 Gamma alarm 18
6.3 Personal protection alarm 19
6.4 Relative intrinsic error 19
6.5 Detection of gradually increasing radiation levels 20
6.6 Over-range 20
6.7 Detection of neutrons (if provided) 20
6.8 Gamma response of neutron detector (if provided) 21
6.9 Identification of single radionuclides 22
6.10 Simultaneous radionuclide identification 23
6.11 Low-exposure rate identification 23
6.12 Over range characteristics for identification 23
7 Environmental requirements 24
7.1 Ambient temperature 24
7.2 Temperature shock 24
7.3 Relative humidity 24
7.4 Dust and moisture protection 25
8 Mechanical requirements 25
8.1 Vibration 25

AVA Documents
Document Sharing Hub
Full document details: IEC 62618-2022

8.2 Microphonics/Impact 26
8.3 Drop 26
9 Electromagnetic requirements 26
9.1 Electrostatic discharge (ESD) 26
9.2 Radio frequency (RF) 27
9.3 Radiated RF emissions 27
9.4 Magnetic fields 27
10 Documentation 28
10.1 Operation and maintenance manual 28
10.2 Test certificate 28
10.3 Declaration of conformity 28
Bibliography 29

Table 1 – Overview of IEC radiation protection instrumentation standards 6
Table 2 – Standard test conditions 11
Table 3 – Test results analysis 15
Table 4 – Identification acceptance criteria[1] 22

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIATION PROTECTION INSTRUMENTATION – SPECTROSCOPY-BASED ALARMING PERSONAL RADIATION DETECTORS (SPRD) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62618 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) making the standard consistent with the new standards for detection of illicit trafficking of radioactive material (see the Introduction);
b) creating unformed functionality test for all environmental, electromagnetic and mechanical tests and a requirement for the coefficient of variation of each nominal mean reading;
c) reference to IEC 62706 for the environmental, electromagnetic and mechanical test conditions;
d) adding information regarding climatic exposures.

Documents
Document Sharing Hub

Full document details: IEC 62618-2022

The text of this International Standard is based on the following documents:

Draft	Report on voting
45B/1011/FDIS	45B/1017/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

Documents
Document Sharing Hub

Full document details: IEC 62618-2022

INTRODUCTION

It is important to detect illicit and inadvertent movement of radioactive materials in the form of radiation sources and contaminated metallurgical scrap. Radioactive sources out of regulatory control, so-called “orphan sources”, have frequently caused serious radiation exposures and widespread contamination. Although illicit trafficking of nuclear and other radioactive materials is not a new problem, concern about a nuclear “black market” has increased particularly in view of its terrorist potential.

In response to the technical policy of the International Atomic Energy Agency (IAEA), the World Customs Organization (WCO), and the International Criminal Police Organization (Interpol) related to the detection and identification of special nuclear materials and security trends, nuclear instrumentation companies have developed and manufactured radiation instrumentation to assist in the detection of illicit movement of radioactive and special nuclear materials. This type of instrumentation is widely used for security purposes at nuclear facilities, border control checkpoints, and international seaports and airports.

To ensure that measurement results made at different locations are consistent, it is imperative that radiation instrumentation be designed to specifications based upon agreed performance requirements. IEC standards have been developed to establish performance requirements for personal radiation detectors, radiation portal monitors, highly sensitive gamma and neutron detection systems, spectrometric personal radiation detectors, and backpack-based radiation detection and identification systems. Table 1 contains a list of those standards.

Table 1 – Overview of IEC radiation protection instrumentation standards

Type of instrumentation	IEC number	Title of the standard
Body-worn	**62401**	Radiation protection instrumentation – Alarming Personal Radiation Devices (PRDs) for the detection of illicit trafficking of radioactive material
	62618	Radiation protection instrumentation – Spectroscopy-Based Alarming Personal Radiation Detectors (SPRD) for the detection of illicit trafficking of radioactive material
	62694	Radiation protection instrumentation – Backpack-type radiation detector (BRD) for the detection of illicit trafficking of radioactive material
Portable or hand-held	**62327**	Radiation protection instrumentation – Hand-held instruments for the detection and identification of radionuclides and for the estimation of ambient dose equivalent rate from photon radiation
	62533	Radiation protection instrumentation – Highly sensitive hand-held instruments for photon detection of radioactive material
	62534	Radiation protection instrumentation – Highly sensitive hand-held instruments for neutron detection of radioactive material
Portal	**62244**	Radiation protection instrumentation – Installed radiation portal monitors (RPMs) for the detection of illicit trafficking of radioactive and nuclear materials
	62484	Radiation protection instrumentation – Spectrometric radiation portal monitors (SRPMs) used for the detection and identification of illicit trafficking of radioactive material
Data format	**62755**	Radiation protection instrumentation – Data format for radiation instruments used in the detection of illicit trafficking of radioactive materials
Mobile system	**63121**	Radiation protection instrumentation – Vehicle-mounted mobile systems for the detection of illicit trafficking of radioactive materials

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

RADIATION PROTECTION INSTRUMENTATION – SPECTROSCOPY-BASED ALARMING PERSONAL RADIATION DETECTORS (SPRD) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

1 Scope

This document applies to Spectroscopy-based alarming Personal Radiation Detectors (SPRD). SPRDs detect and identify gamma radiation and may detect neutron radiation. SPRDs can be worn on a belt or in a pocket to alert the wearer of the presence of a radiation source. SPRDs provide search, similar to that of a Personal Radiation Device (PRD), and identification capability to identify radiation sources. They can discriminate between alarms caused by Naturally Occurring Radioactive Materials (NORM) or medical radionuclides and alarms from industrial sources or Special Nuclear Material (SNM).

This document establishes performance requirements and specifies general characteristics, general test conditions, radiological, climatic, mechanical, and electromagnetic characteristics. This document also provides test methods that are used to determine if an SPRD meets the stated requirements.

This document does not apply to the performance of radiation protection instrumentation which is covered in IEC 61526 and IEC 60846-1. SPRDs are not intended for accurate measurement of personal ($H_p(10)$) or ambient ($H^*(10)$) dose equivalent (rate).

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.

IEC 60050-395:2014, *International Electrotechnical Vocabulary (IEV) – Part 395: Nuclear instrumentation – Physical phenomena, basic concepts, instruments, systems, equipment and* detectors
IEC 60050-395:2014/AMD1:2016
IEC 60050-395:2014/AMD2:2020

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 62706, *Radiation protection instrumentation – Recommended climatic, electromagnetic and mechanical performance requirements and methods of tests*

IEC 62755, *Radiation protection instrumentation – Data format for radiation instruments used in the detection of illicit trafficking of radioactive materials*

IEC TR 62971:2015, *Radiation instrumentation – Radiation sources used in illicit trafficking detection standards – Guidance and recommendations*

UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations*

ICRU report 39, *Determination of Dose Equivalents Resulting from External Radiation Sources*

AVA Documents
Document Sharing Hub

Full document details: IEC 62618-2022

ICRU report 47, *Measurement of Dose Equivalents from External Photon and Electron Radiations*

3 Terms and definitions, abbreviated terms and symbols, quantities and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-395, as well as the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
acceptable identification
correct identification
when an instrument correctly identifies only the radionuclides present

3.1.2
accuracy of measurement
closeness of the agreement between the result of a measurement and the conventionally true value of the measurand

Note 1 to entry: "Accuracy" is a quantitative concept.

Note 2 to entry: The term precision should not be used for "accuracy".

[SOURCE: IEC 60050-395:2014/AMD2:2020, 395-16-14]

3.1.3
alarm
audible, visual, or other signal activated when the instrument reading exceeds a pre-set value or falls outside of a pre-set range

3.1.4
alarm criteria
condition that causes an instrument to alarm

3.1.5
background radiation level
radiation field in which there are no external radioactive sources present other than those in the natural background at the location of the measurements

3.1.6
confidence indication
indication provided by the instrument to assess the reliability assigned to the validity of the identification. For each identified radionuclide, the instrument indicates the likelihood of its correct identification.

3.1.7
coefficient of variation
ratio of the standard deviation σ to the arithmetic mean $\overline{x}$ of a set of n measurements x_i given by the following formula:

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

$$COV = \frac{s}{\overline{x}} = \frac{1}{\overline{x}}\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2}$$

3.1.8
conventionally true value of a quantity
value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

Note 1 to entry: "Conventionally true value of a quantity" is sometimes called assigned value, best estimate of the value, conventional value or reference value.

Note 2 to entry: A conventionally true value is, in general, regarded as sufficiently close to the true value for the difference to be insignificant for the given purpose. For example, a value determined from a primary or secondary standard or by a reference instrument, may be taken as the conventionally true value.

3.1.9
false alarm
alarm not caused by an increase in radiation level over background conditions

3.1.10
functionality test
procedure to measure potential changes in the instrument response, such as drift in energy calibration or sensitivity

3.1.11
influence quantity
quantity that is not the measurand but that affects the result of the measurement

Note 1 to entry: For example, temperature of a micrometer used to measure length.

3.1.12
precision
degree to which repeated measurements under unchanged conditions show the same result (also called reproducibility or repeatability)

3.1.13
radioactive material
material containing one or more constituents exhibiting radioactivity

Note 1 to entry: For the purpose of this document, radioactive material includes special nuclear material.

3.1.14
reference point of an instrument
mark on the equipment at which the instrument is positioned for the purpose of calibration

Note 1 to entry: The point from which the distance to the source is measured.

Note 2 to entry: The reference point for calibration is also used as reference point for testing.

3.1.15
reference source
radioactive secondary standard source for use in calibration of the measuring instrument

Note 1 to entry: In this document, reference sources for calibration are used for testing.

3.1.16
relative intrinsic error
difference between the instrument's reading, M, and the conventionally true value, CTV, of the quantity being measured divided by the conventionally true value when subjected to a specified reference quantity under specified reference conditions

AVA Documents
Document Sharing Hub

Full document details: IEC 62618-2022

$$\varepsilon_{REL} = \frac{M - CTV}{CTV}$$

3.1.17
safety alarm
audible and visual signal for detection of high radiation levels, which requires immediate radiation safety measures

3.1.18
source indication alarm
audible and/or visual signal to indicate the presence of a radiation source

3.1.19
standard test conditions
range of values of a set of influence quantities under which a test, calibration or measurement of response is carried out

3.1.20
performance test
environmental, mechanical or electrical test taken from IEC 62706

[SOURCE: IEC 60050-395:2014/AMD2:2020, 395-14-9]

3.2 Abbreviated terms and symbols

CISPR	Comité International Spécial des Perturbations Radioélectriques (Special International Committee on Radio Interference)
CLYC	Cs_2LiYCl_6:Ce
COV	coefficient of variation
CZT	cadmium zinc telluride
DU	depleted uranium
ESD	electrostatic discharge
HDPE	highly-density polyethylene
HEU	highly-enriched uranium
ICRU	International commission on radiation units and measurements
NORM	naturally occurring radioactive material
PMMA	polymethyl methacrylate
RF	radio frequency
SNM	special nuclear material
SPRD	spectroscopy based personal radiation detector
WGPu	weapons-grade plutonium

3.3 Quantities and units

In this document, units of the International System (SI) are used[1]. The definitions of radiation quantities are given in IEC 60050-395.

[1] International Bureau of Weights and Measures: The International System of Units, 8th edition, 2006.

AVA Documents Document Sharing Hub

The following units may also be used:

– for energy: electron-volt (symbol: eV), 1 eV = 1,602 × 10^{-19} J;
– for time: years (symbol: y), days (symbol: d), hours (symbol: h), minutes (symbol: min);
– for temperature: degrees Celsius (symbol: °C), 0 °C = 273,15 K.

Multiples and submultiples of SI units are used, when practicable, according to the SI system.

4 General test procedure

4.1 Standard test conditions

Except where otherwise specified, the tests described in this document should be performed under the standard test conditions given in Table 2. The ambient temperature, relative humidity, and atmospheric pressure shall be recorded during testing.

Table 2 – Standard test conditions

Influence quantity	Standard test conditions
Ambient temperature	18 °C to 25 °C
Relative humidity	≤ 75 %
Atmospheric pressure	70 kPa to 103,3 kPa
Gamma radiation background	Ambient dose equivalent rate less than or equal to 0,15 μSv•h^{-1} Natural conditions without the presence of man-made emitters
Neutron background	Natural conditions without the presence of man-made emitters

NOTE SPRDs are typically used in non-radiological areas, e.g., shipping ports and border locations. Man-made radiological materials such as radiation sources are not expected to be present in these areas. Non-radiological areas are expected to be used when testing SPRDs.

4.2 Uncertainties

Unless otherwise stated for a specific quantity, the uncertainties for measurable quantities should not exceed 15 % with a coverage factor of k = 1, except for background radiation measurements that may exceed this value.

4.3 Statistical fluctuations

For tests involving the use of radioactive sources to verify susceptibility to a climatic, electromagnetic, or mechanical condition (Clauses 7, 8, and 9), the radiation field produced by the sources to verify an SPRD's response shall be adjusted to reduce the magnitude of the statistical fluctuations.

For measurements without sources (i.e., at the level of background radiation), the SPRD is observed in order to verify that alarms and spurious indications are not produced by an influence quantity (e.g., temperature, humidity, RF, impact, vibration), as readings are expected to display large fluctuations.

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

4.4 Background radiation during testing

Testing shall be performed in an area having a radiation background as defined in Table 2. The background shall be measured prior to testing and monitored during testing. A background spectrum shall also be acquired using a high-resolution gamma-ray spectroscopy (e.g., high-purity germanium [HPGe]) detector to ensure that only naturally-occurring radionuclides (e.g., ^{40}K, ^{232}Th series,^{238}U series) are present in the testing area. The neutron background should be measured unless it can be confirmed that no neutron sources are in the test area. The elevation of the test location shall be recorded.

4.5 Operating parameters and set up

SPRDs shall be set up based on the manufacturer's specifications. Operating parameters such as alarm settings should remain unchanged throughout the test.

For testing purposes, the reference point of the SPRD is the centre of the front face unless otherwise defined by the manufacturer. If the SPRD requires a background measurement, it shall be allowed to acquire the data in a manner specified by the manufacturer prior to the start of a test.

4.6 Radiation sources

For alarm tests, an ambient dose equivalent rate level of 0,5 μSv•h^{-1} (-0 %, +20 %) above background for ^{241}Am, ^{137}Cs, and ^{60}Co is used. For identification tests, an ambient dose equivalent rate level of 1,0 μSv•h^{-1} (-0 %, +20 %) above background for DU, HEU, WGPu, ^{137}Cs, ^{60}Co, ^{67}Ga, ^{131}I, ^{99m}Tc, ^{201}Tl is used. The ambient dose equivalent rate can be calculated or measured and shall be documented.

^{252}Cf, ^{244}Cm or ^{248}Cm is the reference source for neutron alarm testing. The source shall have a neutron emission rate of 20 000 s^{-1} (−10 %, +40 %) and, unless otherwise stated, be surrounded by a high-density polyethylene (HDPE) moderator (density between 0,93 g·cm^{-3} to 0,97 g·cm^{-3}). The HDPE moderator can be spherical or cylindrical and shall have a wall thickness of 4 cm on all sides and an inner cavity no larger than 3 cm in diameter or length. The source shall be positioned at the centre of the cavity.

The medical radionuclides (^{99m}Tc, ^{67}Ga, ^{131}I, and ^{201}Tl) shall be surrounded by 8 cm of PMMA for test purposes as a means to represent in-vivo conditions, the ambient dose equivalent rate is measured outside the PMMA.

4.7 Special nuclear material (SNM) and depleted uranium (DU) sources

Different masses, shapes, and forms may be used for testing as long as the required ambient dose equivalent rate is obtained. For this document, highly-enriched uranium (HEU) has an enrichment that is ≥90 % ^{235}U, depleted uranium (DU) has a ^{235}U abundance of 0,2 % to 0,4 %, and weapons-grade plutonium (WGPu) has a composition of ≤6,5 % ^{240}Pu and >93 % ^{239}Pu.

The 60 keV ^{241}Am emission rate shall not be more than a factor of 10 greater than the 375 keV ^{239}Pu emission rate. The shielding shall reduce the 60 keV ^{241}Am emission rate so that it is not more than a factor of 10 greater than the 375 keV ^{239}Pu emission rate.

NOTE The factor 10 is determined from source material measurements.

4.8 Speed of moving sources including scaling

For dynamic tests, the source or SPRD shall be moved in a configuration that provides no shielding around the source other than that required for the specific test. The source speed shall be 1 m·s^{-1} when tested at a distance of closest approach of 1,5 m, unless otherwise required in a test.

AVA Documents Document Sharing Hub

Full document details: IEC 62618-2022

During the dynamic tests, there shall be a 10 s minimum delay, unless otherwise stated, between each trial with the source positioned at a distance where it does not affect the background surrounding the SPRD. Shielding can be used to reduce the background at the SPRD.

To achieve the required ambient dose equivalent rate at the test point, the distance of closest approach, d, can be adjusted within a range of 0,5 m and 3 m. If the distance of closest approach, d_0, is modified then the passage speed, v, shall be adjusted to:

$$v = v_0 \frac{d}{d_0} \tag{1}$$

where

v_0 = 1 m·s^{-1}, and

d_0 = 1,5 m.

4.9 Functionality test and test acceptance range requirements

4.9.1 General requirements

For most tests in Clauses 7, 8, and 9, the SPRD functionality is evaluated prior to and after the test and in some cases during the test. The response of the SPRD after the test (post-test measurement) is compared with the response prior to the test (pre-test measurement).

When applicable, depending on the test method, the source shall be kept in the same location throughout the duration of the test (pre-test measurements through post-test measurements). Otherwise, if the source needs to be removed during the test, to account for any possible bias introduced by the source placement, the source shall be placed at the same location used for the pre-test measurements.

Gamma-ray measurements are performed using ^{241}Am and ^{60}Co sources (or other sources that emit low- and high-energy gamma-rays) and the neutron measurements are performed using a neutron source, e.g., ^{252}Cf, ^{244}Cm, ^{248}Cm, or ^{241}AmBe. The ^{241}Am and ^{60}Co sources should be positioned so that the COV of each nominal mean reading is less than or equal to 12 %. The following guidance regarding sources applies:

- The same sources shall be used in the pre- and post-tests.
- The sources should activate the appropriate alarms during the pre-test measurements.
- For identification verification, the dead time should be small (e.g., less than 5 %) in order to avoid pile-up effects.

The pre-test, intermediate-test, and post-test measurements shall be carried out on the instrument under test as follows.

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

4.9.2 Pre-test measurements

a) With the SPRD in position for test, expose it to a gamma-radiation field using ^{241}Am and ^{60}Co simultaneously. Source positions shall be marked or otherwise noted to ensure repeatability for the intermediate and post-test measurements.

b) Record 10 gamma radiation readings (e.g., ambient dose-equivalent rates, exposure rates, count rates) with the source(s) present, in order to obtain the mean and standard deviation. The time between readings should be at least 1 s. The time between readings shall be long enough to ensure that the readings are independent. The selected time between readings is dependent on the integration time of the SPRD and the update time of the response indication.

c) Calculate the mean, $\overline{x}_{\text{pre}}$, and standard deviation, s_{pre}, of the count-rate or ambient dose equivalent rate readings.

d) Calculate the COV and verify that it is ≤12 %. If the value is larger than 12 %, adjust the radiation field or the number of readings.

e) Perform a series of 10 radionuclide identifications with ^{241}Am and ^{60}Co. Record the identification results. Save at least one spectrum from the 10-trial series.

f) Verify that the gamma alarm is activated by increasing the radiation field above the gamma alarm threshold. Remove the sources.

g) If applicable, using a neutron source, increase the radiation field above the neutron alarm threshold to verify that the neutron alarm is activated. Remove the neutron source.

4.9.3 Intermediate-test measurements

4.9.3.1 Without sources present

If the intermediate-test is performed without sources present, the SPRD shall be observed to verify that alarms or spurious indications are not produced as a result of the influence quantity (e.g., temperature, humidity, RF, impact, vibration).

4.9.3.2 With sources present

a) If the intermediate-test is required with sources present, position each test source in the same location as in the pre-test.

b) Record the same number of readings as in the pre-test (e.g., ambient dose-equivalent rates, exposure rates, count rates) with the source(s) present.

c) Perform a series of 10 radionuclide identifications with ^{241}Am and ^{60}Co. Record the identification results. Save at least one spectrum from the 10-trial series.

d) Increase the radiation field above the gamma alarm threshold to verify that the gamma alarm is activated. Remove the gamma sources.

e) If applicable, use a neutron source and increase the radiation field above the neutron alarm threshold to verify that the neutron alarm is activated. Remove the neutron source.

f) Calculate the mean, $\bar{x}_{\text{int}}$, standard deviation, s_{int}, and count-rate or ambient dose equivalent rate readings, t_1, and t_2 as described in 4.9.4.

4.9.4 Post-test measurements

a) Position each test source in the same location as for the pre-test.

b) Record the same number of readings as in the pre-test (e.g., ambient dose-equivalent rates, exposure rates, count rates) with the source(s) present.

c) Perform a series of 10 radionuclide identifications with ^{241}Am and ^{60}Co. Record the identification results. Save at least one spectrum from the 10-trial series.

d) Increase the radiation field above the gamma alarm threshold to verify that the gamma alarm is activated. Remove the gamma sources.

Documents
Document Sharing Hub
Full document details: IEC 62618-2022

e) If applicable, use a neutron source and increase the radiation field above the neutron alarm threshold to verify that the neutron alarm is activated. Remove the neutron source.

f) Calculate the mean, $\bar{x}_{\text{post}}$, and standard deviation, s_{post}, of the post-test readings.

g) Calculate the following:

$$t_1 = \frac{\bar{x}_{\text{post}} - 0{,}85\,\bar{x}_{\text{pre}}}{\sqrt{\frac{s_{\text{post}}^2}{N} + \frac{(0{,}85\,pre)^2}{N}}} \tag{2}$$

$$t_2 = \frac{\bar{x}_{\text{post}} - 1{,}15\,\bar{x}_{\text{pre}}}{\sqrt{\frac{s_{\text{post}}^2}{N} + \frac{(1{,}15\,pre)^2}{N}}} \tag{3}$$

where

N is the number of readings taken in each pre-test and post-test measurements, normally equal to 10, unless an increase in the number of readings was required.

If $s_{\text{pre}} = s_{\text{post}} = 0$, then t_1 and t_2 are undefined; see acceptance criteria (4.9.5).

4.9.5 Acceptance criteria

The results of the measurements are analysed in accordance with Table 3.

Table 3 – Test results analysis

Verification test	Analysis technique
Functionality	When the gamma or neutron (if applicable) radiation field is increased above the alarm threshold, verify that the alarm is activated. The results are acceptable if there are no unexpected alarms or fault indications during the test without the radioactive sources present and the alarm(s) is activated when the gamma or neutron (if applicable) radiation field is increased above the alarm threshold.
Identification results	The identification results should not be affected by the influence quantities. The identification results, scored according to Table 4, in the intermediate-test and post-test shall be the same or better than those in the pre-test.
Radiation response	The results are acceptable if changes in gamma response from the pre-test to the intermediate-test and/or the post-test are such that $t_1 \geq -0{,}86$ and $t_2 \leq 0{,}86$. If $s_{\text{pre}} = s_{\text{post}} = 0$, the results are acceptable if changes in gamma response between the pre-test, intermediate test, if applicable, and post-test are such that $\bar{x}_{\text{post}} \geq 0{,}85\bar{x}_{\text{pre}}$ and $\bar{x}_{\text{post}} \leq 1{,}15\bar{x}_{\text{pre}}$.

4.10 Neutron measurement requirements

The SPRD and the neutron source shall be placed at least 1 m from the ground and at least 2 m from concrete walls or areas of low Z material (e.g., polyethylene, water). The SPRD shall be mounted centred on the front side of a standard 30 cm × 30 cm × 15 cm ICRU slab phantom made from PMMA or similar plastic (see ICRU report 39 and ICRU report 47), unless otherwise stated.

AVA Documents
Document Sharing Hub

Full document details: IEC 62618-2022

5 General requirements

5.1 Basic information

5.1.1 Documentation supplied

The manufacturer shall provide SPRD performance specifications and instructions for operation. See Clause 10 for detailed requirements.

5.1.2 Radiation detector

The manufacturer shall provide information describing the radiation detector types used and their associated dimensions and location within the SPRD (e.g., CsI(Tl), CLYC, ^{3}He, ^{6}LiF/ZnS(Ag)). For the neutron detector, the manufacturer shall provide information if any neutron moderator is used and the moderator material, dimensions and location. For gas-filled counter tubes, the internal pressure shall be stated by the manufacturer.

5.1.3 Range of measurement – photons

The effective photon energy response range shall be stated by the manufacturer. The manufacturer shall state the measurement range for ambient dose equivalent rate.

5.1.4 Warm-up time

The manufacturer shall state the time required for the SPRD to become fully operational from the off and standby positions, which shall be less than 5 min. An indication shall be provided to the user when the SPRD is not fully operational.

5.1.5 Batteries and battery lifetime

The manufacturer shall state the continuous operating time using the recommended batteries under standard conditions (functional and environmental) which shall be at least 16 h for non-alarm conditions and greater than 30 min under alarm conditions.

The SPRD shall be equipped with an indicator of battery condition. The low-battery indication shall be displayed before the minimum voltage for proper operation is reached.

5.1.6 Explosive atmospheres

The manufacturer shall state whether or not the SPRD is certified for use in explosive atmospheres and its category. Proof of certification shall be provided when claimed. Certification should be based on IEC 60079-11 or equivalent standard (e.g., UL-913).

5.2 Mechanical characteristics

5.2.1 Size

The dimensions of the SPRD shall be stated by the manufacturer.

5.2.2 Mass

The mass of the SPRD with batteries installed shall be stated by the manufacturer and should not exceed 400 g.

5.2.3 Case construction

The SPRD shall meet the requirements of IP54 classification (see 7.4). A clip or ring, for example, shall be provided to enable a user to wear the SPRD with attention given to the necessary orientation of the detector, alarm type and display.

AVA Documents
Document Sharing Hub

Full document details: IEC 62618-2022

5.2.4 Reference point marking

The reference point of the SPRD shall be clearly marked or described in the manual.

5.2.5 Controls

Controls shall be adequately protected to prevent accidental or unauthorized operation.

5.3 Data output

The SPRD shall have the ability to transfer data to another device. As a minimum each data output file shall contain:

- date and time of the measurement;
- ambient dose equivalent rate or count rate indication;
- neutron count rate indication (if applicable);
- alarm type (gamma and/or neutron if applicable, personal protection);
- energy calibration;
- radionuclides identified; and
- photon spectra.

The output data file shall meet the requirements listed in IEC 62755. The manufacturer shall provide information as to how these data are transferred to an external device.

5.4 User indications

a) The following shall be displayed:
   - gamma count rate or ambient dose equivalent rate;
   - gamma alarm;
   - neutron alarm, if applicable;
   - personal protection alarm;
   - radionuclide identification results; and
   - battery status.

b) The following should be displayed:
   - neutron count rate, if applicable; and
   - radiation field intensity versus time.

5.5 Markings

All external SPRD controls, displays, and adjustments shall be identified as to their function. External markings should be readable and permanently fixed under normal conditions of use. The following markings shall appear on the exterior of the SPRD:

- manufacturer and model number;
- unique serial number;
- function designation for controls, switches, and adjustments that are not menu or software driven.

Documents
Document Sharing Hub

Full document details: IEC 62618-2022

5.6 Alarms

5.6.1 Alarm indication

An alarm shall be provided when the measured ambient dose equivalent rate or count rate is above the alarm threshold. This alarm threshold shall be calculated by the SPRD automatically. If the SPRD provides neutron detection, the neutron alarm shall be different from the gamma alarm.

The frequency of an audible alarm shall be within the range of 1 kHz to 4 kHz. The A-weighted alarm volume at a distance of 30 cm from the alarm source shall be at least 85 db(A) and shall not exceed 100 dB(A). If an intermittent alarm is provided, the signal interval shall not exceed 2 s.

Three types of alarm indications are possible: audible, visual (5.4), and vibration. If an audible alarm can be disabled, the SPRD shall continue to provide a visual alarm. It shall not be possible to disable all three indications of an alarm at the same time.

5.6.2 Personal protection alarm

A personal protection alarm shall be provided to indicate when the ambient dose equivalent rate has increased above a settable rate threshold. The alarm shall be distinguishable from the other alarms. The personal protection alarm shall be both visual and audible. The alarm shall be “acknowledged” by the user. It shall not be possible to switch off all personal protection alarm indicators at the same time.

5.6.3 Audible indication rate for searching

To facilitate the location of sources, an audible signal may be provided with a repetition rate and/or frequency that increases with the increase in the radiation level.

6 Radiation detection requirements

6.1 False alarm rate

6.1.1 Requirements

When tested in an area with a stable background (only natural fluctuations) at the levels stated in Table 2, the false alarm rate shall be less than 1 alarm over a period of 1 h.

6.1.2 Method of test

Place the SPRD in an area that has a stable and controlled background (Table 2). Observe the SPRD over a period of 8 h and record whether any alarms or identifications occur. The results are acceptable if there are no more than 3 alarms, either gamma or neutron, and no more than 3 identifications during the 8 h period.

NOTE This corresponds to 95 % one-sided upper confidence bound for 1 false alarm for 1 h in Poisson distribution.

6.2 Gamma alarm

6.2.1 Requirements

The SPRD shall alarm within 2 s after exposure to an increase in the ambient dose equivalent rate level of 0,5 $\mu Sv \cdot h^{-1}$ (−0 %, +20 %) above background for ^{241}Am, ^{137}Cs and ^{60}Co sources when moving at a speed of 1 $m \cdot s^{-1}$ (±10 %) at a distance of closest approach of 1,5 m.

Documents
Document Sharing Hub
Full document details: IEC 62618-2022