

INTERNATIONAL STANDARD

Radiation protection instrumentation – Spectrometric radiation portal monitors (SRPMs) used for the detection and identification of illicit trafficking of radioactive material

IEC 62484:2020

<https://standards.iteh.ai/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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.

IEC Central Office
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

[IEC 62484:2020](https://standards.iec.ch/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020)

<https://standards.iec.ch/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020>

INTERNATIONAL STANDARD

Radiation protection instrumentation – Spectrometric radiation portal monitors (SRPMs) used for the detection and identification of illicit trafficking of radioactive material

IEC 62484:2020

<https://standards.iteh.ai/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.280

ISBN 978-2-8322-8873-3

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

| | |
|--|----|
| FOREWORD | 5 |
| INTRODUCTION | 7 |
| 1 Scope | 8 |
| 2 Normative references | 8 |
| 3 Terms and definitions, abbreviated terms and symbols, quantities and units | 9 |
| 3.1 Terms and definitions | 9 |
| 3.2 Abbreviated terms and symbols | 10 |
| 3.3 Quantities and units | 11 |
| 4 Design requirements | 11 |
| 4.1 General | 11 |
| 4.1.1 Overview | 11 |
| 4.1.2 Pedestrian monitor | 14 |
| 4.1.3 Road vehicle monitor | 14 |
| 4.1.4 Rail vehicle monitor (includes rail transported containers) | 14 |
| 4.1.5 Package (or conveyor) monitor | 14 |
| 4.2 Physical configuration | 14 |
| 4.3 Spectral identification and count rate information | 15 |
| 4.4 Indication features | 15 |
| 4.5 Occupancy and speed sensors | 16 |
| 4.6 Markings | 16 |
| 4.7 Protection of switches | 16 |
| 4.8 Energy and count rate range | 16 |
| 4.9 Data transfer | 16 |
| 4.10 User interface | 16 |
| 4.10.1 Audible (sound) alarm | 16 |
| 4.10.2 Visual indicators | 16 |
| 4.10.3 Warning indicators | 17 |
| 4.10.4 Basic controls and functions | 17 |
| 4.10.5 Advanced indications and functions | 17 |
| 5 General test procedures | 18 |
| 5.1 General test conditions | 18 |
| 5.1.1 Nature of tests | 18 |
| 5.1.2 Standard test conditions | 18 |
| 5.1.3 Statistical fluctuations | 18 |
| 5.2 Reference neutron radiation for alarm testing | 19 |
| 5.3 Alarm categorization | 19 |
| 5.4 General requirements for testing radionuclide identification ability | 19 |
| 5.5 Functionality test | 20 |
| 5.5.1 General | 20 |
| 5.5.2 Pre-test measurements | 21 |
| 5.5.3 Intermediate (during test) measurements | 21 |
| 5.5.4 Post-test measurements | 21 |
| 6 Radiation detection requirements | 21 |
| 6.1 Stability test | 21 |
| 6.1.1 Requirements | 21 |
| 6.1.2 Method of test | 21 |

| | | |
|-------|---|----|
| 6.2 | Neutron radiation detection, if provided | 22 |
| 6.2.1 | Requirements | 22 |
| 6.2.2 | Method of test..... | 22 |
| 6.3 | Gamma over-range indication | 22 |
| 6.3.1 | Requirements | 22 |
| 6.3.2 | Method of test..... | 22 |
| 6.4 | Detection of neutron radiation in a high gamma field | 23 |
| 6.4.1 | Requirements | 23 |
| 6.4.2 | Method of test – large road vehicle and multiple-sided rail vehicle monitors | 23 |
| 6.4.3 | Method of test – all other types of monitors | 23 |
| 6.5 | Background effects | 23 |
| 6.5.1 | Requirements | 23 |
| 6.5.2 | Method of test..... | 24 |
| 6.6 | Radionuclide identification | 24 |
| 6.6.1 | Radionuclide library and identification categorization | 24 |
| 6.6.2 | Radionuclide identification qualification | 25 |
| 6.6.3 | Single radionuclide identification | 25 |
| 6.6.4 | Simultaneous radionuclide identification | 26 |
| 6.6.5 | Alarm without identification | 27 |
| 7 | Climatic requirements | 27 |
| 7.1 | General..... | 27 |
| 7.2 | Ambient temperature..... | 27 |
| 7.2.1 | Requirements | 27 |
| 7.2.2 | Method of test..... | 27 |
| 7.3 | Relative humidity | 28 |
| 7.3.1 | Requirements | 28 |
| 7.3.2 | Method of test..... | 28 |
| 7.4 | Dust and moisture protection | 28 |
| 7.4.1 | Requirements | 28 |
| 7.4.2 | Method of test – Dust | 28 |
| 7.4.3 | Test method – Moisture | 28 |
| 7.5 | Climatic exposure type test | 29 |
| 7.5.1 | Requirements | 29 |
| 7.5.2 | Method of test..... | 29 |
| 8 | Mechanical requirements..... | 29 |
| 8.1 | Vibration | 29 |
| 8.1.1 | Requirements | 29 |
| 8.1.2 | Method of test..... | 29 |
| 8.2 | Microphonics/Impact | 30 |
| 8.2.1 | Requirements | 30 |
| 8.2.2 | Method of test..... | 30 |
| 9 | Electric and electromagnetic requirements | 30 |
| 9.1 | Electrostatic discharge (ESD) | 30 |
| 9.1.1 | Requirements | 30 |
| 9.1.2 | Method of test..... | 30 |
| 9.2 | Radio frequency (RF)..... | 30 |
| 9.2.1 | Requirements | 30 |
| 9.2.2 | Method of test..... | 30 |

| | | |
|-----------------------|---|----|
| 9.3 | Radiated RF emissions | 31 |
| 9.3.1 | Requirements | 31 |
| 9.3.2 | Method of test..... | 31 |
| 9.4 | Conducted disturbances..... | 31 |
| 9.4.1 | Requirements | 31 |
| 9.4.2 | Method of test..... | 31 |
| 9.5 | Surges and oscillatory waves | 31 |
| 9.5.1 | Requirements | 31 |
| 9.5.2 | Method of test..... | 31 |
| 9.6 | Line voltage and frequency fluctuations | 32 |
| 9.6.1 | Requirements | 32 |
| 9.6.2 | Method of test..... | 32 |
| 10 | Documentation | 32 |
| 10.1 | Operation and maintenance manual | 32 |
| 10.2 | Test certificate | 33 |
| 10.3 | Declaration of conformity | 33 |
| Annex A (informative) | Identification of uranium and plutonium | 36 |
| Bibliography | | 37 |
| Figure 1 | – Example of a two-sided system | 12 |
| Table 1 | – Standards for instrumentation used to detect illicit trafficking of radioactive and nuclear materials | 7 |
| Table 2 | – Speed of moving sources | 13 |
| Table 3 | – Evaluation distances for different applications | 13 |
| Table 4 | – Standard test conditions | 18 |
| Table 5 | – Test radionuclides | 20 |
| Table 6 | – Test materials ¹ | 20 |
| Table 7 | – Test result analysis | 21 |
| Table 8 | – Radionuclide library..... | 24 |
| Table 9 | – Radionuclide categorisation | 24 |
| Table 10 | – Identification acceptance criteria ^{1,2} | 25 |
| Table 11 | – Summary of performance requirements – Informative | 33 |
| Table 12 | – Environmental requirements – Informative ¹ | 35 |
| Table A.1 | – Uranium and plutonium detection and identification guidance..... | 36 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIATION PROTECTION INSTRUMENTATION –
SPECTROMETRIC RADIATION PORTAL MONITORS (SRPMS) USED
FOR THE DETECTION AND IDENTIFICATION 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.

International Standard IEC 62484 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

This second edition cancels and replaces the first edition of IEC 62484 issued in 2010. This edition constitutes a technical revision.

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

- a) title modified;
- b) making the standard consistent with the new standards for detection of illicit trafficking of radioactive material (see the Introduction);
- c) creating unformed functionality test for all environmental, electromagnetic and mechanical tests and a requirement for the coefficient of variation of each nominal mean reading;

- d) reference to IEC 62706 for the environmental, electromagnetic and mechanical test conditions;
- e) adding information regarding climatic exposures.

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

| | |
|--------------|------------------|
| FDIS | Report on voting |
| 45B/969/FDIS | 45B/971/RVD |

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

iTeh STANDARD PREVIEW
(standards.iteh.ai)

IEC 62484:2020

<https://standards.iteh.ai/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020>

INTRODUCTION

Illicit and inadvertent movement of radioactive materials has become a problem of increasing importance. 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 phenomenon, concern about a nuclear "black market" has increased in the last few years 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 are developing and manufacturing 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.

However, to ensure that measurement results made at different locations are consistent, it is imperative that radiation instrumentation be designed to rigorous specifications based upon agreed performance requirements stated in international standards. Several IEC standards have been developed to address body-worn, hand-held and portal instruments, see Table 1.

Table 1 – Standards for instrumentation used to detect illicit trafficking of radioactive and nuclear materials

| Type of instrumentation | IEC number | Title of the standard |
|------------------------------|--------------|---|
| Body-worn | 62401 | Radiation protection instrumentation – Alarming Personal Radiation Devices (PRD) for detection of illicit trafficking of radioactive material |
| | 62618 | Radiation protection instrumentation – Spectroscopy-Based Alarming Personal Radiation Devices (SPRD) for detection of illicit trafficking of radioactive material |
| | 62694 | Radiation protection instrumentation – Backpack-type radiation detector (BRD) for 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 |
| Mobile | 63121 | Radiation protection instrumentation – Vehicle-mounted mobile systems for the detection of illicit trafficking of radioactive materials |
| Data format | 62755 | Radiation protection instrumentation – Data format for radiation instruments used in the detection of illicit trafficking of radioactive materials |

RADIATION PROTECTION INSTRUMENTATION – SPECTROMETRIC RADIATION PORTAL MONITORS (SRPMS) USED FOR THE DETECTION AND IDENTIFICATION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

1 Scope

This document defines the performance requirements of installed monitors used for the detection and identification of gamma emitters and the detection of neutron radiation emitters. These monitors are commonly known as spectrometric radiation portal monitors or SRPMS. They are used to monitor vehicles, cargo containers, people, or packages and are typically used at national and international border crossings and ports of entry. SRPMS may be used at any location where there is a need for this type of monitoring.

This document establishes the general, radiological, climatic, mechanical, electric and electromagnetic and documentation requirements and associated test methods. A summary of the performance requirements is provided in Table 11. An informative listing of environmental requirements from IEC 62706 is provided in Table 12.

This document does not apply to the performance of non-spectroscopic portal monitors covered in IEC 62244.

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, *International Electrotechnical Vocabulary (IEV) – Part 395: Nuclear instrumentation: Physical phenomena, basic concepts, instruments, systems, equipment and detectors*

IEC 60068-2-5, *Environmental testing – Part 2-5: Tests – Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering*

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*

IAEA-TECDOC-1311: September 2002, *Prevention of the inadvertent movement and illicit trafficking of radioactive materials*

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

3.1 Terms and definitions

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

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

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

3.1.1

alarm

audible, visual, or other signal activated when the instrument reading exceeds a pre-set value, falls outside of a pre-set range, or when the instrument detects and/or identifies the presence of the source of radiation according to a pre-set condition

3.1.2

coefficient of variation

COV

statistical measure of the dispersion of data points in a data series around the mean of those data points expressed in %

iTeh STANDARD PREVIEW
(standards.iteh.ai)

$$\text{COV} = \frac{s}{\bar{x}} \times 100$$

where:

<https://standards.iteh.ai/catalog/standards/sist/e15c5cf3-221f-4e52-bfa8-164e720be242/iec-62484-2020>

s is the standard deviation of the dispersion of the data points;

\bar{x} is the mean of the data points.

3.1.3

confidence indication

indication provided by the monitor on the reliability assigned to the determined identification

3.1.4

detection assembly

component of the SRPM that contains the detectors and associated electronic devices

3.1.5

detection zone

location where radiation emitted by an object or person being monitored may be detected by the detection assembly(s)

Note 1 to entry: For two-sided SRPMs, the detection zone is located between detection assemblies; for single-sided SRPMs, the detection zone is adjacent to the front face of the detection assembly.

3.1.6

evaluation distances

distance between an evaluation test source and the exterior surface of the detection assembly(s) that faces the detection zone (see Figure 1)

3.1.7

false alarm

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

3.1.8

false identification

misinterpretation of data being measured by a system leading to the incorrect identification of radionuclide(s) that are present or the identification of radionuclides that are not present

3.1.9

international protection marking

IP

degrees of protection provided by enclosures

3.1.10

live time

time interval during which a detection assembly is sensitive to the input signal

3.1.11

occupancy

when an object such as a person, vehicle, package, or container is in the detection zone

3.1.12

peripheral device

any device connected to the system other than the detector or detection assembly that is not required for operation

3.1.13

radioactive material

in this document, radioactive material includes special nuclear material and any radioactive source, unless otherwise specifically noted

3.1.14

run time

real time

duration (i.e., elapsed clock time) of the acquisition of the spectrum or other data

3.1.15

static mode

when the object being monitored is stationary within the detection zone for the monitoring period

3.1.16

transient mode

when the object being monitored passes through the detection zone

3.1.17

type test

conformity test of one or more items representative of the production device

3.2 Abbreviated terms and symbols

| | |
|------|------------------------------------|
| COV | coefficient of variation |
| ESD | electrostatic discharge |
| DU | depleted uranium |
| HEU | highly enriched uranium |
| HDPE | high density polyethylene |
| IAEA | International Atomic Energy Agency |
| IP | international protection marking |
| LEU | low enriched uranium |

| | |
|------|--|
| NORM | naturally occurring radioactive material |
| PMMA | polymethyl methacrylate |
| RF | radio frequency |
| RH | relative humidity |
| SNM | special nuclear material |
| SRPM | spectrometric radiation portal monitor |
| WGPu | weapons grade plutonium |

3.3 Quantities and units

In the present document, units of the International System (SI) are used¹. The definitions of radiation quantities are given in IEC 60050-395.

The following units may also be used:

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

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

4 Design requirements

4.1 General

4.1.1 Overview

The equipment addressed by this document shall detect the presence of gamma-ray emitting sources, identify gamma-emitting radionuclide(s), and may detect neutron sources.

An indication shall be provided when the measurement results from the detection system exceed an alarm criterion or pre-set condition (user selectable for radiation level or identification result). Measurement occurs when the object passes through the detection zone (transient mode) or with the object static within the detection zone where the user performs controlled analyses of the object (i.e., enters collection time and/or activates the count to obtain a spectrum).

Passage speeds for transient mode testing are stated in each applicable clause and summarized in Table 2. Testing at different speeds may be performed as a special test upon agreement between the manufacturer and user.

Monitors shall be capable of operating independently of any peripheral device or remote station and shall be unaffected by any malfunction of a peripheral device.

According to its use, an SRPM can be classified as a:

- pedestrian monitor,
- small vehicle monitor,
- large road vehicle and rail monitors, or
- package or conveyor monitor.

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