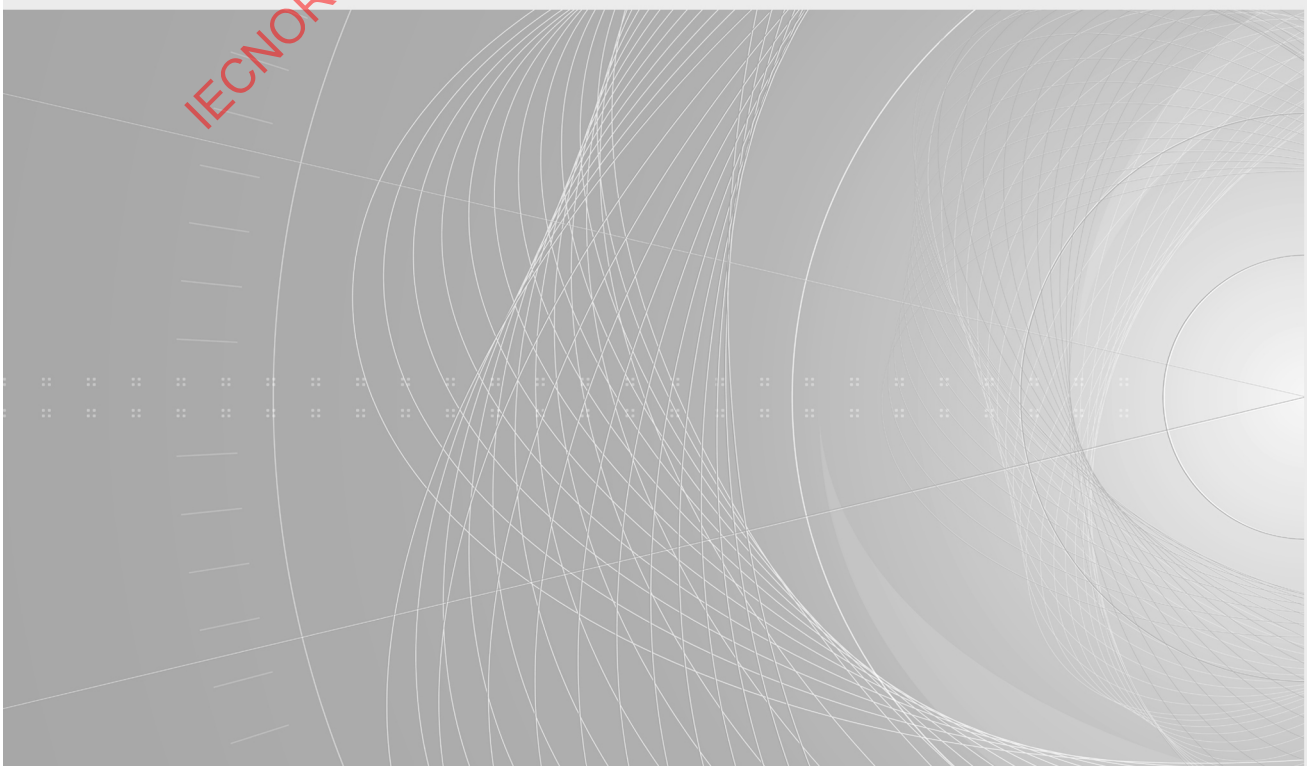
IEC 62484

Edition 2.0 2020-10

INTERNATIONAL STANDARD

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



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

FOREWORD

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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- withdrawn,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.

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 %

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

where:

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 used[1]. 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 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: ºC), 0 ºC = 273,15 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:

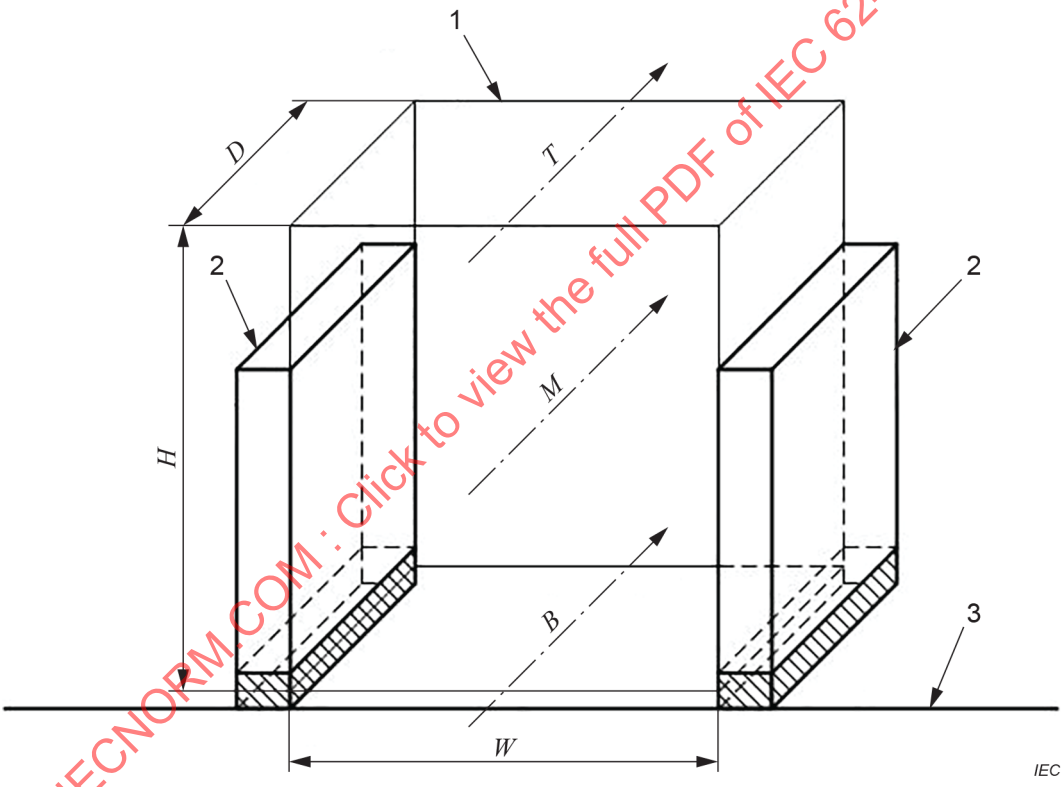
– pedestrian monitor,
– small vehicle monitor,
– large road vehicle and rail monitors, or
– package or conveyor monitor.

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

The detection zone is the area located adjacent to a single-sided detection assembly or between two or more detection assemblies where the measurement of radiation takes place (Figure 1). The size of the detection zone is based on the classification of use. If a monitor is used in two or more classifications, its detection zone shall be appropriate for each classification. The detection zone shall be of a size that ensures that all objects which could move through the detection zone are monitored. The manufacturer shall state the SRPM classification(s) for which the requirements stated in this document are met.

Operational conditions such as separation distance (distance between opposing detection assemblies), object speed, and background radiation should be considered when installing the monitor.

It is important to be able to identify the object that caused an alarm. The alarm should be generated within a period of time to ensure that the object that caused an alarm can be identified. This is important if complex algorithms are in place that need a finite process time. It becomes more important if a constant stream of traffic is being monitored (e.g., pedestrians).



Key

1	Detection zone
2	Detection assembly
3	Ground surface
W	Width of detection zone
H	Height of detection zone
D	Depth of detection zone
T	Top
M	Middle
B	Bottom
– · – ►	Source movement

Figure 1 – Example of a two-sided system

The source movement speed and evaluation test distance for each monitor type in 4.1.2 through 4.1.5 are described in Table 2 and Table 3, respectively.

Table 2 – Speed of moving sources

Monitor classification	Source speed m/s
Pedestrian monitors	1,2 ± 0,12
Small vehicle	2,2 ± 0,22
Large road vehicle and rail monitors	1,2 ± 0,12
Package or conveyor monitor	1,0 ± 0,1

Table 3 – Evaluation distances for different applications

Monitor type	Distance between detection assemblies for testing	Evaluation distance	Detection zone bottom from the ground or floor surface m	Detection zone middle from the ground or floor surface m	Detection zone top from the ground or floor surface m
Single-sided pedestrian monitors	N/A	Source (1,0 ± 0,02) m from detector	0,05	1	2 m or less in case of height restriction
Multiple-sided pedestrian monitors	(1,0 ± 0,02) m apart measured from the surface of each detection assembly, or as stated by the manufacturer	Centred between detection assemblies	0,05	1	2 m or less in case of height restriction
Small vehicle monitors	(3,0 ± 0,1) m apart measured from the surface of each detection assembly, or as stated by the manufacturer	Centred between detection assemblies	0,2	1,25	2,5
Large road vehicle monitors	(5,0 ± 0,1) m apart measured from the surface of each detection assembly, or as stated by the manufacturer	Centred between detection assemblies	0,2	2,25	4,5
Multiple-sided rail vehicle monitors	(6,0 ± 0,1) m apart measured from the surface of each detection assembly, or as stated by the manufacturer	Centred between detection assemblies	1	3	6
Multiple-sided Package (or conveyor) monitor	As stated by the manufacturer	Centred between detection assemblies	As stated by the manufacturer	As stated by the manufacturer	As stated by the manufacturer

Monitor type	Distance between detection assemblies for testing	Evaluation distance	Detection zone bottom from the ground or floor surface m	Detection zone middle from the ground or floor surface m	Detection zone top from the ground or floor surface m
Single-sided Package (or conveyor) monitor	N/A	Source (1,0 ± 0,02) m from detector	As stated by the manufacturer	As stated by the manufacturer	As stated by the manufacturer

4.1.2 Pedestrian monitor

Pedestrian SRPMs shall provide a detection zone to ensure that people are monitored. Pedestrian SRPMs may use a single detection assembly (single-sided) or multiple directly opposing detection assemblies (two-sided). If the height is restricted by the SRPM frame, the top testing height of 2 m may be adjusted to allow test sources to pass through the detection zone.

4.1.3 Road vehicle monitor

Road vehicle monitors are divided into two types, large and small. Small road vehicle SRPMs typically monitor vehicles that are ≤ 2,5 m high. Large road vehicle SRPMs typically monitor vehicles that are typically > 2,5 m high. Both types shall be two-sided.

4.1.4 Rail vehicle monitor (includes rail transported containers)

Rail vehicle SRPMs shall be two-sided. Rail vehicle SRPMs should have the ability to identify an individual railcar that caused an alarm while monitoring an entire multi-car train.

4.1.5 Package (or conveyor) monitor

Package or conveyor SRPMs shall provide a detection zone to ensure that items moving through the detection zone are monitored. Package or conveyor SRPMs may use a single detection assembly or multiple detection assemblies with detectors across the top, bottom, and/or side(s) of the detection zone. The detection zone is located adjacent to a detection assembly for single sided conveyor SRPMs. For multiple detector conveyor SRPMs, the detection zone is located between the detection assemblies.

4.2 Physical configuration

SRPMs may be designed for use in weather controlled or non-controlled environments. The detection assemblies for road and rail vehicle monitoring may be subjected to vibration from the passing of heavy vehicles. Mounting techniques (i.e., concrete pads) that are not addressed by this document shall be designed to minimize the transfer of vibration and shock conditions to the detection assemblies.

Controls and adjustments which affect calibration and alarm settings shall be designed to ensure access to them is limited to authorised persons.

Provisions shall be made to permit testing of visual and/or audible warning indicators without the use of radiation sources.

The SRPM shall have the ability to display operational status including, for example, loss of power, low count rate, high count rate, unstable count rate, or other electronic failures for each detector.

4.3 Spectral identification and count rate information

A displayed gamma-ray spectrum is not required during routine operation. The spectrum display shall be available through manufacturer-defined user actions.

Each alarm data set shall contain the following collection and identification results in accordance with IEC 62755:

– SRPM model and serial number
– Spectrum (spectra for multi-detector systems)
– Time and date
– Run time and live time
– Identified radionuclides and categories
– Occupancy time (when occupancy sensors are used, or the data collection time when occupancy sensors are not used)
– Transient speed (if applicable)
– Alarm condition (gamma-ray and/or neutron)
– Background (gamma-ray and neutron count rate, and spectrum)
– Gamma-ray count rate during measurement
– Neutron count rate during measurement
– Video record or image (e.g., photo, license plate/vehicle registration number), if available.

SRPMs shall have the ability to:

– internally store at least 3 h of measurement data or 1 000 complete occupancy data sets using a method that will prevent data loss in the event of loss of power;
– display gamma-ray and neutron count rate time-history data internally or on an external device;
– perform identification measurements with an object static in the detection zone. This selection of static or transient mode shall be user selectable. The recommended measurement time for static mode shall be stated by the manufacturer and be user selectable.

An indication shall be displayed or otherwise provided (i.e., "not identified", "unknown") if a radionuclide cannot be identified during or after a measurement takes place that activated an alarm.

If a confidence indication is associated with the identification of a radionuclide(s), the value(s) shall be provided in the data set.

4.4 Indication features

The monitor shall provide an indication of its operational status and alarm condition and be able to transmit these signals to remote stations. It shall be possible to select the visibility of the status indication.

All alarm indicators shall automatically or manually reset as defined by the user. Radiation alarm function shall be user selectable and include selection options such as count rate, radionuclide identification, and/or radionuclide categorization.

4.5 Occupancy and speed sensors

If SRPMs are equipped with occupancy or speed sensors, they:

– shall be able to detect presence and to estimate vehicle speed, indicate if a vehicle stops within the detection zone, and not count a single vehicle or object in the detection zone more than once;

– should be capable of operating on a mix of traffic as applicable to the expected use (e.g., cars, vans, pickup trucks, buses, cargo trucks, trains), and

– shall function during conditions required in 7.2 and 7.3, and following conditions in 7.4.

For test purposes, SRPMs that use sensors to activate a measurement should have the capability to perform a user-selected number of consecutive discrete measurements automatically without the need to activate the sensor. Function variables such as occupancy time and time between occupancies shall be selectable by the user.

4.6 Markings

Internal controls shall be identified through markings on electrical circuit boards and/or individual components, and by identification in technical manuals.

Markings shall be permanently fixed under normal conditions of use.

4.7 Protection of switches

Switches and other controls should be designed to ensure that the SRPM can be operated properly while preventing accidental switch operation.

4.8 Energy and count rate range

The gamma-ray energy range, and the range for gamma-ray count rate measurement and neutron count rate indication shall be stated by the manufacturer.

4.9 Data transfer

SRPMs shall have the ability to transfer data to an external device, such as a computer. The transfer process shall be fully described in the technical manual. Consideration should be given to data security when using wireless data transfer techniques.

4.10 User interface

4.10.1 Audible (sound) alarm

User-selectable audible alarms shall be available for the neutron and gamma alarms, and system failure indications. The user shall have the ability to acknowledge audible alarms.

4.10.2 Visual indicators

Displayed information shall include the following:

– Indication that the SRPM is measuring background radiation

– Indication that the SRPM is measuring radiation from an object

– Neutron alarm

– Gamma alarm

– Radionuclide categorization and identification result

– Detection without a radionuclide identified alarm

– Object present, if occupancy sensors are used

– Operational status including system failure.

4.10.3 Warning indicators

The following indications shall be provided at the user interface as a minimum.

– Background changes during non-occupancies that can affect the overall sensitivity of the monitor
– High or low detector count rate conditions
– Energy stabilization invalid or not acceptable
– Occupancy sensor failure, if occupancy sensors are used
– Over-range indication (e.g. "high background" or "high counts")
– Loss of mains power
– Detector failure
– Communication failure
– Over-speed indication for monitors equipped with speed measurement.

4.10.4 Basic controls and functions

The following controls shall be provided for the trained user.

– Start/stop static measurement
– Ability to mute an audible alarm
– Ability to reset alarms.

4.10.5 Advanced indications and functions

The following information and control shall be provided for the supervisory user through the use of access controls or special commands.

– Access to and control of operating parameters
– Access to and control of data logging intervals
– Access to alarm history
– Access to spectra
– Access to radionuclide identification results and control of basic indication function
– Access to occupancy data set (if occupancy sensors are used)
– Access to vehicle photo or video recording (if available)
– Access to radiation profiles (count rate time history data)
– Access to background radiation information
– Access to alarm selection criteria
– Access to status indication criteria including the ability to set the radiation level for activation of the high radiation indicator
– Access to energy and/or efficiency calibration information.

5 General test procedures

5.1 General test conditions

5.1.1 Nature of tests

The tests in this document are to be considered as type tests unless otherwise stated. The given requirements are evaluated by the tests given in the appropriate subclauses. All tests in this document shall be performed using the same conditions with any accessories included with the monitors.

Where no method of test is specified, it is understood to mean that the characteristic can be verified by observation or consultation of the manufacturer's specifications. The user may employ certain parts of the document as acceptance tests.

Operating parameters, alarm parameters, and radionuclide library shall remain the same throughout the entire test process, unless otherwise stated as part of a specific test.

5.1.2 Standard test conditions

Except where otherwise specified, testing should be carried out under the standard test conditions shown in Table 4 understanding that SRPMs may be large, and testing may need to be performed in an uncontrolled environment. The ambient temperature, relative humidity, and atmospheric pressure shall be recorded during testing. The background ambient dose equivalent rate and neutron fluence rate at the test location shall be recorded as well as the instruments used to perform the measurement. Neutron sources at levels that could affect the performance of a test shall not be in the test area.

Table 4 – Standard test conditions

Influence quantity	Standard test conditions
Ambient temperature	(18 to 25) °C
Relative humidity	≤ 75 %
Atmospheric pressure	(70 to 106,6) kPa
Gamma radiation background[1,2]	Ambient dose equivalent rate less than 0,15 $\mu Sv \cdot h^{-1}$
Neutron radiation background[1,2]	Neutron fluence rate less than 200 s^{-1} m^{-2}
[1] SRPMs are typically used in non-radiological areas, e.g., shipping ports, border locations. Man-made radiological materials such as radiation sources are not expected to be present during testing, other than those used while a test is taking place. [2] Natural conditions without the presence of man-made emitters.	

5.1.3 Statistical fluctuations

For the tests stated in Clauses 7, 8, and 9, the magnitude of the statistical fluctuations of the numerical indication arising from the random nature of radiation alone may be a significant fraction of the variation of the indication permitted in the test. Therefore, the coefficient of variation (COV) for each mean reading shall be less than or equal to 12 %.

The value of 12 % is chosen to help determine the results of a test as the series of readings and the associated mean are compared to a requirement set in this document. Processes such as increasing the applied radiation levels will typically reduce the COV to an acceptable level. The number of trials or readings may also be increased to reduce the COV, but this should be secondary to increasing the applied radiation level. When testing without the presence of radioactive sources, the SRPM is observed so it does not produce alarms and/or spurious indications. In this case the COV value is not relevant.

The time interval between each reading shall be long enough to ensure that the readings are independent. The time interval selected is dependent on the integration time of the SRPM and the update time of the indicated response.

5.2 Reference neutron radiation for alarm testing

^{252}Cf or ^{244}Cm shall be used as the neutron test source. The source shall have a neutron emission rate of 20 000 $n \cdot s^{-1}$ (-0 %, +20 %) and be surrounded by a high-density polyethylene (0,93 $g \cdot cm^{-3}$ to 0,97 $g \cdot cm^{-3}$) moderator. The moderator shall be surrounded by wall(s) that have a thickness of 4 cm with the source place not farther than 1,5 cm from each wall. The standard uncertainty in the neutron emission rate shall be less than or equal to 10 % (k=1).

NOTE 1 The activity level is for testing only and is not indicative of the neutron alarm set point or overall neutron detection capability of an SRPM.

NOTE 2 Due to radioactive decay, the ^{252}Cf source will be within the stated range of 20 000 $n \cdot s^{-1}$ to 24 000 $n \cdot s^{-1}$ for only 8 months. For ^{244}Cm, the usage time will be approximately 4,7 years.

5.3 Alarm categorization

Alarms may be categorized based on the level of radiation detected and measured, and the identification results. The International Atomic Energy Agency (IAEA) has recommended a method of categorization (IAEA-TECDOC-1311, September 2002).

5.4 General requirements for testing radionuclide identification ability

Identification ability is tested using sources listed in Table 5 and materials listed in Table 6. The source activity at the time of testing shall be within (–0 %, +20 %) of the values stated in Table 5. Activity values in Table 5 are based on a source encapsulated in 0,25 mm stainless steel. The standard uncertainty in the actual activity value shall be less than or equal to 5 % (k=1). Consideration shall be taken if the source has a different encapsulation in order to obtain the same gamma-ray emission rate outside the source encapsulation for the highest photon energy.

For medical radionuclides shown in Table 5, the source activity at the time of testing shall be within (–0 %, +50 %).

Fluence rate values are used for SNM and DU sources in Table 6. The fluence rate at the time of testing shall be within (–0 %, +20 %) of the values stated in Table 6. When tested, actual values used shall be stated and recorded. The standard uncertainty in the fluence rate value shall be less than or equal to 10 % (k=1).

The medical sources shall be surrounded by 8 cm of polymethyl methacrylate (PMMA) to simulate monitoring people with medical treatments.

SNM sources with different masses, shapes, and forms may be used for testing. The DU source may be assembled from available standard reference materials (i.e., 100 cm^2 plates). A complete description of the source including mass, form, shape, and spectrum shall be obtained as part of the test record. For this document:

– HEU has an enrichment of approximately 93,5 % ^{235}U,

– DU 0,2 % ^{235}U,

– U_{nat} 0,7 % ^{235}U, and

– WGPu ≤6 % ^{240}Pu.

NOTE A discussion regarding the identification of uranium and plutonium is available in Annex A.

In order to gain consistency in testing, the WGPu source may need to be shielded (e.g., with copper) to reduce the count rate at 60 keV from ^{241}Am. The shielding shall reduce the 60 keV ^{241}Am count rate so that it is no more than a factor of 10 greater than the 375 keV ^{239}Pu count rate.

Table 5 – Test radionuclides

Radionuclide	Activity
^{241}Am	1,74 MBq
^{60}Co	260 kBq
^{137}Cs	600 kBq
^{67}Ga	3,5 MBq
^{131}I	850 kBq
^{99m}Tc	4,7 MBq
^{201}Tl	3,3 MBq
^{226}Ra	590 kBq
^{232}Th	700 kBq

Table 6 – Test materials[1]

Radioactive materials	Gamma fluence rate $s^{-1} \cdot cm^{-2}$
DU	1,34
HEU	1,44
WGPu	0,40

[1] The stated fluence rate for the highly enriched uranium (HEU) is based on the emission rate for the 185,7 keV line. The fluence rate for weapons grade plutonium (WGPu) is based on the emission rate for the 375,05 keV line. The fluence rate for depleted uranium (DU) is based on the emission rate for the 1 001 keV line. Each fluence rate was determined at a source to detector distance of 1 m.

5.5 Functionality test

5.5.1 General

The test methods and associated data collection requirements stated in 5.5.2 through 5.5.4 apply to Clauses 7, 8 and 9. The test methods verify the SRPM's functionality and response to radiation during a specific test. They are not intended to estimate the alarm probability or sensitivity of the SRPM. Table 7 provides the test results acceptance criteria.

5.5.2 Pre-test measurements

With the SRPM set up for test, expose each detection assembly to a gamma-ray and neutron radiation field, when provided, using ^{241}Am and ^{60}Co (or sources that emit low and high energy gamma rays) simultaneously, and a neutron source (when applicable). Source positions shall be marked or otherwise noted to ensure repeatability during test measurements.

a) Record a minimum of 10 readings with the sources present. Perform a series of 10 radionuclide identifications or occupancies with the gamma sources present and record the identification results including the confidence indicators, if provided. Collect at least one spectrum from the 10-trial series. Remove the sources.

b) Calculate and record the mean, standard deviation, and COV for each series of count rate measurements. See 5.1.3, if needed, for additional information regarding the determination of the COV.

c) Establish the radiation response acceptance range as ± 15 % of the calculated mean.

5.5.3 Intermediate (during test) measurements

a) While radioactive sources are not present, observe the SRPM and record any alarms or spurious indications.

b) To perform source testing, reposition each test source as determined in 5.5.2.

c) Record the same number of readings and other information as obtained for 5.5.2 with the sources present and verify alarm functionality when tested.

d) Calculate and record the mean, standard deviation, and COV for the measurement data.

5.5.4 Post-test measurements

a) Reposition each test source as determined in 5.5.2.

b) Record the same number of readings and other information as obtained for 5.5.2 with the sources present and verify alarm functionality when tested.

c) Calculate and record the mean, standard deviation, and COV for the measurement data.

Table 7 – Test result analysis

Verification test	Acceptance criteria
Functionality	The results are acceptable if there are no unexpected alarms or fault indications during the test.
Identification results	The identification results are acceptable when they meet the requirements stated in Table 10 in 9 out of 10 trials at each test point.
Radiation response	The mean count rate reading at each test point shall be within the acceptance range of ±15 % determined in 5.5.2.

6 Radiation detection requirements

6.1 Stability test

6.1.1 Requirements

When operated in controlled stable background, the SRPM shall not produce more than 1 identification, 1 gamma alarm, or 1 neutron alarm (if applicable) during a period of 10 h.

6.1.2 Method of test

To verify the SRPM is functioning properly prior to the stability test, perform a 10-trial identification test using ^{137}Cs at the middle height of the detection zone. If applicable, perform a 10-trial neutron and gamma alarm test also only at the middle height of the detection zone following 6.3.2. Remove the radiation sources from the area.

If occupancy sensors are used, determine the process required to cause a 5 s occupancy for vehicle SRPMs or 1 s occupancy for pedestrian and package SRPMs. The process may involve simultaneous blocking of two occupancy sensors, sequential blocking of sensors, or timed blocking of sensors. Over a period of 10 h, initiate the required occupancy every 35 s which should yield 1 028 occupancies. If occupancy sensors are not used, observe the SRPM for 10 h. Observe the SRPM during the test and record any alarms or identification results that occur.

After 10 h, repeat the identification test, and neutron and gamma alarm test to ensure the SRPM remained functional during the test.

The stability test result is acceptable when no more than 1 of each type of alarm (i.e., neutron alarm, gamma alarm, or identification) occurs during the 10 h period.

6.2 Neutron radiation detection, if provided

6.2.1 Requirements

A neutron alarm shall be triggered in 59 out of 60 trials using the neutron test source defined in 5.2 at the monitor-specific transient speed and distance.

6.2.2 Method of test

Pass the neutron test source defined in 5.2 horizontally through the top, middle, and bottom of the detection zone at the passage velocity and test distance for that SRPM type as described in 4.1. See Figure 1 for additional test height information. There shall be 20 trials for each height to obtain a total of 60 trials per test source with a minimum delay of 10 s between each trial with the source moved to a position where it does not affect the background. Gamma-rays emitted from the ^{252}Cf or ^{244}Cm neutron sources may cause gamma indications.

The SRPM is considered acceptable when a neutron alarm occurs in a minimum of 59 out of 60 trials.

6.3 Gamma over-range indication

6.3.1 Requirements

An SRPM shall indicate an over-range condition when exposed to an ambient dose-equivalent rate greater than the maximum ambient dose equivalent rate defined by the manufacturer. Once activated, it shall be possible to silence the audible alarm without affecting the visual indication. The SRPM shall return to non-alarm condition within 1 min after the ambient dose-equivalent rate is returned to the pre-exposure level.

6.3.2 Method of test

Determine the maximum ambient dose-equivalent rate from the manufacturer-provided information. Using a ^{137}Cs source, determine the test distance needed to produce an ambient dose-equivalent rate 1,5 times the stated maximum rate. This distance will be used for source positioning.

Move the test source(s) through the detection zone and once an over-range condition is indicated, stop the source(s) for a period of 1 min. During that time, silence the audible alarm to verify that the visual indication remains activated. After 1 min, remove the test source(s) from the area and verify the alarm stops within 1 min. Repeat the test for a total of 3 trials. The SRPM is considered acceptable if all 3 trials are successful.

6.4 Detection of neutron radiation in a high gamma field

6.4.1 Requirements

An ambient dose equivalent rate of 100 μSv·h^{-1} measured at 50 cm from a ^{137}Cs source shall not activate a neutron alarm.

In addition, a neutron alarm shall be activated when an SRPM is simultaneously exposed to the same ^{137}Cs test field and the neutron source as defined in 5.2.

If the SRPM over-ranges at the above dose rate value and the neutron alarm cannot be verified, then the ambient dose equivalent rate should be reduced to the maximum value for which the over-range condition is no longer present and the test should be carried out as described below.

6.4.2 Method of test – large road vehicle and multiple-sided rail vehicle monitors

To verify the gamma-only requirement, horizontally pass the required ^{137}Cs source at a distance of 1,25 m from the surface of the detection assembly(s) and at the appropriate test speed (Table 2) through the top, middle, and bottom of the detection zone (Table 3). See Figure 1 for additional test height information.

NOTE The test distance of 1,25 m is based on the position of a source of radiation (i.e., passenger or driver with a medical radionuclide) nearer to the detection assembly as could exist in a vehicle as it passes through the detection zone.

There shall be 3 trials for each height with a minimum delay of 10 s between each trial. The SRPM is considered acceptable when no neutron alarms occur. Gamma identifications are expected.

To verify the simultaneous requirement, repeat the gamma-only requirement test with the addition of the neutron source moved at the appropriate speed and distance (see Tables 2 and 3) through the top, middle, and bottom of the detection zone. There shall be 3 trials for each height with a minimum delay of 10 s between each trial. The SRPM is considered acceptable when a neutron alarm occurs for each trial. Gamma alarms and identifications are expected.

6.4.3 Method of test – all other types of monitors

To verify the gamma-only requirement, pass the required ^{137}Cs source horizontally through the top, middle, and bottom of the detection zone at the passage velocity and test distance for that SRPM type (see Tables 2 and 3). See Figure 1 for additional test height information. There shall be 3 trials for each height with a minimum delay of 10 s between each trial. The SRPM is considered acceptable when no neutron alarms occur. Gamma identifications are expected.

To verify the simultaneous requirement, pass the required ^{137}Cs source and neutron source horizontally through the top, middle, and bottom of the detection zone at the passage velocity and test distance for that SRPM type. There shall be 3 trials for each height with a minimum delay of 10 s between each trial. The SRPM is considered acceptable when a neutron alarm occurs for each trial. Gamma alarms and identifications are expected.

6.5 Background effects

6.5.1 Requirements

The SRPM shall provide a warning indication if a gradual change in background occurs that is great enough to cause a substantial change in detection capability, e.g., from a slowly approaching radiation source.

6.5.2 Method of test

Place the ^{137}Cs source from Table 5 at a distance of at least 8 m from the detection assembly(s) at the middle height of the detection zone. Move the source horizontally towards the detection zone without causing an occupancy at a speed that is 10 % of that listed in Table 2. Repeat the process for a total of 3 trials with the source moved to the starting point after each pass.

The results are acceptable when the SRPM either identifies the ^{137}Cs source either prior to or when the source is within the detection zone or indicates the background has changed in each of the 3 trials.

If applicable, repeat the entire 3-trial process for neutrons using the neutron alarm test source as defined in 5.2. The results are considered acceptable when a neutron alarm is activated in each trial.

6.6 Radionuclide identification

6.6.1 Radionuclide library and identification categorization

6.6.1.1 Requirements

The identification library shall be stated by the manufacturer and shall contain as a minimum, the sources listed in Table 8. The library should contain the applicable source category as recommended in Table 9.

This is an informative list of radionuclides and should not be considered as all-inclusive.

Table 8 – Radionuclide library

^{241}Am	^{67}Ga	^{192}Ir	^{40}K
^{133}Ba	^{131}I	^{235}U	^{137}Cs
^{57}Co	^{99m}Tc	^{238}U	^{226}Ra
^{60}Co	^{201}Tl	^{239}Pu	^{232}Th

Table 9 – Radionuclide categorisation

Category	Material
Special Nuclear Materials (SNM)	Uranium (DU, LEU, HEU, refined Uranium), Plutonium (WGPu)
Medical radionuclides	^{67}Ga, ^{99m}Tc, ^{131}I, ^{201}Tl
Naturally occurring radioactive materials (NORM)	^{40}K, ^{226}Ra and daughters, ^{232}Th and daughters, Uranium ore (usually identified as radium)
Industrial radionuclides	^{57}Co, ^{60}Co, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{226}Ra, ^{232}Th, and ^{241}Am

6.6.1.2 Method of test

Verify that the requirement is met by review of manufacturer's information provided in the technical manual and in the operating system.

6.6.2 Radionuclide identification qualification

Sources used for testing shall be checked for gamma-ray emitting impurities. Other than medical radionuclides, sources with impurities should not be used. Identification of daughter radionuclides and medical source impurities is acceptable.

Table 10 – Identification acceptance criteria[1,2]

Source	Required identification (at least one)	Additional acceptable identification
^{241}Am	^{241}Am	None
^{137}Cs	^{137}Cs	None
^{60}Co	^{60}Co	None
^{67}Ga	^{67}Ga	None
^{131}I	^{131}I	None
^{99m}Tc	^{99m}Tc	^{99}Mo
^{201}Tl	^{201}Tl	^{202}Tl
^{226}Ra	^{226}Ra, Radium	None
^{232}Th	^{232}Th, Thorium, Th	^{228}Th
DU	DU, U, ^{238}U, uranium	^{235}U
HEU	HEU, U, ^{235}U, uranium	^{238}U
WGPu	WGPu, Pu, ^{239}Pu, plutonium	^{241}Pu, ^{240}Pu, ^{238}Pu, ^{241}Am, ^{237}U, ^{242}Pu, neutron, ^{233}U
^{99m}Tc + HEU	^{99m}Tc + HEU, U, ^{235}U, or uranium	^{238}U, ^{99}Mo
^{131}I + WGPu	^{131}I + WGPu, Pu, ^{239}Pu, or plutonium	^{241}Pu, ^{240}Pu, ^{238}Pu, ^{241}Am, ^{237}U, ^{242}Pu, neutron, ^{233}U

[1] For either transient or static testing, the additional identification of NORM (i.e.,^{40}K, ^{226}Ra and daughters, ^{232}Th and daughters, Uranium ore (usually identified as radium)) is considered acceptable.

[2] Identification results may be notated differently. For example, ^{241}Am may be shown as Am-241; "neutron" may be abbreviated to "neutr."

6.6.3 Single radionuclide identification

6.6.3.1 Requirements

An SRPM shall identify the gamma emitting sources and materials listed in Table 5 and Table 6 at the distances and speeds applicable to the SRPM type (e.g., pedestrian, vehicle, etc.).

6.6.3.2 Method of test

For transient measurements, pass each source and material listed in Table 5 and Table 6 through the detection zone horizontally at the required test speed (Table 2) at the application-specific distance (Table 3). The transit heights shall be based on the application and are the bottom, middle, and top of the detection zone.

The test for transient measurements shall consist of 20 consecutive trials for ^{241}Am, ^{137}Cs, ^{60}Co, HEU, and WGPu at each test height as required for that monitor's application for a total of 60 trials for each source. For other test materials and radionuclides, the transient test shall consist of 10 trials at each test height for a total of 30 trials. The SRPM shall be reset after (or before) each trial, if appropriate. There shall be a delay of at least 10 s between each trial with the source either positioned at a distance where it does not affect the background or is shielded during the delay.

The transient performance is acceptable when the monitor identifies ^{241}Am, ^{137}Cs, ^{60}Co, HEU, and WGPu as described in Table 10 (required identification and additional acceptable identification) in at least 59 out of 60 total trials. For other test materials and radionuclides, the transient test acceptance criteria shall be as described in Table 10 (required identification and additional acceptable identification) in at least 9 out of 10 total trials at each test height.

For static measurements, manually start a measurement cycle with each source and material listed in Table 5 and Table 6 positioned at the application-specific distance (Table 3) at the middle height as required for that monitor's application. The recommended measurement time shall be stated by the manufacturer with a maximum of 60 s.

The static test shall consist of 20 trials for each radionuclide. The performance is acceptable when the SRPM identifies the radionuclide as described (required and additional acceptable identification) in Table 10 in at least 19 out of 20 trials.

6.6.4 Simultaneous radionuclide identification

6.6.4.1 Requirements

The SRPM shall have the ability to identify more than one radionuclide simultaneously.

6.6.4.2 Method of test

The following source combinations using sources from Table 5 and Table 6 shall be used for testing:

– HEU + ^{99m}Tc

– WGPu + ^{131}I

NOTE During field use, the SPRM may prioritize the identification results.

For transient measurements, pass each source combination through the detection zone horizontally at the required test speed (Table 2) at the application-specific distance (Table 3). The transit heights shall be based on the application and are the bottom, middle, and top of the detection zone.

The test for transient measurements shall consist of 20 consecutive trials for each radionuclide at each height as required for that SRPM's application for a total of 60 trials. The SRPM shall be reset after (or before) each trial, if appropriate. There shall be a delay of at least 10 s between each trial with the source either positioned at a distance where it does not affect the background or is shielded during the delay.

The performance is acceptable when the SRPM identifies the combination as required in Table 10 in at least 59 out of 60 total trials.

For static measurements, manually start a measurement cycle with each source combination positioned at the application-specific distance (Table 3) at the middle height as required for that monitor's application. The recommended measurement time shall be stated by the manufacturer with a maximum of 60 s.

The static test shall consist of 20 trials. The performance is acceptable when the SRPM identifies the source combination as required in Table 10 in at least 19 out of 20 trials.

For either transient or static testing, the additional identification of NORM (i.e.,^{40}K, ^{226}Ra and daughters, ^{232}Th and daughters, Uranium ore (usually identified as radium)) is considered acceptable.

6.6.5 Alarm without identification

6.6.5.1 Requirements

The SRPM shall alarm and indicate, for example, "source not in library" or "unknown source" when exposed to a radioactive source that could not be identified. This capability shall be stated by the manufacturer.

The SRPM shall alarm when exposed to a radioactive source that does not produce photo-peaks.

6.6.5.2 Method of test

To verify the response to a radioactive source that does not produce photopeaks, it is recommended that the test be performed using a $^{90}Sr/^{90}Y$ source in an assembly that produces bremsstrahlung radiation. The dose equivalent rate at the surface of the detection assembly should be 0,2 $\mu Sv \cdot h^{-1}$ (0 %, +50 %).

Start a measurement cycle with the source positioned to produce the required dose equivalent rate at the surface of a detection assembly. The recommended measurement time shall be stated by the manufacturer with a maximum of 60 s.

The performance is acceptable when the SRPM alarms and provides a message such as "non-NORM source", "source not in library", "unknown source", "unknown peak", "Sr/Y", or "bremsstrahlung."

7 Climatic requirements

7.1 General

SRPMs shall comply with the climatic requirements for the expected environments as stated in IEC 62706.

To ensure that each requirement is met, ^{241}Am and ^{60}Co (or sources that emit low and high energy gamma rays) are used to provide the gamma response and a neutron source, e.g., ^{252}Cf, ^{241}Am-Be, or ^{244}Cm, is used to provide the neutron response.

7.2 Ambient temperature

7.2.1 Requirements

The SRPM shall function properly when tested over the applicable temperature range specified in IEC 62706 (i.e., non-weather protected, or controlled weather protected).

7.2.2 Method of test

Follow the applicable ambient temperature method of test specified in IEC 62706.

To verify the performance of each detection assembly and any components used in uncontrolled environments against the requirements, perform the pre-test measurements as described in 5.5.2 at 22 ± 2 °C (nominal temperature). During the test, perform the intermediate measurements as described in 5.5.3 at 10 °C intervals after a 2 h soak at each temperature, and at the beginning, middle, and end of the 16 h temperature extreme soak intervals.

Following return to the nominal temperature, perform the post-test measurements as described in 5.5.4 and analyse the results in accordance with Table 7.

7.3 Relative humidity

7.3.1 Requirements

Follow the relative humidity method of test specified in IEC 62706.

If the SRPM is designed for use in uncontrolled environments, it shall function properly when tested over the relative humidity conditions specified in IEC 62706. Following exposure to the selected test technique, there shall be no visible external damage to a detection assembly and any other component used in an uncontrolled environment.

SRPMs may be installed in locations where extremes in humidity exist. Users may want to evaluate the expected installation conditions and add design requirements to prevent degradation of the SRPM after installation. Guidance can be found in IEC 62706.

7.3.2 Method of test

To verify the performance of each detection assembly and any components used in uncontrolled environments against the requirements, perform the pre-test measurements as described in 5.5.2 at the nominal temperature and humidity. During the test, perform the intermediate measurements as described in 5.5.3 at the intermediate and extreme temperature and humidity values.

Following return to the nominal temperature and humidity values, perform the post-test measurements as described in 5.5.4 and analyse the results in accordance with Table 7.

7.4 Dust and moisture protection

7.4.1 Requirements

The SRPM shall meet the IP classification requirements stated in IEC 62706 for the appropriate installation location as stated by the manufacturer (IP 51 or 54).

SRPMs may be installed in locations where the presence of mould (flora) and invasive fauna such as ants may cause degradation of the SRPM. Users may want to evaluate the expected installation conditions and add design requirements to prevent degradation of the SRPM after installation. Guidance can be found in IEC 62706.

7.4.2 Method of test – Dust

Follow the manufacturer-defined IP classification method of test for dust as specified in IEC 62706.

To verify the performance of the detection assembly against the requirement, perform the pre-test measurements as described in 5.5.2. Following exposure to the dust environment, perform the post-test measurements as described in 5.5.4 and analyse the results in accordance with Table 7. For this test, also inspect the detection assembly to determine the extent of dust ingress.

7.4.3 Test method – Moisture

Follow the manufacturer-defined IP classification method of test for moisture as specified in IEC 62706.

To verify the performance of the detection assembly against the requirements, perform the pre-test measurements as described in 5.5.2. Observe the response of the detection assembly while being exposed to the water spray without sources present and record any functional changes that may occur (e.g., alarms, fault indications). Following exposure to the moisture environment, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7. For this test, also inspect the unit to determine the extent of moisture ingress.

If saltwater spray testing is desired, IEC 60068-2-11, using a conditioning duration of 16 h is recommended.

7.5 Climatic exposure type test

7.5.1 Requirements

There have been observable effects on some installed radiation portal monitors after long-term use that indicate incursion of moisture to the detector. Verification of susceptibility is difficult to quantify using the requirements and test methods stated in a normal performance requirement standard such as this document. To gain confidence in a detection assembly enclosure design, a type test is recommended. The type test should be performed on a typical detection assembly that does not need to include detectors. It should be in the configuration used to include the door seals and any penetrations for electrical connections. The test method is based on a cyclic humidity condition to accelerate the stress on the enclosure materials that could be brought about by changes in temperature, relative humidity, and solar/ultraviolet light.

7.5.2 Method of test

Obtain 2-3 detection assembly enclosures configured as they would be for a normal system, i.e., door seals, seal-type vents, and wiring penetrations (with means attached to ensure no moisture penetration) except without individual detectors included. Prior to the test, perform a moisture test as defined in 7.4.3 on each enclosure to verify that no moisture penetrates the enclosure. If the enclosure is acceptable, perform 4 cycles of Procedure Sa 2 – 24 h cycle, 20 h irradiation and 4 h darkness from IEC 60068-2-5. Upon completion, repeat 7.4.3 and inspect as necessary.

8 Mechanical requirements

8.1 Vibration

8.1.1 Requirements

Detection assembly(s) shall withstand exposure to vibrations associated with the operation of installed equipment as defined in IEC 62706.

8.1.2 Method of test

Follow the installed equipment vibration method of test specified in IEC 62706.

To verify the performance of the detection assembly against the requirements, perform the pre-test measurements as described in 5.5.2. Observe the response from the detection assembly while being exposed to the vibration without the sources present and record any functional changes that may occur (e.g., alarms, fault indications). Following vibration, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7. In addition, inspect the detection assembly to ensure that the physical condition was not affected by the shocks (e.g., solder joints shall hold; nuts and bolts shall not come loose).

8.2 Microphonics/Impact

8.2.1 Requirements

Detection assembly(s) shall be unaffected by microphonic conditions such as those that may occur from low intensity impacts from sharp contact with hard surfaces in accordance with the microphonic/impact requirements for all other instrument types defined in IEC 62706, low intensity sharp contacts at energies of up to 1,0 J.

8.2.2 Method of test

Follow the microphonics/impact method of test for "all other" equipment as defined in IEC 62706.

To verify the performance of the SRPM against the requirements, perform the pre-test measurements as described in 5.5.2. Observe the response of the SRPM while being exposed to the impacts without the sources present and record any functional changes that may occur (e.g., alarms, fault indications). Following the test, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7.

9 Electric and electromagnetic requirements

9.1 Electrostatic discharge (ESD)

9.1.1 Requirements

SRPMs shall not be affected by exposure to electrostatic discharges in accordance with the electrostatic requirements defined in IEC 62706.

9.1.2 Method of test

Follow the ESD method of test as defined in IEC 62706.

To verify the performance of the SRPM against the requirement, perform the pre-test measurements as described in 5.5.2. Observe the response of the SRPM while being exposed to the discharges without the sources present and record any functional changes that may occur (e.g., alarms, fault indications). Following the exposure, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7.

9.2 Radio frequency (RF)

9.2.1 Requirements

SRPMs should not be affected by RF fields in accordance with the radiofrequency immunity requirements for installed instruments as defined in IEC 62706.

NOTE Wireless interface technologies may not work in the presence of RF.

9.2.2 Method of test

Follow the RF method of test as defined in IEC 62706. It is recommended the SRPM be set up as it would be installed. Any connecting cables that are normally installed in conduit or underground should be set up to ensure consistency with an installation.

To verify the performance of the SRPM against the requirements, perform the pre-test measurements as described in 5.5.2. Without moving the radiation test sources, observe the response of the detection assembly while being exposed to the radio frequency conditions and record any functional changes that may occur (e.g., alarms, display changes, fault indications). Remove the radiation test sources and repeat the radiofrequency exposure while observing the response of the SRPM. Record any functional changes that may occur (e.g., alarms, indications, display changes, fault indications).

Following the completion of the test, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7.

9.3 Radiated RF emissions

9.3.1 Requirements

The electromagnetic (EM) fields emitted by the detection assembly at 3 m shall be in accordance with the emission requirements stated in IEC 62706.

9.3.2 Method of test

Follow the RF emissions method of test as defined in IEC 62706.

9.4 Conducted disturbances

9.4.1 Requirements

SRPMs shall not be affected by RF fields that can be conducted onto the instrument through an external conducting cable in accordance with IEC 62706, immunity from conducted RF. SRPMs that do not have at least one external conducting cable are excluded.

9.4.2 Method of test

Follow the conducted disturbances method of test as defined in IEC 62706.

To verify the performance of the SRPM against the requirements, perform the pre-test measurements as described in 5.5.2. Without moving the radiation test sources, observe the response from the detection assembly while being exposed to the radio frequency conditions and record any functional changes that may occur (e.g., alarms, display changes, fault indications). Remove the radiation test sources and repeat the radiofrequency exposure while observing the response of the SRPM. Record any functional changes that may occur (e.g., alarms, identifications, display changes, fault indications).

Following the completion of the test, perform the post-test measurements as described in 5.5.4, and analyse the results in accordance with Table 7.

9.5 Surges and oscillatory waves

9.5.1 Requirements

SRPMs shall not be affected by surges or oscillatory waves in accordance with IEC 62706.

9.5.2 Method of test

Follow the surges and oscillatory waves method of test as defined in IEC 62706.