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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radiation protection instrumentation – Spectroscopy-based portal monitors used for the detection and identification of illicit trafficking of radioactive material

Instrumentation pour la radioprotection – Moniteurs spectroscopiques pour portiques d'accès utilisés pour la détection et l'identification du trafic illicite des matières radioactives

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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.

The text of this standard is based on the following documents:

FDIS	Report on voting
45B/634/FDIS	45B/644/RVD

Full information on the voting for the approval of this 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,
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- replaced by a revised edition, or
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RADIATION PROTECTION INSTRUMENTATION – SPECTROSCOPY-BASED PORTAL MONITORS USED FOR THE DETECTION AND IDENTIFICATION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

1 Scope and object

This International Standard specifies the operational and performance requirements for spectroscopy-based portal monitors used for the detection and identification of illicit trafficking of radioactive material. Spectroscopy-based portal monitors have the ability to detect gamma and neutron radiation and identify gamma-emitting radionuclides that may be present in or on persons, vehicles, containers, or packages in a static or transient mode of operation.

Operational requirements established by this standard include radiation detection and gamma-emitting radionuclide identification, and those requirements associated with the expected electrical, mechanical, and environmental conditions when a portal monitor is deployed.

The object of this standard is to establish performance requirements and to give examples of acceptable test methods, and to specify general characteristics, general test conditions, radiation characteristics, electrical safety, and environmental characteristics to determine if a portal monitor meets the requirements of this standard.

Special applications, which may include a monitor's operation under weather conditions or for detection needs not addressed by this standard, shall require additional testing.

Obtaining operating performance that meets or exceeds the specifications as stated in this standard depends upon properly installing the monitor, establishing appropriate operating parameters, providing security for the monitor, maintaining calibration, implementing a suitable response testing and maintenance program, auditing compliance with quality requirements, and providing proper training for operating personnel.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-393:2003, *International Electrotechnical Vocabulary (IEV) – Part 393: Nuclear instrumentation – Physical phenomena and basic concepts*

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation – Instruments, systems, equipment and detectors*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (1999)

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

ISO 4037-1:1996, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 1: Radiation characteristics and production methods*

ISO 4037-2:1997, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 2: Dosimetry for radiation protection over the energy ranges from 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

ISO 4037-3:1999, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence*

ISO 8529-1:2001, *Reference neutron radiations – Part 1: Characteristics and methods of production*

ISO 8529-2:2000, *Reference neutron radiations – Part 2: Calibration fundamentals of radiation protection devices related to the basic quantities characterizing the radiation field*

ISO 8529-3:1998, *Reference neutron radiations – Part 3: Calibration of area and personal dosimeters and determination of response as a function of neutron energy and angle of incidence*

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

3 Terms and definitions, abbreviations, 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 60050-393 and IEC 60050-394 apply.

3.1.1
acceptable (or correct) identification
when a monitor identifies the radionuclide(s) that are present

3.1.2
alarm
an audible, visual, or other signal activated when the instrument reading exceeds a preset value, falls outside of a preset range, or when the instrument detects and/or identifies the presence of the source of radiation according to a preset condition

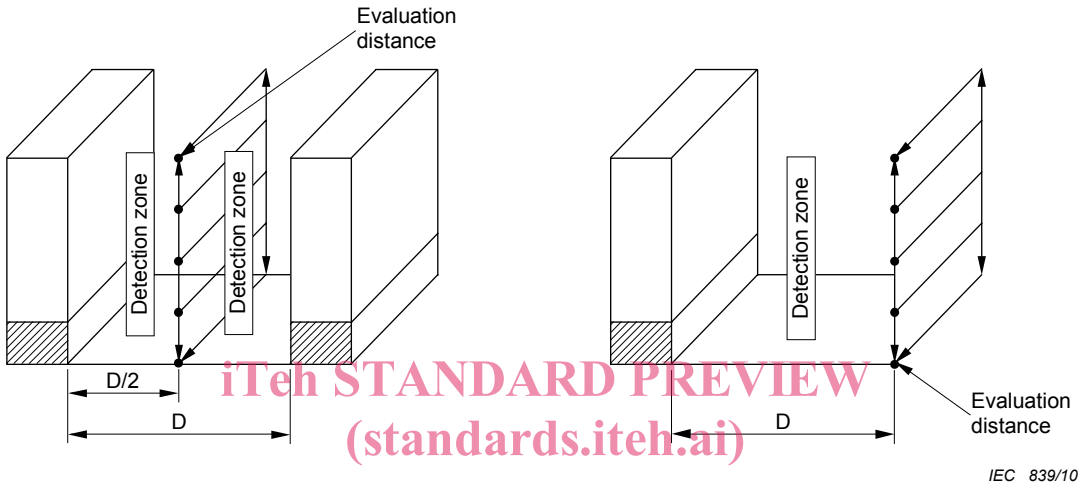
[IEV 393-18-03, modified]

3.1.3
alarm criteria
conditions that cause a monitor to alarm

3.1.4
confidence indication
an indication provided by the monitor on the reliability assigned to the determined identification

3.1.5
detection zone
volume where radiation emitted by an object or person may be detected by the detection assembly(s). For two-sided monitors, the detection zone is located between opposing detection assemblies; for single-sided monitors, the detection zone is adjacent to the detection assembly surface (see Figure 1)

3.1.6
evaluation distances
the distance between an evaluation test source and the exterior surface of the detection assembly(s) that faces the detection zone (see Figure 1)



Key

D Distance between detection assemblies or evaluation distance for single-sided monitors
(D = 5 m for single-sided vehicle monitors and 1 m for single-sided pedestrian or package monitors. For fixed monitors, “D” is stated by the manufacturer.)

Figure 1 – Diagram of mounting dimensions for radionuclide identifying portal monitors

3.1.7
false alarm
alarm not caused by an increase in radiation level over background conditions

[IEC 62401]

3.1.8
false identification
misinterpretation of data being measured by a system leading to the incorrect identification of radionuclide(s) or isotopes of all radionuclides that are present

3.1.9
innocent alarm
an alarm, as designated by the operator, caused by an increase in radiation from radioactive material such as NORM (e.g., fertilizer, tiles, ceramics), legal radioactive shipments, or in-vivo medical radionuclides

3.1.10
live time
time interval during which a detection assembly is sensitive to the input signal

[IEV 394-39-31, modified]

3.1.11
manufacturer
includes the designer of the equipment

3.1.12
occupancy
when the detection zone is occupied with an object (e.g., person, vehicle, package) that is being monitored

3.1.13
peripheral device
any device connected to the system other than the detector or detection assembly that is not required for operation

3.1.14
purchaser
includes the user of the equipment

3.1.15
radioactive material
in this standard, radioactive material includes special nuclear material and any radioactive source, unless otherwise specifically noted

3.1.16
reference point of the detection zone
the point at the geometric centre of the detection zone for two-sided monitors or at the geometric centre of the detection zone that is adjacent to a single-sided monitor at a distance from the detection assembly surface that is based on the monitor type (Figure 1)

3.1.17
run time
the duration (i.e., elapsed clock time) of the acquisition of the spectrum or other data

3.1.18
standard test sources
a set of radioactive sources required to perform an evaluation that are traceable to a national or international standard

3.1.19
static mode
when the object being monitored is stationary within the detection zone for the monitoring period

3.1.20
transient mode
when the object being monitored passes through the detection zone

3.2 Abbreviations

3.2.1
ESD
electrostatic discharge

3.2.2
DU
depleted uranium

3.2.3
HEU
highly enriched uranium

3.2.4
IAEA
International Atomic Energy Agency

3.2.5
LEU
low enriched uranium

3.2.6
NORM
naturally occurring radioactive material

3.2.7
PMMA
polymethyl methacrylate

3.2.8
RF
radio frequency

3.2.9
RGPu
reactor grade plutonium

3.2.10
RH
relative humidity

3.2.11
SNM
special nuclear material

3.2.12
WGPu
weapons grade plutonium

3.3 Quantities and units

In the present standard, units of the International System (SI) are used[1]. The definitions of radiation quantities are given in IEC 60050-393 and IEC 60050-394. The corresponding old units (non SI) are indicated in brackets.

Nevertheless, the following units may also be used:

– for energy: electron-volt (symbol: eV), 1 eV = 1,602 × 10^{-19} J;
– for magnetic flux density: gauss (G);
– for time: years (symbol: y), days (symbol: d), hours (symbol: h), minutes (symbol: min).

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

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

4 Design requirements

4.1 General requirements

The equipment addressed by this standard shall detect the presence of gamma-ray and neutron sources, and identify gamma-emitting radionuclide(s) in objects, containers, vehicles, or in, or being carried by, pedestrians.

An alarm shall be activated when the signal from the detection system exceeds an alarm or preset condition (user selectable for radiation level or identification result). Measurement occurs when the object passes through the detection zone 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).

Passage speeds for transient mode testing are stated in Table 1. Testing at different speeds may be performed as a special test upon agreement between the manufacturer and user. The manufacturer shall state the time required for static measurements.

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 their use, spectroscopy-based portal monitors are classified as:

– pedestrian monitor,
– vehicle (including containerized cargo handlers) monitor,
– rail vehicle monitor, and
– package monitor (i.e., conveyor).

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 size of the detection zone for which the requirements stated in this standard are met.

The monitor shall meet the performance requirements of this standard when installed as tested. Operational conditions such as separation distance (distance between opposing detection assemblies) and background radiation shall be considered when installing the monitor. The manufacturer shall state the distance and background level at which the monitor meets this standard. If the manufacturer-stated distance is different from that required by this standard, testing should be carried out at the manufacturer stated distance.

It is important to be able to identify the person or vehicle 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 (i.e., pedestrians).

4.1.1 Pedestrian monitor

Pedestrian monitors shall provide a detection zone to ensure that people are monitored. For evaluation purposes, the height of the detection zone shall be 1,9 m measured from 0,1 m above the ground. The recommended distance between detection assemblies for evaluation purposes is listed in Table 2 or provided by the manufacturer for monitors where each detection assembly is part of a structure with a fixed distance between each assembly.

Pedestrian monitors may use a single detection assembly (single-sided) or multiple opposing detection assemblies with or without detectors across the top and/or bottom part of the detection zone. For monitors with a restricted passage height, the height of the detection zone shall be from the ground or base surface to the top surface of the monitors' detection assembly.

The passage speed for transient mode testing shall be the speed listed in Table 1.

4.1.2 Vehicle monitor

Vehicle monitors shall provide a detection zone that ensures that the entire vehicle is monitored during passage when operated in transient mode. The height of the detection zone shall be stated by the manufacturer.

NOTE Different heights may be used based on the region of use and associated local requirements.

For trucks, the height of the detection zone for testing purposes shall be 4,3 m measured from 0,2 m above the ground. For passenger cars, the height of the detection zone for testing purposes shall be 2,8 m measured from 0,2 m above the ground. The distance between vertical detection assemblies for evaluation purposes is listed in Table 2 or is given by the manufacturer.

Passage speeds for transient mode testing are stated in Table 1. Testing at slower speeds may be performed as a special test upon agreement between the manufacturer and user. The manufacturer shall state the time required for static measurements.

4.1.3 Rail vehicle monitor (includes rail transported containers)

Rail vehicle monitors shall provide a detection zone that ensures that the entire rail vehicle is monitored during passage. For evaluation purposes, the height of the detection zone shall be 5,7 m measured from 0,3 m above the rail (for test purposes, the ground surface should be considered as the top of the rail). For monitors with a restricted passage height, the top of the detection zone shall be to the top surface of the monitors' detection assembly. The distance between vertical detection assemblies for evaluation purposes is listed in Table 2 or is given by the manufactured dimension.

NOTE Different heights may be used based on the region of use and associated local requirements.

The passage speed for transient mode testing shall be the speed listed in Table 1.

4.1.4 Package (or conveyor) monitor

Package or conveyor monitors shall provide a detection zone that ensures that items moving through the detection zone are monitored. The dimensions of the detection zone shall be stated by the manufacturer. Monitors may use a single detection assembly (single-sided) or multiple opposing detection assemblies which may have detectors across the top and/or bottom part of the detection assembly (multi-sided).

For evaluation purposes, the height of the detection zone shall be

a) 1 m from the base surface (that surface which corresponds to the ground or conveyor bottom surface) for detectors mounted below the base surface, or

b) 1 m from the base surface to the face of the detection assembly for detectors mounted above the base surface. For monitors with a restricted passage height, the height of the detection zone shall be from the base surface to the manufacturer-specified distance.

The passage speed for transient mode testing shall be the speed listed in Table 1.