

INTERNATIONAL STANDARD

**Radiation protection instrumentation – Alarming personal radiation devices
(PRDs) for the detection of illicit trafficking of radioactive material**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIATION PROTECTION INSTRUMENTATION – ALARMING PERSONAL RADIATION DEVICES (PRDs) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62401 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 62401, issued in 2007. It constitutes a technical revision.

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

- a) making the standard consistent with the new standards for detection of illicit trafficking of radioactive material (see the Introduction);
- b) changing some requirements:
 - removal of the 2 levels of background levels (high and low) needed for the different tests. Only one background level (laboratory) remains,
 - the gamma alarm is tested using moving sources and not statically (6.2),

- relative intrinsic error,
 - over-range,
 - detection of neutrons;
- c) creating a uniform 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.

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

FDIS	Report on voting
45B/881/FDIS	45B/888/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

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

A bilingual version of this publication may be issued at a later date.

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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 in 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 – IEC standards concerning instruments for the detection of illicit trafficking of radioactive material

Type of instrumentation	IEC number	Title of the standard
Body-worn	62401	Radiation protection instrumentation – Alarming Personal Radiation Devices (PRDs) for the detection of illicit trafficking of radioactive material
	62618	Radiation protection instrumentation – Spectroscopy-Based Alarming Personal Radiation 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 – Spectroscopy-based portal monitors used for the detection and identification of illicit trafficking of radioactive material
Data format	62755	Radiation protection instrumentation – Data format for radiation instruments used in the detection of illicit trafficking of radioactive materials

RADIATION PROTECTION INSTRUMENTATION – ALARMING PERSONAL RADIATION DEVICES (PRDs) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

1 Scope

This document applies to alarming radiation detection instruments that are pocket-sized, carried on the body and used to detect and indicate the presence and general magnitude of gamma radiation fields. Neutron detection may also be provided.

Personal Radiation Devices (PRDs) alert the user to the presence of a source of radiation that is distinctly above the measured average local background radiation level. They are not intended to provide a measurement of the ambient or personal dose equivalent rate.

The object of this document is to describe design and functional criteria along with testing methods for evaluating the performance of the PRDs used for detection of illicit trafficking of radioactive material (e. g., for border radiation monitoring).

This document does not apply to the ambient or personal dose equivalent rate meters which are covered in IEC 60846-1 or IEC 61526, respectively. If the manufacturer states that the PRD can be used for radiation protection purposes, compliance with IEC 60846-1 or IEC 61526 will be needed.

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 – Part 395: Nuclear instrumentation: Physical phenomena, basic concepts, instruments, systems, equipment and detectors*

IEC 60068-2-11, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

IEC 62706:2012, *Radiation protection instrumentation – Environmental, electromagnetic and mechanical performance requirements*

IEC 62755, *Radiation protection instrumentation – Data format for radiation instruments used in the detection of 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 terms and definitions given in IEC 60050-395, as well as the following, 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

A-weighted sound level

frequency weighting of an acoustic spectrum according to a standardized frequency response curve based on the frequency response of the human ear

3.1.2

accuracy

quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

3.1.3

alarm

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

3.1.4

background

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

3.1.5

coefficient of variation

COV

ratio of the standard deviation s to the arithmetic mean \bar{x} of a set of n measurements x_i given by the following formula:

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

3.1.6

conventionally true value of a quantity

best estimate of the value of a quantity used for a given purpose

3.1.7

effective range of measurement

range of values of the quantity to be measured over which the performance of a device meets the requirements of this document

3.1.8

false alarm

alarm not caused by a radioactive source under the specified background conditions

3.1.9

fluence

quotient of dN by da , where dN is the number of particles incident on a sphere of cross-sectional area da (unit: m^{-2})

3.1.10

fluence rate

quotient of $d\Phi$ by dt , where $d\Phi$ is the increment of the fluence in the time interval dt (unit: $\text{m}^{-2}\cdot\text{s}^{-1}$)

3.1.11**point of measurement**

place at which the conventionally true value is determined

3.1.12**reference point**

defined position on instrument to be used to position it at a point where the conventionally true value of the quantity to be measured is known

3.1.13**relative intrinsic error** ϵ_{REL}

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

$$\epsilon_{\text{REL}} = \frac{M - CTV}{CTV}$$

3.1.14**response**

reading or indication of the PRD

3.1.15**standard deviation**

positive square root of the variance

3.1.16**standard test conditions**

prescribed range for influence quantities to be used during testing of a measuring instrument

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type test

test for conformity evaluation on the basis of one or more specimens of a product representative of the production

3.1.18**routine test**

test to which an individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria

3.1.19**acceptance test**

contractual test to prove to the customer that the device meets certain conditions of its specification

3.1.20**uncertainty <of measurement>**

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

Note 1 to entry: Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by experimental standard deviations, are evaluated from assumed probability distributions based on experience or other information.