IEC 62694

Edition 2.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Radiation protection instrumentation – Backpack-type radiation detector (BRD) for the detection of illicit trafficking of radioactive material

Instrumentation pour la radioprotection – Détecteur de rayonnement de type sac à dos (BRD) pour la détection du trafic illicite des matières radioactives



IEC 62694:2022-11(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RADIATION PROTECTION INSTRUMENTATION – BACKPACK-TYPE RADIATION DETECTOR (BRD) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

FOREWORD

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IEC 62694 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

This second edition cancels and replaces the first edition, published in 2014. This edition constitutes a technical revision.

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

a) making the standard consistent with the new standards for detection of illicit trafficking of radioactive material;
b) creating unformed functionality test for all environmental, electromagnetic and mechanical tests and a requirement for the coefficient of variation of each nominal mean reading;
c) revised radiological requirements including the simplification of radionuclide identification acceptance criteria;
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:

Draft	Report on voting
45B/1012/FDIS	45B/1018/RVD

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

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

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

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INTRODUCTION

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 particularly in view of its terrorist potential.

In response to the technical policy of agencies such as 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, international seaports, airports, and major events.

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

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 (SPRDs) for the detection of illicit trafficking of radioactive material
	62694	Radiation protection instrumentation – Backpack-type radiation detector (BRD) for the detection of illicit trafficking of radioactive material
Portable or hand-held	62327	Radiation protection instrumentation – Hand-held instruments for the detection and identification of radionuclides and for the estimation of ambient dose equivalent rate from photon radiation
	62533	Radiation protection instrumentation – Highly sensitive hand-held instruments for photon detection of radioactive material
	62534	Radiation protection instrumentation – Highly sensitive hand-held instruments for neutron detection of radioactive material
Portal	62244	Radiation protection instrumentation – Installed radiation portal monitors (RPMs) for the detection of illicit trafficking of radioactive and nuclear materials
	62484	Radiation protection instrumentation – Spectrometric radiation portal monitors (SRPMs) used for the detection and identification of illicit trafficking of radioactive material
Data format	62755	Radiation protection instrumentation – Data format for radiation instruments used in the detection of illicit trafficking of radioactive materials
Mobile system	63121	Radiation protection instrumentation – Vehicle-mounted mobile systems for the detection of illicit trafficking of radioactive materials

RADIATION PROTECTION INSTRUMENTATION – BACKPACK-TYPE RADIATION DETECTOR (BRD) FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

1 Scope

This document applies to backpack-type radiation detectors (BRDs) that are primarily used for the detection of illicit trafficking of radioactive material. BRDs are portable instruments designed to be worn during use. BRDs detect gamma radiation and may include neutron detection and the ability to identify gamma-ray emitting radionuclides.

This document establishes the operational and testing requirements associated with radiation measurements and the expected electrical, mechanical, and environmental conditions while in use.

This document does not apply to ambient or personal dose equivalent rate meters which are covered in IEC 60846-1 or IEC 61526, respectively.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-395:2014, *International Electrotechnical Vocabulary (IEV) – Part 395: Nuclear instrumentation – Physical phenomena, basic concepts, instruments, systems, equipment and* detectors
IEC60050-395:2014/AMD1:2016
IEC 60050-395:2014/AMD2:2020

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

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

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

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

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

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
alarm
audible, visible, 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 the presence of the source of radiation according to a pre-set condition

3.1.2
background level
radiation field in which there are no external radioactive sources present other than those in the natural background at the location of the measurements

3.1.3
backpack-type radiation detector
instrument composed of several radiation detection components that are placed inside a backpack or other similar enclosure with an external user interface or control device

3.1.4
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:

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

3.1.5
fluence
Φ
quotient of dN by da, where dN is the number of particles incident on a sphere of cross-sectional area da: $\Phi = dN/da$

3.1.6
fluence rate
$\dot{\phi}$
quotient of $d\Phi$ by dt, where $d\Phi$ is the increment of the fluence in the time interval dt, thus $\dot{\phi} = \frac{d\phi}{dt}$

Note 1 to entry: The unit of fluence rate is $m^{-2} \cdot s^{-1}$.

3.1.7
type test
conformity test made on one or more items representative of the production

3.1.8
user interface
software and/or hardware that manages interactions between a user and equipment

3.1.9
variance
σ^2
measure of dispersion, which is the sum of the squared deviation of observations from their mean divided by one less than the number of observations

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

3.2 Abbreviated terms and symbols

BRD	backpack-type radiation detector
COV	coefficient of variation
cps	counts per second
DU	depleted uranium
ESD	electrostatic discharge
GPS	global positioning system
HDPE	high-density polyethylene
HEU	highly-enriched uranium
HPGe	high purity germanium
ICRU	International commission on radiation units and measurements
NORM	naturally occurring radioactive material
PMMA	polymethyl methacrylate
r	radius
RF	radio frequency
SNM	special nuclear material
WGPu	weapons-grade plutonium
XML	eXtensible Markup Language

3.3 Quantities and units

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

The following units may also be used:

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

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

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