

INTERNATIONAL STANDARD



**Radiation protection instrumentation –
Vehicle-mounted mobile systems for the detection of illicit trafficking of
radioactive materials**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

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

IEC Glossary - webstore.iec.ch/glossary

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

INTERNATIONAL STANDARD



**Radiation protection instrumentation –
Vehicle-mounted mobile systems for the detection of illicit trafficking of
radioactive materials**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.280

ISBN 978-2-8322-7706-5

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

CONTENTS

INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions, abbreviated terms and symbols, quantities and units.....	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms and symbols	10
3.3 Quantities and units	11
4 General test procedure	11
4.1 General.....	11
4.2 Standard test conditions	11
4.3 Uncertainties.....	12
4.4 Statistical fluctuations	12
4.5 Background radiation during testing	12
4.6 Operating parameters and set up.....	12
4.7 Setup and test parameters	12
4.8 Dynamic testing	13
4.9 Static testing.....	13
4.10 Radiation sources	14
4.11 Special nuclear material (SNM) and depleted uranium (DU) sources.....	15
4.12 Functionality test and test acceptance range requirements	16
4.12.1 General requirements	16
4.12.2 Pre-test measurements.....	17
4.12.3 Intermediate-test measurements.....	18
4.12.4 Post-test measurements	18
4.12.5 Acceptance criteria	19
5 General requirements	19
5.1 General characteristics	19
5.2 Physical configuration	20
5.3 Data storage and data files	20
5.3.1 Requirements	20
5.3.2 Method of test.....	21
5.4 Communications protocol.....	21
5.4.1 Requirements	21
5.4.2 Method of test.....	21
5.5 Indication and alarm features.....	21
5.5.1 Requirements	21
5.5.2 Method of test.....	21
5.6 Markings	22
5.6.1 Requirements	22
5.6.2 Method of test.....	22
5.7 Power supply	22
5.7.1 Requirements	22
5.7.2 Method of test.....	22
5.8 User interface	22
5.8.1 User accessible controls requirements.....	22
5.8.2 Supervisory-user accessible indications and functions requirements.....	22
5.8.3 User display and visual indicators requirements	23

5.8.4	Warning indicators requirements.....	23
5.8.5	Method of test.....	23
6	Radiological tests	24
6.1	False alarm test	24
6.1.1	Requirements	24
6.1.2	Method of test.....	24
6.2	Gamma radiation alarm.....	24
6.2.1	Requirements	24
6.2.2	Method of test.....	25
6.3	Neutron radiation alarm	25
6.3.1	Requirements	25
6.3.2	Method of test.....	25
6.4	Over-range indication.....	25
6.4.1	Requirements	25
6.4.2	Method of test.....	26
6.5	Neutron indication in the presence of photons.....	26
6.5.1	Requirements	26
6.5.2	Method of test.....	26
6.6	Slowly approaching source—vehicle-mounted mobile system is stationary during use.....	27
6.6.1	Requirements	27
6.6.2	Method of test.....	27
6.7	Background effects—vehicle-mounted mobile system is mobile during use	27
6.7.1	Requirements and background information	27
6.7.2	Method of test.....	28
6.8	Radionuclide identification—when provided	30
6.8.1	Radionuclide categorisation	30
6.8.2	Single radionuclide identification	31
6.8.3	Simultaneous radionuclide identification	32
6.8.4	Radionuclide not available	32
7	Climatic requirements	33
7.1	General.....	33
7.2	Ambient temperature.....	34
7.2.1	Requirements	34
7.2.2	Method of test.....	34
7.3	Relative humidity	34
7.3.1	Requirements	34
7.3.2	Method of test.....	34
7.4	Dust and moisture protection	35
7.4.1	Requirements	35
7.4.2	Method of test—dust.....	35
7.4.3	Method of test—moisture	35
8	Mechanical requirements	35
8.1	Microphonics/impact	35
8.1.1	Requirements	35
8.1.2	Method of test.....	36
8.2	Vibration	36
8.2.1	Requirements	36
8.2.2	Method of test.....	36

9	Electrical and electromagnetic requirements.....	36
9.1	Electrostatic discharge (ESD)	36
9.1.1	Requirements	36
9.1.2	Method of test.....	36
9.2	Radio frequency (RF).....	37
9.2.1	Requirements	37
9.2.2	Method of test.....	37
9.3	Radiated emissions.....	37
9.3.1	Requirements	37
9.3.2	Method of test.....	37
9.4	Battery lifetime.....	37
9.4.1	Requirements	37
9.4.2	Method of test.....	37
10	Documentation	38
10.1	Report.....	38
10.2	Operation and maintenance manual.....	38
	Annex A (informative) Uranium/plutonium detection and identification guidance.....	39
	Bibliography.....	40

	Figure 1 – Reference point diagram for a two-sided vehicle-mounted mobile system (top down view)	14
--	--	----

	Figure 2 – Increasing background with source	29
--	--	----

	Figure 3 – Decreasing background with source	29
--	--	----

	Table 1 – Standard test conditions	11
--	--	----

	Table 2 – Setup and test parameters	13
--	---	----

	Table 3 – Test radionuclides and materials ^a used for Clause 6 of this document.....	15
--	---	----

	Table 4 – SNM fluence rates	16
--	-----------------------------------	----

	Table 5 – Test results analysis.....	19
--	--------------------------------------	----

	Table 6 – Radionuclide library	30
--	--------------------------------------	----

	Table 7 – Radionuclide decay products and impurities	30
--	--	----

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIATION PROTECTION INSTRUMENTATION –
VEHICLE-MOUNTED MOBILE SYSTEMS FOR THE DETECTION
OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIALS**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 63121 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/946/FDIS	45B/955/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 website 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.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Illicit and inadvertent movement of radioactive materials in the form of radiation sources and contaminated metallurgical scrap 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 problem, concern about a nuclear “black market” has increased, 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, radiation instrumentation companies have developed and manufactured instruments 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.

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 this document. IEC standards have also been developed to address personal radiation detectors, radiation portal monitors, highly sensitive gamma and neutron detection systems, spectrometric personal radiation detectors, and backpack-based radiation detection and identification systems. Those standards are listed 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 (SPRD) 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	62211	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
Mobile system	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 – VEHICLE-MOUNTED MOBILE SYSTEMS FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIALS

1 Scope

This document applies to vehicle-mounted mobile systems (also known as mobile systems or mobile monitors) that are used for the detection of illicit trafficking of radioactive materials; these instruments may also be used for protection of major public events and for rapid screening of large areas. These vehicle-mounted mobile systems consist of one or more radiation detectors mounted in a vehicle, e.g., car or van, which travels predominantly on public roads. This document does not apply to detection systems mounted in other types of vehicles, e.g., planes, helicopters, trains, or boats. Vehicle-mounted detection systems covered by this document are designed to detect radioactive sources while the vehicle is in motion. They may also be used as stationary monitors that scan stationary or moving objects. Vehicle-mounted mobile systems detect gamma radiation and may include neutron detection and/or identification of gamma-ray emitting radionuclides.

The purpose of this document is to set minimum requirements for vehicle-mounted mobile systems for the detection of radioactive material. This document establishes general, radiological, climatic, mechanical, electric and electromagnetic, and documentation requirements, and the associated test methods.

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*

IEC 61187, *Electrical and electronic measuring equipment – Documentation*

IEC 62706, *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.