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

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

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 in library 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

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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,
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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	**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
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.

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

3.1.2
alarm response
audible signal or visual signal, initiated when the reading of an instrument exceeds a pre-set value or falls outside a pre-set range

3.1.3
ambient dose equivalent
dose equivalent at a point in a radiation field, produced by the corresponding aligned and expanded field, in the ICRU sphere at a depth d, on the radius opposing the direction of the aligned field

Note 1 to entry: This definition does not include the notes that are part of the definition IEC 60050-395:2014,395-05-43.

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
categorisation
ability of an instrument to determine the type of radioactive material based on its emitted radiation, e.g., naturally occurring radioactive material, nuclear material, medical radionuclides, and industrial sources

3.1.6
coefficient of variation
ratio of the standard deviation to the mean of a value

3.1.7
coverage factor
k
numerical factor, *k*, used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

3.1.8
detection zone
location from which radiation emitted by an object being monitored may be detected by the detection assembly

3.1.9
error of indication
difference between the indicated value v of a quantity and the conventionally true value v_c of that quantity at the point of measurement

3.1.10
nuclear material
plutonium except that with isotopic concentration exceeding 80 % in plutonium-238 (^{238}Pu); uranium-233 (^{233}U); uranium enriched in the isotope 235 or 233 (^{235}U or ^{233}U); uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore-residue; any material containing one or more of the foregoing

[SOURCE: IAEA-TECDOC-1311, September 2002]

3.1.11
reference point
location marked on the instrument or described in the manual used to establish radiation source to instrument distances and orientation for test or calibration purposes

3.1.12
relative intrinsic error
relative error of indication of a piece of equipment or an assembly with respect to a quantity when subjected to a specified reference quantity under specified reference conditions, expressed as:

$$e_i = (v - v_c)/v_c,$$

where

v is the indicated value of a quantity, and

v_c is the conventionally true value of this quantity at the point of measurement.

Note 1 to entry: Simple definition: error of a measuring instrument when used under reference conditions.

3.1.13
type test
conformity test made on one or more items representative of the production

3.1.14
uncertainty <of measurement>
parameter, associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.2 Abbreviated terms and symbols

AAI	additional acceptable identification
CISPR	Comité International Spécial des Perturbations Radioélectriques (Special International Committee on Radio Interference)
COV	coefficient of variation
DU	depleted uranium
ESD	electrostatic discharge
HDPE	high-density polyethylene
HEU	highly-enriched uranium
ICRU	International commission on radiation units and measurements
NORM	naturally occurring radioactive material
PMMA	polymethyl methacrylate
RF	radio frequency
RGPu	reactor grade plutonium
RI	required identification

SNM special nuclear material

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 General test procedure

4.1 General

Unless otherwise specified in an individual step, tests enumerated in this document may be used as part of a type test or an acceptance test.

4.2 Standard test conditions

Except where otherwise specified, the tests described in this document should be performed under the standard test conditions given in Table 1, understanding that vehicle-mounted mobile systems may be large, and that testing may need to be performed in an uncontrolled environment. The ambient temperature, relative humidity, and atmospheric pressure shall be recorded during testing.

Table 1 – Standard test conditions

Influence quantity	Standard test conditions
Ambient temperature	18 °C to 25 °C
Relative humidity	≤ 75 %
Atmospheric pressure	70 kPa to 106,6 kPa
Gamma radiation background	Ambient dose equivalent rate less than or equal to 0,15 μSv•h^{-1}
Neutron background	Neutron fluence rate less than 200 s^{-1}•m^{-2}

NOTE Vehicle-mounted mobile systems are typically used in non-radiological areas, e.g., shipping ports and border locations. Man-made radiological materials such as radiation sources are not expected to be present in these areas. Non-radiological areas are expected to be used when testing vehicle-mounted mobile systems.

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