BS EN 62327:2011

BSI Standards Publication

Radiation protection instrumentation — Hand-held instruments for the detection and identification of radionuclides and for the indication of ambient dose equivalent rate from photon radiation

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National foreword

This British Standard is the UK implementation of EN 62327:2011. It was derived by CENELEC from IEC 62327:2006.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by 〖C〉 〈C〗 tags.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Radiation protection and measurement.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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EUROPEAN STANDARD

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English version

Radiation protection instrumentation - Hand-held instruments for the detection and identification of radionuclides and for the indication of ambient dose equivalent rate from photon radiation

(IEC 62327:2006, modified)

Instrumentation pour la radioprotection - Instruments portables pour la détection et l'identification des radionucléides et pour l'indication du débit d'équivalent de dose ambiant pour le rayonnement de photons (CEI 62327:2006, modifiée)

Strahlenschutz-Messgeräte - Handgeräte für den Nachweis und die Identifizierung von Radionukliden und die Anzeige der durch Gammastrahlung erzeugten Umgebungs-Äquivalentdosisleistung (IEC 62327:2006, modifiziert)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 62327:2006, prepared by SC 45B, “Radiation protection instrumentation”, of IEC TC 45, “Nuclear instrumentation”, together with the common modifications prepared by the Technical Committee CENELEC TC 45B, Radiation protection instrumentation, was submitted to the CENELEC formal vote and was approved by CENELEC as EN 62327 on 2011-06-27.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-06-27
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-06-27

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62327:2006 was approved by CENELEC as a European Standard with agreed common modifications as given below.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-393	2003	International Electrotechnology Vocabulary - Part 393: Nuclear instrumentation - Physical phenomena and basic concepts	-	-
IEC 60050-394 + A1 + A2	1995 1996 2000	International Electrotechnical Vocabulary - Chapter 394: Nuclear instrumentation: Instruments	- - -	- - -
IEC 60529 + A1	1989 1999	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May + A1	1991 1993 2000
IEC 60846 (mod)	2002	Radiation protection instrumentation - Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation	EN 60846	2004
IEC 61187 (mod)	1993	Electrical and electronic measuring equipment - Documentation	EN 61187 + corr. March	1994 1995
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 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 22188	2004	Monitoring for inadvertent movement and illicit trafficking of radioactive material	-	-
International Bureau of Weights and Measures	1998	The international System of Units (SI)	-	-

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INTRODUCTION

Illicit and inadvertent movement of radioactive materials in the form of radiation sources and contaminated metallurgical scrap have become a problem of increasing importance. Radioactive sources out of regulatory control, so-called “orphan sources”, have frequently caused serious radiation exposures and wide spread 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 posts, 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 this International Standard.

RADIATION PROTECTION INSTRUMENTATION – HAND-HELD INSTRUMENTS FOR THE DETECTION AND IDENTIFICATION OF RADIONUCLIDES AND FOR THE INDICATION OF AMBIENT DOSE EQUIVALENT RATE FROM PHOTON RADIATION

1 Scope and object

This International Standard applies to hand-held instruments used for the detection and identification of radionuclides, the detection of neutron radiation and the indication of the ambient dose equivalent rate from photon radiation. This standard does not apply to the performance of radiation protection instrumentation which is covered in IEC 60846.

It is recognized that front line law-enforcement officers, who are generally not radiation experts, may use instruments covered by this standard. This requires user-friendly instrument design and operation with a high degree of inherent safety.

This standard specifies requirements for hand-held photon spectrometers, in particular for the detectors, the electronic multi-channel analyzers, the identification software, the radionuclide libraries, and the instrument display. It further specifies general characteristics, general test procedures, radiation characteristics, as well as electrical, mechanical, safety, and environmental characteristics.

This standard provides guidelines for selecting suitable radionuclide libraries covering radioactive materials that have been most frequently detected at border crossings.

This standard refers to instrumentation which may be used for the purposes described in ISO 22188.

This standard may be used for instruments that do not have neutron response capabilities, in which case, neutron response requirements do not apply. [C] In which case it shall be clearly identified that the instrument is for the measurement of photon radiation only.〈C〉

This standard does not cover laboratory type, high-resolution photon spectrometers.

[C] Conformation with the requirements of this standard does not guarantee that a radionuclide will always be detected.〈C〉

2 Normative references

The following referenced documents are [C] relevant to 〈C〉 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):1995, *International Electrotechnical Vocabulary (IEV) – Chapter 394: Nuclear instrumentation: Instruments*
Amendment 1 (1996)
Amendment 2 (2000)

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

IEC 60846:2002, *Radiation protection instrumentation – Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation*

IEC 61187:1993, *Electrical and electronic measuring equipment – Documentation*

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 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 22188:2003, *Monitoring for inadvertent movement and illicit trafficking of radioactive material*

International Bureau of Weights and Measures: *The international System of Units (SI)*, 7th edition, 1998.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions for radiation quantities and dosimetric terms from IEC 60050(393) and IEC 60050(394), as well as the following terms and definitions apply.

3.1
routine mode
operating mode that is used by a trained non-expert user. Includes detection and identification of radionuclides, and indication of the ambient dose equivalent rate level

NOTE This mode may be called automated or easy mode.

3.2
restricted or expert mode
advanced operating mode used by an expert user to access spectral data and to control the parameters that can affect the result of a measurement (for example – radionuclide library, routine function control, calibration parameters, alarm thresholds, etc.). Access to this mode should be limited through password protection or other similar methods

NOTE This mode may also be called the “advanced” or “protected” mode.

3.3
expert user
person permitted access to an instrument’s operating parameters located in the restricted mode

3.4

[C〉indication of ambient dose equivalent rate〈C]

indication of the ambient dose equivalent rate, not a quantitative measurement of that ambient dose equivalent rate

3.5

conventionally true value of a quantity

value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

[IEV 394-20-10, modified]

3.6

error of indication

difference between the indicated value v of [C〉a quantity〈C] and the conventionally true value v_c of [C〉that quantity〈C] at the point of measurement

[IEV 394-20-13, modified]

3.7

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

[IEV 394-20-12]

3.8

response of a radiation measuring assembly

ratio, under specified conditions, given by the relation:

$$R = v / v_c$$

where v is the value of the quantity measured by the equipment or assembly under test and v_c is the conventionally true value of this quantity

[IEV 394-20-21]

3.9

type test

conformity testing on the basis of one or more specimens of a product representative of the production

[IEV 394-20-28]

3.10

routine test

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

[IEV 394-20-08, modified]

3.11

acceptance test

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

[IEV 394-20-09]

3.12
supplementary tests
tests intended to provide supplementary information on certain characteristics of the devices

3.13
ambient dose equivalent rate

$\dot{H}^*(10)$
quotient of the ambient dose equivalent at the recommended depth for environmental monitoring of 10 mm $dH^*(10)$ by dt, where $dH^*(10)$ is the increment of ambient dose equivalent in the time interval dt

$$\dot{H}^*(10) = \frac{dH^*(10)}{dt}$$

4 General characteristics of hand-held Instruments for the detection and identification of radionuclides

4.1 General

These instruments are used for the detection, localization, and identification of radioactive material and for indication of the ambient dose equivalent rate level. They typically measure the photon spectrum and identify the radionuclide by comparison with an internal radionuclide library. They are hand-held, battery-powered instruments used for field measurements.

4.2 Radiation detectors

These instrument types typically use more than one detector for the different applications. The instrument 〖C〗may〈C〗 be sensitive to both photon and neutron radiation, and discriminate between both. Spectrometric photon detectors shall have sufficient energy resolution, sensitivity, and stability to enable accurate radionuclide identification.

4.3 Energy calibration

The photon energy calibration shall remain stable over the required temperature range.

The calibration shall be unaffected by changes in battery voltage, count rate, or functional status (switched off or on).

A means shall be provided to detect a calibration drift and allow a re-adjustment in the field.

4.4 Software

Built-in software shall be able to identify the presence of radionuclides listed in 6.1, 6.2 and 6.3 in the presence of other radionuclides.

4.5 User interface

The instrument shall use:

– a display that is easily readable under typical lighting conditions, and over the required temperature range,
– user friendly controls,

– a menu structure that is simple and easy to follow, and
– at least two different operating modes, one for routine operation and the other as an expert mode.

4.6 Communication interface

The instrument shall have the ability to transfer data, such as the photon spectra to another device such as a personal computer. The manufacturer shall provide a full description of the transfer data format.

4.7 Moisture and dust protection

The instrument case design shall meet the requirements stated for IP code 53 (〈C〉See 9.5 〈C〉).

〈C〉 *Text deleted* 〈C〉

4.8 Markings

4.8.1 General

All external instrument controls, displays, and adjustments shall be identified according to their function. Internal controls shall be identified through markings on circuit boards and identification in technical manuals.

4.8.2 Exterior markings

The following markings shall appear on the exterior of the instrument or each major assembly (for example, detector probes) as appropriate:

– manufacturer and model number,
– unique serial number,
– location of the effective 〈C〉centre〈C〉 of detector(s), and
– function designation for controls, switches, and adjustments.

Markings shall be easily readable and permanently fixed under normal conditions of use (including use of normal decontamination procedures).

4.9 Battery status Indication

The instrument shall be equipped with a test circuit or other visible direct indicator of battery condition.

4.10 Protection of switches

Switches and other controls should be protected to minimize or prevent inadvertent deactivation or improper operation of the instrument.

4.11 Spectral storage and display

A displayed photon spectrum is not required during routine operation.

The instrument shall have the ability to store at least 50 spectra.

Each stored spectrum shall contain collection and identification results information including:

– time and date,
– identified radionuclides and associated confidence levels,
– indicated ambient gamma dose equivalent rate, and
– where the equipment is able to detect neutrons, neutron count rate at the time of measurement.

4.12 Ambient dose equivalent rate indication

4.12.1 Photon

The instrument shall provide an indication of the ambient dose equivalent rate. Interference from neutron radiation shall be kept to a minimum and be stated by the manufacturer.

4.12.2 Neutron

Neutron indication should be in (neutron) counts per second. Whenever neutrons are detected, an alarm shall also be provided.

4.12.3 Alarm

An alarm shall be provided to alert the user that indicated ambient dose equivalent rates are above the threshold level. The alarm shall be both audible and visual, and adjustable through the expert mode. A means for silent alarm indication shall be provided, for example through the use of vibration and/or earphones.

The alarm shall have an "acknowledge" or other similar control to silence the audible function. The neutron alarm shall be different from the photon alarm.

5 General test procedures

5.1 Nature of tests

Unless otherwise specified in the individual steps, all tests enumerated in this standard are to be considered type tests. Certain tests may be considered acceptance tests by agreement between the customer and the manufacturer.

5.2 Reference conditions and standard test conditions

Reference conditions are given in the second column of Table 1. Except where otherwise specified, tests shall be carried out under the standard test conditions shown in the third column of Table 1. For those tests carried out under standard test conditions, the values of temperature, pressure, and relative humidity shall be stated and the appropriate corrections made to give the response under reference conditions. The values of any corrections should be stated.

Table 1 – Reference conditions and standard test conditions

Influence quantity	Reference conditions (unless otherwise indicated by the manufacturer)	Standard test conditions (unless otherwise indicated by the manufacturer)
Photon radiation energy for: $H^*(10)$	^{137}Cs ([C]S-Cs[C] ISO[C]4037-3[C])	^{137}Cs ([C]S-Cs[C] ISO[C]4037-3[C])
Neutron radiation energy, [C]$H^*(10)$[C]	^{252}Cf	^{252}Cf
Stabilization time	As stated by the manufacturer	As stated by the manufacturer
Ambient temperature	20 °C	18 °C to 22 °C
Relative humidity	65 %	50 % to 75 %
Atmospheric pressure	101,3 kPa	70 kPa to 106,6 kPa
Battery voltage	Nominal voltage	Battery used up to half of its useful life
Angle of incidence of radiation	Reference direction given by the manufacturer	Direction given ±5°
Electromagnetic field of external origin	Negligible	Less than the lowest value that causes interference
Magnetic induction of external origin	Negligible	Less than twice the induction due to the earth's magnetic field
Orientation of instrument	To be stated by the manufacturer	Stated orientation ±5°
Instrument controls	Set up for normal operation	Set up for normal operation
Radiation background	Ambient dose equivalent rate of 0,1 μSv h^{-1} or less if practical	Less than ambient dose equivalent rate of 0,25 μSv h^{-1}
Contamination by radioactive elements	Negligible	Negligible

5.3 Statistical fluctuations

For any test involving the use of radiation, if the magnitude of the statistical fluctuations of the indication arising from the random nature of radiation alone is a significant fraction of the variation of the indication permitted in the test, then sufficient readings shall be taken to ensure that the mean value of such readings may be estimated with sufficient precision to determine whether the requirements for the characteristic under test are met.

The interval between such readings shall be sufficient to ensure that the readings are statistically independent.

6 Radionuclide identification

6.1 Radionuclide categorization

6.1.1 General

The radionuclides of greatest interest and those most likely to be encountered are listed below in four different categories:

– nuclear materials: ^{233}U, ^{235}U, ^{237}Np, Pu (weapon or reactor grade),

– medical radionuclides: Positron Emission Tomography – PET (for example ^{18}F), ^{67}Ga, ^{99m}Tc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{133}Xe, ^{201}Tl,

– industrial radionuclides: ^{57}Co, ^{75}Se, ^{60}Co, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{241}Am, [C] ^{226} Ra and decay products (radioactive source),[C]

– Naturally Occurring Radioactive Materials (NORM): ^{40}K, ^{226}Ra and decay products, ^{232}Th and decay products, ^{238}U and decay products.

NOTE This is an informative list and should not be considered as exhaustive.

The radionuclide database (library) when used as part of the identification process shall contain the radionuclides listed above for test purposes as a minimum, and it shall not be altered during the entire testing process.

An indication shall be made (i.e.: “not identified”) if a radionuclide cannot be clearly identified.

6.1.2 Special requirements for categorizing iodine, uranium, plutonium and thorium

The following requirements are by agreement with the manufacturer and the user.

– “Medical-Iodine” should be indicated if any iodine isotope is detected,

– “Uranium” may be indicated if any uranium isotope is identified,

– “Nuclear-Plutonium” may be indicated if any plutonium isotope is identified,

– “NORM-Thorium may be indicated if ^{232}Th plus decay products are identified,

– “Bremsstrahlung” or “not identified” should be indicated if Bremsstrahlung sources (for example ^{90}Sr/^{90}Y) are detected.

6.2 Identification of single radionuclides

6.2.1 Requirement

The instrument shall be able to identify and/or categorize as stated previously the following radionuclides within the times indicated after exposure to the radionuclide.

– unshielded, in 1 min: ^{111}In, ^{133}Xe, ^{99m}Tc, ^{201}Tl, ^{67}Ga, ^{125}I, ^{123}I, ^{131}I, ^{18}F(PET)[1],

– behind 3 mm steel shielding, in 2 min: Low Enriched Uranium (LEU), Reactor Grade Plutonium (RGPu), Highly Enriched Uranium (HEU), Weapons Grade Plutonium (WGPu), ^{57}Co, ^{241}Am, ^{237}Np,

– behind 5 mm steel shielding, in 2 min: RGPu, HEU, WGPu, ^{133}Ba, ^{40}K, ^{226}Ra [C](and decay products)[C], ^{232}Th [C](and decay products)[C], ^{137}Cs, ^{60}Co, ^{192}Ir.

NOTE For this standard, HEU has an enrichment of >90 % ^{235}U and LEU 3-5 % ^{235}U. RGPu contains 24 % ^{240}Pu and WGPu 6 % ^{240}Pu.

6.2.2 Test method

Expose the instrument to the radionuclides listed in 6.2.1. The ambient dose equivalent rate at the detector measured with an independent radiation measuring device such as an ambient dose equivalent meter from each source, unshielded or shielded, shall be 0,5 μSv h^{-1} (±30 %) above background. The test shall consist of 10 or more trials for each radionuclide. The performance is acceptable if the instrument correctly identifies the radionuclide in at least 90 % of the trials.

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[1] It is acceptable to indicate positron annihilation radiation or other similar text for ^{18}F.

6.3 Identification of mixed radionuclides

6.3.1 Requirement

The following combined radionuclides shall be identified within 1 minute. Each radionuclide shall produce an ambient dose equivalent rate (unshielded) at the detector of 0,5 μSv h^{-1} (±30 %) above background:

- ^{137}Cs + HEU,
- ^{131}I + HEU,
- ^{57}Co + HEU, and
- ^{133}Ba + RGPu.

6.3.2 Test method

Expose the instrument to all radionuclides in a group simultaneously. Each radionuclide shall produce an ambient dose equivalent rate (unshielded) at the detector of 0,5 μSv h^{-1} (±30 %) above background.

The identification shall be made within 1 min after exposure. [C] The test shall consist of 10 or more trials for each combination of radionuclides. The performance is acceptable if the instrument correctly indicates within 1 min the combination of radionuclides in at least 90 % of the trials.〈C〉

6.4 Overload characteristics for identification

6.4.1 Requirement

[C] The manufacturer shall state the maximum ambient dose equivalent rate for identification. The instrument shall indicate if the ambient dose equivalent rate is too high for proper identification.〈C〉

6.4.2 Test method

Increase the ambient dose equivalent rate using ^{137}Cs to 80 % of the maximum ambient dose equivalent rate for radionuclide identification as stated by the manufacturer and perform a radionuclide identification. The instrument shall correctly identify ^{137}Cs. Increase the ambient dose equivalent rate to 120 % of the maximum ambient dose equivalent rate for radionuclide identification as stated by the manufacturer and perform a radionuclide identification. The instrument shall [C] indicate 〈C〉 that the proper identification of the radionuclide is not possible [C] or ^{137}Cs is continued to be identified. In the latter case increase the ambient dose equivalent rate slowly until indication that proper identification of is not possible occurs.〈C〉

6.5 Source indicator

6.5.1 Requirement

The instrument shall provide a means to indicate an increase in the ambient radiation field that may be caused by the presence of a radiation source when searching or scanning for radioactive sources.

The indicator shall be both audible and visual, and adjustable through the expert mode. A means for silent indication shall be provided, for example through the use of vibration and/or earphones. This requirement is separate from the ambient dose equivalent rate alarm that is described in 7.2.

6.5.2 Test method

With the instrument in a stable ambient dose equivalent rate of approximately 0,2 μSv h^{-1}, slowly move a ^{137}Cs source past the instrument where the maximum ambient dose equivalent rate is 0,5 μSv h^{-1}. The instrument shall indicate that there is an increase in the ambient dose equivalent rate and a decrease in the field as the source is moved away from the instrument.

7 Ambient dose equivalent rate indication

7.1 Relative intrinsic error

7.1.1 Requirement

Under standard test conditions, the relative intrinsic error in the response of the instrument to the reference photon radiation from ^{137}Cs shall not exceed ±30 % for all ambient dose equivalent rates from 1 μSv h^{-1} up to 100 μSv h^{-1}. The range of ambient dose equivalent rate indication shall include natural background levels down to 0,03 μSv h^{-1} with possibly higher uncertainty limits.

7.1.2 Test method

Expose the instrument to ambient dose equivalent rates of 5 μSv h^{-1}, 20 μSv h^{-1}, 80 μSv h^{-1} and verify that the readings are within ±30 % of the applied ambient dose equivalent rate.

7.2 Alarm and response time

7.2.1 Requirement

The instrument shall alarm when it is exposed to an increase in the ambient background radiation level that is greater than the user settable alarm threshold within 3 s of the step change. The alarm shall be audible and visual. In addition, the displayed ambient dose equivalent rate indication shall be within ±30 % of the changed ambient dose equivalent rate within 5 s of the change.

7.2.2 Test method

Adjust the alarm threshold to 0,25 μSv h^{-1}. Place the instrument in a stable ambient dose equivalent rate of approximately 0,2 μSv h^{-1}. Increase the ambient dose equivalent rate using a ^{137}Cs source to 0,5 μSv h^{-1} within 1 second. Observe the instrument's response. The alarm shall be activated within 3 s of the step change, and the indicated ambient dose equivalent rate shall be within ±30 % of 0,5 μSv h^{-1} within 5 s. The alarm shall then be acknowledged and the process repeated nine additional times. Acceptable results are when the alarm is activated 9 out of 10 exposures.

7.3 Over range characteristics for ambient dose equivalent rate indication

7.3.1 Requirement

The instrument shall indicate that an over range condition exists when the ambient dose equivalent rate is greater than 10 times the manufacturer's stated maximum ambient dose equivalent rate.

7.3.2 Test method

Expose the instrument to a step change in the ambient dose equivalent rate from ambient to 10 times that of the manufacturer-stated maximum ambient dose equivalent rate. The instrument shall indicate that an over range condition exists within 5 s of the step change and shall remain in that condition for the entire exposure period (minimum of 5 min). After a minimum of 5 min exposure, reduce the radiation field to the pre-test value. The instrument shall operate normally within 5 min.

8 Neutron detection

8.1 Neutron indication

8.1.1 Requirement

[C] If the instrument is neutron sensitive the [C] instrument shall indicate the presence of neutron radiation and trigger an alarm when exposed to neutron radiation.

8.1.2 Test method

[C] *Text deleted* [C]

Expose the instrument to a neutron flux emitted from an unmoderated ^{252}Cf source of 0,01 µg (emitting not more than 20 000 [C] neutrons per second [C] – approximately 3 µSv h^{-1} with the source placed approximately 25 cm from the instrument's reference point). The test source shall be shielded with 1 cm lead to reduce the gamma radiation to less than 1 % of that with the source unshielded. The neutron indication and alarm shall be activated within 10 s of the step change.

[C] Remove the neutron source and leave the instrument switched on for one hour. Insure that there is no more than one neutron alarm, with the alarm setting as recommended by the manufacturer. [C]

8.2 Neutron indication in the presence of photons

8.2.1 Requirement

The instrument shall not trigger neutron alarms when exposed to an ambient gamma dose equivalent rate of up to 0,1 mSv h^{-1} at the reference point of the detector.

The instrument shall indicate the presence of neutron radiation when exposed to a neutron source while being exposed to an increased level of gamma radiation.

8.2.2 Test method

The instrument shall first be tested for neutron sensitivity according to test procedure 8.1.2 and the neutron alarm signal verified. After removal of the neutron source, it shall be exposed to photons from ^{137}Cs at an ambient dose equivalent rate of 0,1 mSv h^{-1} at the detector. Verify that that no neutron alarm is triggered within a continuous exposure time of 10 min. In order to eliminate dependence on the neutron detector geometry, the distance between the ^{137}Cs source and the detector should be at least 50 cm.

While the instrument is exposed to the elevated gamma field, expose the instrument to the neutron source using the same technique that was used in 8.1.2. The response shall be within 20 % of the response without the presence of gamma radiation.

9 Electrical and environmental performance requirements

9.1 Stabilization time

9.1.1 Requirement

The manufacturer shall state the time required for the instrument to become fully functional. The maximum time shall be less than 10 min.

9.1.2 Test method

Immediately after the manufacturer-stated stabilization time, expose the instrument to ^{241}Am and ^{60}Co each producing an ambient dose equivalent rate of 0,5 µSv h^{-1} (±30 %) above the background. [C] The requirement is met if the instrument is operational as determined by having a stable response, for example indicating approximately 1 µSv.h^{-1}, and being able to perform an identification. This is not a test of the instrument's ability to identify radionuclides and so correct (9 out of 10) identifications are not required. [C]

NOTE This is not a test of the instrument's ability to identify radionuclides and so correct (9 out of 10) identifications are not required.

9.2 Power supplies – battery

9.2.1 General

The instrument shall be fully functional (be able to detect and identify) for a minimum of 5 h under standard test conditions.

NOTE When operated at temperatures below –20 °C, the capacity of most types of batteries significantly decreases.

9.2.2 Requirement

The manufacturer shall state battery lifetimes and any associated operating temperature requirements. The manufacturer shall also state the minimum voltage required for satisfactory operation of the instrument. The minimum voltage is defined as that voltage where there is less than [C] ± 10 % [C] change in indicated ambient dose equivalent rate (compared to the response with fresh batteries) and/or when the instrument is still capable of performing a correct radionuclide identification to the specification of this standard.

The low battery indication shall be no lower than the minimum voltage as defined above.

9.2.3 Test method

The instrument shall be equipped with fully charged batteries [C] or new primary batteries [C]. All functional circuits (alarms and speakers excluded) shall be switched on and remain on during the test. The detector shall be exposed using ^{241}Am and ^{60}Co sources that provide an ambient dose equivalent rate of 0,5 µSv h^{-1} from each radionuclide at the detector's reference point. A sufficient number of readings shall be taken and the radionuclides shall be correctly identified after the manufacturer's recommended warm-up period and every hour thereafter The battery lifetime shall be where the ratio of the mean reading relative to the initial mean reading falls outside the interval 0,9 to 1,1, and/or when the radionuclides are no longer correctly identified.

9.3 Vibration

9.3.1 Requirement

The instrument shall withstand exposure to vibrations as shown in Table 2 without damage.

9.3.2 Test method

Conduct an external examination (visual inspection) and ensure that the instrument is functioning properly. Expose the instrument to the vibration conditions as stated in Table 2 in three directions. After the tests, check the instrument for mechanical damage and loose components. Switch the instrument on and verify that the instrument functions properly.

9.4 Mechanical shock

9.4.1 Requirement

The instrument shall withstand exposure to shocks as shown in Table 2 without damage if the instrument is exposed in its shipping case.

9.4.2 Test method

Conduct an external examination (visual inspection) and ensure that the instrument is functioning properly. Mount the instrument to a shock machine and expose it to the shock transients shown in Table 2. After the tests, check the instrument for mechanical damage or loose components. Switch the instrument on and verify that the instrument functions properly.

Table 2 – Vibration and shock test levels

Vibration	Frequency, Hz	10 to 500
	Maximum acceleration, $m \cdot s^{-2}$	10
	Number of axes	3
	Test duration	15 min per axis
Shock	Maximum acceleration, $m \cdot s^{-2}$	300
	Pulse duration, ms	6
	Total number of shocks/direction	3
	Direction of shocks	6

9.5 Moisture and dust protection

9.5.1 Requirement

9.5.1.1 General

The instrument case design shall meet the requirements stated for IP code 53 (see IEC 60529), which means that the instrument shall be protected from the ingress of dust and spraying water. For IP53, the ingress of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the instrument or to impair safety, and water sprayed at an angle up to 60º on either side of the vertical shall have no harmful effects.

9.5.1.2 Test method – dust

The test shall be made using a dust chamber (IEC 60529-category 2) where the powder circulation pump may be replaced by other means suitable to maintain the talcum powder (or Portland cement) in suspension in a closed test chamber. The amount of powder to be used should be 2 kg per cubic metre of the test chamber volume. The powder shall not have been used for more than 20 tests.

The instrument shall be exposed to a ^{137}Cs source that is of sufficient intensity to minimize the effect of the statistical fluctuations of the instrument readings. The instrument shall then be exposed to the dust environment for a period of 1 hour. The instrument shall respond to the presence of radiation throughout the test and after the test.

Following exposure, an inspection shall be performed to determine the extent of dust ingress. Particular attention shall be made to the battery compartment and any other easily accessed portions of the instrument. The protection is satisfactory if, on inspection, powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the instrument or impair safety.

9.5.1.3 Test method – moisture

[C]The test shall be made using a suitable nozzle (see IEC 60529, spray nozzle) with the water pressure adjusted to give flow rate of 10 l/min ± 5 %, which should be kept constant during the test. The water temperature shall not differ by more than 5 K from the temperature of the instrument under test. The test duration 5 min.〈C]

Prior to the test, the instrument shall be exposed to a ^{137}Cs source that is of sufficient intensity to minimize the effect of the statistical fluctuations of the instrument readings. The instrument shall then be exposed to the water spray. The spray nozzle shall be located approximately 2 m from the instrument. The instrument shall respond to the presence of radiation throughout the test and after the test.

The instrument shall be positioned such that the nozzle is directly pointed at the display. During the exposure, the orientation shall be changed by +60º and –60º in two orthogonal planes.

Following exposure, the instrument including the battery compartment shall be inspected to ensure that moisture did not penetrate into the instrument.

9.6 Ambient temperature influence

9.6.1 Requirement

The instrument shall be operational at temperatures from –20 °C to +50 °C.

9.6.2 Test method

NOTE For this test, an external power supply may be used to power the instrument.

Place the instrument in an environmental chamber and allow it to stabilize at 20 °C then perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides an ambient dose equivalent rate of 0,5 μSv h^{-1} at the detector from each source. The temperature shall then be maintained at each of its extreme values for at least 8 h, with the simultaneous identification test performed during the last 30 min of 8 h period. The temperature change rate shall be not greater than 10 °C h^{-1} and the relative humidity levels shall remain less than 75 %. The instrument shall correctly identify each radionuclide in 9 out of 10 trials performed at each temperature extreme. In addition, the mean reading from each temperature extreme shall be within ±30 % of the mean reading obtained at 20 °C.

9.7 Temperature shock

9.7.1 Requirement

The instrument shall be fully functional within 1 h of exposure to rapid temperature changes from 20 to –20, –20 to 20, 20 to 50, and 50 to 20 (in °C) with each change being made in less than 5 min. The instrument shall provide an indication if it is not fully functional.

9.7.2 Test method

NOTE For this test, an external power supply may be used to power the instrument.

Place the instrument in an environmental chamber and allow it to stabilize at 20 °C then perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides an ambient dose equivalent rate of 0,5 μSv h^{-1} at the detector from each source. The instrument and radioactive sources shall then be exposed to a temperature of 50 $(^{+0}_{-5})$ °C with the temperature change being made in less than 5 min.

The instrument shall be observed continuously. Every 15 min, a simultaneous radionuclide identification shall be performed as stated previously, and a series of ambient dose equivalent rate readings shall be recorded. Do not perform a radionuclide identification if the instrument indicates that it is not functional. After 1 h, the instrument shall correctly identify each radionuclide in 9 out of 10 trials. In addition, the mean ambient dose equivalent rate readings from each temperature extreme shall be within ± 30 % of the ambient dose equivalent rate reading obtained at 20 °C.

If the instrument is unable to perform a radionuclide identification after the first hour, an additional hour at the temperature is recommended with the time required for recovery noted. If the instrument recovers within the first hour, data does not need to be taken during the second hour; however, the instrument should remain in this environment during the period to reach temperature stabilization. Following the stabilization period, expose the instrument to a temperature of 20 °C ± 2 °C. This change shall be performed in less than 5 min and the analysis process stated above repeated.

The entire process shall be repeated for the 20 °C to –20$(^{+5}_{-0})$ °C and –20$(^{+5}_{-0})$ °C to 20 °C.

9.8 Relative humidity

9.8.1 Requirement

The instrument shall be fully functional over the range of humidity up to 93 % at 35 °C.

9.8.2 Test method

Place the instrument in an environmental chamber and allow it to stabilize at 20 °C and 40 % relative humidity for 2 h. Perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides an ambient dose equivalent of 0,5 μSv h^{-1} at the detector from each source. The humidity level shall then be increased at a rate not exceeding 10 % RH per hour to 93 ± 3 %. Simultaneously increase the temperature to 35 °C ± 2 °C at a rate of 10 °C h^{-1}. The temperature and humidity shall be maintained at 35 °C ± 2 °C and 93 ± 3 % for 16 h. A 10-trial radionuclide identification shall be performed and the mean ambient dose equivalent rate reading recorded during the last 30 min of this period.

The humidity shall then be reduced to 40 % while maintaining the temperature at 35 °C ± 2 °C. After allowing the instrument to stabilize in those conditions for a minimum of 2 h, a 10-trial radionuclide identification shall be performed and the mean ambient dose equivalent reading recorded.

The instrument shall correctly identify each radionuclide in 9 out of 10 trials at each test point. In addition, the mean ambient dose equivalent rate reading from each test point shall be within ±30 % of the mean ambient dose equivalent rate reading obtained prior to the humidity exposure.

9.9 Electromagnetic compatibility

9.9.1 General

Special precautions shall be taken to ensure proper operation in the presence of electromagnetic disturbances, particularly radio-frequency fields.

9.9.2 Electrostatic Discharge (ESD)

9.9.2.1 Requirement

The instrument shall function properly after exposure to electrostatic discharges at intensities of up to 6 kV for contact and 8 kV for air.

9.9.2.2 Test method

〈C〉 The test shall comply with IEC 61000-4-2. 〈C〉 In order to evaluate an instrument's immunity to ESD, the "contact discharge" technique shall be used Discharge points shall be selected based on user accessibility.

There shall be ten discharges per discharge point with a 1 s recovery time between each discharge. The maximum intensity of each discharge is 6 kV. The instrument shall be able to perform a simultaneous radionuclide identification of ^{241}Am and ^{60}Co placed in a location that provides an ambient dose equivalent rate of 0,5 μSv h^{-1} from each source after exposure to the ESD test. No alarms or false identifications shall occur when exposed to each discharge.

9.9.3 Radio Frequency (RF)

9.9.3.1 Requirement

The instrument shall not be affected by RF fields over the frequency range of 20 MHz to 1 000 MHz and 1 400 MHz to 2 500 MHz at an intensity of 10 volts per metre (V/m). The ambient dose equivalent rate reading shall remain within ±20 % of the reading with no 〈C〉 RF field applied. 〈C〉

9.9.3.2 Test method

〈C〉 The test shall comply with IEC 61000-4-6. Place an ^{241}Am and ^{60}Co source in a location that provides an ambient dose equivalent rate of 0,5 μ Sv.h^{-1} (from each source) at the detector and expose the detector to 〈C〉 a RF field of 20 V/m measured without an instrument present in the irradiation area over a frequency range of 20 MHz to 1 000 MHz and 1 400 MHz to 2 500 MHz. The field shall be 80 % amplitude modulated with a 1 kHz sine wave. 〈C〉 Perform tests at the radiation frequencies (20, 22, 24, 26, 29, 32, 35, 38, 42, 46, 51, 56, 62, 68, 75, 80, 90, 100, 110, 120, 130, 140, 150, 160, 180, 200, 220, 240, 260, 290, 320, 350, 380, 420, 460, 510, 560, 620, 680, 750, 820, 900, 1 000) MHz and (1,4; 1,5; 1,6; 1,8; 2,0; 2,2; 2,4, 2,5) GHz. 〈C〉

NOTE 20 V/m is selected in order to reduce test time by permitting tests in one orientation.

〈C〉 *Text deleted* 〈C〉

No alarms or other spurious indications shall occur and there shall be no change in radionuclide identification. The indicated ambient dose equivalent rate shall remain within ±20 % of the initial indicated value throughout the RF exposure.

9.9.4 Radiated RF emissions

9.9.4.1 Requirement

Radiation protection instrumentation can be used in many different areas. RF emissions from an instrument shall be less than that which can interfere with other equipment located in the area of use. The emission limits when measured at three metres are as given in Table 3.

Table 3 – Radiated emission limits

Emission frequency range MHz	**Field strength** microvolts/metre
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

9.9.4.2 Test method

[C〉The test shall comply with IEC 61000-4-3.〈C] Place the instrument in a shielded room or chamber, as appropriate. Place an antenna 3 m from the assembly. With the instrument off, collect a background spectrum using a bandwidth of 50 kHz. Switch the instrument on and perform a RF scan. Repeat the test with the instrument performing a radionuclide identification.

9.9.5 Conducted disturbances

9.9.5.1 Requirement

The instrument shall not be affected by RF fields that can be conducted [C〉to〈C] the instrument through an external conducting cable. Instruments that do not have at least one external conducting cable are excluded.

9.9.5.2 Test method

Place an ^{241}Am and ^{60}Co source in a location that provides a ambient dose equivalent rate of 0,5 μSv h^{-1} (from each source) at the detector and expose the instrument to a conducted RF field over the frequency range of 150 kHz to 80 MHz at an intensity of 140 dB(μV) 80 % amplitude modulated with a 1 kHz sine wave. [C〉 Perform tests at the radiation frequencies (150, 160, 180, 200, 220, 240, 260, 290, 320, 350, 380, 420, 460, 510, 560, 620, 680, 750, 820, 900, 1 000) kHz and (1,0; 1,1; 1,2; 1,3; 1,4; 1,5; 1,6; 1,8; 2,0; 2,2; 2,4; 2,6; 2,9; 3,2; 3,5; 3,8; 4,2; 4,6; 5,1; 5,6; 6,2; 6,8; 7,5; 8,0; 9,0; 10; 11; 12;13; 14; 15; 16; 18; 20; 22; 24; 26; 29; 32; 35; 38; 42; 46; 51; 56; 62; 68; 75, 80) MHz.〈C] No alarms or other spurious indications shall occur and there [C〉 shall be 〈C] no change in radionuclide identification The. indicated ambient dose equivalent rate shall remain within ±20 % of the initial indicated value throughout the RF exposure.

9.9.6 Magnetic fields

9.9.6.1 Requirement

[C〉The instrument shall be fully functional when exposed to d.c. magnetic fields in three orientations mutually at right angles to a 10 Gauss (about 800 A m^{-1} in vacuum) magnetic field.〈C]

9.9.6.2 Test method

Place an ^{241}Am and ^{60}Co source in a location that provides a ambient dose equivalent rate of 0,5 μSv h^{-1} (from each source) at the detector and expose the instrument to a 10 Gauss magnetic field. 〖C〉 No additional alarms shall be activated and the two radionuclides shall be correctly identified and the indicated ambient dose equivalent rate shall remain within ± 20 % of the initial indicated value. The test shall be carried out in three orientations mutually at right angles.〈C〗

9.10 Storage and transport

All instruments designed for use in temperate climates shall be designed to operate within the specifications of this standard after sufficient time has been allowed to reach ambient temperature following storage (or transport), without batteries, for a period of at least three months in the manufacturer's packaging at any temperature between –25 °C and +50 °C.

In certain circumstances, more severe specifications may be required such as capability for withstanding air transport at low ambient pressure.

10 Documentation

10.1 Certificate

A certificate shall accompany each hand held nuclide identifier, giving at least the following information:

– manufacturer’s name or registered trademark,
– type of instrument, serial number, and firmware version,
– list of radionuclides to which the instrument was tested,
– ambient dose equivalent rate range, and
– tests performed and results.

10.2 Operation and maintenance manual

Each instrument shall be supplied with an appropriate instruction manual in accordance with IEC 61187.

11 Summary of the tests (see Tables 4 to 6)

Table 4 – Requirements for radionuclide identification

Characteristic under test or influence quantity	Requirement	Test method
Radionuclide categorization	6.1	6.1
Identification of single radionuclide	6.2.1	6.2.2
Identification of mixed radionuclides	6.3.1	6.3.2
Overload characteristics for identification	6.4.1	6.4.2
Source indicator	6.5.1	6.5.2

Table 5 – Requirements for photon ambient dose equivalent rate indication

Characteristic under test or influence quantity	Requirement	Test method
Relative intrinsic error	7.1.1	7.1.2
Alarm and response time	7.2.1	7.2.2
Over range characteristics for ambient dose equivalent rate indication	7.3.1	7.3.2
Neutron indication	8.1.1	8.1.2
Neutron indication in the presence of photons	8.2.1	8.2.2

Table 6 – Electrical and environmental performance requirements

Characteristic under test or influence quantity	Requirement	Test
Stabilization time	9.1.1	9.1.2
Power supplies – battery	9.2.2	9.2.3
Vibration	9.3.1	9.3.2
Mechanical shock	9.4.1	9.4.2
Moisture and dust protection	9.5.1	9.5.1.2 and 9.5.1.3
Ambient temperature	9.6.1	9.6.2
Temperature shock	9.7.1	9.7.2
Relative humidity	9.8.1	9.8.2
Electrostatic discharge	9.9.2.1	9.9.2.2
Radio frequency	9.9.3.1	9.9.3.2
Radiated emissions	9.9.4.1	9.9.4.2
Conducted immunity	9.9.5.1	9.9.5.2
Magnetic fields	9.9.6.1	9.9.6.2

Bibliography

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

〔C〉NOTE Harmonized as EN 60068-2-27:1993 (not modified). 〈C〉

IEC 60086-1:2000, *Primary batteries – Part 1: General*

〔C〉NOTE Harmonized as EN 60086-1:2001 (not modified). 〈C〉

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

〔C〉NOTE Harmonized as EN 61000-4-2:1995 + A1:1998 + A2:2001 (not modified). 〈C〉

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

〔C〉NOTE Harmonized as EN 61000-4-3:2002 + A1:2002 (not modified). 〈C〉

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency field* – Basic EMC Publication
Amendment 1 (2004)

〔C〉NOTE Harmonized as EN 61000-4-6:2007 (not modified). 〈C〉

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test* – Basic EMC Publication
Amendment 1 (2000)

〔C〉NOTE Harmonized as EN 61000-4-8:1993 + A1:2001 (not modified). 〈C〉

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*

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