BRITISH STANDARD

BS EN 62363:2011

Radiation protection instrumentation — Portable photon contamination meters and monitors

ICS 13.280

British Standards

National foreword

This British Standard is the UK implementation of EN 62363:2011. It is identical with IEC 62363:2008. It supersedes BS IEC 62363:2008, which is withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text 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.

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

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31 August 2011	This corrigendum renumbers BS IEC 62363:2008 as BS EN 62363:2011

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62363

June 2011

ICS 13.280

English version

Radiation protection instrumentation - Portable photon contamination meters and monitors
(IEC 62363:2008, modified)

Instrumentation pour la radioprotection - Appareils portables de mesure et de surveillance de la contamination par des photons
(CEI 62363:2008, modifiée)

Strahlenschutz-Messgeräte - Tragbare Oberflächenkontaminations-Messgeräte und -Überwachungsgeräte für Photonenstrahlung
(IEC 62363:2008, modifiziert)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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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 62363:2008, 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 formal vote and was approved by CENELEC as EN 62363 on 2011-06-20.

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)	2012-06-20
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-06-20

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62363:2008 was approved by CENELEC as a European Standard with agreed common modifications as given below.

CONTENTS

RADIATION PROTECTION INSTRUMENTATION – PORTABLE PHOTON CONTAMINATION METERS AND MONITORS

1 Scope and object

This International Standard is applicable to portable and transportable contamination meters and monitors designed for the direct measurement or the direct detection of surface contamination by photon radiation emitting radionuclides and which comprise at least:

- a detection assembly (comprising counter tube, scintillation detector or semiconductor detector, etc.), which may be connected either rigidly or by means of a flexible cable or incorporated into a single assembly;
- a measurement assembly.

The standard is applicable to:

- photon surface contamination meters;
- photon surface contamination monitors.

The standard is applicable to detection assemblies that are designed to measure photon contamination from radionuclides which emit photons with energy in excess of 5 keV. In particular, this standard should be used to assess the performance of assemblies used to demonstrate that material is free from surface contamination by photon emitting radionuclides.

This standard is also applicable to special purpose assemblies and to assemblies specifically designed to provide limited spectroscopic information to the user.

NOTE These detection assemblies may be used to measure photon emissions from radionuclides that also emit alpha and beta radiations, where the alpha and beta emissions may be shielded due to the nature of the contamination. If shielding of the radioactive emissions occurs, then strictly speaking, the contamination is near to rather than on the surface of the article being monitored.

The object of this standard is to lay down standard requirements and to give examples of acceptable methods, and also to specify general characteristics, general test conditions, radiation characteristics, electrical safety, environmental characteristics, and the requirements of the identification certificate for photon contamination meters and monitors.

2 Normative references

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.

IEC 60050-393:2003, *International Electrotechnical Vocabulary (IEV) – Part 393: Nuclear Instrumentation – Physical phenomena and basic concepts*

IEC 60050(394):2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation: Instruments, systems, equipment and detectors*

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

IEC 60086 (all parts), *Primary batteries*

IEC 60325:2002, *Radiation protection instrumentation – Alpha, beta and alpha/beta (beta energy >60 keV) contamination meters and monitors*

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

ISO 7503-1:1988, *Evaluation of surface contamination – Part 1: Beta-emitters (maximum beta energy greater than 0,15 MeV) and alpha-emitters*

ISO 7503-3:1996, *Evaluation of surface contamination – Part 3: Isomeric transition and electron capture emitters, low energy beta-emitters (E Beta max less than 0,15 MeV)*

ISO 8769-2:1996, *Reference sources for the calibration of surface contamination monitors – Part 2: Electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV*

ISO 11929-1:2000, *Determination of the detection limit and decision threshold for ionizing radiation measurements – Part 1: Fundamentals and application to counting measurements without the influence of sample treatment*

BIPM, *The international system of units (SI)*, 7^{th} edition, 1998

3 Terms and definitions

For the purposes of this document, the general terminology concerning the detection and measurement of ionizing radiation and nuclear instrumentation given in IEC 60050-393 and IEC 60050-394 applies. Also, the terms and definitions specific to this standard given in ISO 7503-1, ISO 7503-3, ISO 8769-2 and ISO 11929-1, as well as the following, apply.

3.1
particle
very small portion of matter or energy

[IEV 393-11-01]

3.2
photon
quantum of electromagnetic radiation considered as an elementary particle of energy $h\nu$, where h is the Planck constant and ν the frequency of the radiation

[IEV 393-11-06]

3.3
surface emission rate (for a radioactive source)
number of particles of a given type, whose energies are above a given value, emerging from the face of the radioactive source or its window per unit time

[IEV 393-14-87]

NOTE In the context of this standard, a particle refers to a photon.

3.4
calibrated source activity
activity of a test source in Becquerels, as stated by the source manufacturer at the time of purchase, or an appropriately accredited calibration laboratory. The calibrated activity shall always have a correction applied to take into account radioactive decay

3.5
effective range of measurement
absolute value of the difference between the two limits of a nominal range

[IEV 394-40-16]

3.6
response time (of a measuring assembly)
duration between the instant of a step change in the measured quantity and the instant when the output signal reaches for the first time a specified percentage of its final value, that percentage being usually taken as 90 %

[IEV 394-39-09]

NOTE For integrating measuring assemblies, the response time is 90 % of the equilibrium value of the first derivative or slope of the indication.

3.7
source efficiency
ε_s
ratio between the surface emission rate and the number of particles of the same type created or released within the source per unit time

[ISO 8769-2, 3.3, modified]

NOTE Source efficiency will be affected by self-absorption and backscatter.

3.8
decay efficiency of a radionuclide with respect to photons
ε_d
ratio of the number of photons of a given energy, created per unit time by a given radionuclide, to the number of decays of this radionuclide per unit time

[ISO 7503-3, 3.1, modified]

3.9
small area source
source where the largest dimension of the active surface does not exceed 1 cm

3.10
surface emission rate response
S
ratio of the number of detected photons per unit time (for example the net count rate) to the conventionally true surface emission rate of photons of the same type per unit area, under stated conditions specified by the manufacturer

3.11
surface activity response
ratio of the number of detected photons per unit time (for example the net count rate) to the activity (in Becquerels) of the radioactive source per unit area, under stated conditions specified by the manufacturer

3.12
effective sensitive area
area under the detector, where the efficiency to a small area source located within that area is always greater than 1 % of the maximum efficiency to the same source within that area

NOTE The plane of the sensitive surface of the detection assembly is maintained 10 mm above the plane of the source.

3.13
sensitive volume (of a detector)
part of the detector which is sensitive to a radiation and is used for detection

[IEV 394-38-22]

3.14
sensitivity (of a measuring assembly)
K
for a given value of the measured quantity, ratio of the variation of the observed variable to the corresponding variation of the measured quantity

[IEV 394-39-07]

NOTE For example in this standard, the sensitivity is used to relate the indicated net count rate (observed variable) to the air kerma rate (measured quantity) from photon radiation.

3.15
normalised relative intrinsic error (surface emission rate response)
ratio (I_S) of the deviation of the surface emission rate response from the reference surface emission rate response ($S_i - S_r$) to the reference surface emission rate response S_r. It may be expressed as a percentage

$$I_S = 100 \times \frac{S_i - S_r}{S_r}$$

3.16
normalised relative intrinsic error (sensitivity)
ratio (I_K) of the deviation of the sensitivity from the reference sensitivity ($K_i - K_r$) to the reference sensitivity, K_r. It may be expressed as a percentage

$$I_K = 100 \times \frac{K_i - K_r}{K_r}$$

3.17
coefficient of variation
ratio of the standard deviation s to the value of the arithmetic mean $\bar{x}$ of a set of n measurements x_i given by the following formula:

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

[IEV 394-40-14]

3.18
detection limit (minimum detectable surface emission rate per unit area)
surface emission rate per unit area derived according to the procedure given in ISO 11929-1

NOTE With values of counting rates and counting times of adequate size, a simplified formula for the counting rate at the lower limit of detection is used. In the case of time preselection and known background counting rate, the following simplified formula applies:

$$R_n = (k_{1-\alpha} + k_{1-\beta}) \sqrt{R_o \left(\frac{1}{t_o} + \frac{1}{t_b} \right)}$$

where

R_n is the counting rate at the lower limit of detection;

R_o is the background counting rate;

t_b is the preselected time for background counting;

t_o is the preselected time for measurement;

$k_{1-\alpha}$ is the quantile of the standard deviation of errors of the first kind;

$k_{1-\beta}$ is the quantile of the standard deviation of errors of the second kind.

For instance for $\alpha = \beta = 0{,}05$, $(k_{1-\alpha}) = (k_{1-\beta}) = 1{,}645$

$$R_n = (1{,}645 + 1{,}645)\sqrt{R_o\left(\frac{1}{t_o} + \frac{1}{t_b}\right)}$$

The detection limit of the surface emission rate per unit area for a specified radionuclide becomes

$$DL = \frac{R_n}{S}$$

where S is the surface emission rate response (see 3.10). The surface emission rate per unit area is expressed in s^{-1} cm^{-2}.

3.19
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 394-40-10]

NOTE A conventionally true value is, in general, regarded as sufficiently close to the true value for the difference to be insignificant for the given purpose. For example, a value determined from a primary or secondary standard or by a reference instrument may be taken as the conventionally true value.

3.20
detection assembly
assembly containing at least the detector

3.21
measurement assembly
assembly processing the signals received from the detection assembly and displaying the level of contamination detected

3.22
photon surface contamination meter
assembly including one or more radiation detectors, that is designed to measure photon surface emissions from the surface under examination

3.23
limit distance
lateral distance of a small area test source emitting photons of a given photon energy from the central axis of the detection assembly where the reading of the measurement assembly is 1 % of the maximum reading. The plane of the sensitive surface of the detection assembly is maintained 10 mm above the plane of the source

3.24
influence quantity
quantity that is not the measurand but that affects the result of the measurement

[IEV 394-40-27]

3.25
test
technical operation that consists of the determination of one or more characteristics of a given product, process of service according to a specified procedure

[IEV 394-40-01]

NOTE 1 A test is carried out to measure or classify a characteristic or a property of an item by applying to the item a set of environmental and operating conditions and/or requirements.

NOTE 2 Tests are subdivided into type tests and routine tests and are identified as such in this standard.

3.26
type test
conformity test made on one or more items representative of the production

[IEV 394-40-02]

3.27
routine test
conformity test made on each individual item during or after manufacture

[IEV 394-40-03]

3.28
acceptance test
contractual test to prove to the customer that the device fulfils certain specifications

[IEV 394-40-05]

NOTE These tests are, in general, selected from the tests specified, but this selection is a contractual matter and does not form any part of this standard.

4 Units

In this standard, the units are the multiples and sub-multiples of units of the International System of Units (SI). The following non-SI units are also used:

Time: years, days, hours (h), minutes (min).

For energy: electron-volt (eV) (1eV = $1{,}602 \times 10^{-19}$ J).

NOTE Definitions of the radiation quantities and dosimetric terms are given in IEC 60050-393 and IEC 60050-394.

5 General characteristics

5.1 Classification

The manufacturer shall classify the assembly according to the following photon energy range or ranges for which it is designed:

Greater than 50 keV

Between 20 keV and 50 keV

[C) Less than 20 keV (C]

5.2 Detection assemblies

The dimensions of the sensitive volume of the detection assembly shall be stated. For assemblies designed to measure low energy photons, the manufacturer shall also state the area of the detection window.

5.3 Ease of decontamination

The assembly shall be constructed so as to permit easy decontamination. It is recommended that it be provided, for example, with a smooth non-porous external surface which is free from crevices. Alternatively, it shall be possible to use at least the measurement assembly when placed in a thin flexible envelope which is either disposable or easy to decontaminate and which is provided with transparent parts to permit the instrument scale to be read.

5.4 Sealing

For assemblies intended for outdoor use, the manufacturer shall state the precautions that have been taken to prevent the ingress of moisture.

5.5 Alarm threshold

This clause is applicable to monitors only.

A monitor shall include circuits necessary for activating an alarm at one or more thresholds. The number of tripping levels shall be subject to agreement between manufacturer and purchaser.

The values of alarm threshold shall be given either as percentages of the ranges or in terms of units of the display.

Each alarm threshold shall be designed to allow convenient operational verification by means of test signals, radioactive sources or signal input circuitry.

The range of adjustment shall be specified and the value of the alarm threshold shall be capable of being adjusted to any point within this range. It shall not be possible to incapacitate the alarm by any means such as setting the alarm thresholds beyond range limits. If a mute facility is provided it shall automatically reset when the alarm condition ceases.

Alarm threshold adjustments shall not be easily accessible to the operator (for example keyswitch operated or protected password).

5.6 Pulse height thresholds

Measurement assemblies should have the facility to set pulse height thresholds, which correspond to photon energy thresholds, in order to discriminate against interfering photon and/or beta radiations. Thresholds should be secure and only changed through internal controls or menus accessed by means of a password.

5.7 Measurement assembly indications

5.7.1 Meter display

The assembly should display the count rate.

Displays where the quantity displayed is derived from count rate such as activity should only be used where the radionuclide mix has been characterised. In this situation, the measurement assembly shall be programmed with the relationship between the surface emission rate and total activity (or activity per unit area) of the mix, taking account of the decay efficiency of the radionuclide(s), the surface emission rate response and the source efficiency. The manufacturer shall state the method used to program the assembly with this relationship. Where the assembly indicates activity, the manufacturer should indicate the assumed surface area of the activity. The unit of activity shall be the Becquerel (Bq).

For digital displays, an additional pseudo-analogue graphical indication should be provided which shows the count rate (or activity) in terms of the proportion of the maximum of the range indication, for example a bargraph.

Where an instrument has a digital display, a feature shall be provided to check that all segments of the display are operational.

Where linearly scaled displays are used for this application, autoranging functionality should also be provided.

5.7.2 Audible indication

An audible indication of count rate shall be provided. There shall be a facility for muting this indication. Where the equipment has been designed for use where noise levels could be high, provision shall be made for the use of a head set.

5.7.3 Additional indication

Indication shall be given of operational conditions in which the indication is not correct (within the specifications of this standard), for example low battery or detector failure.

5.7.4 Monitors

All the characteristics described in 5.7.1, 5.7.2 and 5.7.3 are also required for monitors.

In addition to the audible indication of count rate (or activity) above, there shall be either an audible indication of contamination above a certain preset value or visual indication. Although the audible indication may be produced by the same transducer as the indication of count rate, it shall be distinctly different from this indication.

5.8 Effective range of measurement

For logarithmically scaled assemblies, the effective range of measurement shall be from below one third of the least significant decade to full scale.

For digitally scaled assemblies, the effective range of measurement shall be from the start of the second least significant digit to the maximum of the rated range of measurement.

The manufacturer shall state the effective range of measurement of each scale range. For assemblies with more than one scale range, the effective range of measurement for each range shall overlap.

For assemblies with digital and scientific display (e.g. $x,y \times 10^{\pm 2}$) the mantissa shall have at least two digits (for instance 1,0 to 9,9) and the manufacturer shall define the effective range of measurement (for instance $1,0 \times 10^{-2}$ to $9,9 \times 10^{4}$ with units counts·s^{-1}). For the purposes of this standard, assemblies using this type of display shall conform to the requirements of digital scaled assemblies.

Consideration should be given to providing the capability for the determination of low count rates, possibly using an integration facility.

5.9 Mechanical shocks

Portable assemblies shall be able to withstand without damage mechanical shocks from all directions involving a peak acceleration of 300 m·s^{-2} for a time interval of 18 ms, the shape of the shock being semi-sinusoidal (see IEC 60068-2-27).

5.10 Setting up and maintenance facilities for electronic equipment

In addition to an adequate instruction and maintenance manual, all assemblies shall be provided with sufficient easily accessible test points to facilitate setting up and fault location, together with, where necessary, maintenance aids such as extension printed wiring boards, extension leads and special maintenance tools. Facilities shall be provided to prevent the unauthorised access to all the set-up functions of the equipment.

6 General test procedures

6.1 Nature of tests

Qualification tests are performed in order to verify that the requirements of a specification are fulfilled (see 3.25). Qualification tests are subdivided into type tests and routine tests (see 3.26 and 3.27).

All tests enumerated in the following clauses are to be considered as "type tests", with the exception of the test described in 8.3.4.

Some of these tests may, by agreement between the manufacturer and purchaser, be considered to be acceptance tests (see 3.28). Unless otherwise specified, the requirements corresponding to the tests shall be met over the whole effective range of measurement of the instrument.

Since the configuration of the measurement assembly is critical to the performance characteristics of the instrument, then both the measurement and the detection assemblies shall be tested together as a single unit. Tests on measurement assemblies are described fully in IEC 60325.

6.2 Test conditions

6.2.1 Reference and standard test conditions

Reference conditions are given in the second column of Table 1. Except where otherwise specified, the tests in this standard shall be carried out under the standard test conditions given in the third column of Table 1.

6.2.2 Tests performed under standard test conditions

Tests which are performed under standard test conditions are listed in Table 2 which indicates, for each characteristic, the requirement (permissible variation in indication) and the subclause where the corresponding test method is described.

6.2.3 Tests performed with variation of influence quantities

These tests are intended to determine the effects of variations in influence quantities, and are given in Table 3 with the range of variation of each influence quantity and limits of consequent variation in the indication of an assembly.

In order to test the effect of variation in any one of the influence quantities listed in Table 3, all other influence quantities shall be maintained within the limits for standard test conditions given in Table 1, unless otherwise specified in the test procedure concerned.

6.3 Reference radionuclides

The reference radionuclide is dependent on the photon energy range stated by the manufacturer. The reference radionuclides and associated photon energy ranges are:

Greater than 50 keV	^{137}Cs
Between 20 keV and 50 keV	^{129}I
[C) Less than 20 keV (C]	^{55}Fe

6.4 Background

The background indicated by the instrument shall be subtracted from the observed signal by a suitable procedure which could include calculation.

If the equipment has the capability to determine background rates for net rate determination, the manufacturer shall clearly state the method used and the uncertainties involved.

6.5 Statistical fluctuations

For any test involving the use of radiation, if the magnitude of the statistical fluctuations of the indications, arising from the random nature of the emission 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 demonstrate compliance with the requirement in question. The interval between such readings shall be at least three times the response time to ensure that the readings are statistically independent.

6.6 Test source

Photon emitting reference sources shall include the filtration specified in ISO 8769-2. The filters should normally be an integral part of the source; they should not be removable. The area of the filter should be such that it extends 1 cm beyond the active area of the source.

The surface emission rate of the reference source shall be determined with an uncertainty which shall not exceed ±10 %.

The uniformity of a reference source with respect to surface emission rate shall be better than ±10 %.

NOTE The uncertainties are quoted at the 68 % confidence level (one standard deviation).

Calibrations of photon surface emission rate may be difficult to realise in some situations. Therefore, for higher energy photon emitters, it is acceptable to derive the photon surface emission rate using the calibrated source activity, the decay efficiency and assuming a source efficiency of 0,5. However it is important to estimate the uncertainty associated with this procedure.

Typically, a test source will have an active area of 100 cm^2 (10 cm long by 10 cm wide) or 150 cm^2 (15 cm long by 10 cm wide).

7 Electrical characteristics

7.1 Statistical fluctuations

7.1.1 Requirements

Owing to the random nature of photon emissions, the indications of a contamination meter fluctuate about an average value. The coefficient of variation of the indication due to these random fluctuations shall be less than 0,2. This requirement applies to any contamination level exceeding that corresponding to the following indications:

- logarithmic scales: three times the lowest significant graduation on the scale;
- linear scales: one third of the scale maximum on the most sensitive range;
- digital display: ten times the value of the least significant digit.

This does not preclude the possibility of having selectable time constants, not all of which have to be met by this requirement. In this case, the manufacturer shall state which time constants meet this requirement.

7.1.2 Method of test

Expose the assembly to a source of radiation giving an indication between one third and one half of scale maximum on the most sensitive range (linear scale) or the most sensitive decade (logarithmic scale) or an indication of the number 1 in the second least significant digit (digital displays).

Take a series of at least 20 readings at convenient time intervals. In order for the readings to be independent from one another, this time interval shall be not less than that corresponding to three times the response time of the measurement assembly. Find the mean value and the coefficient of variation of all the readings taken. The coefficient of variation shall lie within the limits of 7.1.1.

7.2 Response time

7.2.1 Requirements

The response time shall be such that, if there is a sudden change in the contamination being measured, the indication will reach the following value in less than 7 s for both an increase and a decrease in the indication:

$$M_{\mathrm{i}} + \frac{90}{100}\left(M_{\mathrm{f}} - M_{\mathrm{i}}\right)$$

where

M_{i} is the initial indication, and

M_{f} is the final indication.

The response time shall be stated by the manufacturer.

7.2.2 Method of test

The test should be carried out with a radiation source.

The initial and final indications shall differ by a factor of 10 or more. The lower indication shall not exceed one third of the least significant complete decade.

Measurements shall be made for both an increase and a decrease in indication.

The assembly shall be subjected first to the higher activity radiation source and the reading M_{f} noted. The assembly shall then be subjected to the lower activity source for a time sufficient for the indication M_s to reach a steady value and this indication noted. The level of activity shall then be changed as quickly as possible to that corresponding to the reading M_{f} and the time taken to reach the value given by the formula in 7.2.1 measured.

The decreasing reading test shall be performed in the same way with the readings corresponding to M_{f} and M_{i} interchanged.

7.3 Interrelationship between response time and statistical fluctuations

The response time and coefficient of variation of the statistical fluctuations are interdependent characteristics, acceptable limits for which are given in 7.1 and 7.2.

For high contamination levels, it is recommended that, whenever possible, the response time be reduced, while conforming to the limits laid down for the statistical fluctuations.

If the limits in 7.1 and 7.2 can be met with a response time of not more than 1 s, it is preferable to reduce the statistical fluctuations rather than to reduce the response time below 1 s.

If the above requirements are not met at low contamination levels, the manufacturer shall state the appropriate values of the coefficient of variation and response time in this range.

7.4 Warm-up time test

7.4.1 Requirements

The time taken for the assembly, after switching on while it is exposed to the reference radiation, to give an indication which does not differ by more than 20 % from the final value obtained under standard test conditions shall be less than 1 min.

7.4.2 Method of test

With the assembly switched off, expose it to an appropriate radiation source that will provide an indication of at least half of the scale maximum on the most sensitive range or decade. Switch on the instrument and note the readings every 5 s during a period of 6 min after switching on.

30 min after switching on, take a sufficient number of readings and use the mean value as the final value of the indication. From the graph of readings as a function of time, note the warm-up time, where the reading should be within 20 % of the final reading.

7.5 Overload protection

7.5.1 Requirements

For activities corresponding to 10 times greater than maximum of the range of indication, the indication of the assembly shall be off scale at the higher end of the scale range, or display the overload indication. For assemblies with more than one scale range, this requirement shall apply to each scale range.

The overload shall be indicated within 5 s of applying the activity and the indication shall return to be on scale within 30 s of the removal of the activity.

7.5.2 Method of test

Compliance with this requirement is tested by submitting the assemblies for 1 min to an activity of at least 10 times that corresponding to full scale deflection of each scale or equivalent to 10^6 counts per second, whichever is the greater. This requirement shall apply to each scale range. Five minutes after removal of overload activity, the performance shall return to normal (see 8.3.2).

7.6 Power supplies – battery operation

7.6.1 General

Battery power shall be provided for the assembly. Facilities shall be provided for testing the battery under maximum load. Also, provision shall be made for indicating when the battery condition is no longer adequate for the performance of the assembly to meet the requirements of this standard. Batteries may be connected in any desired manner but shall be individually replaceable; the correct polarity shall be clearly indicated on the measurement assembly by the manufacturer.

7.6.2 Requirements – primary batteries (non-rechargeable)

When power is supplied by primary batteries, the capacity of these should be such that, after 40 h of intermittent use during operation under standard test conditions, the reading of the measurement assembly shall remain within ±5 %, other functions remaining within specification.

It is recommended that batteries as specified in IEC 60086 be used.

NOTE 40 h of intermittent use means 8 h of continuous use followed by 16 h with the instrument switched off, for 5 consecutive days.

7.6.3 Requirements – secondary batteries (rechargeable)

When power is supplied by secondary batteries, the capacity of these shall be such that after 8 h of continuous use, the indication of the assembly shall remain within ±5 %, other functions remaining within specifications.

If secondary batteries are used, it shall be possible to recharge the batteries from the mains supply within 16 h. The use of a device which switches off the charger when the complete charge is obtained is recommended.

7.6.4 Method of test

The evaluation of the remaining battery capacity may be undertaken either by measuring the actual voltage of the internal batteries or, especially for secondary batteries, by performing charge measurements during use and recharging.

If the actual voltage is measured, the test shall be performed as follows. The internal batteries shall be removed and the assembly connected to an external power supply via an adjustable series resistance. The power supply shall be set to the nominal battery voltage U_{nom} and the series resistance to zero. The assembly shall be switched on and allowed to stabilize at normal background levels. If the assembly has a separate battery test function, this shall be selected. If the assembly continuously monitors the battery condition, then the assembly shall be switched to the radiation measurement indication. The supply voltage shall then be reduced until the assembly first indicates that the battery condition is no longer adequate. This voltage U_{low} and the supply current A_{low} shall be noted. The supply voltage shall then be returned to the nominal value U_{nom} and the series resistance increased until the battery condition is no longer adequate. This resistance R_{low} shall be noted.

The assembly shall then be exposed to a radiation source of sufficient activity to give an indication close to the maximum of the range of indication. The supply voltage shall be set to the nominal value U_{nom} and the series resistance to zero. Any functions which increase the assembly's demand on the battery shall be switched on, including the scale illumination, lamps and audio output. Then the assembly indication $M_{\text{i,nom}}$ shall be recorded. The supply voltage shall then be decreased to U_{low} and the assembly indication $M_{\text{i,low,1}}$ recorded. The supply voltage shall then be returned to U_{nom} and the series resistance increased to R_{low}. The assembly indication $M_{\text{i,low,2}}$ shall be noted and the assembly checked to ensure that any auxiliary functions selected are operating correctly.

The assembly shall meet the following criteria:

– $0{,}95 \le \dfrac{M_{\text{i,low,1}}}{M_{\text{i,nom}}} \le 1{,}05$ and $0{,}95 \le \dfrac{M_{\text{i,low,2}}}{M_{\text{i,nom}}} \le 1{,}05$

– all auxiliary functions operating as selected and

– $\dfrac{Q_{\text{nom}}}{A_{\text{low}}} \ge 40\ \text{h}$ primary batteries and for $\dfrac{Q_{\text{nom}}}{A_{\text{low}}} \ge 8\ \text{h}$ for secondary batteries

Q_{nom} is the nominal capacity of the batteries (typically in mA·h).

8 Radiation characteristics

8.1 General

For the determination of the radiation characteristics of the assembly, the manufacturer shall set the distance between the window of the detector and the active surface of the test source to 10 mm.

8.2 Detector profile

8.2.1 Requirements

The manufacturer shall state the lateral distance (limit distance) between the central point directly under the surface of the detection assembly to a small area source of the reference radionuclide, where the reading of the detection assembly falls to 1 % of the central value.

8.2.2 Method of test

To determine a detector profile, the detection assembly should be mounted C〉 centrally 〈C 10 mm above a small area source of an appropriate radionuclide. The instrument reading should be recorded successively as the source is moved radially away from the central position. In this fashion, a detector profile can be formed: an example of such a profile is provided in Figure 1.

C〉 In the case of a rectangular detector three profiles shall be taken. One from the centre in the direction normal to the shortest side of the sensitive area of the detector, another from the centre in the direction normal to the longest side of the sensitive area of the detector and one from the centre in the direction of a corner of the sensitive area of the detector. In the case of square detectors the first above is unnecessary. In the case of a cylindrical detector there is only a single profile. 〈C

The distance at which the net instrument reading falls to 1 % of the central value denotes the outer dimensions of the large area source required to perform a contiguous portions calibration. This is defined as the limit distance (see 3.23). Clearly, the dimensions of that large area source are dependent upon the size of the detector area of the monitor used, its structural characteristics and the energy of the radiation.

8.3 Surface emission rate response

8.3.1 General

Photon contamination meters and monitors will be sensitive to contamination that is found at a distance from the centre of the detection assembly that is considerably greater than the largest dimension of the detector window. Therefore the large area test source should have a smallest linear dimension that is greater than the limit distance evaluated when undertaking the detector profile in 8.2. However in practice, this area may be very large for detection assemblies C〉 with large sensitive volumes and/or areas 〈C, so for the purposes of standardisation, the largest linear dimension of the large area test source should not exceed 30 cm.

NOTE 1 A limit distance of 17 cm is equivalent to an effective sensitive area under the detector of 900 cm^2 (circle of radius 17 cm). This area is simulated using a square large area test source with a linear dimension of 30 cm.

NOTE 2 Annex A gives examples of limit distances.

If a large area test source of the required dimensions is unavailable, then the surface emission rate response shall be derived by undertaking a contiguous portions measurement. In the case of a 900 cm^2 test source, this is then achieved with a square grid of six 150 cm^2 or nine 100 cm^2 test sources.

8.3.2 Type test

The surface emission rate response is dependent on the surface area of the test source, and its shape. The manufacturer shall state on the test certificate the surface emission rate response of the assembly to the appropriate reference radionuclide averaged over an area of both 30 cm × 30 cm (900 cm^2); and an area of 10 cm × 10 cm or 15 cm × 10 cm.

The manufacturer shall state the relationship between the surface emission rate response averaged over 900 cm^2, and that averaged over a single large area calibration source (100 cm^2 or 150 cm^2).

In the case of rectangular detectors, the manufacturer shall state the relative orientation of the detector and the source used.

8.3.3 Method of test

8.3.3.1 General

The surface emission rate response (S) of the detection assembly shall be measured using a high efficiency source with an area such that the effective sensitive area under the detector is irradiated.

Where sources of area 30 cm × 30 cm are unavailable, the contiguous portions method shall be used.

8.3.3.2 Contiguous portions measurement

A large area calibration source of standard dimensions (100 cm^2 or 150 cm^2) can be used repeatedly to simulate a square 900 cm^2 source. By placing the test source in successive positions, the whole area required may be covered. The instrument readings observed in those positions can then be combined to obtain the total indication of the detector that may have been observed if a 900 cm^2 source had been used.

A grid should be drawn up to outline the adjacent, but not overlapping, source positions in which measurements are to be made: the grid should accommodate the active area of the source rather than the whole area if an inactive rim is fitted. The number of source positions used in the grid should be sufficient to cover the area of the 900 cm^2. The use of a grid, as illustrated in Figure 2, serves to minimise errors in positioning the source and hence reduce any additional contribution to the overall uncertainty in the calibration.

With the detector fixed 10 mm above the central position, the source should be placed in each of the grid positions in turn and the observed instrument readings should be recorded. The observed readings (R_i), should then be background corrected ($R_i - B$), and summed to obtain the total detector indication ($\Sigma(R_i - B)$). Division of the corrected total detector indication by the surface emission rate per unit area of the source, allows the surface emission rate response (S_{CP}) in terms of counts per second per emission per second per unit area (counts·s^{-1} per photon·s^{-1} per cm^2) to be calculated.

8.3.3.3 Relationship between contiguous portions and large area source measurements

A further test shall be undertaken, where the detection assembly is placed centrally over a single large area calibration source (100 cm^2 or 150 cm^2), and surface emission rate response (single source) S_S shall be derived. The following area correction factor shall be evaluated:

$$C = S_{CP}/S_S$$

This correction factor shall be stated by the manufacturer.

NOTE Ideally the single large area source should be a square source of dimensions 100 cm^2. However, the rectangular 150 cm^2 has been included since it is frequently used for calibration purposes.

8.3.4 Routine test

Place the detection assembly centrally over a single large area source and evaluate the surface emission rate response S_S. The dimensions of the single large area source shall be identical to those used for the type test (10 cm × 10 cm or 10 cm × 15 cm).

The area correction factor shall be stated on the test certificate.

8.4 Relative intrinsic error

8.4.1 Requirements

Under standard test conditions, the normalised relative intrinsic error I, in the surface emission rate response (or sensitivity) of the assembly to the relevant reference radionuclides shall not exceed ±20 % over the whole of the effective range of measurement.

NOTE This error does not include the uncertainty in the value of the conventionally true surface emission rate per unit area for the test source used.

8.4.2 Method of test

The normalised relative intrinsic error should be evaluated based on the variation of the surface emission rate response using a number of geometrically identical sources with a wide range of surface emission rates.

The reference surface emission rate response S_r should be selected at a count rate where dead time effects are minimised and an order of magnitude above the background count rate, typically between 100 s^{-1} and 500 s^{-1}.

Where a suitable range of surface emission rate sources is unavailable, a suitable range of air kerma rates from a collimated ^{137}Cs source may be used. In this situation, the sensitivity should be evaluated (see 3.14) and the normalised relative intrinsic error should be evaluated using the formula in 3.16. The reference sensitivity $K_{r,}$ should be selected at an indication where dead time effects are minimised.

For linear and logarithmically scaled assemblies, the test should be performed for at least three values in each decade of the effective range of measurement, with test points at approximately 25 %, 50 % and 75 % of each decade. For digitally scaled instruments the test should be performed for a single value in each decade of the effective range of measurement; the value should be close to the mid-point of the decade.

Where more than one type of scale is used, the requirements for each shall be met.

For this test, a radiation other than that from the reference sources specified in 6.3 may be used.

8.5 Variation of surface emission rate response with photon radiation energy

8.5.1 Requirements

In addition to the measurements specified in 8.3, the surface emission rate response shall be measured with photon emitters of at least four different energies distributed as follows:

- one less than 10 keV
- one between 10 keV and 50 keV
- one between 50 keV and 600 keV
- one between 600 keV and 1 000 keV
- one greater than 1 000 keV

As a guide, suitable radionuclides are:

^{55}Fe	(most abundant photon energy 5,9 keV, half life 2,7 years);
^{129}I	(most abundant photon energy 32 keV, half-life $1{,}57 \times 10^7$ years);
^{241}Am	(most abundant photon energy 59,5 keV, half-life 432 years);
^{57}Co	(most abundant photon energy 122 keV, half-life 0,74 years);
^{137}Cs	(most abundant photon energy 662 keV, half-life 30 years);
^{60}Co	(photon energies 1 170 keV and 1 330 keV, half-life 5,27 years).

These sources shall utilise the additional filtration specified in ISO 8769-2, in order to remove the effects of interfering alpha or beta radiations.

The manufacturers shall state:

a) the radionuclides for which the surface emission rate response has been measured;

b) the value of surface emission rate response for each of them.

In addition, derive the surface activity response of the assembly to each of the radionuclides tested.

8.5.2 Method of test

The method of measurement of surface emission rate response for each radionuclide used shall utilise large area test sources and shall be in accordance with the methods described in 8.3.3.

NOTE For low energy photon emitters, the limit distance will be lower than for high energy photon emitters. The limit distance should be evaluated for each radionuclide to be tested, and consequently the area of the large area test source should be evaluated on the basis of this distance. Alternatively, a large area test source of 900 cm^2 should be selected for each radionuclide.

The surface activity response shall be derived by dividing the surface emission rate response S_{CP} by the product of the source efficiency and the decay efficiency.

8.6 Variation of response with absorption

8.6.1 Requirement

The manufacturer should state the proportional reduction in the surface emission rate response when an absorber is placed between the contamination and the detection assembly.

As a guide, the following absorbers are suitable for this test:

Paper	typical density, 0,7 $g \cdot cm^{-3}$
PMMA	typical density, 1 $g \cdot cm^{-3}$
Aluminium	typical density, 3 $g \cdot cm^{-3}$
Stainless steel	typical density, 8 $g \cdot cm^{-3}$

This test is not mandatory and is not required when the source of contamination is always found on the surface of the article being monitored.

8.6.2 Method of test

Two absorbers, one of density greater than 2 $g \cdot cm^{-3}$, and one less, should be placed between the test source and the detection assembly. The thickness of the absorber should be approximately 3 mm.

The manufacturer shall state the proportional reduction in the surface emission rate response for each radionuclide tested in 8.5, and for each absorber. The manufacturer shall state the mass thickness of each absorber in units of $mg \cdot cm^{-2}$.

8.7 Response to beta radiation

8.7.1 Requirement

The assembly should not respond to beta emitting radionuclides with a maximum energy of less than 500 keV. The manufacturer should minimise the response of the assembly to beta emitting radionuclides with a maximum energy of greater than 500 keV. The manufacturer shall state the surface emission rate response of the assembly to beta emitters with maximum energies in the following ranges:

– one between 200 keV and 500 keV;
– one greater than 500 keV.

NOTE A mass of thickness of 180 $mg \cdot cm^{-2}$ is required to attenuate 99 % of 500 keV beta particles. The material should have a low atomic number to reduce the effect of bremsstrahlung.

8.7.2 Method of test

Where the assembly is sensitive to beta radiation, the surface emission rate response should be evaluated using the methods described in 8.3.3.

8.8 Response to background photon radiation

8.8.1 Requirement

Since the detection assemblies are sensitive to photon radiations, they will be sensitive to interfering background photon radiation. The response to interfering photon radiation is highly energy dependent and will also depend on the material used to encapsulate the detector. It is therefore necessary to establish the photon sensitivity over a range of photon energies.

The manufacturer shall state the sensitivity, in terms of count rate per unit air kerma rate, of the detection assembly to photons in the energy ranges:

– one not more than 100 keV,
– one between 100 keV and 700 keV,
– one greater than 700 keV.

One of the radiation sources shall be ^{137}Cs.

The manufacturer shall test the detection assembly in the following orientations:

– one with the detector window facing the source of radiation;
– one that is normal to this direction – if the detection assembly is not symmetrical about its axis, then at least 4 measurements separated by 90° should be performed in this plane;
– one that is 180° to this detector window.

8.8.2 Method of test

Place the detection assembly so that its detector window is facing the source of photon radiation. Expose the assembly to the photon radiation and evaluate the sensitivity.

Rotate the detection assembly so that its detector window is normal to the direction of the radiation and repeat this procedure. Where the detection assembly does not have symmetry about it central axis, more than one measurement will be required. Rotate the detection assembly so that the direction of radiation is 180°.

Evaluate the sensitivity in each orientation.

8.9 Neutrons

A test for neutron response is not mandatory and need only be carried out if this requirement is specified. The nature of the test shall be subject to agreement between the manufacturer and the purchaser.

8.10 Detection limit (minimum detectable surface emission rate per unit area)

8.10.1 Requirement

The minimum detectable surface emission rate per unit area (see 3.18) in a photon background air kerma rate of 250 nGy·h^{-1} from ^{137}Cs, shall be stated by the manufacturer. This value shall be based on the surface emission rate response from the reference radionuclide.

8.10.2 Method of test

This calculation is based on the unprocessed count rate, irrespective of whether the indication is in terms of count rate or activity. Evaluate the count rate associated with 250 nGy·h^{-1} using the data derived in 8.8.2, for all orientations. Insert these count rates (R_0) into the formula shown in 3.18, to evaluate the minimum detectable surface emission rate per unit area for each relevant radionuclide.

9 Environmental characteristics

9.1 Ambient temperature

9.1.1 Requirements

9.1.1.1 Temperature stability

For indoor use, within the range of temperature from 10 °C to 40 °C, the indication shall remain within ±15 % of that obtained under standard test conditions.

For outdoor use, within the range of temperature from –10 °C to 50 °C, the indication shall remain within ±20 % of that obtained under standard test conditions.

9.1.1.2 Temperature shock

The surface emission rate response and background count rate shall not vary by more than ±30 % for indoor use, and by ±40 % for outdoor use from a set of reference readings taken at a temperature of 20 °C when the equipment is taken from 20 °C to 40 °C and to –10 °C (10 °C for exclusive indoor use), each in less than 5 min.

9.1.1.3 Low temperature start-up

After being subjected to the lowest specified temperature for 4 h in an off condition the equipment shall operate satisfactorily after switch on.

9.1.2 Method of test

9.1.2.1 General

It will normally be necessary to carry out this test in a climatic chamber. A radioactive source shall be used to provide an adequate indication.

It is not in general necessary to control the humidity in the climatic chamber unless the assembly is particularly sensitive to changes in humidity. Precautions however shall be made to prevent the formation of dew.

Any unusual behaviour associated with the assembly should be noted i.e. alarm condition changed, display malfunction, power supply variation.

9.1.2.2 Temperature stability

The temperature shall be maintained at each of its extreme values for at least 4 h and the measurement of the indication made during the last 30 min of this period. The rate of change of temperature in this case should be less than 10 °C per hour. The limits of variation shall be those given in Table 3.

9.1.2.3 Temperature shock

The assembly shall be placed in a temperature of 20 °C ± 2 °C and allowed to stabilize for a minimum of 40 min. The temperature shall then be changed to 40 °C in less than 5 min. The indication will be noted at 5 min and then every 15 min for 2 h. The assembly shall then be allowed to return to 20 °C ± 2 °C for 4 h. The temperature shall then be changed to –10 °C (10 °C for exclusive indoor use) in less than 5 min. The indication will be noted at 5 min and then every 15 min for 2 h.

9.1.2.4 Low temperature start up

The assembly shall be placed in a temperature of −10 °C (or an alternative appropriate temperature) for at least 4 h and shall then be switched on without affecting the climatic conditions. The performance of the assembly shall operate in the same way as during the temperature stability test.

9.2 Relative humidity

9.2.1 Requirements

Over the humidity range 40 % to 90 %, the indication shall not vary by more than 7,5 % from the indication at the reference humidity.

9.2.2 Method of test

This test shall be carried out in a manner similar to that of 9.1.2 with the temperature maintained at 35 °C.

9.3 Electromagnetic compatibility

The assembly shall be tested for electromagnetic compatibility. The requirements are identical to those for alpha and beta contamination monitoring assemblies, which are described in detail in IEC 60325.

10 Storage

10.1 General

All assemblies designed for use in temperate regions shall be designed to operate within the specifications of this standard following storage (or transport) for a period of at least three months in the manufacturer's packaging at a temperature from −25 °C to +50 °C without batteries.

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

10.2 Mechanical shock

The assemblies shall meet the mechanical shock requirements given in 5.9.

11 Documentation

11.1 Identification certificate

An identification certificate shall accompany each assembly giving at least the following information (see IEC 61187).

Concerning the detection assembly:

- the manufacturer's name or registered trade mark;
- the type of detection assembly and serial number;
- the sensitive volume, and detector window area for low energy photons (if applicable), of the detection assembly;
- materials of the window between the source and the sensitive volume of the detector, and the total mass per unit of the material in $mg \cdot cm^{-2}$;
- the range of photon energies to which the assembly is sensitive;
- the surface emission rate response for the reference radionuclide to a 900 cm^2 source;
- the surface emission rate response to a 900 cm^2 source as a function of photon energy;
- surface emission rate response area correction factor;
- the beta radiation energy below which the assembly is insensitive;
- mass and dimensions of the assembly.

Concerning the measurement assembly:

- the manufacturer's name or registered trade mark;
- the type of detection assembly and serial number;
- the parameter settings required for the detection assembly, including the high voltage setting and pulse triggering threshold;
- mass and dimensions of the assembly.

Concerning meters and monitors:

- all the information shown above, required for detection and measurement assemblies;
- the upper and lower limits of the effective range of measurement for each scale.

11.2 Operation and maintenance manual

Each assembly shall be provided with an appropriate instruction manual in accordance with IEC 61187.

Table 1 – Reference conditions and standard test conditions

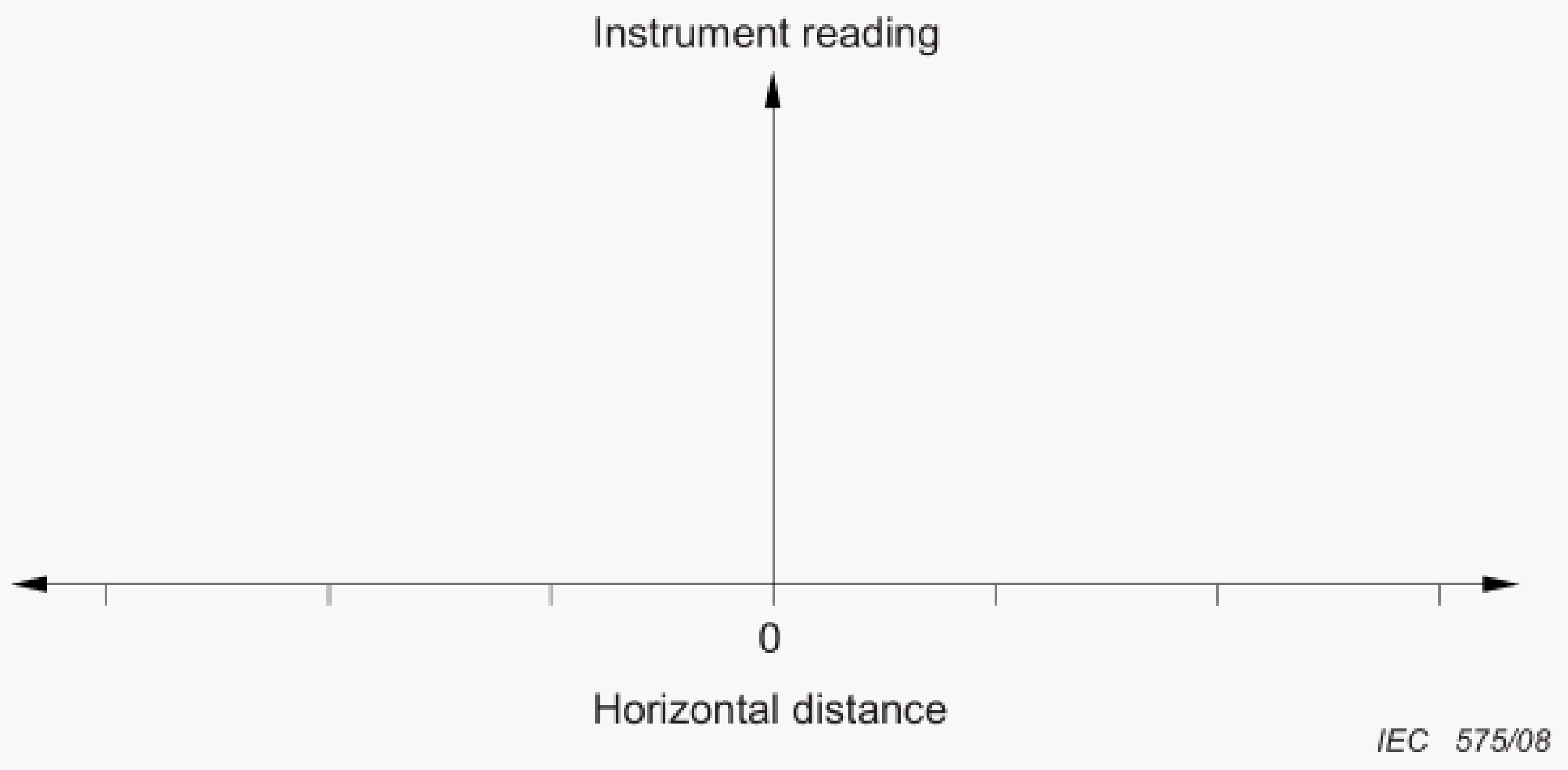
Influence quantities	Reference conditions	Standard test conditions
Warm-up time	15 min	≥15 min
Ambient temperature	20 °C	18 °C to 22 °C
Relative humidity	65 %	55 % to 75 %
Atmospheric pressure	101,3 kPa	86 kPa to 106 kPa
Background gamma radiation	Air kerma rate of less 0,1 $\mu Gy \cdot h^{-1}$	Air kerma rate of less than 0,2 $\mu Gy \cdot h^{-1}$
Electromagnetic field of external origin	Negligible	Less than the lowest value that caused interference
Magnetic induction of external origin	Negligible	Less than twice the induction due to the earth's magnetic field
Setting up instrument	Set up for normal operation	Set up for normal operation
Contamination by radioactive materials	Negligible	Negligible

Table 2 – Test performed under standard test conditions

Characteristics under test	Requirements	Relevant subclause
Surface emission rate response	To be stated by manufacturer	8.3.3
Variation of response with photon energy	To be stated by manufacturer	8.5.2
Relative intrinsic error	±20 % over whole range	8.4.2
Statistical fluctuations	Coefficient of variation less than 0,2	7.1.2
Response time	< 7s for increases and for decreases	7.2.2

Table 3 – Test performed with variation of influence quantities

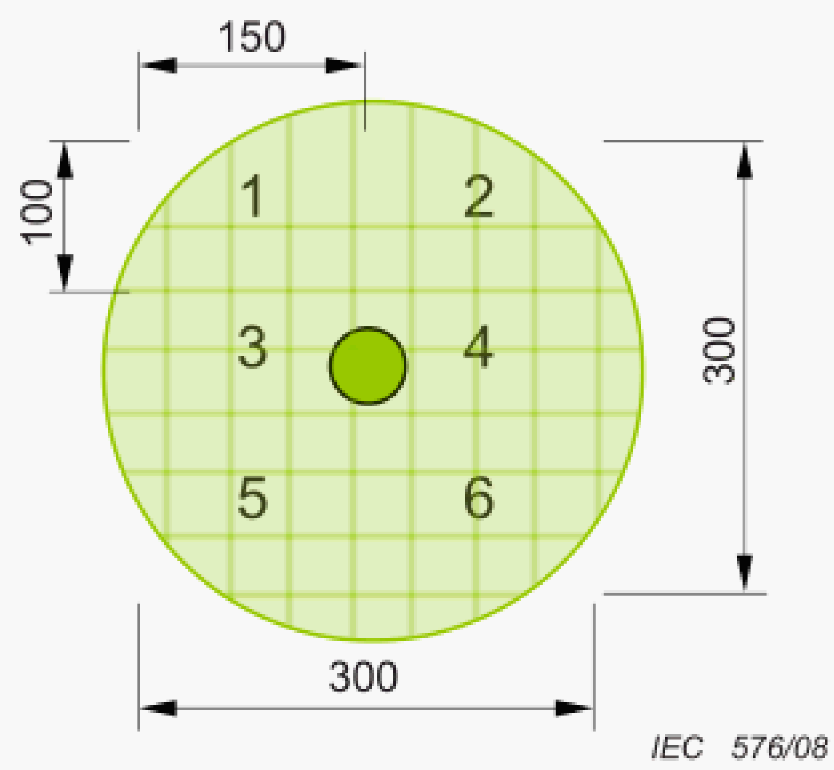
Influence quantity	Range of values of influence quantity	Limits of variation of indication	Relevant subclause
Beta radiation energy	Energies above and below 500 keV	No response below 500 keV Response stated by manufacturer above 500 keV	8.7.2
Background photon radiation	Photon energies < 0,1 MeV to > 0,7 MeV	Sensitivity to be stated by the manufacturer	8.8.2
Neutrons	No specification		8.9
Detection limit	Dose equivalent rate of 250 $nGy \cdot h^{-1}$	To be stated by the manufacturer	8.10.2
Warm-up (portable assemblies)	Less than 1 min	Time taken to read within ±20 % of final value under reference conditions to be stated.	7.4.2
Overload	Activity corresponding to 10 times the activity that would give full scale deflection on each range, or 10^6 counts s^{-1}	To display overload indication within 5 s of exposure, and returning to normal operation within 5 min of removal of exposure	7.5.2
Ambient temperature	Indoor use +10 °C +40 °C	±15 %	9.1.2.2
	Outdoor use –10 °C to 50 °C	±20 %	9.1.2.2
	Shock	Twice limits for slow change in temperature	9.1.2.3
Relative humidity	40 % to 90 % at 35 °C	±7,5 %	9.2.1
Power supply, battery operated	40 h of intermittent use for primary 8 h continuous use for secondary	±5 % of indication	7.6.4
Storage	–25 °C to 50 °C	To meet limits of this specification	10.1



NOTE The figure shows the reading of a measurement assembly when a small area source is moved away from the central axis of the detection assembly. The limit distance is the horizontal distance where the instrument reading is 1 % of the instrument reading in the central position (see 8.2).

Figure 1 – Detector profile

Dimensions in millimetres



NOTE The grid shows the source grid used to simulate a contiguous portions area of 900 cm^2 using six 150 cm^2 sources (see 8.3.1). The detection assembly is placed in the centre of the grid. The large circle shows the circular area which has the equivalent area to the grid.

Figure 2 – Contiguous portions area for testing

Annex A
(informative)

Ⓒ Limit distances for typical cylindrical detectors Ⓒ

Table A.1 shows typical limit distances for sodium iodide detectors of various detector volumes, for a number of radionuclides. In practice, this type of detector will respond to photon radiation outside of the 900 cm^2 test area.

Table A.1 – Limit distance for various detector volumes and window types

Radionuclide	Limit distances cm			
	13 ml	100 ml	350 ml	Ⓒ 2 ml Ⓒ with Be
^{60}Co	29	41	57	19
^{137}Cs	27	37	51	8
^{133}Ba	26	35		5,5
^{241}Am	N/A	N/A	N/A	5

NOTE 1 The 13 ml, 100 ml and 350 ml volume sodium iodide detectors equate to 25,4 mm, 50,8 mm and 76,2 mm detector diameters (1, 2 and 3 inch respectively).

NOTE 2 Ⓒ Be refers to a detector with a beryllium window of area 8 cm^2. Ⓒ

NOTE 3 The detectors are connected to ratemeters with both an upper and lower pulse height discrimination threshold enabled in order to minimise the background count rate.

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 Where 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	2007	International Electrotechnical Vocabulary - Part 394: Nuclear instrumentation - Instruments, systems, equipment and detectors	-	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60086	series	Primary batteries	EN 60086	series
IEC 60325 (mod)	2002	Radiation protection instrumentation - Alpha, beta and alpha/beta (beta energy > 60 keV) contamination meters and monitors	EN 60325	2004
IEC 61187 (mod)	1993	Electrical and electronic measuring equipment - Documentation	EN 61187 + corr. March	1994 1995
ISO 7503-1	1988	Evaluation of surface contamination - Part 1: Beta-emitters (maximum beta energy greater than 0,15 MeV) and alpha-emitters	-	-
ISO 7503-3	1996	Evaluation of surface contamination - Part 3: Isomeric transition and electron capture emitters, low energy beta-emitters (E bêtamax less than 0,15 MeV)	-	-
ISO 8769-2	1996	Reference sources for the calibration of surface contamination monitors - Part 2: Electrons of energy less than 0,15 MeV and photons of energy less than 1,5 MeV	-	-
ISO 11929-1	2000	Determination of the detection limit and decision threshold for ionizing radiation measurements - Part 1: Fundamentals and application to counting measurements without the influence of sample treatment	-	-
BIPM	1998	The international system of units (SI)	-	-

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