IEC 62363

Edition 1.0 2008-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radiation protection instrumentation – Portable photon contamination meters and monitors

Instrumentation pour la radioprotection – Appareils portables de mesure et de surveillance de la contamination par des photons

IEC 62363:2008

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX V

ICS 13.280

ISBN 2-8318-9733-5

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIATION PROTECTION INSTRUMENTATION – PORTABLE PHOTON CONTAMINATION METERS AND MONITORS

FOREWORD

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International Standard IEC 62363 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

This standard should be regarded as a complementary standard to IEC 60325, which is applicable to alpha and beta contamination monitoring assemblies.

The text of this standard is based on the following documents:

FDIS	Report on voting
45B/579/FDIS	45B/590/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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)*, 7th 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 hv, where h is the Planck constant and v 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 = 1,602×10^{-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

Less than 10 keV

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.