

# Radiation protection instrumentation — Alpha, beta and alpha/beta (beta energy > 60 keV) contamination meters and monitors

The European Standard EN 60325:2004 has the status of a  
British Standard

ICS 13.280

## National foreword

This British Standard is the official English language version of EN 60325:2004. It was derived by CENELEC from IEC 60325:2002. It supersedes BS IEC 60325:2002 which is withdrawn.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 tags **[C]** **[C]**.

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

Instrumentation pour la radioprotection -  
Contaminamètres et moniteurs de  
contamination alpha, bêta et alpha/bêta  
(énergie des bêta > 60 keV)  
(CEI 60325:2002, modifiée)

Strahlenschutz-Messgeräte -  
Alpha-, Beta- und Alpha/Beta-  
(Betaenergie > 60 keV)  
Kontaminationsmessgeräte und -monitore  
(IEC 60325:2002, modifiziert)

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## CENELEC

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

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

## Foreword

The text of the International Standard IEC 60325:2002, prepared by SC 45B, Radiation protection instrumentation, of IEC TC 45, Nuclear instrumentation, together with the common modifications prepared by the CENELEC BTTF 111-3, Instrumentation for ionizing radiation measurement and protection, was submitted to the formal vote and was approved by CENELEC as EN 60325 on 2004-05-01.

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Annex ZA has been added by CENELEC.

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## ALPHA, BETA AND ALPHA/BETA (BETA ENERGY >60 keV) CONTAMINATION METERS AND MONITORS

### 1 Scope and object

This International Standard is applicable to radiation meters and monitors designed for the direct measurement or the direct detection of surface contamination by alpha and/or beta radiation emitting nuclides and which comprise at least:

- a detection assembly (comprising ~~☐~~ *text deleted* ~~☐~~ 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.

Some meters and monitors consist of detection assemblies and measurement assemblies where it is possible to separate the detector assembly and use alternative detection assemblies. Conformity with the standard can either be achieved by:

All combinations of the detection assembly and the measurement assembly conforming to the requirements of this standard.

or

The detection assembly and the measurement assembly separately conforming to the relevant parts of this standard in isolation.

NOTE The use of the latter criteria verifies conformance with this standard but does not infer that calibration of a particular combination of instruments is interchangeable with any other combination.

The use of the latter criteria could allow a purchaser to use combinations of assemblies from different manufacturers with confidence.

The standard is applicable to:

- alpha surface contamination meters;
- alpha surface contamination monitors;
- beta surface contamination meters;
- beta surface contamination monitors;
- alpha/beta surface contamination meters;
- alpha/beta surface contamination monitors.

The latter two are equipment capable of determining alpha and beta contamination simultaneously and displaying the measurement of either:

- Alpha (beta, alpha/beta) surface contamination meter

An assembly including one or more radiation detectors and associated assemblies or basic function units, designed to measure alpha (beta, alpha/beta) surface emission rate associated with the contamination of the surface under examination.

- Alpha (beta, alpha/beta) surface contamination monitor.

This standard is also applicable to special purpose assemblies and to assemblies specifically designed for a surface of a particular nature. However, some of the requirements may need to be amended or supplemented according to the particular requirements applicable to such assemblies.

If an assembly has been designed to carry out combined functions, it must comply with the requirements pertaining to these different functions. If, on the other hand, it has been designed to perform one function, and, in addition, it is also capable of carrying out other functions, then it must comply with the requirements for the first function, and it would be desirable for it to comply with requirements pertaining to the others.

This standard is not applicable to radiation monitors or meters designed to measure or detect beta particles with  $E_{\max} < 60$  keV.

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 alpha, beta and alpha-beta contamination meters and monitors.

## 2 Normative references

☐ Text deleted ☐

☐ NOTE Normative references to international publications are listed in Annex ZA (normative). ☐

## 3 Terms and definitions

The general terminology concerning the detection and measurement of ionizing radiation and nuclear instrumentation is given in IEC 60050(393) and IEC 60050(394).

For the purposes of this International Standard, the following definitions apply:

### 3.1 effective range of measurement

range of values of the quantity to be measured over which the performance of a meter or monitor meets the requirements of this standard

### 3.2 ☐ surface emission rate (of a source)

number of particles of a given type above a given energy emerging from face of the source or its window per unit time ☐

### 3.3 ☐ source efficiency

largest of the two quotients, of the surface emission rate by the number of particles of the same type created or released per unit time either within the source thickness or within the source saturation layer ☐

### 3.4 high efficiency source

source in which the efficiency for particles with an energy greater than 5,9 keV is greater than 0,25, including backscattered particles. (This definition applies to beta emitters with a maximum energy >150 keV).

### 3.5 small area source

source whose active surface area has a maximum linear dimension not exceeding 1 cm

**3.6****surface emission rate response (instrument efficiency)**

under stated conditions specified by the manufacturer (sensitive area of the detector,  active surface  area of the source and the distance between source and detector), the surface emission rate response (efficiency) of the detector used in conjunction with the assemblies is the ratio of the number of detected particles (for instance counts per unit time, corrected for background) to the number of particles of the same type emitted by the radiation source in the same interval of time (conventionally true surface emission rate)

**3.7****response time (of a measuring assembly)**

the time required after a step variation in the measured quantity for the output signal variation to reach a given percentage, usually 90 %, of its final value for the first time

[IEV 394-19-09]

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

**3.8****sensitive area of the detector:**

the area of the detector, defined by the manufacturer, where the efficiency for a small area source is greater than 50 % of the maximum efficiency

**3.9****total equivalent thickness**

the thickness, generally expressed in mass per unit area that a particle (alpha or beta), emitted normally from the contaminated surface crosses in order to reach the sensitive volume of the detector

 Note deleted 

NOTE This thickness includes the distance in the air plus the detector window thickness and, sometimes, the thickness of any screen fitted over the detector window which protects it from contamination.

**3.10****indication error**

 the difference between the indicated value of a quantity,  $v$ , and the conventionally true value of that quantity,  $v_c$ , at the point of measurement. It is expressed as  $v - v_c$  

**3.11**** response (of a radiation measuring assembly)**

ratio, under specified conditions, given by the relation:

$$R = \frac{v}{v_c}$$

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 

**3.12****relative error of indication  $I$** 

the quotient of the error of indication of a measured quantity by the conventionally true value of the quantity. It may be expressed as a percentage



$$I(\%) = \frac{v - v_c}{v_c} \times 100$$

⌈C⌋ where  $v$  is the indicated value of a quantity and  $v_c$  is the conventionally true value of the quantity at the point of measurement ⌋C⌋

### 3.13

#### relative intrinsic error

relative error of indication of an assembly with respect to a quantity when subjected to a specified reference radiation under specified reference conditions

### 3.14

#### coefficient of variation $V$

the ratio ( $V$ ) 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:

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

### 3.15

#### detection limit of the 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 an adequate size, a simplified formula for the counting rate at the lower limit of detection should be used. In the case of time preselection and known background counting rate, the following simplified formula applies:

$$R_n = (k_{1-\alpha} + k_{1-\beta}) \sqrt{R_0 \left( \frac{1}{t_0} + \frac{1}{t_b} \right)}$$

where

- ⌈C⌋  $S_{(\text{nuclide})}$  is the surface emission rate response (see 3.6); ⌋C⌋
- $R_0$  is the background counting rate;
- $t_0$  is the preselected time for background counting;
- $t_b$  is the preselected time for measurement;
- $k_{1-\alpha}$  is the quantile of the normal law for a risk of errors of the first kind;
- $k_{1-\beta}$  is the quantile of the normal law for a risk of errors of the second kind.

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

$$R_n = (1,645 + 1,645) \sqrt{R_0 \left( \frac{1}{t_0} + \frac{1}{t_b} \right)}$$

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

$$DL = \frac{R_n}{S_{(\text{nuclide})} A}$$

where

- $S_{(\text{nuclide})}$  is the surface emission response (see 3.2);
- $A$  is the sensitive area of the detection assembly.

The surface emission rate per unit area shall be expressed in  $\text{s}^{-1} \cdot \text{cm}^{-2}$ .

### 3.16

#### conventionally true value of a quantity

⌈C⌋ best estimate of the value of a quantity used for a given purpose

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. ⌋C⌋

**3.17**

**detection assembly**

assembly containing at least the detector

**3.18**

**measurement assembly**

an assembly displaying the level of contamination detected

**3.19**

**alpha, beta or alpha/beta surface contamination meter**

an assembly including one or more radiation detectors and associated assemblies or basic function units that is designed to measure respectively alpha (beta, alpha/beta) surface emission rate associated with the contamination of the surface under examination

**3.20**

**alpha beta or alpha/beta surface contamination monitor**

respectively an alpha (beta, alpha/beta) activity meter provided with means for giving perceptible warning (generally visual and/or audible) that the indicated surface emission rate per unit surface area associated with the contamination of the surface under examination exceeds some adjustable predetermined value

## **4 Units**

In this standard, the units are the multiples and sub multiples of units of the International System of Units (SI)<sup>1</sup>. The following non-SI units are also used:

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

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

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

## **5 Classification of assemblies**

Assemblies are classified according to their status as:

- detection assemblies;
- measurement assemblies;
- complete contamination meters or monitors.

For measurement assemblies and complete contamination meters or monitors, according to their use as:

- transportable assemblies;
- portable assemblies.

For measurement assemblies and complete contamination meters or monitors, according to their power supplies as:

- mains;
- primary or secondary batteries.

For detection assemblies and complete contamination meters or monitors, according to the type of radiation as:

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<sup>1</sup> International Bureau of Weights and Measures: The International System of Units (SI), 7th edition 1998.

alpha contamination meters or monitors,  
beta contamination meters or monitors,  
alpha/beta contamination meters or monitors.

## **6 General characteristics**

### **6.1 Detection assemblies**

Detection assemblies shall be designed so that the sensitive area of the detector can be placed less than 5 mm, in the case of alpha detectors, and less than 10 mm, in the case of beta detectors, from the surface under examination.

If the sensitive surface of the detector is provided with a protective grille, the nominal obscuration of this grille shall be stated by the manufacturer. The thickness of this protective grille shall be such that shielding effect at all entry angles should be minimised (a collimation effect is to be avoided.)

Both the total area and the sensitive area of the detection assembly shall be stated.

If the detector requires a supply of counting gas, the manufacturer shall state the type of gas supply and the flow rate required.

Where the instrument efficiency is stored within a memory, checks shall be made with more than one appropriate measurement assembly to ensure the factors are not affected by the measurement assembly.

### **6.2 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.

### **6.3 Sealing**

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

### **6.4 Alarm threshold**

This clause is applicable to monitors only.

A monitor shall include circuits necessary for tripping an alarm at one or more thresholds.

The number of tripping levels shall be subject to agreement between manufacturer and purchaser.

Alarm threshold values shall be given either as percentages of ranges of adjustment 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 adjustable to any point within this range. It shall not be possible to incapacitate the alarm.

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). For transportable and installed assemblies, there shall be at least one set of electrical contacts available, operated by the trip unit, for external alarm purposes. They shall be operational under normal operating conditions. For portable assemblies, this facility may be provided by agreement between the purchaser and the manufacturer.

## **6.5 Instrument indication**

### **6.5.1 For contamination meters**

In addition to the visual indication of count rate, 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.

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

Calibration controls shall be protected against unauthorised adjustment.

### **6.5.2 For monitors**

In addition to the above-mentioned audible indication of count rate, there shall be either an audible indication of contamination above a certain preset value or a 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.

### **6.5.3 Indications in terms of activity**

Where the indication is in terms of activity or activity per unit area, there shall be clear indication of the energy range or radionuclide for which this indication is valid. It is likely that where the indication is given in activity or activity per unit area, this is given on the assumption that the ratio between surface emission rate and activity is 0,5. This in practice will not always be so because of backscatter, or, more likely self-absorption will be different between reference source and the sample. A good practice solution is to use a reference source representative of the contaminated surfaces to be monitored. (Similar self-absorption and backscatter.) Where this is not possible, the ratio between the response for the type of surface assumed and the reference shall be in conformity with ISO 7503 and shall be specified by the manufacturer.

## **6.6 Effective range of measurement**

For linearly scaled assemblies, the effective range of measurement shall be from 10 % to 100 % of each range.

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

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

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.