

Equipment for continuous monitoring radioactivity in gaseous effluents —

Part 2: Specific requirements for aerosol monitors including transuranic aerosols

The European Standard EN 60761-2:2004 has the status of a
British Standard

ICS 13.280

National foreword

This British Standard is the official English language version of EN 60761-2:2004.

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]. Where a common modification has been introduced by amendment, the tags carry the number of the amendment. For example, the common modifications introduced by CENELEC amendment A11 are indicated by [C11] [C11].

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 21, the Annex ZA page, an inside back cover and a back cover.

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Equipment for continuous monitoring radioactivity in gaseous effluents
Part 2: Specific requirements for aerosols monitors
including transuranic aerosols
(IEC 60761-2:2002, modified)

Equipements de surveillance en continu
de la radioactivité
dans les effluents gazeux
Partie 2: Exigences particulières
aux moniteurs d'aérosols radioactifs,
y compris les aérosols transuraniens
(CEI 60761-2:2002, modifiée)

Einrichtungen zur kontinuierlichen
Überwachung von Radioaktivität
in gasförmigen Ableitungen
Teil 2: Besondere Anforderungen
an Monitore für radioaktive Aerosole
einschließlich Transuranaerosole
(IEC 60761-2:2002, modifiziert)

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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 60761-2:2002, 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 60761-2 on 2004-11-01.

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) 2005-11-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2007-11-01

Annex ZA has been added by CENELEC.

EQUIPMENT FOR CONTINUOUS MONITORING OF RADIOACTIVITY IN GASEOUS EFFLUENTS –

Part 2: Specific requirements for radioactive aerosol monitors including transuranic aerosols

1 Scope and object

This part of IEC 60761 is applicable to equipment intended for simultaneous, delayed or discrete sequential measurement of aerosols in gaseous effluents discharged into the environment.

It is applicable to equipment designed to fulfill the following functions:

- the measurement of the volumic activity (Bq/m^3) of the aerosols in gaseous effluents and/or the released total activity of aerosols (Bq);
- the actuation of an alarm signal when either a predetermined volumic activity or a predetermined total released activity of aerosols is exceeded.

This equipment is intended for measurement over a wide range of activity, including very small quantities in the presence of a much larger natural background. The daughters of ^{222}Rn (radon) and ^{220}Rn (thoron) are naturally occurring aerosols contributing to the natural background. The discrimination against natural activity can be an important problem in monitoring low level activity. In order to provide more and better information, complementary or retrospective laboratory analysis of the filters after collection may be performed.

The object of this standard is to establish specific standard requirements, including technical characteristics and general test conditions, and to give examples of acceptable methods for aerosol effluent monitors.

The general requirements, technical characteristics, test procedures, radiation characteristics, electrical, mechanical, safety and environmental characteristics are given in IEC 60761-1. Unless otherwise stated, these requirements apply to this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60761. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60761 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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

IEC 60761-1:2002, *Equipment for continuous monitoring of radioactivity in gaseous effluents – Part 1: General requirements*

IEC 61000 (all parts): *Electromagnetic compatibility (EMC)*

IEC 61578:1997, *Radiation protection instrumentation – Calibration and verification of the effectiveness of radon compensation for alpha and/or beta aerosol measuring instruments – Test methods*

EN 481:1993, *Workplace Atmospheres: Size Fraction Definitions for Measurement of Airborne Particles*

EN 55022:1994, *Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment*

3 Terms and definitions

For the purpose of this part of IEC 60761, the following definitions apply.

3.1

aerosols

a suspension in air or gas of solid or liquid particles

3.2

aerodynamic equivalent diameter

diameter of a unit-density sphere having the same gravitational-settling velocity as the particle in question

3.3

activity median aerodynamic diameter (AMAD)

the aerodynamic particle diameter for which 50 % of the aerosol activity is associated with sizes smaller than (or larger than) that particular size

3.4

aerosol monitor

equipment designed for the continuous, delayed or sequential measurement of aerosol activity in gaseous effluents discharged into the environment

3.5

total equivalent window thickness

the equivalent window thickness (or density thickness), generally expressed in mass per unit area (mg/cm^2), that a particle emitted normally from the surface of the aerosol collecting medium must traverse to reach the sensitive volume of the detector

NOTE This thickness includes the distance covered in air plus the thickness of the entry window of the detector, thickness which may include any coating over the detector for protection against radioactive contamination, noxious chemicals or water vapour.

3.6

high efficiency source

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

3.7

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

4 Classification of aerosol effluent monitors

The equipment may be classified according to the type of measuring method such as:

- gross gamma aerosol monitors;
- gross beta aerosol monitors;
- gross alpha aerosol monitors;
- gross alpha and gross beta aerosol monitors;
- alpha spectroscopy monitors;
- gamma spectroscopy monitors.

It may also be classified according to the method of operation (see bibliography) such as:

- equipment with static filter sampler and simultaneous measurement;
- equipment with moving filter sampler and simultaneous measurement;
- equipment with moving filter sampler and delayed measurement;
- equipment with moving filter sampler and simultaneous and delayed measurement;
- equipment with static filter sampler and simultaneous measurement combined with a moving filter sampler and simultaneous and/or delayed measurement;
- equipment with impactor;
- equipment with electrostatic precipitator.

5 Sampling and detection assembly

5.1 Air delivery system including pump

The requirement of clause 11 of IEC 60761-1 is applicable. Additionally, the air or gas pump shall be capable of holding the variation of pressure induced by normal operating conditions (maximum expected sampling time, collection media or back-up filter, atmospheric dust, mass concentration contributing to blockage, etc.), so that there shall not be a reduction from nominal air flow-rate of more than 10 % or an error in the value of total air volume sampled of more than 8 % at the end of the sampling. A back-up filter should be used to minimize contamination of the pump.

In all cases, the instrument shall be designed to prevent flow blockage or malfunctioning of the collection device in its ability to retain particles.

An alarm shall be fitted to detect the absence, rupture or blockage of the collection medium, for example a filter or an impactor.

NOTE The delivery line efficiency is not always constant and can change with the operation time of the system. Therefore, the efficiency should be verified after installation of the system and then periodically, for example every two years.

5.2 Aerosol collection device

The collection surface may have different geometries according to the method of operation of the assembly (see clause 4):

- circular, for example, for static filter assemblies or cassette systems where filter papers are moved under a detector or circular impactor;
- square or rectangular, for example, for moving filter assemblies, or rectangular impactor designs.

NOTE For moving filters, square or rectangular geometry allows a simplification for calculations.

- For equipment measuring alpha radiation that uses a detector to view the collection medium, it is important to minimize, as much as possible, the absorption of alpha radiation by the collection medium.
- Significant non-uniformity of deposition of aerosols collected on the filters shall be avoided.
- The design of the aerosol retention device shall minimize deposition on surfaces other than the collection media.
- The filter-holder design characteristics (dimensions, geometry, filter support, etc.) shall take account of the mechanical strength of the filters used and the characteristics of the air (or gas) sampling pump.
- For simultaneous sampling and measuring assemblies, the measurement of aerosol volumic activity may be disturbed by radioactive gases, such as ^{41}Ar , ^{85}Kr , ^{133}Xe , etc., liable to be present in the sampled air (or gas). This shall be minimized by the special geometry of cavities located near the detector in front of and behind the filter and the corresponding reduction of dead volumes.
- The design shall minimize leaks, particularly internal leaks causing the flow to bypass the collection media.
- Access to the collection media shall be designed in such a manner as to permit fast and easy removal without risk of damage to the detection device and minimum risk to the operator when a high level of activity has been accumulated.
- To improve the accuracy and sensitivity of the measurements, the equipment should be designed so that complementary laboratory analyses of the media after collection can be performed. In addition, the collection media may provide a means of verification of the instrumental measurements. Also, in the case of a failure of the electronic part of the instrument, the medium analysis may serve as a back-up to the measurements.

5.3 Particle collection efficiency

The manufacturer shall state the collection efficiency of the sampling device for at least particles over a range of 0,1 μm to 10 μm aerodynamic equivalent diameter or other values agreed upon by the manufacturer and the purchaser. The efficiency values shall be given for the normal operating conditions, for example air sampling flow-rate.

NOTE 50 % of particles with aerodynamic diameter less than 10 μm are capable of penetrating into the pulmonary region of the lung (EN 481).

 NOTE Accuracy and sensitivity of the measurement depends on the collection efficiency of the filter material as well as on the free passing of the components not to be retained. If the gas flow rate is 10 % lower than its nominal value, the collecting media is to be replaced by a new one. 

5.4 Radiation detector

The manufacturer shall specify the detector characteristics, including the detector dimensions and transmission characteristics (for example effective area, thickness, etc.) of any protective screens. The manufacturer should also specify the variation of detection efficiency with particle energy.

The useful detection surface area of the detector should be approximately equal to that of the aerosol collecting surface.

- For gross activity measurement, the detector may be larger than the collection medium.
- For α spectroscopic measurement, the two dimensions should be similar.

The maximum total equivalent window thickness (normal to the source surface at the entrance to the useful volume of the detector) shall be chosen according to the type of radiation detected:

- gross alpha measurement: less than 2 mg/cm^2 (loss of energy equivalent to 3,2 MeV);