

Equipment for continuous monitoring of radioactivity in gaseous effluents —

Part 1: General requirements

The European Standard EN 60761-1:2004 has the status of a British Standard.

ICS 13.280

National foreword

This British Standard is the official English language version of EN 60761-1:2004. It is identical with IEC 60761-1:2002.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Health physics instrumentation, which has the responsibility to:

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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Equipment for continuous monitoring radioactivity in gaseous effluents
Part 1: General requirements
(IEC 60761-1:2002, modified)

Equipements de surveillance en continu
de la radioactivité
dans les effluents gazeux
Partie 1: Exigences générales
(CEI 60761-1:2002, modifiée)

Einrichtungen zur kontinuierlichen
Überwachung von Radioaktivität
in gasförmigen Ableitungen
Teil 1: Allgemeine Anforderungen
(IEC 60761-1:2002, modifiziert)

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of the International Standard IEC 60761-1:2002, 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 60761-1 on 2004-11-01.

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Subclauses, notes and annexes that are additional to those in the IEC standard are prefixed with the letter Z.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60761-1:2002 was approved by CENELEC as a European Standard with agreed common modifications.

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EQUIPMENT FOR CONTINUOUS MONITORING OF RADIOACTIVITY IN GASEOUS EFFLUENTS –

Part 1: General requirements

1 Scope and object

This part of IEC 60761 defines acceptable forms of such monitoring, provides some general guidance as to the possible range of measurement and capability of such equipment as may be envisaged, and indicates when and where its uses may be practicable.

This standard is applicable to equipment for continuous monitoring of radioactivity in gaseous effluents during normal operations and during anticipated operational occurrences. This standard does not apply to equipment specifically for use in accident conditions. Such equipment may require additional capabilities.

This standard is restricted to equipment for continuously monitoring radioactivity in gaseous effluent. It does not deal with sample extraction and laboratory analysis.

The object of this standard is to lay down mandatory general requirements and give examples of acceptable methods for equipment for continuous monitoring of radioactivity in gaseous effluents.

It specifies, for the equipment described above, the general characteristics, general test procedures, radiation, electrical, safety and environmental characteristics and the identification and certification of the equipment. If this equipment is part of a centralized system for continuous radiation monitoring in a nuclear facility, there may be additional requirements from other standards related to those systems.

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 60038:1983, *IEC standard voltages*

IEC 60050(151):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 60050(393):1996, *International Electrotechnical Vocabulary (IEV) – Chapter 393: Nuclear instrumentation – Physical phenomena and basic concepts*

IEC 60050(394):1995, *International Electrotechnical Vocabulary (IEV) – Chapter 394: Nuclear instrumentation – Instruments*

☐ Text deleted ☐

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

IEC 60181:1964, *Index of electrical measuring apparatus used in connection with ionizing radiation*

IEC 60181A:1965, *Index of electrical measuring apparatus used in connection with ionizing radiation – First supplement*

IEC 60761 (all parts), *Equipment for continuous monitoring of radioactivity in gaseous effluents*

☐ IEC 61000-4-2, *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test*

IEC 61000-4-12, *Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Oscillatory waves immunity test* ☐

ISO:1995, *Guide to the expression of uncertainty in measurement*

ISO 2889:1975, *General principles for sampling airborne radioactive materials*

ISO 10012-1:1992, *Quality assurance requirements for measuring equipment – Part 1: Metrological confirmation system for measuring equipment*

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

3 Terms, definitions and units

For the purpose of this part of IEC 60761, the definitions concerning the detection and measurement of ionizing radiation and nuclear instrumentation given in IEC 60050(393), IEC 60050(394), IEC 60181 and IEC 60181A, and the following, apply.

3.1

gaseous effluent monitor

equipment intended for continuous monitoring of radioactivity in gaseous effluents. The different parts of the monitor may conveniently be grouped into two assemblies which may be associated or separated according to the monitoring and operating requirements

3.2

detection assembly

includes one or more radiation detectors and associated function units

3.3

control and measurement assembly

includes assemblies and function units designed to measure quantities connected with ionizing radiation (activity, volumic activity, etc.). The assembly is provided with function units to give a perceptible warning that the quantity being measured exceeds some predetermined value

3.4

conventionally true value (of a quantity)

the best estimate of the value of a quantity

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 and its uncertainty determined from a primary or a secondary standard, or by a reference instrument which has been calibrated against a primary or secondary standard, may be taken as the conventionally true value.

3.5

coefficient of variation

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

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

3.6

measurement uncertainty

parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand

3.7

coverage factor

numerical factor (k) used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty (see ISO 1995: Guide to the expression of uncertainty in measurement)

3.8

decision quantity

random variable for the decision whether the physical effect to be measured is present or not

3.9

decision threshold

fixed value of the decision quantity by which when exceeded by the result of an actual measurement of a measurand quantifying a physical effect, one decides that the physical effect is present

NOTE The statistical test shall be designed so that the probability of wrongly rejecting the hypothesis (error of the first kind) is equal to a given value α . For this standard, α equals 5 %.

3.10

detection limit

smallest true value of the measurand which is detectable by the measuring method

NOTE The detection limit is the smallest true value of the measurand which is associated with the statistical test and hypotheses (see decision quantity) by the following characteristics: if in reality the true value is equal to or exceeds the detection limit, the probability of wrongly not rejecting the hypothesis (error of the second kind) shall be at most equal to a given value β . For this standard, β equals 5 %.

3.11

effective range of measurement

range of the values of the activity to be measured over which the performance of a piece of equipment or an assembly meets the requirements of its specifications

3.12

dynamic range

quotient of the signal from the maximum measurable indication of a quantity to the signal from the decision threshold

3.13 error of indication

difference between the indicated value (v) of a quantity and the conventionally true value (v_c) of that quantity at the point of measurement

$$\Delta v = v - v_c$$

3.14 relative intrinsic error

relative error of indication (e_i) of a piece of equipment or an assembly with respect to a quantity when subjected to a specified reference quantity under specified reference conditions expressed as:

$$e_i = \frac{v - v_c}{v_c}$$

where

v is the indicated value of a quantity;

v_c is the conventionally true value of the quantity at the point of measurement.

3.15 response time

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

3.16 monitor sampling efficiency

monitor sampling efficiency is defined as the ratio of the volumic activity as available for measurement on the collection medium, to the volume activity in the air supplied to the inlet of the monitor. It is the product of the collection efficiency times the air circuit efficiency of the monitor

3.17 collection efficiency

where applicable, the collection efficiency of a monitor is defined as the ratio of the total activity available for measurement on the collection medium, for example filter or activated charcoal pack, to the total activity in the air at the inlet of the collection medium

3.18 monitor air circuit efficiency

the air circuit efficiency of the monitor describes the losses of activity on the walls of the monitor between the air circuit inlet and the collection medium. It is defined as the ratio of the total activity available for the monitor to sample, to the total activity in the air supplied at the inlet of the monitor

3.19 retention capacity

maximum quantity of a defined substance which can be retained at equilibrium in the medium considered

3.20 reference response

ratio, under standard test conditions, given by the relation:

$$R_{\text{ref}} = \frac{A_v}{A_{vc}}$$

where

A_v is the value of the volumic activity indicated by the equipment or assembly under test;

A_{vc} is the conventionally true value of the volumic activity.

3.21

sensitivity

for a given value of the measured quantity, ratio of the variation of the observed variable to the corresponding variation of the measured quantity

3.22

volumic activity

activity per unit volume of air or gas

3.23

surface emission rate of solid sources

number of particles of a given type above a given energy emerging from the front face of the source per unit time

3.24

test nomenclature

3.24.1

type test

a test of one or more devices made to a certain design to show that the design meets certain specifications

[IEV 151-04-15]

3.24.2

routine test

a test to which each individual device is subject during or after manufacture to ascertain whether it complies with certain criteria

[IEV 151-04-16]

3.24.3

acceptance test

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

[IEV 151-04-20]

3.24.4

maintenance test

a test carried out periodically on a device or equipment to ascertain and, if necessary, make certain adjustments to ensure that its performance remains within specified limits

[IEV 151-04-22]

3.25

manufacturer and purchaser

the term "manufacturer" includes the designer and the seller of the equipment.

The term "purchaser" includes the user of the equipment.

3.26 Units

This standard uses the SI system of units. The following units of practical importance are also used where appropriate:

- for time: year (y), day (d), hour (h), minute (min);
- for energy: electron-volt (eV);
- for volumic activity: Becquerel per cubic metre (Bq/m³).

4 Symbols and abbreviations

MTBF Mean Time Between Failures.

5 General requirements

The primary purpose of radioactive effluent monitoring equipment is, generally, to provide assurance that the effluent discharged from each establishment conforms to the authorized discharge limits.

It may also provide the purchaser with data relevant to the control of any process carried out. While this is usually a secondary purpose, in certain circumstances, situations may be envisaged where the detection of activities significantly below the allowed discharge limits may give early warning of plant malfunction.

Irrespective of whether the proposed effluent monitoring is intended to meet the requirements of the responsible authority or is mainly intended to provide control information to the purchaser, the most likely requirement is the capability to measure a defined level of discharge, characterized by its volumic activity and the total effluent flow-rate.

This capability is affected by a number of factors including detector type and performance, mode of operation of the monitor, dilution of activity in the overall effluent stream, and effectiveness of the sampling system (where part, not all, of the effluent stream is actually measured).

Of the various factors involved, it is obviously possible to optimize, at a very late stage, the detailed monitor design, but often not enough thought is given, early in plant design, to the possible monitoring requirements and how the overall effluent system should be arranged so as to allow effective monitoring at the sensitivity level required. Thus, for maximum performance capability, it is recommended that the need for and the necessary performance of monitoring equipment be identified early in the design of any plant and the plant design influenced as necessary to achieve the requirements.

6 Types of monitors

6.1 General

The types of gaseous effluent monitoring envisaged are radioactive aerosol monitors, radioactive noble gas monitors and specific radionuclide monitors. They are dealt with in detail in the other parts of this standard. However, the following summary highlights some significant features.