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Ugotavljanje zmogljivosti neprekinjeno delujočih zračnih nadzornikov - 1. del: Zračni nadzorniki na podlagi tehnik vzorčenja kopičenja zraka (ISO/TR 22930-1:2020)

Evaluating the performance of continuous air monitors - Part 1: Air monitors based on accumulation sampling techniques (ISO/TR 22930-1:2020)

Ermittlung der Leistungsfähigkeit kontinuierlicher Luftmonitore - Teil 1: Luftmonitore basierend auf Sammeltechnik mittels Anreicherung (ISO/TR 22930-1:2020)

Évaluation des performances des dispositifs de surveillance de l'air en continu - Partie 1: Dispositifs de surveillance de l'air basés sur des techniques de prélèvement avec accumulation (ISO/TR 22930-1:2020)

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Evaluating the performance of continuous air monitors - Part 1: Air monitors based on accumulation sampling techniques (ISO/TR 22930-1:2020)

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European foreword

The text of ISO/TR 22930-1:2020 has been prepared by Technical Committee ISO/TC 85 "Nuclear energy, nuclear technologies, and radiological protection" of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TR 22930-1:2021 by Technical Committee CEN/TC 430 "Nuclear energy, nuclear technologies, and radiological protection" the secretariat of which is held by AFNOR.

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Endorsement notice

The text of ISO/TR 22930-1:2020 has been approved by CEN as CEN ISO/TR 22930-1:2021 without any modification.

TECHNICAL REPORT

ISO/TR 22930-1

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Evaluating the performance of continuous air monitors —

Part 1: Air monitors based on accumulation sampling techniques

Évaluation de la performance des dispositifs de surveillance de l'air en continu —

Partie 1: Moniteurs d'air basés sur des techniques d'échantillonnage par accumulation

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

A list of all the parts in the ISO/TR 22930 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Sampling and monitoring of airborne activity concentration in workplaces are critically important for maintaining worker safety at facilities where dispersible radioactive substances are used.

The first indication of a radioactive substance dispersion event comes, in general, from a continuous air monitor (CAM) and its associated alarm levels. In general, the response of a CAM is delayed in time compared to the actual situation of release.

The knowledge of a few factors is needed to interpret the response of a CAM and to select the appropriate CAM type and its operating parameters.

The role of the radiation protection officer is to select the appropriate CAM, to determine when effective release of radioactive substances occurs, to interpret measurement results and to take corrective action appropriate to the severity of the release.

The objective of ISO/TR 22930 series is to assist radiation protection officer in evaluating the performance of a CAM.

ISO/TR 22930 series describes the factors and operating parameters and how they influence the response of a CAM.

This document deals with monitoring systems based on accumulation sampling techniques.

Evaluating the performance of continuous air monitors —

Part 1: Air monitors based on accumulation sampling techniques

1 Scope

The use of a continuous air monitor (CAM) is mainly motivated by the need to be alerted quickly and in the most accurate way possible with an acceptable false alarm rate when a significant activity concentration value is exceeded, in order to take appropriate measures to reduce exposure of those involved.

The performance of this CAM does not only depend on the metrological aspect characterized by the decision threshold, the limit of detection and the measurement uncertainties but also on its dynamic capacity characterized by its response time as well as on the minimum detectable activity concentration corresponding to an acceptable false alarm rate.

The ideal performance is to have a minimum detectable activity concentration as low as possible associated with a very short response time, but unfortunately these two criteria are in opposition. It is therefore important that the CAM and the choice of the adjustment parameters and the alarm levels be in line with the radiation protection objectives.

The knowledge of a few factors is needed to interpret the response of a CAM and to select the appropriate CAM type and its operating parameters.

Among those factors, it is important to know the half-lives of the radionuclides involved, in order to select the appropriate detection system and its associated model of evaluation.

CAM using filter media accumulation sampling techniques are usually of two types:

a) fixed filter;

b) moving filter.

This document first describes the theory of operation of each CAM type i.e.:

— the different models of evaluation considering short or long radionuclides half-lives values,

— the dynamic behaviour and the determination of the response time.

In most case, CAM is used when radionuclides with important radiotoxicities are involved (small value of ALI). Those radionuclides have usually long half-life values.

Then the determination of the characteristic limits (decision threshold, detection limit, limits of the coverage interval) of a CAM is described by the use of long half-life models of evaluation.

Finally, a possible way to determine the minimum detectable activity concentration and the alarms setup is pointed out.

The annexes of this document show actual examples of CAM data which illustrate how to quantify the CAM performance by determining the response time, the characteristics limits, the minimum detectable activity concentration and the alarms setup.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 16639, *Surveillance of the activity concentrations of airborne radioactive substances in the workplace of nuclear facilities*

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

ISO 11929-1, *Determination of the characteristic limits (decision threshold, detection limit and limits of the coverage interval) for measurements of ionizing radiation — Fundamentals and application — Part 1: Elementary applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11929-1, ISO 16639, IEC 60761-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
annual limit on intake
ALI
derived limit for the amount of radioactive substance (in Bq) taken into the body of an adult worker by inhalation or ingestion in a year

[SOURCE: ISO 16639:2017, 3.7]

3.2
continuous air monitor
CAM
instrument that continuously monitors the airborne activity concentration on a near real-time basis

[SOURCE: ISO 16639:2017, 3.10]

3.3
decision threshold
value of the estimator of the measurand, which when exceeded by the result of an actual measurement using a given measurement procedure of a measurand quantifying a physical effect, it is decided that the physical effect is present

Note 1 to entry: The decision threshold is defined such that in cases where the measurement result, y, exceeds the decision threshold, y^*, the probability of a wrong decision, namely that the true value of the measurand is not zero if in fact it is zero, is less or equal to a chosen probability α.

Note 2 to entry: If the result, y, is below the decision threshold, y^*, it is decided to conclude that the result cannot be attributed to the physical effect; nevertheless, it cannot be concluded that it is absent.

[SOURCE: ISO 11929-1:2019, 3.12]

3.4
derived air concentration
DAC
concentration of a radionuclide in air that, if breathed over the period of a work year, would result in the intake of one ALI for that radionuclide

Note 1 to entry: The DAC is calculated by dividing the ALI by the volume of air breathed by reference man under light-activity work during a working year (in Bq m^{-3}).

Note 2 to entry: The parameter values recommended by the International Commission on Radiological Protection for calculating the DAC are a breathing rate of 1,2 $m^3 \cdot h^{-1}$ and a working year of 2 000 h (i.e. 2 400 m^3).

Note 3 to entry: The air concentration can be expressed in terms of a number of DAC. For example, if the DAC for a given radionuclide in a particular form is 0,2 Bq m^{-3} and the observed concentration is 1,0 Bq m^{-3}, then the observed concentration can also be expressed as 5 DAC (i.e. 1,0 divided by 0,2).

Note 4 to entry: The derived air concentration-hour (DAC-hour) is an integrated exposure and is the product of the concentration of a radioactive substance in air (expressed as a fraction or multiple of DAC for each radionuclide) and the time of exposure to that radionuclide, in hours.

[SOURCE: ISO 16639:2017, 3.12]

3.5
detection alarm level
S0
value of time-integrated activity concentration activity concentration corresponding to an acceptable false alarm rate

Note 1 to entry: When S0 increases false alarm rate decreases.

Note 2 to entry: Others values of alarm level higher than S0 can also be set up for operational reasons.

3.6
detection limit
smallest true value of the measurand which ensures a specified probability of being detectable by the measurement procedure

Note 1 to entry: With the decision threshold according to 3.3, the detection limit is the smallest true value of the measurand for which the probability of wrongly deciding that the true value of the measurand is zero is equal to a specified value, β, when, in fact, the true value of the measurand is not zero. The probability of being detectable is consequently $(1-\beta)$.

Note 2 to entry: The terms detection limit and decision threshold are used in an ambiguous way in different standards (e.g. standards related to chemical analysis or quality assurance). If these terms are referred to one has to state according to which standard they are used.

[SOURCE: ISO 11929-1:2019, 3.13]

3.7
limits of the coverage interval
values which define a coverage interval

Note 1 to entry: The limits are calculated in the ISO 11929 series to contain the true value of the measurand with a specified probability $(1-\gamma)$

Note 2 to entry: The definition of a coverage interval is ambiguous without further stipulations. In this standard two alternatives, namely the probabilistically symmetric and the shortest coverage interval are used.

Note 3 to entry: The coverage interval is defined in ISO 11929-1:2019, 3.4, as the interval containing the set of true quantity values of a measurand with a stated probability, based on the information available.

[SOURCE: ISO 11929-1:2019, 3.16 modified – Note 3 to entry has been added]