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Workplace air — General requirements for the performance of procedures for the measurement of chemical agents

Air des lieux de travail — Exigences générales concernant les performances des procédures de mesure des agents chimiques

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

The committee responsible for this document is ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*.

Introduction

National laws and regulations require the assessment of the potential exposure of a worker to chemical agents in workplace atmospheres. One way of assessing such exposure is to measure the concentration of a chemical agent in the air in the worker's breathing zone. The procedures used for such measurements should provide reliable and valid results for the comparison purpose of exposure measurements with occupational exposure limit values and for the provision of acceptable control strategies.

This document is based on EN 482:2012, amended by Amendment 1:2015, and introduces general requirements to fulfil the measurement procedures in the process of quantitative exposure assessment. Specific International Standards and European Standards have been prepared for different types of measuring procedures and measuring devices. These include standards for airborne particle samplers [EN 13205 (all parts)], diffusive samplers (ISO 16107 and EN 838), pumped samplers (EN 1076), short-term detector tubes (ISO 17621), personal sampling pumps (ISO 13137), metals and metalloids in airborne particles (EN 13890), mixtures of airborne particles and vapour (EN 13936) and direct reading instruments for toxic gases and vapours [EN 45544 (all parts)]. In these specific standards, additional requirements have been included for the procedure or device in question, so that the general requirements of this document are not compromised. Where no specific International and/or European Standard exists, only the general requirements apply.

Performance requirements given in this document are intended to apply under environmental conditions present at the workplace. However, because a wide range of environmental conditions is encountered in practice, this document specifies requirements that have to be fulfilled by measuring procedures when tested under prescribed laboratory conditions.

It is the user's responsibility to choose the appropriate procedures or devices that meet the requirements of this document. One way of doing this is to obtain information or confirmation from the provider of a procedure or the manufacturer of a device. Type-testing or, more generally, assessment of the performance of procedures or devices can be undertaken by the manufacturer, user, testing house or research and development laboratory, as is most appropriate. A number of existing procedures for workplace measurements have either been tested over a part of the required minimum measuring range, but not over the entire range, or have not been tested for all environmental influences and potential interferences. If these partially validated procedures meet the performance requirements of this document, they can be used at present. Nevertheless, these procedures should be tested over the full ranges as soon as is reasonably practicable.

Workplace air — General requirements for the performance of procedures for the measurement of chemical agents

1 Scope

This document specifies general performance requirements for procedures for the determination of the concentration of chemical agents in workplace atmospheres. These requirements apply to all steps of measuring procedures regardless of the physical form of the chemical agent (gas, vapour, airborne particles), measuring procedures with separate sampling and analytical methods, and direct-reading devices.

This document specifies requirements that have to be fulfilled by measuring procedures when tested under prescribed laboratory conditions due to a wide range of environmental conditions encountered in practice.

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 78-2, *Chemistry — Layouts for standards — Part 2: Methods of chemical analysis*

ISO 7708, *Air quality — Particle size fraction definitions for health-related sampling*

ISO 13137, *Workplace atmospheres — Pumps for personal sampling of chemical and biological agents — Requirements and test methods*

ISO 16107, *Workplace atmospheres — Protocol for evaluating the performance of diffusive samplers*

ISO 17621, *Workplace atmospheres — Short term detector tube measurement systems — Requirements and test methods*

EN 838, *Workplace exposure — Procedures for measuring gases and vapours using diffusive samplers — Requirements and test methods*

EN 1076, *Workplace exposure — Procedures for measuring gases and vapours using pumped samplers — Requirements and test methods*

EN 13205 (all parts), *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations*

EN 13890, *Workplace exposure — Procedures for measuring metals and metalloids in airborne particles — Requirements and test methods*

EN 13936, *Workplace exposure — Procedures for measuring a chemical agent present as a mixture of airborne particles and vapour — Requirements and test methods*

EN 45544 (all parts), *Workplace atmospheres — Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18158 apply.

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

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

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

4 Classification

4.1 General

In this document, measurements are classified according to their purposes. These classifications are based upon the measurement strategy in EN 689.

4.2 Screening measurements of time-weighted average concentration

Screening measurements of time-weighted average concentration are performed to obtain semiquantitative information on exposure levels. Such information is used to identify potential health hazards, and to estimate the risk to health based on the likely severity of harm and the probability of its occurrence. These measurements can also determine if the exposure is significantly below or above the occupational exposure limit value (OELV). Apparatus intended for detection and concentration measurements of chemical agents, that meets the requirements of this document and is capable of reporting the time-weighted average, can be used.

4.3 Screening measurements of variation of concentration in time and/or space

Screening measurements of variation of concentration in time and/or space are used to provide information on the likely pattern of the concentration of chemical agents in the air and to identify locations and periods of elevated exposure. The screening measurements also provide information on the location and intensity of emission sources and to estimate the effectiveness of ventilation or other technical measures. Apparatus intended for detection and concentration measurements of chemical agents, that meets the requirements of this document, can be used.

4.4 Measurements for comparison with occupational exposure limit values

Provided the method meets established acceptable uncertainty criteria, measurements can be made for comparison with OELVs. Measurements can be taken to determine whether a worker's exposure exceeds the OELV initially and repeated after any significant change in working conditions, industrial process, products or chemicals, or OELV.

4.5 Periodic measurements

Periodic measurements are used to determine whether exposure conditions have changed since the measurements for comparison with OELVs were performed, or whether control measures remain effective. The interval between measurements should be established based on the initial occupational exposure assessment or subsequent amendments to it.

NOTE Since the composition of the workplace atmosphere will have been investigated during the initial occupational exposure assessment and the composition is known not to vary over time, it can be appropriate for periodic measurements to use procedures with lower selectivity.

5 Performance requirements

5.1 General

Performance requirements for measuring procedures depend on the purpose for which they are used. The performance requirements for screening measurements are less stringent than for measurements for the comparison with limit values and periodic measurements. Therefore, the performance requirements for screening measurements in 5.2 and 5.3 are only given in general terms.

5.2 Screening measurements of time-weighted average concentration

The purpose of these measurements is described in 4.2. The measurement procedures shall have

a) adequate selectivity for the chemical agent,

b) averaging time less than or equal to the limit value reference period,

c) measuring range that includes the limit value, and

d) expanded uncertainty that is fit for purpose.

5.3 Screening measurements of variation of concentration in time and/or space

The purpose of these measurements is described in 4.3. The measuring procedures shall have

a) adequate selectivity for the chemical agent,

b) short averaging time (for variation of concentration in time ≤5 min; for variation of concentration in space ≤15 min),

c) measuring range that is fit for purpose (see 4.3), and

d) expanded uncertainty that is fit for purpose.

5.4 Measurements for comparison with limit values and periodic measurements

5.4.1 Unambiguity

A measuring procedure shall produce an unambiguous result for the concentration of the chemical agent being measured in the specified measuring range, i.e. an analytically determined value shall correspond to one concentration only within a known uncertainty.

5.4.2 Selectivity

The measuring procedure shall contain appropriate information about the nature and magnitude of any interference.

NOTE 1 Selectivity requirements vary from case to case, depending on what is known in advance about the workplace air. If the identity of all contaminants present is not known in advance, then the measuring procedure will need to have a high selectivity. If the identity of all contaminants is known prior to measurement and there are no interferents present, then it might be possible to use a measurement procedure with a low or adequate selectivity.

Where a particle size fraction, as defined in ISO 7708, is specified for an OELV, procedures for measuring chemical agents present as airborne particles shall prescribe a method for sampling the specified particle size fraction.

NOTE 2 In addition to samplers meeting the requirements of ISO 7708, there are samplers which themselves define the sample [see ISO 13205 (all parts)].

If different limit values are set for different species of a chemical agent, then the measuring procedure shall determine the individual species concerned.

5.4.3 Averaging time

The averaging time is equal to the sampling time, which shall be less than or equal to the limit value reference period. Depending on the sampling techniques, the sampling time can vary.

NOTE A full shift average concentration, typically the 8 h time-weighted concentration, gives a representative description of the occupational exposure situation.

Exposure peaks which may occur systematically or randomly during the shift should fulfil the short-term exposure limit conditions, if any.

5.4.4 Measuring range

The measuring range of the procedure listed in Table 1 shall cover at least the concentrations from 0,1 times to 2 times the limit value for long-term measurements, and from 0,5 times to 2 times the limit value for short-term measurements. The relevant OELV shall be determined by the proper authorities where the measuring procedure is to be used.

NOTE Reference [10] provides a list of limit values from many jurisdictions.

5.4.5 Expanded uncertainty

The requirements for expanded uncertainty are given in Table 1.

Table 1 — Expanded uncertainty requirements for measurements for comparison with limit values and periodic measurements

Reference period	Measuring range	Relative expanded uncertainty	Relative expanded uncertainty (mixtures of airborne particles and vapour)
Short-term (e.g. 15 min)	0,5 times to 2 times limit value	≤50 %	≤50 %
Long-term	0,1 times to <0,5 times limit value	≤50 %	≤50 %
Long-term	0,5 times to 2 times limit value	≤30 %	≤50 %

NOTE Variation of exposure to chemical agents in the workplace can be significantly greater than indicated by the uncertainty of a single measurement calculated according to this document. This is due to the temporal and spatial variability of workplace exposure.

5.4.6 Chemical agents where compliant methods are not available

Limit values are determined by authorities independently from those developing measuring procedures. If a measuring procedure is not available for a given limit value which meets the requirements given in 5.4.4 and 5.4.5, a measuring procedure should be used whose performance is closest to the requirements. The method employed should clearly state its limitations when measuring at the exposure limit.

5.5 Composite procedures

The performance requirements detailed in 5.2, 5.3 and 5.4 shall be fulfilled for the whole measuring procedure even if the measuring procedure consists of several distinct steps, e.g. preparation of equipment, sampling, transport and storage, sample preparation and analysis. Each step of the measuring procedure may be tested individually and can be combined as a whole.

5.6 Transport, handling and/or storage

Transport, handling and/or storage of samples, if appropriate, shall be carried out in such a way that the physical and chemical integrity is maintained between sampling and analysis.

5.7 Environmental conditions

The effect of environmental conditions (e.g. temperature, humidity, atmospheric pressure, and/or air speed) on the performance of the method shall be tested in the laboratory. Performance requirements concerning unambiguity, selectivity, expanded uncertainty, minimum measuring range and averaging time shall be fulfilled under the conditions likely to be encountered in the workplace.

NOTE Due to the time, cost, and effort involved, it is not practicable to carry out a comprehensive evaluation of environmental influences in the field and therefore laboratory tests are specified in this document. However, field tests can provide valuable information on the performance of measurement methods (e.g. interferences from nearby workplaces).

The range of environmental conditions under which the performance requirements of 5.2 to 5.5 are fulfilled shall be specified in the measuring procedure.

5.8 Description of measuring procedure

The measuring procedure shall be documented in accordance with ISO 78-2. Any clause or subclause which is unnecessary in a particular case may be omitted, and others, if required, may be added in the most appropriate places. The description shall contain all necessary information to perform the measuring procedure, including information about the attainable expanded uncertainty, measuring range, averaging time, interferences, and environmental or other conditions that can influence the performance of the measuring procedure.

If correction factors are applied, e.g. for a known and explainable bias due to environmental influences, these shall be justified in the measuring procedure.

NOTE An example for the structure of a method description based on ISO 78-2 is given in Annex A.

5.9 Dimension of result

The final measurement result shall be expressed in the same units as those of the limit value. This can be achieved directly or by means of a suitable conversion.

This requirement is not obligatory for screening measurements of the variation of concentration in time and/or space.

5.10 Additional requirements

In addition to the requirements given in 5.2 to 5.9, further requirements specified in ISO 13137, ISO 16107, ISO 17621, EN 838, EN 1076, EN 13205 (all parts), EN 13890, EN 13936 and EN 45544 (all parts) shall be met for particular types of measuring procedures and devices, as appropriate.

Table 2 lists additional requirements of testing parameters.