
**Workplace air — Determination of metals
and metalloids in airborne particulate
matter by inductively coupled plasma
atomic emission spectrometry —**

Part 1:

Sampling

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*Air des lieux de travail — Détermination des métaux et métalloïdes dans
les particules en suspension dans l'air par spectrométrie d'émission
atomique avec plasma à couplage inductif —*

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Partie 1: Échantillonnage



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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15202 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15202-1 was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*.

ISO 15202 consists of the following parts, under the general title *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry*:

— *Part 1: Sampling*

— *Part 2: Sample preparation*

— *Part 3: Analysis*

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Annexes A and B of this part of ISO 15202 are for information only.

Introduction

The health of workers in many industries is at risk through exposure by inhalation of toxic metals and metalloids. Industrial hygienists and other public health professionals need to determine the effectiveness of measures taken to control workers' exposure, and this is generally achieved by taking workplace air measurements. This part of ISO 15202 has been published in order to make available a method for making valid exposure measurements for a wide range of metals and metalloids in use in industry. It will be of benefit to: agencies concerned with health and safety at work; industrial hygienists and other public health professionals; analytical laboratories; industrial users of metals and metalloids and their workers, etc.

This part of ISO 15202 specifies a generic method for determination of the mass concentration of metals and metalloids in workplace air using inductively coupled plasma atomic emission spectrometry (ICP-AES).

This part of ISO 15202 gives details of relevant International, European and National Standards which specify characteristics, performance requirements and test methods relating to sampling equipment. It augments guidance provided elsewhere on assessment strategy and measurement strategy, and specifies a method for collecting samples of airborne particulate matter for subsequent chemical analysis.

Part 2 of ISO 15202 describes a number of procedures for preparing sample solutions for analysis by ICP-AES.

Part 3 of ISO 15202 gives requirements and test methods for analysis of sample solutions by ICP-AES.

It has been assumed in the drafting of this part of ISO 15202 that the execution of its provisions, and the interpretation of the results obtained, is entrusted to appropriately qualified and experienced people.

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Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry —

Part 1: Sampling

1 Scope

1.1 This part of ISO 15202 specifies a method for collecting samples of airborne particulate matter for subsequent determination of metals and metalloids using inductively coupled plasma - atomic emission spectrometry.

1.2 The method is not applicable to the sampling of mercury, which is present in air in the vapour phase at ambient temperatures; inorganic compounds of metals and metalloids that are permanent gases, e.g. arsine (AsH_3); or inorganic compounds of metals and metalloids that are present in the vapour phase at ambient temperatures, e.g. arsenic trioxide (As_2O_3).

NOTE Although the method does not describe a means of collecting inorganic compounds of metals and metalloids that are present in the vapour phase, in most instances this is relatively easily achieved by using a back-up filter which has been pre-treated to trap the compound(s) of interest, e.g. a back-up paper pad impregnated with sodium carbonate is suitable for collecting arsenic trioxide (see ISO 11041).

1.3 The method is applicable to personal sampling of the inhalable or respirable fraction of airborne particles, as defined in ISO 7708, and to static sampling.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15202. 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 ISO 15202 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 ISO and IEC maintain registers of currently valid International Standards.

ISO 7708:1995, *Air quality — Particle size fraction definitions for health-related sampling*.

ISO 15202-2:—¹), *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry — Part 2: Sample preparation*.

ISO 15202-3:—¹), *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry — Part 3: Analysis*.

1) To be published.

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EN 482:1994, *Workplace atmospheres — General requirements for the performance of procedures for the measurement of chemical agents.*

EN 13205:—¹⁾, *Workplace atmospheres — Assessment of performance of instruments for measurement of airborne particle concentrations.*

ASTM D 4840–95, *Standard Guide for Sampling Chain-of-Custody Procedures.*

3 Terms and definitions

For the purposes of this part of ISO 15202, the following terms and definitions apply.

3.1 General definitions

3.1.1

chemical agent

any chemical element or compound, on its own or admixed as it occurs in the natural state or as produced by any work activity, whether or not produced intentionally and whether or not placed on the market

[EN 1540]

NOTE This definition is taken from the "Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work".

3.1.2

breathing zone

space around the worker's face from where he or she takes his or her breath

NOTE For technical purposes a more precise definition is as follows:

hemisphere (generally accepted to be 0,3 m in radius) extending in front of the human face, centred on the mid-point of a line joining the ears; the base of the hemisphere is a plane through this line, the top of the head and the larynx

This definition is not applicable when respiratory protective equipment is used.

[EN 1540]

3.1.3

exposure (by inhalation)

situation in which a chemical agent is present in air which is inhaled by a person

3.1.4

limit value

reference figure for concentration of a chemical agent in air

3.1.5

measuring procedure

procedure for sampling and analysing one or more chemical agents in the air and including storage and transportation of the sample

3.1.6

operating time

period during which a sampling pump can be operated at specified flow rate and back pressure without recharging or replacing the battery

[EN 1232]

3.1.7**reference period**

specified period of time stated for the limit value of a specific chemical agent

3.1.8**time-weighted average (TWA) concentration**

concentration of a chemical agent in the atmosphere, averaged over the reference period

NOTE A more detailed discussion of TWA concentrations and their use can be found in the American Conference of Government Industrial Hygienists publication *Threshold Limit Values for Chemical Substances and Physical Agents; Biological Exposure Indices* ACGIH, Cincinnati, OH (updated annually).

3.1.9**workplace**

defined area or areas in which the work activities are carried out

[EN 1540]

3.2 Particle size fraction definitions**3.2.1****inhalable convention**

target specification for sampling instruments when the inhalable fraction is of interest

[ISO 7708]

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3.2.2**inhalable fraction**

mass fraction of total airborne particles that is inhaled through the nose and mouth

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[ISO 7708]

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NOTE The inhalable fraction depends on the speed and direction of air movement, on breathing rate and other factors.

3.2.3**respirable convention**

target specification for sampling instruments when the respirable fraction is of interest

[ISO 7708]

3.2.4**respirable fraction**

mass fraction of inhaled particles penetrating to the unciliated airways

[ISO 7708]

3.2.5**total airborne particles**

all particles surrounded by air in a given volume of air

[ISO 7708]

NOTE Because all measuring instruments are size-selective to some extent, it is often impossible to measure the total concentration of airborne particles.

3.3 Sampling definitions

3.3.1

personal sampler

device attached to a person which samples air in the breathing zone

[EN 1540]

3.3.2

personal sampling

process of sampling carried out using a personal sampler

[EN 1540]

3.3.3

sampling instrument; sampler

device for collecting airborne particles

NOTE Instruments used to collect airborne particles are frequently referred to by a number of other terms, e.g. sampling heads, filter holders, filter cassettes, etc.

3.3.4

static sampler; area sampler

device, not attached to a person, that samples air in a particular location

3.3.5

static sampling; area sampling

process of air sampling carried out using a static sampler

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3.4 Statistical terms

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3.4.1

bias

consistent deviation of the results of a measurement process from the true value of the air quality characteristic itself

[ISO 6879]

3.4.2

overall uncertainty (of a measuring procedure or of an instrument)

quantity used to characterize as a whole the uncertainty U of a result given by an apparatus or measuring procedure, expressed, as a percentage, by a combination of bias and precision, usually according to the formula:

$$U = 2 \left(\frac{s}{x_{\text{ref}}} \right) + \frac{|\bar{x} - x_{\text{ref}}|}{x_{\text{ref}}}$$

where

\bar{x} is the mean value of results of a number (n) of repeated measurements;

x_{ref} is the true or accepted reference value of concentration;

s is the standard deviation in the measurements.

[EN 482]

3.4.3**precision**

closeness of agreement of results obtained by applying the method several times under prescribed conditions

[ISO 6879]

3.4.4**true value**

value which characterizes a quantity perfectly defined in the conditions which exist when that quantity is considered

[ISO 3534-1]

NOTE The true value of a quantity is a theoretical concept and, in general, cannot be known exactly [EN 1540].

4 Principle

4.1 Airborne particles containing metals and metalloids are collected by drawing a measured volume of air through a filter mounted in a sampler designed to collect an appropriate size fraction of airborne particles (see 8.1.1.1).

4.2 The filter and collected sample are then treated to dissolve the metals and metalloids of interest using one or more of the sample preparation methods prescribed in ISO 15202-2.

4.3 The resultant solution is subsequently analysed for the metals and metalloids of interest using inductively coupled plasma-atomic emission spectrometry, as described in ISO 15202-3.

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5 Requirement

ISO 15202-1:2000

The measuring procedure as a whole (covered by ISO 15202-1, ISO 15202-2 and ISO 15202-3) shall comply with any relevant International, European or National Standard which specifies performance requirements for procedures for measuring chemical agents in workplace air (e.g. EN 482).

6 Sampling equipment**6.1 Samplers**

6.1.1 Inhalable samplers, designed to collect the inhalable fraction of airborne particles, complying with the provisions of EN 13205, for use when the exposure limits for metals and metalloids of interest apply to the inhalable fraction of airborne particles.

NOTE 1 In general, personal samplers for collection of the inhalable fraction of airborne particles do not exhibit the same size selective characteristics if used for static sampling.

NOTE 2 Some inhalable samplers are designed to collect the inhalable fraction of airborne particles on the filter, and any particulate matter deposited on the internal surfaces of the sampler is not of interest. Other inhalable samplers are designed such that airborne particles which pass through the entry orifice(s) match the inhalable convention, in which case particulate matter deposited on the internal surfaces of the sampler does form part of the sample. (Samplers of this second type generally incorporate an internal filter cassette or cartridge which can be removed from the sampler to enable this material to be easily recovered.) The operating instructions supplied by the manufacturer should be consulted to find out whether particulate matter deposited on the internal surfaces of the sampler forms part of the sample.