INTERNATIONAL STANDARD

**ISO 15202-1**

Second edition
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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



*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 —*

*Partie 1: Échantillonnage*



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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition (ISO 15202-1:2000), which has been technically revised. The major changes in the second edition are as follows:

— definitions have been updated;

— a new Annex A has been added to provide guidance regarding sampler wall deposits.



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*

# 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 sampling method for subsequent determination of the mass concentration of metals and metalloids in workplace air using inductively coupled plasma atomic emission spectrometry (ICP-AES). Samples obtained using the method described herein can also be subsequently analysed by other instrumental methods, such as atomic absorption spectrometry (AAS) or inductively coupled plasma mass spectrometry (ICP-MS).

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.

# 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 (ICP-AES). Samples obtained using the method described herein can also be subsequently analysed for elemental composition by other instrumental methods, such as atomic absorption spectrometry (AAS) or inductively coupled plasma mass spectrometry (ICP-MS).

**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[2]).



**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 referenced documents are indispensable for the application 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 7708:1995, *Air quality — Particle size fraction definitions for health-related sampling*

ISO 15202-2, *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, *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry — Part 3: Analysis*

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

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

## 3.1 General definitions

**3.1.1**
**breathing zone**
<general> space around the worker's face from which breath is taken

**3.1.2**
**breathing zone**
<technical> hemisphere (generally accepted to be 0,3 m in radius) extending in front of the human face, centred on the midpoint 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

NOTE 1 The definition is not applicable when respiratory protective equipment is used.

NOTE 2 Adapted from EN 1540:2011[6].

**3.1.3**
**chemical agent**
any chemical element or compound, on its own or admixed as it occurs in the natural state or as produced, used, or released including release as waste, by any work activity, whether or not produced intentionally and whether or not placed on the market

[Council Directive 98/24/EC[13], Art. 2(a)]

**3.1.4**
**exposure**
**exposure by inhalation**
situation in which a chemical agent is present in air which is inhaled by a person



NOTE Adapted from EN 1540:2011[6].



**3.1.5**
**occupational exposure limit value**
**limit value**
limit of the time-weighted average of the concentration of a chemical agent in the air within the breathing zone of a worker in relation to a specified reference period

[Council Directive 98/24/EC[13], Art. 2(d)]

EXAMPLES Threshold Limit Values® (TLVs) established by the ACGIH[14], Indicative Occupational Exposure Limit Values (IOELVs) promulgated by the European Commission[12] and national limit values. Information on national limit values is available from the International Labour Organization (ILO)[15] and on the GESTIS database[16].

**3.1.6**
**measuring procedure**
**measurement procedure**
set of operations, described specifically, for the sampling and analysis of chemical agents in air

NOTE 1 A measuring procedure usually includes preparation for sampling, sampling, transportation and storage, preparation of samples for analysis and analysis.

NOTE 2 Adapted from EN 1540:2011[6].

**3.1.7**
**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][5]

**3.1.8**
**reference period**
specified period of time for which the occupational exposure limit value of a chemical agent applies

NOTE 1 The reference period is usually 8 h for long-term measurements and 15 min for short-term measurements.

NOTE 2 Examples for different reference periods are short-term and long-term limit values, such as those established by the ACGIH[14].

NOTE 3 Adapted from EN 1540:2011[6].

**3.1.9**
**time-weighted average concentration**
**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 Reference [14].

**3.1.10**
**workplace**
designated area or areas in which the work activities are carried out

[EN 1540:2011][6]

## 3.2 Particle size fraction definitions



**3.2.1**
**inhalable convention**
target specification for sampling instruments when the inhalable fraction is of interest

[ISO 7708:1995]



**3.2.2**
**inhalable fraction**
mass fraction of total airborne particles that is inhaled through the nose and mouth

[ISO 7708:1995]

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 7708:1995]

**3.2.4**
**respirable fraction**
mass fraction of inhaled particles penetrating to the unciliated airways

[ISO 7708:1995]

**3.2.5**
**total airborne particles**
all particles surrounded by air in a given volume of air

[ISO 7708:1995]

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**
sampler, attached to a person, that collects airborne particles in the breathing zone to determine exposure to chemical agents

NOTE Adapted from EN 1540:2011[6].

**3.3.2**
**personal sampling**
process of sampling carried out using a personal sampler

[EN 1540:2011][6]

**3.3.3**
**air sampler**
**sampler**
device for separating chemical agents from the surrounding air

NOTE 1 Air samplers are generally designed for a particular purpose, e.g. for sampling airborne particles.

NOTE 2 Adapted from EN 1540:2011[6].

**3.3.4**
**static sampler**
area sampler
sampler, not attached to a person, that collects airborne particles at a particular location



NOTE Adapted from EN 1540:2011[6].



**3.3.5**
**static sampling**
area sampling
process of (air) sampling carried out using a static sampler

[EN 1540:2011][6]

## 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.

## 5 Requirement

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 that specifies performance requirements for procedures for measuring chemical agents in workplace air (e.g. EN 482[3] and EN 13890[8]).

# 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 limit value(s) 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. For many samplers, particulate matter deposited on the internal surfaces of the sampler or insert is included as part of the sample. For more information on the issue of internal wall deposits, see Annex A.

**6.1.2 Respirable samplers**, designed to collect the respirable fraction of airborne particles, complying with the provisions of EN 13205, for use when the limit values for the metals and metalloids of interest apply to the respirable fraction of airborne particles.

NOTE 1 Cyclone-type samplers are typically used for personal sampling. Cascade impactors are often used to characterize the particle size distribution in static sampling.

NOTE 2 For many samplers, internal wall deposits are included as part of the sample.



**6.1.3 Multi-fraction samplers**, designed to collect airborne particles and fractionate them so as to enable two or more particle size fractions to be separately determined, complying with the provisions of EN 13205, for use as an alternative to collecting multiple samples when limit values for the metals and metalloids of interest apply to more than one particle size fraction.



Multi-fraction samplers sometimes use polyurethane foam to collect larger particles. In such cases, the foam should be compatible with the selected sample preparation method (see ISO 15202-2) and should have the same low metal content specified for filters in 6.2.

## 6.2 Filters

The filters shall be of a diameter suitable for use with the samplers (6.1), have a collection efficiency of not less than 99,5 % for particles with a 0,3 µm diffusion diameter (see 2.2 of ISO 7708:1995), have a very low metal content (typically less than 0,1 µg of each metal or metalloid of interest per filter) and be compatible with the selected sample preparation method (see ISO 15202-2).

NOTE 1 See Annex B for guidance on filter selection.

NOTE 2 Besides filters, other types of collection substrates can be suitable, such as foams.

NOTE 3 Commercial products are available[1)] that combine a filter and an associated 'shell' that are heat-sealed together to form a sampler insert that primarily collects airborne particles on the filter but also collects on the shell particles that would otherwise be deposited on the internal walls of the sampler.

## 6.3 Sampling pumps

The sampling pumps shall have an adjustable flow rate and be capable of maintaining the selected flow rate (between 1 l/min and 5 l/min for personal sampling pumps, and between 5 l/min and 400 l/min for high-volume

1) A sampler insert of this type is available from SKC Inc and this is referred to as an Accu-Cap™. At the time when this International Standard was developed the Accu-Cap™ was the only known commercially available product. This information is given for the convenience of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.