



SLOVENSKI STANDARD

SIST ISO 17733:2005

01-december-2005

NfU `bUXYcj bYa `a Ygli `!`8c`c Yj Ub`Y`y]j Y[UgfYVfU]b`Ubcf[Ubg_`_ `gdc`]b`y]j Y[U
gfYVfU!`A YtcXUUrca g_`YUVgcfW`g_`YgdY`fca Yff]`Y`g` `UXb]a]`dUfUa]`U`]`n
Urca g_`c`Zi cfYgWb bc`gdY`fca Yff]`c

Workplace air - Determination of mercury and inorganic mercury compounds - Method by cold-vapour atomic absorption spectrometry or atomic fluorescence spectrometry

ITeH STANDARD PREVIEW
(standards.iteh.ai)

Air des lieux de travail - Détermination du mercure et des composés minéraux de mercure - Méthode par spectrométrie d'absorption atomique ou spectrométrie de fluorescence atomique de la vapeur froide

Ta slovenski standard je istoveten z: **ISO 17733:2004**

ICS:

13.040.30 Kakovost zraka na delovnem mestu Workplace atmospheres
mestu

SIST ISO 17733:2005

en

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST ISO 17733:2005](#)

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfbf-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

INTERNATIONAL
STANDARD

ISO
17733

First edition
2004-11-15

**Workplace air — Determination of
mercury and inorganic mercury
compounds — Method by cold-vapour
atomic absorption spectrometry or
atomic fluorescence spectrometry**

iTeh STANDARD PREVIEW
(standards.iteh.ai)

*Air des lieux de travail — Détermination du mercure et des composés
minéraux de mercure — Méthode par spectrométrie d'absorption
atomique ou spectrométrie de fluorescence atomique de la vapeur
froide*

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

[https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-
ae222ff62525/sist-iso-17733-2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)



Reference number
ISO 17733:2004(E)

© ISO 2004

ISO 17733:2004(E)**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

© ISO 2004

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword.....	v
Introduction	vi
1 Scope.....	1
2 Normative references	1
3 Terms and definitions.....	2
3.1 General definitions.....	2
3.2 Particle size fraction definitions.....	3
3.3 Sampling definitions.....	4
3.4 Analytical definitions	5
3.5 Statistical terms	6
4 Principle	7
5 Interferences.....	8
6 Requirement	8
7 Reagents	8
8 Apparatus.....	10
8.1 Sampling equipment for diffusive sampling.....	10
8.2 Sampling equipment for pumped sampling.....	11
8.3 Laboratory apparatus	14
8.4 Analytical instrumentation	15
9 Occupational exposure assessment.....	20
9.1 General	20
9.2 Personal sampling	20
9.3 Static (area) sampling.....	20
9.4 Selection of measurement conditions and measurement pattern.....	21
10 Sampling	22
10.1 Selection of sampling method.....	22
10.2 Consideration of temperature and pressure effects	22
10.3 Diffusive sampling	23
10.4 Pumped sampling	25
11 Analysis.....	29
11.1 General	29
11.2 Cleaning of glassware and plasticsware	29
11.3 Preparation of blank, sample and calibration solutions for analysis of diffusive badges.....	30
11.4 Preparation of blank, sample and calibration solutions for analysis of pumped samples.....	31
11.5 Instrumental analysis	33
11.6 Estimation of detection and quantification limits.....	36
11.7 Quality control.....	37
11.8 Measurement uncertainty.....	38
12 Expression of results.....	38
12.1 Calculation of the volume of air samples	38
12.2 Calculation of mercury in air concentrations.....	39
13 Method performance.....	39
13.1 General	39
13.2 Detection and quantification limits	39
13.3 Upper limits of the analytical range	40

ISO 17733:2004(E)

13.4	Blank values.....	40
13.5	Bias and precision.....	41
13.6	Overall uncertainty of sampling and analysis methods.....	41
13.7	Effects on sampler performance	42
13.8	Sample uptake rate and sampling capacity of diffusive badges.....	43
13.9	Collection efficiency, breakthrough volume and sampling capacity of sorbent tubes	43
13.10	Storage stability.....	43
13.11	Mechanical strength.....	43
13.12	Interferences	44
14	Test report.....	44
14.1	Test record	44
14.2	Laboratory report	45
Annex A (informative) Guidance on selection of a sampling method for mercury vapour.....		46
Annex B (informative) Temperature and pressure corrections		47
Bibliography.....		49

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

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 17733 was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

Introduction

The health of workers in many industries is at risk through exposure by inhalation of mercury and inorganic mercury compounds. 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 making workplace air measurements. This International Standard presents a method for making valid exposure measurements for mercury and inorganic mercury compounds 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 mercury and inorganic mercury compounds and their workers, etc.

The procedure described in this International Standard is based upon a method published by the United Kingdom Health and Safety Executive^[1], which was developed after a thorough review of sampling and analysis techniques available for determination of mercury and inorganic mercury compounds in air^[2]. This procedure has been fully validated and the resulting back-up data are freely available^{[3],[4]}. Similar methods have been published by the United States Occupational Safety and Health Administration (OSHA)^{[5],[6]} and the United States National Institute of Occupational Safety and Health (NIOSH)^[7].

It has been assumed in the drafting of this International Standard that the execution of its provisions and the interpretation of the results obtained are entrusted to appropriately qualified and experienced people.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

Workplace air — Determination of mercury and inorganic mercury compounds — Method by cold-vapour atomic absorption spectrometry or atomic fluorescence spectrometry

1 Scope

This International Standard specifies a procedure for determination of the time-weighted average mass concentration of mercury vapour and inorganic mercury compounds in workplace air. Mercury vapour is collected on a solid sorbent using either a diffusive badge or a pumped sorbent tube. Particulate inorganic mercury compounds, if present, are collected on a quartz fibre filter. Samples are analysed using either cold vapour atomic absorption spectrometry (CVAAS) or cold vapour atomic fluorescence spectrometry (CVAFS) after acid dissolution of the mercury collected.

This International Standard is applicable to the assessment of personal exposure to mercury vapour and/or particulate inorganic mercury compounds in air for comparison with long-term or short-term exposure limits for mercury and inorganic mercury compounds and for static (area) sampling.

The lower limit of the working range of the procedure is the quantification limit. This is determined by the sampling and analysis methods selected by the user, but it is typically in the range 0,01 µg to 0,04 µg of mercury (see 13.1). The upper limit of the working range of the procedure is determined by the capacity of the diffusive badge, sorbent tube or filter used for sample collection, but it is at least 30 µg of mercury (see 13.2). The concentration range of mercury in air for which this International Standard is applicable is determined in part by the sampling method selected by the user, but it is also dependent on the air sample volume.

The diffusive badge method is not applicable to measurements of mercury vapour when chlorine is present in the atmosphere, e.g. in chloralkali works, but chlorine does not interfere with the pumped sorbent tube method (see 13.11.1). Gaseous organo-mercury compounds could cause a positive interference in the measurement of mercury vapour (see 13.11.2). Similarly, particulate organo-mercury compounds and gaseous organo-mercury compounds adsorbed onto airborne particles could cause a positive interference in the measurement of particulate inorganic mercury compounds (see 13.11.3).

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 648, *Laboratory glassware — One-mark pipettes*

ISO 1042, *Laboratory glassware — One-mark volumetric flasks*

ISO 3585, *Borosilicate glass 3.3 — Properties*

ISO 3696:1987, *Water for laboratory use — Specifications and test methods*

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

ISO 8655-1, *Piston-operated volumetric apparatus — Part 1: Terminology, general requirements and user recommendations*

ISO 17733:2004(E)

ISO 8655-2, *Piston-operated volumetric apparatus — Part 2: Piston pipettes*

ISO 8655-5, *Piston-operated volumetric apparatus — Part 5: Dispensers*

ISO 8655-6, *Piston-operated volumetric apparatus — Part 6: Gravimetric methods for the determination of measurement error*

EN 13205:2002, *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****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

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".

[EN 1540^[8]]

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.1.2**breathing zone**

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

<https://standards.iteh.ai/catalog/standards/sist/5fbfbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

3.1.3**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, whose base is a plane through this line, the top of the head and the larynx

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

NOTE 2 Adapted from EN 1540^[8].

3.1.4**exposure**

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

3.1.5**measuring procedure**

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

3.1.6**operating time**

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

[EN 1232^[9]]

3.1.7**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 has been published by the American Conference of Government Industrial Hygienists (ACGIH)^[10].

3.1.8**limit value**

reference figure for concentration of a chemical agent in air

NOTE An example is the Threshold Limit Value[®] (TLV) for a given substance in workplace air, as established by the ACGIH^[10].

3.1.9**reference period**

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

NOTE Examples of limit values for different reference periods are short-term and long-term exposure limits, such as those established by the ACGIH^[10].

3.1.10**workplace**

defined area or areas in which work activities are carried out

[EN 1540^[8]]

iTeh STANDARD PREVIEW
(standards.iteh.ai)

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]

3.2.2**inhalable fraction**

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

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

[ISO 7708]

3.2.3**total airborne particles**

all particles surrounded by air in a given volume of air

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

[ISO 7708]

ISO 17733:2004(E)

3.3 Sampling definitions

3.3.1

diffusive badge**dosimeter****badge-type diffusive sampler****passive badge**

diffusive sampler in which the gas or vapour passes to the sorbent by permeation through a thin solid membrane or diffusion across a porous membrane

NOTE The cross-sectional area of a diffusive badge is large in relation to the internal air gap.

3.3.2

diffusive sampler**passive sampler**

device which is capable of taking samples of gases or vapours from the atmosphere at a rate controlled by a physical process such as gaseous diffusion through a static air layer or permeation through a membrane, but which does not involve the active movement of air through the sampler

[EN 838^[11]]

3.3.3

personal sampler

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

[EN 1540^[8]]

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.3.4

personal sampling

process of sampling carried out using a personal sampler

[SIST ISO 17733:2005](https://standards.iteh.ai/catalog/standards/sist/5fb1bbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005)

[EN 1540^[8]]

<https://standards.iteh.ai/catalog/standards/sist/5fb1bbfc-495a-49dd-8195-ae222ff62525/sist-iso-17733-2005>

3.3.5

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.

3.3.6

pumped sorbent tube

tube, usually made of metal or glass, containing an active sorbent or reagent-impregnated support, through which sampled atmosphere is passed at a rate controlled by an air sampling pump

[EN 1076^[12]]

3.3.7

static sampler**area sampler**

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

3.3.8

static sampling**area sampling**

process of air sampling carried out using a static sampler

3.4 Analytical definitions

3.4.1

blank solution

solution prepared by taking a reagent blank, laboratory blank or field blank through the same procedure used for sample preparation

3.4.2

calibration blank solution

calibration solution prepared without the addition of any working standard solution

NOTE The concentration of mercury in the calibration blank solution is taken to be zero.

3.4.3

calibration solution

solution prepared by dilution of the working standard solution, containing mercury at a concentration that is suitable for use in calibration of the analytical instrument

NOTE The technique of matrix-matching is normally used when preparing calibration solutions.

3.4.4

field blank

sorbent capsule, filter or sorbent tube that is taken through the same handling procedure as a sample, except that it is not used for sampling

NOTE For the purposes of this International Standard, the field blank is loaded into a diffusive badge, sampler or sorbent tube holder, transported to the sampling site and then returned to the laboratory for analysis.

3.4.5

laboratory blank

unused sorbent capsule, filter or sorbent tube, taken from the same batch used for sampling, that does not leave the laboratory

3.4.6

linear dynamic range

range of concentrations over which the calibration curve for mercury is linear

NOTE The linear dynamic range extends from the detection limit to the onset of calibration curvature.

3.4.7

matrix interference

matrix effect

non-spectral interference

interference of a non-spectral nature caused by a difference between the matrices of the calibration and test solutions

3.4.8

matrix-matching

technique used to minimize the effect of matrix interferences on analytical results, involving the preparation of calibration solutions in which the concentrations of acids and other major solutes are matched with those in the test solutions

3.4.9

reagent blank

combination of all reagents used in sample dissolution, in the same quantities used for preparation of laboratory blank, field blank and sample solutions

ISO 17733:2004(E)**3.4.10****sample dissolution**

process of obtaining a solution containing mercury from a sample, which might or might not involve complete dissolution of the sample

3.4.11**sample preparation**

all operations carried out on a sample, after transportation and storage, to prepare it for analysis, including transformation of the sample into a measurable state, where necessary

3.4.12**sample solution**

solution prepared from a sample by the process of sample dissolution

NOTE A sample solution might need to be subjected to further operations, e.g. dilution, in order to produce a test solution that is ready for analysis.

3.4.13**stock standard solution**

solution, used for preparation of the calibration solutions, containing mercury at a certified concentration that is traceable to national standards

3.4.14**test solution**

blank solution or sample solution that has been subjected to all operations, including dilution, required to bring it into a state in which it is ready for analysis

NOTE The blank test solution is the blank solution and the sample test solution is the sample solution, if these solutions are not subjected to any further operations before analysis.

3.4.15**working standard solution**

solution, prepared by dilution of the stock standard solution, that contains mercury at a concentration that is better suited to preparation of calibration solutions than the concentration of mercury in the stock standard solution

3.5 Statistical terms**3.5.1****analytical recovery**

ratio of the mass of analyte measured when a sample is analysed to the known mass of analyte in that sample

NOTE It is expressed as a percentage.

3.5.2**bias**

consistent deviation of the measured value from the value of the air quality characteristic itself, or the accepted reference value

[ISO 6879^[13]]

3.5.3**overall uncertainty**

(of a measuring procedure or of an instrument) quantity used to characterize as a whole the uncertainty of a result given by an apparatus or measuring procedure

NOTE It is expressed, as a percentage, by a combination of bias and precision, usually according to the formula:

$$\frac{|\bar{x} - x_{\text{ref}}| + 2s}{x_{\text{ref}}} \times 100$$

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 the measurement;

s is the standard deviation of the measurements.

[EN 482^[14]]

3.5.4

precision

closeness of agreement between independent test results obtained under stipulated conditions

[ISO 6879^[13]]

3.5.5

true value

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

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

[ISO 3534-1^[15]]

3.5.6

uncertainty

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

[VIM^[16]]

NOTE 1 The parameter might be, for example, a standard deviation (or a given multiple of it), or the width of a confidence interval.

NOTE 2 Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from the statistical distribution of the results of series of measurements and can be characterized by standard deviations. The other components, which also can be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information. The GUM^[17] refers to these different cases as Type A and Type B evaluations of uncertainty, respectively.

4 Principle

Mercury vapour is collected either actively or passively. Active sampling involves drawing a known volume of air through a sorbent tube using a pump, whilst passive sampling relies upon the principle of controlled diffusion into a badge. In both the pumped and diffusive sampling methods, mercury vapour entering the sampling device is collected on a proprietary solid sorbent that is widely known as Hydrar (see 8.1.2) but is currently marketed as Anasorb C 300.

Different sampling methods are used depending on the specific application.

- a) If it is known that no particulate inorganic mercury compounds are present in the test atmosphere, mercury vapour is collected using a diffusive badge or by drawing a known volume of air through a sorbent tube using a pump.
- b) If it is known that no mercury vapour is present in the test atmosphere, particulate inorganic mercury compounds are collected by drawing a known volume of air through a quartz fibre filter mounted in a sampler designed to collect the inhalable fraction of airborne particles, as defined in ISO 7708, using a pump.