

**Workplace exposure - Assessment of sampler
performance for measurement of airborne particle
concentrations - Part 2: Laboratory performance test
based on determination of sampling efficiency**

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 13205-2:2014 sisaldab Euroopa standardi EN 13205-2:2014 inglisekeelset teksti.	This Estonian standard EVS-EN 13205-2:2014 consists of the English text of the European standard EN 13205-2:2014.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 18.06.2014.	Date of Availability of the European standard is 18.06.2014.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 13.040.30

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

English Version

**Workplace exposure - Assessment of sampler performance for
measurement of airborne particle concentrations - Part 2:
Laboratory performance test based on determination of sampling
efficiency**

Exposition sur les lieux de travail - Évaluation des performances des dispositifs de prélèvement pour le mesurage des concentrations de particules en suspension dans l'air - Partie 2: Essai de performances en laboratoire par détermination de l'efficacité de prélèvement

Exposition am Arbeitsplatz - Beurteilung der Leistungsfähigkeit von Sammlern für die Messung der Konzentration luftgetragener Partikel - Teil 2: Laborprüfung der Leistungsfähigkeit basierend auf der Bestimmung des Probenahmewirkungsgrads

This European Standard was approved by CEN on 7 May 2014.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents	Page
Foreword.....	4
Introduction	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols and abbreviations	8
4.1 Symbols	8
4.1.1 Latin	8
4.1.2 Greek	10
4.2 Enumerating subscripts	10
4.3 Abbreviations	11
5 Principle	11
6 Test method.....	11
6.1 General.....	11
6.2 Test conditions	11
6.3 Test variables	12
6.3.1 General.....	12
6.3.2 Particle size	14
6.3.3 Wind speed.....	14
6.3.4 Wind direction	14
6.3.5 Aerosol composition	14
6.3.6 Sampled or internally separated mass	14
6.3.7 Aerosol charge.....	14
6.3.8 Specimen variability	15
6.3.9 Excursion from the nominal flow rate	15
6.3.10 Surface treatments	15
7 Experimental requirements	15
8 Calculation of sampler bias and expanded uncertainty	17
8.1 General.....	17
8.2 Determination of the sampling efficiency	18
8.3 Calculation of sampler bias	18
8.3.1 Calculation of the sampled aerosol concentration	18
8.3.2 Calculation of the ideal sampled aerosol concentration	20
8.3.3 Calculation of the sampler bias.....	21
8.4 Calculation of the expanded uncertainty of the sampler	21
8.4.1 General.....	21
8.4.2 Calibration of sampler test system	22
8.4.3 Estimation of sampled concentration	23
8.4.4 Bias relative to the sampling convention.....	23
8.4.5 Individual sampler variability	24
8.4.6 Excursion from the nominal flow rate	24
8.4.7 Combined uncertainty (of measurement)	28
8.4.8 Expanded uncertainty	31
9 Test report	31
9.1 General.....	31

9.2	Testing laboratory details and sponsoring organisation	31
9.3	Description of the candidate sampler	31
9.4	Critical review of sampling process	32
9.5	Laboratory methods used	32
9.6	Details of experimental design	33
9.7	Presentation of experimental results	33
9.8	Data analysis.....	33
9.9	Candidate sampler performance	33
9.10	Report of workplace comparison	33
9.11	Summary and information for the user of the sampler	33
	Bibliography.....	36

Foreword

This document (EN 13205-2:2014) has been prepared by Technical Committee CEN/TC 137 "Assessment of workplace exposure to chemical and biological agents", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2014 and conflicting national standards shall be withdrawn at the latest by December 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document together with EN 13205-1, CEN/TR 13205-3, EN 13205-4, EN 13205-5 and EN 13205-6 supersedes EN 13205:2001.

EN 13205, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations*, consists of the following parts:

- *Part 1: General requirements;*
- *Part 2: Laboratory performance test based on determination of sampling efficiency* (the present document);
- *Part 3: Analysis of sampling efficiency data* [Technical Report];
- *Part 4: Laboratory performance test based on comparison of concentrations;*
- *Part 5: Aerosol sampler performance test and sampler comparison carried out at workplaces;*
- *Part 6: Transport and handling tests.*

Significant technical changes from the previous edition, EN 13205:2001:

- This part of EN 13205 is based on Annex A of the previous edition, EN 13205:2001.
- The scope has been limited to aerosol samplers, and the current version of the standard is not (directly) applicable to other types of aerosol instruments.
- As this is now a standard in its own right, a clause on symbols used has been added. Almost all definitions are now given either in EN 1540, *Workplace exposure — Terminology* or in Part 1 of this standard.
- The method of calculating the uncertainty of a sampler or a measuring procedure has been revised in order to comply with ENV 13005. The concept of "accuracy" is no longer used, instead the concept of "expanded uncertainty" is used.
- The five major sources of uncertainty due to aspects of the sampling performance of an aerosol sampler (calibration of sampler test system, estimation of sampled concentration, bias relative to the sampling convention, individual sampler variability and excursion from nominal flow rate) are described with equations on how to incorporate these uncertainties into the expanded uncertainty of a sampler. CEN/TR 13205-3 gives recommendations how these entities may be calculated from measured sampling efficiency data.
- The list of the particle size distributions (per sampling convention) to be used for the evaluation of sampler performance has been restricted at the lower end to reflect that particles with an aerodynamic

diameter less than 0,5 μm are not sampled due to aerodynamic forces. In the current version, an additional requirement on the size distributions is that at least 84 % of the aerosol mass consists of particles exceeding 0,5 μm .

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

EN 481 defines sampling conventions for the particle size fractions to be collected from workplace atmospheres in order to assess their impact on human health. Conventions are defined for the inhalable, thoracic and respirable aerosol fractions. These conventions represent target specifications for aerosol samplers, giving the ideal sampling efficiency as a function of particle aerodynamic diameter.

In general, the sampling efficiency of real aerosol samplers will deviate from the target specification, and the aerosol mass collected will therefore differ from that which an ideal sampler would collect. In addition, the behaviour of real samplers is influenced by many factors such as external wind speed. In many cases there is an interaction between the influence factors and fraction of the airborne particle size distribution of the environment in which the sampler is used.

EN 13205 (all parts) enables manufacturers and users of aerosol samplers to adopt a consistent approach to sampler validation, and provide a framework for the assessment of sampler performance with respect to EN 481 and EN 482.

It is the responsibility of the manufacturer of aerosol samplers to inform the user of the sampler performance under the laboratory conditions¹⁾ specified in this part of EN 13205. It is the responsibility of the user to ensure the actual conditions of intended use are within what the manufacturer specifies as acceptable conditions according to the performance test.

1) The inhalable convention is undefined for particle sizes in excess of 100 μm or for wind speeds greater than 4 m/s. The tests required to assess performance are therefore limited to these conditions. If such large particle sizes or wind speeds actually existed at the time of sampling, it is possible that different samplers meeting this document give different results.

1 Scope

This European Standard specifies a laboratory performance test for samplers for the inhalable, thoracic and respirable aerosol fractions, based on determining the sampling efficiency curve of a candidate sampler at a minimum of nine particle sizes. It specifies methods for testing aerosol samplers under prescribed laboratory conditions in order to test whether the performance of a candidate sampler fulfils the requirements of EN 13205-1:2014.

This part of EN 13205 is applicable to all samplers used for the health-related sampling of particles in workplace air.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1540, *Workplace exposure — Terminology*

EN 13205-1:2014, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 1: General requirements*

CEN/TR 13205-3:2014, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 3: Analysis of sampling efficiency data*

EN 13205-5:2014, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 5: Aerosol sampler performance test and sampler comparison carried out at workplaces*

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

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 1540, EN 13205-1:2014 and the following apply.

NOTE With regard to EN 1540, in particular, the following terms are used in this document: total airborne particles, respirable fraction, sampling efficiency, static sampler, thoracic fraction, inhalable fraction, measuring procedure, non-random uncertainty, random uncertainty, expanded uncertainty, standard uncertainty, combined standard uncertainty, uncertainty (of measurement), coverage factor and precision.

3.1

relative concentration

concentration expressed as a fraction of the total airborne concentration

3.2

total airborne particle concentration

concentration of aerosol particles present in the air before the particles are affected by the presence of the sampler, or in the case of a personal sampler by the presence of the person wearing the sampler