SLOVENSKI STANDARD
oSIST prEN 481:2026

01-september-2026

Izpostavljenost na delovnem mestu - Definicije velikostnih razredov za merjenje lebdečih delcev

Workplace exposure - Size fraction definitions for measurement of airborne particles

Arbeitsplatzatmosphäre - Festlegung der Größenfraktionen zur Messung luftgetragener Partikel

Atmosphères des lieux de travail - Définition des fractions de taille pour le mesurage des particules en suspension dans l'air

Ta slovenski standard je istoveten z: **prEN 481**

ICS:

13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

oSIST prEN 481:2026 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 481

July 2026

ICS 13.040.30

Will supersede EN 481:1993

English Version

Workplace exposure - Size fraction definitions for measurement of airborne particles

Atmosphères des lieux de travail - Définition des fractions de taille pour le mesurage des particules en suspension dans l'air

Exposition am Arbeitsplatz - Festlegung der Größenfraktionen zur Messung luftgetragener Partikel

This draft European Standard is submitted to CEN members for second enquiry. It has been drawn up by the Technical Committee CEN/TC 137.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CEN 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.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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Ref. No. prEN 481:2026 E

Contents

Page

European foreword

This document (prEN 481:2026) 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 document is currently submitted to the 2nd CEN enquiry.

This document will supersede EN 481:1993.

The technical modifications in comparison with the previous edition are listed in Annex A.

Introduction

The proportion of total particulate matter that is inhaled into a human body depends on the aerodynamic diameter of the particles, on the speed and direction of air movement near the body, on the breathing rate of the individual, and whether breathing is through the nose or mouth. Inhaled particles can then deposit somewhere in the respiratory tract or can be exhaled. The site and amount of deposition, and probability of exhalation, depend on the aerodynamic diameter of the particle, respiratory tract anatomy, breathing pattern, and other factors.

Tissues in the respiratory tract can absorb soluble components from deposited particles at any site of deposition. Particles can cause health damage due to the constituents they carry which can be reactive, either chemically or biologically, depending on their composition. Insoluble particles can be transported to another part of the respiratory tract or body, where they can be taken up by cells and tissues and be detrimental to health.

There is considerable inter-individual variability in particle inhalation and deposition probabilities. Nevertheless, it is necessary to define conventions for size-selective sampling of airborne particles when the purpose of sampling is health-related, such as for compliance testing.

This document defines the inhalable, thoracic, and respirable sampling conventions based on the penetration probability of particles into the respiratory tract. The separation of particles from the inhaled air by other mechanisms than impaction is disregarded in this document, because the transport of particles with an aerodynamic diameter less than 0,5 µm do not primarily depend on inertia. For these particles, the separation mechanism is instead mainly governed by diffusion, and the size of these particles is best described by the particle diffusive (equivalent) diameter. The particle diffusive (equivalent) diameter equals the diameter of a sphere with the same diffusion coefficient as the particle under the prevailing conditions of temperature, pressure and relative humidity.

These conventions establish relationships between particle aerodynamic diameter and health-related fractions, which approximate the quantity of particles penetrating specific regions of the respiratory tract under average breathing conditions.

Measurements using sampling devices according to these conventions provide a more accurate correlation between the measured concentration and the health risk compared to measurements of undisturbed airborne particle size distribution. Relevant environmental conditions are stated in EN 689 [1].

Guidance for sampling the defined aerosol fractions is given in CEN/TR 15230 [2]. EN 13205-1 to –6 ([3] to [8]) describe performance tests for candidate aerosol samplers for any of the sampling conventions defined in this document. EN 482[9] outlines general performance requirements for samplers, instruments, and analytical methods used in occupational hygiene. A strategy for testing compliance with occupational exposure limits is given in EN 689 [1]. EN ISO 13138 [10] describes sampling conventions for fractions deposited in regions of the respiratory tract.

1 Scope

This document specifies sampling conventions for airborne particle size fractions to assess health-related exposure resulting from the inhalation of particles in workplace atmospheres. Conventions are defined for the inhalable, thoracic and respirable fractions. The sampling conventions only describe the inhalation of particles and their penetration in the respiratory tract as governed by inertia (impaction). Exhaled particles and deposition in the respiratory tract by other mechanisms, e.g. diffusion, are not considered in this document. The sampling conventions defined in this document apply to both indoor and outdoor workplaces. The conventions assume particles penetration and only oral breathing as a worst-case scenario. Nevertheless, the conventions are applicable to both oral and nasal breathing.

The conventions are defined based on assumptions given in Clause 6. The choice of convention for a specific application depends on the region of the respiratory tract affected by the health impact of the particle component of interest (see Clause 5). The conventions can be applied to various metrics, including particle number, length, surface area, volume, or mass, depending on the type of particle analysis performed on the sampled aerosol fraction. The health-related fraction concentrations defined in this document are often expressed as the mass of sampled particles per volume of sampled air to allow comparison with mass-based occupational exposure limit values.

The conventions primarily apply to the aforementioned metrics, however, they are not applicable to situations involving limit values expressed in a different metric, such as fibre limit values defined by length, diameter, and aspect ratio, unless a measurement procedure explicitly specifies sampling a particular health-related size fraction [11].

The primary objective of this document is to establish standardized conventions for health-related particle size fractions. Sampling is generally carried out using dedicated samplers, for which there is no need to measure the aerodynamic size distribution of the airborne particles to be sampled. Samplers separating airborne particles into one or more relevant fractions are currently available. In general, no assumptions or pre-knowledge are needed on the number of modes, modal diameter(s) or width of the particle aerodynamic size distribution of the airborne particles to be sampled.

The conventions in this document are intended to be used for the determination of the exposure of an average worker based on average penetration curves. This document is not intended to determine the deposited dose of an individual worker.

The conventions are primarily intended for assessing workers' exposure to airborne particles by sampling the airborne particles. This document does not apply to large particles emitted at high speed that travel due to their initial momentum, instead of being carried by the air (airborne) and aspirated into humans' respiratory tract and aerosol samplers by suction (see Annex B).

All wind speeds referenced throughout this document are based on the relative speed between the worker and the surrounding air.

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.

EN 1540, *Workplace exposure — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540 and the following apply.

NOTE The terms and definitions given in EN 1540 are reproduced here for improved readability.

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

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

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

3.1
airborne particle
chemical or biological agent, in solid or liquid form, dispersed in air

Note 1 to entry: Smoke, fume, mist and fog consist of airborne particles.

Note 2 to entry: This term describes a class of particles with a specific property, namely those that are airborne while being measured or sampled.

Note 3 to entry: Particle projectiles are a specific class of particles that move through air under ~~its~~ their own momentum, which they obtained when they were ejected into air. A typical example is particles generated by using grinding wheels. In order to be able to travel a long distance under its own momentum, a particle projectile needs to be large (much larger than 100 µm) and have been emitted at high speeds (exceeding 5 m/s to 10 m/s). Once drag has consumed all the original momentum of a particle projectile, it moves in the air as any other airborne particle, under the influence of air currents, air suction, drag and external forces, e.g. gravity.

[SOURCE: EN 1540:2021, 3.1.1.5, modified — Notes 1 to 3 to entry have been added.]

3.2
alveolar region
compartment of the human respiratory tract consisting of respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli

Note 1 to entry: The American Conference of Governmental Industrial Hygienists uses the term Gas-Exchange region and the (US) National Commission on Radiological Protection uses the term Pulmonary region [12].

3.3
inhalability
ratio of the concentration of particles entering the respiratory tract as a function of the aerodynamic particle diameter to the corresponding concentration in the air before the particles are affected by the presence of the exposed individual and inhalation (i.e., the undisturbed airborne particle size distribution)

3.4
inhalable sampling convention
$E_{\mathrm{I,x}}$
sampling convention describing the probability of undisturbed particles entering the respiratory tract by inhalation through the mouth as a function of the aerodynamic particle diameter for wind speed range x

3.5
particle aerodynamic diameter
d_{ae}
diameter of a sphere of 1 g/cm^3 density with the same terminal settling velocity in calm air as the particle, under the prevailing conditions of temperature, pressure and relative humidity

Note 1 to entry: The particle aerodynamic diameter is the diameter of an equivalent sphere that is used to describe the mass based transport phenomena of a particle of arbitrary shape and density like inertia or gravitational settling.

[SOURCE: EN 1540:2021, 3.1.2.11, modified — Note 1 to entry has been deleted and a new Note 1 has been added.]

3.6
respirable penetration probability convention
e_R
convention describing the probability of inhaled particles penetrating to the alveolar region as a function of the aerodynamic particle diameter

3.7
respirable sampling convention
$E_{R,x}$
sampling convention describing the probability of undisturbed particles penetrating to the alveolar region as a function of the aerodynamic particle diameter for wind speed range x

3.8
sampling convention
the probability of the undisturbed airborne particles to be included in the health-related fraction in question as a function of their aerodynamic diameter that defines the target specification for the sampling efficiency of a sampling system for this fraction

3.9
thoracic penetration probability convention
e_T
convention describing the probability of inhaled particles penetrating beyond the larynx as a function of the aerodynamic particle diameter

3.10
thoracic sampling convention

$E_{T,x}$
sampling convention describing the probability of undisturbed particles penetrating beyond the larynx as a function of the aerodynamic particle diameter for wind speed range x

3.11
undisturbed airborne particle size distribution
size distribution of all airborne particles present in the air before the particles are affected by the presence of the sampler, or in the case of a personal sampler (mounted on a mannequin/person) by the presence of the mannequin/person

3.12
undisturbed particle
airborne particle before being disturbed by the presence of the sampler, or in the case of a personal sampler (mounted on a mannequin/person) by the presence of the mannequin/person

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviations apply:

d_{ae}	particle aerodynamic diameter
$d_{ae,R,p=0,50}$	median of the lognormal distribution expressing the definition of the respirable sampling convention