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# Workplace atmospheres — Size fraction definitions for measurement of airborne particles

The European Standard EN 481 : 1993 has the status of a British Standard

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

Arbeitsplatzatmosphäre — Festlegung der Teilchengrößenverteilung zur Messung luftgetragener Partikel

UDC 628.511 : 331.1 : 620.113

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STANDARDS

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This British Standard, having been prepared under the direction of the Environment and Pollution Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 September 1993

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# Contents

## National foreword

This British Standard has been prepared under the direction of the Environment and Pollution Standards Policy Committee and is the English language version of EN 481 : 1993 *Workplace atmospheres — Size fraction definitions for measurement of airborne particles*, published by the European Committee for Standardization (CEN).

Compliance with a British Standard does not of itself confer immunity from legal obligations.

EUROPEAN STANDARD

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English version

## Workplace atmospheres — 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

Arbeitsplatzatmosphäre — Feslegung der Teilchengrößenverteilung zur Messung luftgetragener Partikel

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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## CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 481 : 1993 E

## Foreword

This European Standard was drawn up by Technical Committee 137 'Assessment of workplace exposure' of which the secretariat is held by DIN.

This standard was submitted for Formal Vote, and the result was positive.

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 January 1994, and conflicting national standards shall be withdrawn at the latest by January 1994.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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## 0 Introduction

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

Liquid particles or soluble components of solid particles can be absorbed by the tissues wherever they deposit. Particles can cause damage close to the deposition site if they are corrosive, radioactive, or capable of initiating some other type of damage. Insoluble particles can be transported to another part of the respiratory tract or body, where they can be absorbed or cause a biological effect.

There is a wide variation from one person to another in the probability of particle inhalation, deposition, reaction to deposition, and clearance. Nevertheless, it is possible to define conventions for size selective sampling of airborne particles when the purpose of sampling is health-related. These conventions are relationships between aerodynamic diameter and the fractions to be collected or measured, which approximate to the fractions penetrating to regions of the respiratory tract under average conditions. Measurement conducted according to these conventions will probably yield a better relationship between measured concentration and risk of disease.

NOTE. For further information on the factors affecting inhalation and deposition, and their application in standards, see [8], [9], [10], [11], [12] and [13].

## 1 Scope

This standard defines sampling conventions for particle size fractions which are to be used in assessing the possible health effects resulting from inhalation of airborne particles in the workplace. They are derived from experimental data for healthy adults. Conventions are defined for the inhalable, thoracic and respirable fractions; extrathoracic and tracheobronchial conventions may be calculated from the defined conventions. (The inhalable fraction is sometimes called inspirable — the terms are equivalent. The nomenclature of the fractions is discussed in annex A.) Assumptions are given in clause 4. The convention chosen will depend on the region of effect of the component of interest in the airborne particles (see clause 3). Conventions are stated in terms of mass fractions, but they may also be used when the intention is to evaluate the total surface area or the number of particles in the collected material.

In practice, the conventions will often be used to specify instruments to sample airborne particles for the purpose of measuring concentrations corresponding to the defined fractions. It should be noted that experimental error in the testing of instruments, and possible dependence on factors other than aerodynamic diameter, mean that it is only possible to make a statement of probability that an instrument's performance falls within a certain range, and that different instruments will fall within an acceptable range.

NOTE. The problem of comparing instruments with the conventions is to be dealt with in another standard.

One application is the comparison of mass concentration of airborne size fractions with limit values. It should be noted with respect to relevant European Directives that the use of other methods is allowed provided that they yield the same or stricter conclusion. One important example is the respirable convention in relation to compliance with the limit value. Equipment matching the Johannesburg convention [2] will in practical circumstances give the same or a higher mass concentration (by up to about 20 %) than equipment matching the respirable convention given in 5.3, so the use of equipment matching the Johannesburg convention will be consistent with the European Directive.

The conventions should not be used in association with limit values defined in completely different terms, for example for fibre limit values defined in terms of the length and diameter of fibres.

## 2 Definitions

For the purposes of this standard, the following definitions apply.

### 2.1 sampling convention

A target specification for sampling instruments which approximates to, for each particle aerodynamic diameter:

— in the case of inhalable convention, the ratio of the mass concentration of particles entering the respiratory tract to the corresponding mass concentration in the air before the particles are affected by the presence of the exposed individual and inhalation;

— in the case of the other conventions, the ratio of the mass concentration of particles entering the specified region of the respiratory tract to the mass concentration of particles entering the respiratory tract. (These other conventions can also be expressed as ratios to the mass concentration of total airborne particles.)

## 2.2 particle aerodynamic diameter

The diameter of a sphere of density $1 \, g \cdot cm^{-3}$ with the same terminal velocity due to gravitational force in calm air, as the particle, under the prevailing conditions of temperature, pressure and relative humidity (see clause 4).

NOTE. For particles of aerodynamic diameter less than $0.5 \, \mu m$, the particle diffusion diameter should be used instead of the particle aerodynamic diameter. The particle diffusion diameter means the diameter of a sphere with the same diffusion coefficient as the particle under the prevailing conditions of temperature, pressure and relative humidity.

## 2.3 inhalable fraction

The 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 the air movement, on breathing rate and other factors.

## 2.4 inhalable convention

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

## 2.5 extrathoracic fraction

The mass fraction of inhaled particles failing to penetrate beyond the larynx.

## 2.6 extrathoracic convention

A target specification for sampling instruments when the extrathoracic fraction is of interest.

## 2.7 thoracic fraction

The mass fraction of inhaled particles penetrating beyond the larynx.

## 2.8 thoracic convention

A target specification for sampling instruments when the thoracic fraction is of interest.

## 2.9 tracheobronchial fraction

The mass fraction of inhaled particles penetrating beyond the larynx, but failing to penetrate to the unciliated airways.

## 2.10 tracheobronchial convention

A target specification for sampling instruments when the tracheobronchial fraction is of interest.

## 2.11 respirable fraction

The mass fraction of inhaled particles penetrating to the unciliated airways.

## 2.12 respirable convention

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

## 2.13 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 total airborne particle concentration.

## 3 Principle of conventions

The sampling conventions recognize that only a fraction of the airborne particles which are near to the nose and mouth is inhaled. This fraction is called the inhalable fraction (see 2.3). For some substances, the subfractions of this which penetrate beyond the larynx, or to the unciliated airways are of special significance for health. This standard presents conventionalized curves approximating to the fraction inhaled and the subfractions reaching beyond the larynx or to the unciliated airways. These curves are called the inhalable convention (see 2.4), the thoracic convention (see 2.8) and the respirable convention (see 2.12). Extrathoracic (see 2.6) and tracheobronchial (see 2.10) conventions may be calculated from these. Instruments used for sampling need to conform with the sampling convention appropriate to the region of the respiratory tract where deposition of the substance being measured might lead to biological effect. For example, the inhalable convention would be chosen if the substance might lead to a biological effect wherever it deposited, the thoracic convention would be chosen if the region was the bronchi, and the respirable convention if the region was the alveoli.

Instruments can be used to collect individual fractions according to the conventions, or to collect several fractions simultaneously. For example, an instrument could collect particles from the air according to the inhalable convention, and then separate this material into portions according to thoracic, tracheobronchial and respirable conventions. Alternatively, an instrument might just collect the respirable fraction from the air. In this case, the design would have to ensure that selection at the entry due to aerodynamic effects, and subsequently within the instrument, was such that the overall selection was in accordance with the conventions.

## 4 Assumptions and approximations

Approximations and assumptions are unavoidable in simulating by sampling conventions the very complex interaction of variables that governs respiratory tract entry and penetration.

The conventions are necessarily only approximations to respiratory tract behaviour, and the following assumptions are particularly important:

— The inhalable fraction depends on air movement — speed and direction — on breathing rate, and on whether breathing is by nose or mouth. The values given in the inhalable convention are for representative values of breathing rate, and averaged for all wind

directions. This is appropriate for an individual uniformly exposed to all wind directions or predominantly to wind from the side or from behind. The convention usually underestimates the inhalable fraction of larger particles for an individual who usually faced the wind, particularly in windspeeds greater than 4 m·s$^{-1}$.

— The respirable and thoracic fractions vary from individual to individual and with breathing pattern, and the conventions are necessarily approximations to the average case.

— Each convention approximates to the fraction penetrating to a region, not to the fraction depositing there. In general, particles must deposit to have a biological effect. In this respect, the conventions will lead to an overestimate of the potential biological effect. The most important example is that the respirable convention overestimates the fraction of very small particles which are deposited in the unciliated airways, because a fraction of these particles is exhaled without being deposited. In many workplaces, these very small particles do not contribute much to the sampled mass.

— The thoracic convention approximates to the thoracic fraction during mouth breathing, which is greater than the thoracic fraction during nose breathing. The extrathoracic convention can therefore underestimate the 'worst case' extrathoracic fraction, which occurs during nose breathing.

## 5 Specifications for conventions

### 5.1 Inhalable convention

Sampling of the inhalable fraction shall conform with the following convention: the percentage $E_I$ of airborne particles of aerodynamic diameter $D$ in micrometres which are to be collected shall be given by:

$$E_I = 50(1 + \exp[-0{,}06D]) \qquad (1)$$

Some values given by this equation are given in table 1 and illustrated in figure 1.

NOTE. Experimental data on the inhalable fraction do not yet exist for $D > 100$ µm, and the convention should not be applied to larger particles.

### 5.2 Thoracic convention

Sampling of the thoracic fraction shall conform with the following conventions: the percentage $E_T$ of the inhalable convention which is to be collected at an aerodynamic diameter $D$ in micrometres shall be given by a cumulative log-normal distribution with a median of 11,64 µm and a geometric standard deviation of 1,5.

A numerical approximation for ease of calculation is given in annex B. Note that $E_T$ is calculated from the inhalable convention.

The fraction of the total airborne particles (see 2.13) at an aerodynamic diameter $D$ is obtained by multiplying $E_T$ by $0{,}01E_I$ from equation (1). Some values obtained are given in table 1 and illustrated in figure 1. It will be seen from the table that 50 % of airborne particles with $D = 10$ µm are in the thoracic fraction.

### 5.3 Respirable convention

Sampling of the respirable fraction shall be as follows: the percentage $E_R$ of the inhalable fraction convention which is to be collected at an aerodynamic diameter $D$ in micrometres shall be given by a cumulative log-normal distribution with a median diameter of 4,25 µm and a geometric standard deviation of 1,5.

A numerical approximation for ease of calculation is given in annex B. Note that $E_R$ is calculated from the inhalable convention.

The fraction of the total airborne particles (see 2.13) at an aerodynamic diameter $D$ is obtained by multiplying $E_R$ by $0{,}01E_I$ from equation (1). Some values obtained are given in table 1 and illustrated in figure 1.

NOTE. Attention is drawn to clause 1 on the use of other conventions.

### 5.4 Extrathoracic convention

The extrathoracic convention shall be calculated as $(E_I - E_T)$ (see 5.1 and 5.2) at each aerodynamic diameter $D$.
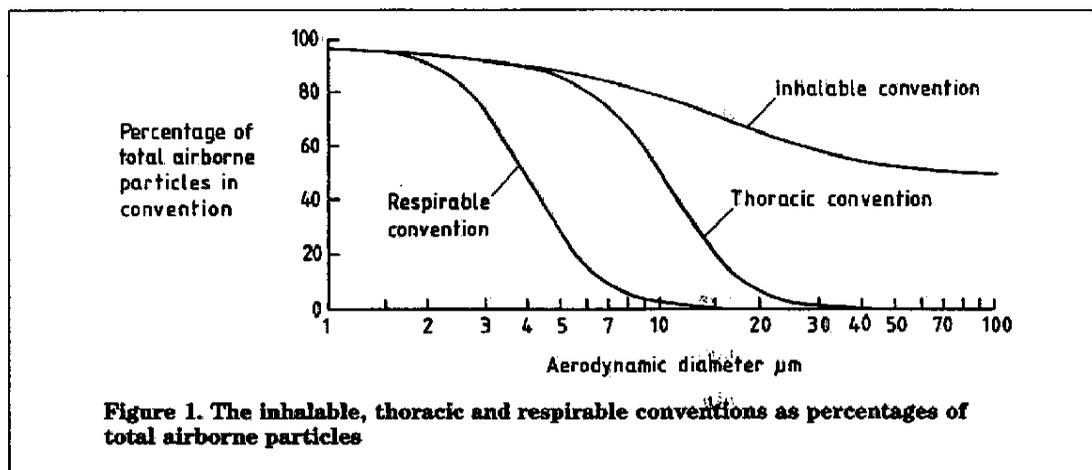
### 5.5 Tracheobronchial convention

The tracheobronchial convention shall be calculated as $(E_T - E_R)$ (see 5.2 and 5.3) at each aerodynamic diameter $D$.

Table 1. Numerical values of the conventions, as percentages of the inhalable convention or of total airborne particles

| | As percentage of inhalable | | | As percentage of total | | | |
|---|---|---|---|---|---|---|---|
| Aerodynamic diameter $D$ μm | Inhalable convention $E_I$ % | Thoracic convention $E_T$ % | Respirable convention $E_R$ % | Inhalable convention $E_I$ % | Thoracic convention $E_T \times E_I$ % | Respirable convention $E_R \times E_I$ % | Aerodynamic diameter $D$ μm |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 |
| 1 | 100 | 100 | 100 | 97,1 | 97,1 | 97,1 | 1 |
| 2 | 100 | 100 | 96,8 | 94,3 | 94,3 | 91,4 | 2 |
| 3 | 100 | 100 | 80,5 | 91,7 | 91,7 | 73,9 | 3 |
| 4 | 100 | 99,6 | 55,9 | 89,3 | 89,0 | 50,0 | 4 |
| 5 | 100 | 98,1 | 34,4 | 87,0 | 85,4 | 30,0 | 5 |
| 6 | 100 | 94,9 | 19,8 | 84,9 | 80,5 | 16,8 | 6 |
| 7 | 100 | 89,5 | 10,9 | 82,9 | 74,2 | 9,0 | 7 |
| 8 | 100 | 82,2 | 5,9 | 80,9 | 66,6 | 4,8 | 8 |
| 9 | 100 | 73,7 | 3,2 | 79,1 | 58,3 | 2,5 | 9 |
| 10 | 100 | 64,6 | 1,7 | 77,4 | 50,0 | 1,3 | 10 |
| 11 | 100 | 55,5 | 0,9 | 75,8 | 42,1 | 0,7 | 11 |
| 12 | 100 | 47,0 | 0,5 | 74,3 | 34,9 | 0,4 | 12 |
| 13 | 100 | 39,3 | 0,3 | 72,9 | 28,6 | 0,2 | 13 |
| 14 | 100 | 32,4 | 0,2 | 71,6 | 23,2 | 0,2 | 14 |
| 15 | 100 | 26,6 | 0,1 | 70,3 | 18,7 | 0,1 | 15 |
| 16 | 100 | 21,6 | 0,1 | 69,1 | 15,0 | ≈0 | 16 |
| 18 | 100 | 14,1 | 0 | 67,0 | 9,5 | | 18 |
| 20 | 100 | 9,1 | | 65,1 | 5,9 | | 20 |
| 25 | 100 | 3,0 | | 61,2 | 1,8 | | 25 |
| 30 | 100 | 1,0 | | 58,3 | 0,6 | | 30 |
| 35 | 100 | 0,3 | | 56,1 | 0,2 | | 35 |
| 40 | 100 | 0,1 | | 54,5 | 0,1 | | 40 |
| 50 | 100 | 0 | | 52,5 | 0 | | 50 |
| 60 | 100 | | | 51,4 | | | 60 |
| 80 | 100 | | | 50,4 | | | 80 |
| 100 | 100 | | | 50,1 | | | 100 |

Figure 1. The inhalable, thoracic and respirable conventions as percentages of total airborne particles

## Annex A (informative)

### Nomenclature of inhalable and respirable fractions in English

The term 'inhalable' is used in the English version of this standard because it is the word most naturally describing the meaning of the fraction for which it is used. There has been some confusion over terminology in the past. 'Inhalable' was used in the late 1970s in European English-language literature with the same meaning as in this standard. ISO/TR 7708 and the Directive 88/642/EEC used the name 'inspirable' for this fraction, and the terms 'inspirable' and 'inhalable' are equivalent. The US Environmental Protection Agency for a time used 'inhalable' for what is now called 'total thoracic particulate' or 'PM10'. EPA no longer uses the term 'inhalable', and so this standard has adopted the term with its original meaning.

The term 'respirable' has been used in English for the fraction penetrating to the unciliated airways since at least 1952 ([2], [7]). ISO/TR 7708 adopted the term 'alveolar', partly because of the risk of confusion between 'respirable' and 'inspirable', but as this European Standard uses the term 'inhalable' this argument no longer applies, and the familiar term 'respirable' has been adopted.

The equivalent terms are:

| German | French | English |
|---|---|---|
| einatembar | inhalable | inhalable |
| alveolengängig | alvéolaire | respirable |
| thorakal | thoracique | thoracic |

## Annex B (informative)

### Numerical approximations to cumulative log-normal distributions

For convenience of calculation, the following approximations may be used in calculating $E_T$ and $E_R$. This formula gives $E_T$ and $E_R$ as a percentage.

$E = 100(1 - G)$ if $D \leq M$

$E = 100G$ if $D \geq M$

$y$ is absolute value of $\dfrac{\log_e (D/M)}{\sqrt{(2)} \log_e 1,5}$

$G = 0,5(1 + 0,14112821y + 0,08864027y^2 + 0,02743349y^3 - 0,00039446y^4 + 0,00328975y^5)^{-8}$

For thoracic fraction, $E = E_T$ if $M = 11,64$ µm; $D$ is particle aerodynamic diameter in micrometres.

For respirable fraction, $E = E_R$ if $M = 4,25$ µm; $D$ is particle aerodynamic diameter in micrometres.

## Annex C (informative)

## Bibliography

[1] Directive 88/642/EEC amending Directive 80/1107/EEC on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work.

[2] HAMILTON, J.R. and WALTON, W.E. (1961) *The selective sampling of respirable dust. Inhaled particles and vapours* (C.N. Davies, ed.) pp. 465-475. (Pergamon Press, Oxford).

[3] HASTINGS, C. (1955) *Approximations for digital computers.* (Princeton University Press).

[4] HEYDER, J., GEBHARD, J., RUDOLPH, G., SCHILLER, C.F., and STAHLHOFEN, W. (1986) Deposition of particles in the human respiratory tract in the size range 0.0015-15 µm. *J. Aerosol Sci.*, 17, 811-825. Also, Erratum. *J. Aerosol Sci.*, 18, 353.

[5] ISO/TR 7708 : 1983 *Air quality — Particle size fraction definitions for health-related sampling.* Techn. Rep. (International Standardization Organization, Geneva).

[6] LIPPMANN, M., GURMAN, J. and SCHLESINGER, R.B. (1983) *Role of particle deposition in occupational lung disease. Aerosols in the mining and industrial work environments.* (V.A. Marple and B.Y.E. Liu, eds.) Vol. 1, pp. 119-137. (Ann Arbor, Ann Arbor), ISBN 0 250 40531 8.

[7] LIPPMANN, M. and HARRIS, W.B. (1962) *Size-selective samplers for estimating 'respirable' dust concentrations. Health Phys.* 8, 155-163.

[8] MILLER, F.J., MARTONEN, T.B., MENACHE, M.G., GRAHAM, R.C., SPEKTOR, D.M. and LIPPMANN, M. (1985) *Influence of breathing mode and activity level on the regional deposition of inhaled particles and implications for regulatory standards. Inhaled particles VI* (J. Dodgson, R.I. McCallum, M.R. Bailey and D.R. Fisher, eds.) pp. 3-10. (Pergamon Press, Oxford), ISBN 0 08 034185 3.

[9] OGDEN, T.L. and BIRKETT, J.L. (1977) *The human head as a dust sampler. Inhaled particles IV* (W.H. Walton, ed.) pp. 93-105. (Pergamon Press, Oxford) ISBN 0 08 020560 7.

[10] PHALEN, R.F., HINDS, W.C., JOHN, W., LIOY, P.J., LIPPMANN, M., McCAWLEY, M., RAABE, O.G., SODERHOLM, S.C., STUART, B.O. (1986) *Rationale and recommendations for particle size-selective sampling in the workplace. Appl. Ind. Hyg.* 1, 3-14.

[11] RUDOLF, G., STANLHOFEN, W. and JAMES, A.C. (1988) *Extrathoracic aerosol deposition for nose and mouth breathing: intercomparison and model. J. Aerosol Med.,* 1, 209-210.

[12] SODERHOLM, S.C. (1989) *Proposed international conventions for particle size-selective sampling. Ann. Occup. Hyg.* 33, 301-320.

[13] STUART, B.O. LIOY, P.J., PHALEN, R.F. (1986) *Particle size-selective sampling in establishing threshold limit values. Appl. Ind. Hyg.* 1, 138-144.

[14] VINCENT, J.E. (1989) *Aerosol sampling science and practice.* (John Wiley, Chichester) ISBN 0 471 92175 0.

## National annex NA (informative)

### Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Environment and Pollution Standards Policy Committee (EPC/-) to Technical Committee EPC/35, upon which the following bodies were represented:

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British Gas plc
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European Resin Manufacturers' Association
GAMBICA (BEAMA Ltd.)
Health and Safety Executive
Institute of Petroleum
Institution of Environmental Health Officers
Institution of Gas Engineers
National Society of Clean Air
Royal Society of Chemistry

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Asbestos Information Centre Ltd.
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