SLOVENSKI STANDARD
SIST EN 12341:2000

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Kakovost zraka – Določevanje frakcije PM10 ledbečih trdnih delcev – Referenčna metoda in terenski preskusni postopek za potrditev ustreznosti merilnih metod

Air quality - Determination of the PM 10 fraction of suspended particulate matter - Reference method and field test procedure to demonstrate reference equivalence of measurement methods

Luftbeschaffenheit - Ermittlung der PM10-Fraktion von Schwebstaub - Referenzmethode und Feldprüfverfahren zum Nachweis der Gleichwertigkeit von Meßverfahren und Referenzmeßmethode

Qualité de l'air - Détermination de la fraction MP10 de matiere particulaire en suspension - Méthode de référence et procédure d'essai in situ pour démontrer l'équivalence a la référence de méthodes de mesurage

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English version

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This European Standard was approved by CEN on 2 November 1998.

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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 Central Secretariat has the same status as the official versions.

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

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 264 "Air quality", 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of an identical text or by endorsement, at the latest by May 1999, and conflicting national standards shall be withdrawn at the latest by May 1999.

Annex A, annex B and annex C are normative annexes and annex D and annex E are informative annexes.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

ISO 7708 defines sampling conventions for the particle size fractions to be collected from ambient (and also workplace) atmospheres in order to assess their impact on human health. Conventions are defined for the inhalable, thoracic and respirable suspended particulate matter (SPM) fractions. These conventions represent target specifications for samplers, giving the ideal sampling efficiency as a function of particle aerodynamic diameter.

In general, the sampling efficiency of real samplers will deviate from the target specification, and the SPM 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 wind speed, humidity, temperature, and barometric pressure. The wide range of particle sizes and compositions present in ambient air has led to the development of a diversity of instruments for collection and quantification of the aforementioned SPM fractions.

Obviously, the aforementioned situation calls for standardised test procedures to ensure that the performance of candidate sampling instruments according to pertinent sampling conventions can be established reliably.

1 Scope

This standard specifies the performance of PM10 sampling instruments in order to harmonize the monitoring within the framework of the European Union Council Directive 96/62/EC [1] on ambient air quality assessment and management, and the first daughter directive. In the daughter directive, by convention the ISO thoracic sampling convention has been assimilated to the PM10 fraction (see annex A; [2]).

The standard specifies a test protocol for comparing the results of a candidate PM10 sampler with a reference PM10 one in a field test [3]. Basically, the reference equivalence awarded to a candidate sampler applies only to the range of conditions under which the field tests were carried out. By carrying out the ambient field test in characteristic situations covering a wide range of relevant ambient parameters it is secured that reference equivalence does hold in prevailing conditions within European countries. Reference equivalence will explicitly not be awarded for specific situations (e.g. background only or urban situations only). Above all, the procedure given in this standard is thought to be a practical one, enabling European institutions or industries to assess candidate sampling systems under ambient conditions.

The reference equivalence awarded using the procedures given in this standard, only applies to the process of sampling SPM in ambient air. It does not deal with the equivalence of commonly employed automated methods (e.g. attenuation of â-radiation or the oscillating mass balance method) to analyse the ambient SPM collected on the collection substrate. The limit of detection and the precision of the analytical method are important considerations for the user, but their determination is outside the scope of this standard.

The main arguments for the designated field test procedure are elucidated in D.1.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 45001
General criteria for the operation of testing laboratories

ISO 8756
Air Quality - Handling of temperature, pressure and humidity data

ISO 7708
Air quality - Particle size fraction definitions for health related sampling

3 Definitions

For the purposes of this standard the following definitions apply:

3.1 Suspended particulate matter (SPM): Notion of all particles surrounded by air in a given, undisturbed volume of air.

3.2 Thoracic fraction: Mass fraction of inhaled particles which penetrate beyond the larynx (ISO 7708).

3.3 Thoracic convention: Target specification for sampling instruments when the thoracic fraction is of interest (ISO 7708).

3.4 Thoracic particles: Inhaled particles which penetrate beyond the larynx.

3.5 PM10: A target specification for sampling the thoracic particles, see annex A.

3.6 Sampling efficiency: For each particle aerodynamic diameter, the ratio of SPM mass concentration as determined by the sampling instrument, to the corresponding SPM mass concentration.

3.7 Average sampling efficiency: For the target specification of interest, the ratio of SPM mass concentration as determined by the sampling instrument, to the corresponding SPM mass concentration.

3.8 PM10 reference sampler: By convention, a sampling instrument that possesses the required performance characteristics, in order to assess the PM10 mass concentration.

3.9 PM10 candidate sampler: A sampling instrument, intended for consideration as an equivalent to the reference sampler.

3.10 True value (of a quantity): Value consistent with the definition of a given particular quantity [4].

NOTE 1: This is a value that would be obtained by a perfect measurement.
NOTE 2: True values are by nature indeterminate.
NOTE 3: The indefinite article "a" rather than the definite article "the" is used in conjunction with "true value" because there may be many values consistent with the definition of a given particular quantity.

3.11 Conventional true value (of a quantity): Value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose [4].

NOTE 1: Conventional true value is sometimes called: assigned value, best estimate of the value, conventional value, or reference value.
NOTE 2: Frequently, a number of results of measurements of a quantity is used to establish a conventional true value.

3.12 Uncertainty (of measurement): Parameter, associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand [4].

NOTE 1: The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.
NOTE 2: Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterised by experimental standard deviations. The other components, which can also be characterised by standard deviations, are evaluated from assumed probability distributions based on experience or other information.
NOTE 3: It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

4 Requirements for reference equivalence

4.1 General

The reference equivalence of candidate samplers focuses on the following aspects:

a) Comparability of candidate samplers
from the uncertainty between duplicate measurements of collocated specimens of candidate samplers

b) Comparability of candidate and reference sampler
from the so-called reference equivalence function describing the relation between the measured mass concentrations by the candidate and reference sampler respectively.

The main arguments for the designated procedure to test the reference equivalence are summarised in D.2.

4.2 Requirements

The test method described in clause 5 shall be used to test the reference equivalence of candidate samplers against the following requirements:

a) Comparability of candidate samplers
test statistic of uncertainty according to 95% confidence level:
$\leq$ 5 µg/m³, if the average concentrations $(Y_{i1} + Y_{i2}) / 2$ obtained from duplicate measurements with collocated candidate samplers are $\leq$ 100 µg/m³, or
$\leq$ 5 % with respect to the average concentrations $(Y_{i1} + Y_{i2}) / 2$ obtained from duplicate measurements with collocated candidate samplers, if the average concentrations are > 100 µg/m³.

b) Comparability with reference instrument
reference equivalence function bounded within a two-sided acceptance envelope, over the relevant concentration range:
$\leq$ 10 µg/m³, if the reference concentrations X_i are $\leq$ 100 µg/m³, or
$\leq$ 10 % with respect to the reference concentrations X_i, if the reference concentrations are > 100 µg/m³.

4.3 Reference instrument

The reference measuring method shall consist of a PM10 sampling inlet, directly coupled with a filter substrate and a regulated flow device, followed by gravimetric determination of the PM10 mass collected on the filter.

Either of the following sampling inlet devices shall be employed:

a) Low Volume system: the LVS-PM10 sampler (see B.1);
b) High Volume system: the HVS-PM10 sampler (see B.2);
c) Superhigh Volume system: the WRAC-PM10 sampler (see B.3).

5 Test method

5.1 Field test

5.1.1 Test sites

When selecting the test sites, due consideration shall be given to the integrity of the site on a macro environment scale (i.e. type of location), and on a micro environment scale (i.e. area directly surrounding the station).

On a macro environment scale, the test location(s) shall be selected to represent both commonly encountered and extreme situations. The proportion of PM10 to SPM, together with the PM10 mass concentration serve as indication of the characteristic situation upon consideration:

a) the range of PM10 concentrations shall cover at least 150 % of the pertinent limit value from the Council Directive 96/62/EC [1];

b) the proportion of PM10 to SPM shall range between a very high contribution (well over 90 %) and about 50 %;

On a micro environment scale the candidate sampler and the reference sampler shall probe the same proportion of PM10 to SPM under the same ambient conditions so as to yield comparable data. As a minimum the following basic rules shall be met [5]:

c) the flow around the sampler's inlet shall be unrestricted without any obstructions (such as balconies, trees, vertical surfaces or walls, etc.) affecting the air flow in the vicinity of the samplers;

d) the inlets shall be well extended from each other in order to avoid mutual interferences on the sampling process (e.g. not near each others sampling pump exhausts);

e) all inlets shall be set at the same height (between 1,5 m and 8 m) above the ground;

f) the inlets shall be positioned away from local sources in order to avoid drifting plumes (e.g. not near chimneys serving the test site's own domestic heating furnace).

Once the type of location has been determined, selection of actual test sites shall take into account a number of factors, in particular operational aspects (accessibility, safety against vandalism, protection against external weather conditions), and infrastructural aspects (electricity and telephone). The necessary requirements as to installation of test sites are duly specified; see e.g. [6, 7].

5.1.2 Site characterization

The macro integrity of the test site, notably the proportion of PM10 to SPM, can be assessed either

a) from acknowledged previous experiences regarding the test site, or
b) from the WRAC reference sampler (if employed), or
c) by employing a suitable classifying method during the field test,
e.g. the PM10 reference sampler in combination with a conventional High Volume Sampler or a Aerosol Tunnel Sampler [8] as a realistic estimate of the total SPM concentration.

5.1.3 Operational procedures

A candidate sampler shall consist of a PM10 sampling inlet, directly coupled with a filter substrate and a regulated flow device. Afterwards, the PM10 mass collected on the filter shall be determined gravimetrically.

The average flow rate over the sampling time shall be within 5 % of the initial (nominal) flow rate, and all instantaneous flow rates during the sampling time shall remain within 10 % of the initial (nominal) flow rate.

As to the handling, conditioning and weighing procedures of the collection filter, the user shall follow the procedures outlined in annex C [9].

Reference, candidate and site classifying samplers shall be operated in accordance with the instructions given in the manufacturer's manual. Notably, attention shall be paid to maintenance procedures, and stability and calibration of sampling flow rate.

One reference sampler and two candidate samplers in parallel shall be used.

The number of measurements obtained in the comparison exercise between each of the candidate samplers and the reference one shall at least be fourty in total.

The PM10 mass concentrations to be compared shall have the same time basis, i. e. be averaged concentrations measured over the same sampling time. As a rule, the sampling time shall be 24 h. However, lower concentrations may require longer sampling times, whereas higher concentrations may give rise to shorter ones.

The measured concentrations shall be distributed over the pertinent concentration range, i. e. a set of clustered data points in a small concentration range only shall not serve as a basis for awarding reference equivalence.

The measurements shall cover a commonly encountered range of environmental conditions occurring in the European Union, in particular regarding (low vs. high) wind speed and (low vs. high) relative humidity.

The technical competence of the testing laboratories shall be according to the criteria specified in EN 45001.

5.1.4 Data treatment

The PM10 mass concentrations are calculated by dividing the filter mass loading by the pertinent total flow during the sampling time. The PM10 concentrations shall be expressed with respect to reference conditions, so that reliable comparisons can be made between the candidate and reference PM10 concentration values obtained at different test sites, times and climatic conditions.

Following ISO 8756, a temperature of 273 K and a pressure of 101,3 kPa shall be used as standard temperature and pressure (STP).

5.1.5 Handling of data

All reference and candidate concentrations measured shall be subject to an appropriate validation procedure to obviate the effects of apparently non-bona-fide data, notably due to technical-operational problems. In such out-of-control situations, the pertinent candidate data shall be rejected, provided a sound consideration of the technical-operational situation. All data thus approved technically shall be included in the reference equivalence test according to 5.2.

Before carrying out the procedures laid down in 5.2, the measurement data from the various test sites shall be merged into one overall data set. The data from the duplicate candidate samplers shall be treated separately. If appropriate, any standard statistical outlier test can be applied. In this case no more than 5 % of the original data shall be rejected.

5.2 Comparison with requirements

5.2.1 General

The reference equivalence of candidate samplers has to be shown in a field test against one of the reference instruments (see annex B), to be selected at the discretion of the user.

According to 4.1, the reference equivalence is judged from the following aspects:

a) Comparability of candidate samplers: see 5.2.3;
b) Comparability of candidate and reference sampler: see 5.2.4;