

STN	Pracovná expozícia Meranie inhalačnej expozície nanočasticiam a ich agregátom a aglomerátom Metriky (indikátory), ktoré sa majú použiť, ako je koncentrácia častíc, povrchová koncentrácia a hmotnostná koncentrácia	STN EN 16966 83 3613
------------	---	--

Workplace exposure - Measurement of exposure by inhalation of nano-objects and their aggregates and agglomerates - Metrics to be used such as number concentration, surface area concentration and mass concentration

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 03/19

Obsahuje: EN 16966:2018

128262

EUROPEAN STANDARD

EN 16966

NORME EUROPÉENNE

EUROPÄISCHE NORM

November 2018

ICS 13.040.30

English Version

Workplace exposure - Measurement of exposure by inhalation of nano-objects and their aggregates and agglomerates - Metrics to be used such as number concentration, surface area concentration and mass concentration

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation de nano-objets et de leurs agrégats et agglomérats - Métriques à utiliser telles que concentration en nombre, concentration en surface et concentration en masse

Exposition am Arbeitsplatz - Messung der inhalativen Exposition gegenüber Nanoobjekten und deren Aggregaten und Agglomeraten - Zu verwendende Metriken wie Anzahlkonzentration, Oberflächenkonzentration und Massenkonzentration

This European Standard was approved by CEN on 27 August 2018.

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, Serbia, 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: Rue de la Science 23, B-1040 Brussels

EN 16966:2018 (E)**Contents**

Page

European foreword	5
Introduction	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols and abbreviations	12
5 Relevance of ISO definition for assessing health impacts of airborne NOAA	13
6 Particle metrics and their selection	13
6.1 Workplace aerosols consisting of NOAA	13
6.2 NOAA metrics	14
6.3 NOAA number metric, NOAA surface area metric and NOAA mass metric	14
6.4 Occupational exposure limits for NOAA	15
7 Exposure assessment strategy based on EN 17058	15
7.1 General	15
7.2 Basic assessment according to EN 17058	16
7.3 Comprehensive assessment according to EN 17058	16
7.4 Personal samplers versus static samplers/monitors	17
8 Determination of exposure	17
8.1 General	17
8.2 Introductory remarks regarding the measurement of particle metrics	18
8.2.1 General	18
8.2.2 Continuous measurement and display (using a monitor) or post-sampling analytical determination of a NOAA metric	19
8.2.3 Calculation/estimation of a NOAA metric based on the size-resolved NOAA distribution	20
8.2.4 Calculation of NOAA mass ensemble metric based on the size-resolved NOAA mass metric	20
8.3 Information of the measurement of particle metrics	20
Annex A (informative) Source domains of workplace exposure scenarios for engineered/ manufactured NOAA	21
Annex B (informative) Evolution of available instrumental technology since the publication of ISO/TR 27628 and ISO/TR 12885	22
Annex C (informative) Direct-reading instruments for measuring the NOAA ensemble number metric	23
C.1 General	23
C.2 Condensation particle counter	23
C.2.1 Principle of operation	23
C.2.2 Assumptions, limits and potential problems	23
C.2.3 Accuracy and comparability according to EN 16897	24

C.2.4	International standards on the use of CPC	24
C.3	Diffusion chargers	24
C.3.1	General	24
C.3.2	Assumptions, limits and potential problems.....	24
C.3.3	Accuracy and comparability	25
Annex D (informative)	Monitors for measuring the NOAA ensemble surface area metric.....	26
D.1	General	26
D.2	Assumptions, limits and potential problems.....	26
D.3	Accuracy and comparability	28
Annex E (informative)	Samplers for determining the NOAA mass (chemical element) metric by off-line analysis	29
E.1	General	29
E.2	Ensemble of all sampled particles analysed	29
E.2.1	General	29
E.2.2	Assumptions, potential problems and comparability.....	30
E.3	Individual particles analysed.....	30
E.3.1	General	30
E.3.2	Assumptions, potential problems and comparability.....	30
Annex F (informative)	Monitors for measuring the size-resolved NOAA number metric (number-weighted electric mobility equivalent diameter distribution).....	31
F.1	General	31
F.2	DMAS of various designs	31
F.2.1	General	31
F.2.2	Assumptions, potential problems and comparability.....	31
F.2.3	International Standards on the use of DMAS.....	32
Annex G (informative)	Samplers for determining the size-resolved NOAA mass metric (mass-weighted diffusive equivalent diameter distribution) by off-line analysis	33
G.1	General	33
G.2	Diffusion spectrometers.....	33
G.2.1	General	33
G.2.2	Assumptions and potential problems	33
Annex H (informative)	Samplers for determining the size-resolved NOAA mass (chemical element/ compound) metric (mass-weighted aerodynamic equivalent diameter distribution) by off-line analysis.....	34
H.1	General	34
H.2	Cascade impactors.....	34
H.2.1	General	34
H.2.2	Assumptions and potential problems	34

EN 16966:2018 (E)

Annex I (informative) Monitors for determining the size-resolved NOAA number metric (number-weighted aerodynamic equivalent diameter distribution).....	35
I.1 General.....	35
I.2 Assumptions and potential problems.....	35
Annex J (informative) Number-weighted minimum Feret diameter distribution of primary particles of aggregates and constituent parts of aggregates	36
J.1 Distinction between a NOAA and a non-NOAA particle	36
J.2 Aggregates and agglomerates.....	36
J.3 Sample analysis in an electron microscope.....	36
J.3.1 General.....	36
J.3.2 Assumptions and potential problems.....	37
Bibliography.....	38

European foreword

This document (EN 16966:2018) 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 May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

EN 16966:2018 (E)**Introduction**

Historically, workers' occupational exposure to airborne non-radioactive particles has been expressed as mass concentrations. The main exception has been fibres of various compositions that have been given as a number concentration for fibres within specified diameter and length limits. Other exceptions are units of glycine per cubic metre for enzymes and number of colony-forming units for airborne microbiological organisms.

Engineered/manufactured nanomaterials are now being used on a wide scale. Only for a few nanomaterials is there currently large enough knowledge of which parameters of the exposure are critical for specific health end-points. Scientific documents for the elaboration of OELs for airborne nano-objects and their aggregates and agglomerates (NOAA) greater than 100 nm are limited, and nano-object specific legally binding Occupational Exposure Limits (OELs) have not been established. However, for some NOAA recommended OELs have been published. Currently, there is no overall agreement on the metric of occupational exposure to airborne NOAA. Nevertheless, all existing legally binding OELs are respected, as substances in their non-nanoscale or microscale form may have recognised OELs. Concentrations of airborne particles can be expressed as a number, surface area or mass concentrations. For spherical particles these are mathematically related to the integral over all particle sizes of the number of particles (per size) times the corresponding particle size raised to zero, two and three, respectively. The different expressions of particle concentrations are generally referred to as different metrics.

Instruments used for the determination of concentrations of airborne particles are generally based on a specific measurement principle that measures the particles in only one of the metrics. Particle concentrations given by these metrics are related to each other via the particle size distribution. In general it is difficult, not to say impossible, to recalculate a concentration given in one metric into another if the complete size distribution is not known and the particles are not spherical or of varying/unknown effective density. It is therefore important that the user of measurement data on occupational exposure to NOAA understands the concepts of particle metrics.

For comprehensive exposure assessments of NOAA, it is recommended that the occupational exposure is determined in parallel for more than one metric, as it is presently unknown which metric later will be considered as most relevant for the critical health effect.

1 Scope

This European Standard specifies the use of different metrics for the measurement of exposure by inhalation of NOAA during a basic assessment and a comprehensive assessment, respectively, as described in EN 17058 [1].

This document demonstrates the implications of choice of particle metric to express the exposure by inhalation to airborne NOAA, e.g. released from nanomaterials¹ and present the principles of operation, advantages and disadvantages of various techniques that measure the different aerosol metrics.

Potential problems and limitations are described and need to be addressed when occupational exposure limit values might be adopted in the future and compliance measurements will be carried out.

Specific information is mainly given for the following metrics/measurement techniques:

- Number/Condensation Particle Counters by optical detection;
- Number size distribution/differential mobility analysing systems by electrical mobility;
- Surface area/electrical charge on available particle surface;
- Mass/chemical analyses (e.g. Inductively Coupled Plasma atomic Mass Spectrometry (ICP-MS), X-Ray Fluorescence (XRF)) on size-selective samples (e.g. by impaction or diffusion).

This document is intended for those responsible for selecting measurement methods for occupational exposure to airborne NOAA.

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*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN

¹ Currently, the EU has a recommendation for a definition of nanomaterial [SOURCE: *Official Journal of the European Union* L275/38, 20 October 2011]. In this document the ISO definition on nanomaterial is used.