# SLOVENSKI STANDARD
# SIST EN 17199-4:2019

**01-september-2019**

---

**Izpostavljenost na delovnem mestu - Meritve prašnosti razsutih materialov, ki vsebujejo ali sproščajo respirabilne nanopredmete ter njihove agregate in aglomerate (NOAA) in druge respirabilne delce - 4. del: Metoda z majhnim vrtečim bobnom**

Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 4: Small rotating drum method



Exposition am Arbeitsplatz - Messung des Staubungsverhaltens von Schüttgütern, die Nanoobjekte oder Submikrometerpartikel enthalten oder freisetzen - Teil 4: Verfahren mit kleiner rotierender Trommel



Exposition sur les lieux de travail - Mesurage du pouvoir de resuspension des matériaux en vrac contenant ou émettant des nano-objets et leurs agrégats et agglomérats (NOAA) ou autres particules en fraction alvéolaire - Partie 4: Méthode impliquant l'utilisation d'un petit tambour rotatif

**Ta slovenski standard je istoveten z:** **EN 17199-4:2019**

---

**ICS:**

| | | |
|---|---|---|
| 13.040.30 | Kakovost zraka na delovnem mestu | Workplace atmospheres |

**SIST EN 17199-4:2019** **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 17199-4

March 2019

ICS 13.040.30

English Version

# Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 4: Small rotating drum method

Exposition sur les lieux de travail - Mesurage du pouvoir de resuspension des matériaux en vrac contenant ou émettant des nano-objets et leurs agrégats et agglomérats (NOAA) ou autres particules en fraction alvéolaire - Partie 4: Méthode impliquant l'utilisation d'un petit tambour rotatif

Exposition am Arbeitsplatz - Messung des Staubungsverhaltens von Schüttgütern, die Nanoobjekte oder Submikrometerpartikel enthalten oder freisetzen - Teil 4: Verfahren mit kleiner rotierender Trommel

This European Standard was approved by CEN on 8 February 2019.

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**

# Contents

Page

## European foreword

This document (EN 17199-4:2019) 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 September 2019 and conflicting national standards shall be withdrawn at the latest by September 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 mandate given to CEN by the European Commission and the European Free Trade Association.

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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# Introduction

Dustiness measurement and characterization provide users (e.g. manufacturers, producers, occupational hygienists and workers) with information on the potential for dust emissions when the bulk material is handled or processed in workplaces. They provide the manufacturers of bulk materials containing NOAA with information that can help to improve their products and reduce their dustiness. It allows the users of the bulk materials containing NOAA to assess the controls and precautions required for handling and working with the material and the effects of pre-treatment (e.g. modify surface properties or chemistry). It also allows the users to select less dusty products, if available. The particle size distribution of the aerosol and the morphology and chemical composition of its particles can be used by occupational hygienists, scientists and regulators to further characterize the aerosol in terms of particle size distribution and chemical composition and to thus aid users to evaluate and control the health risk of airborne dust.

This document gives details on the design and operation of the small rotating drum method that can be used to measure the dustiness of bulk materials that contain or release respirable NOAA or other respirable particles in terms of dustiness indices or emission rates. Dustiness indices as well as particle emission rates can be mass-based of the health-related respirable dustiness mass fraction using a cyclone for the respirable dust fraction and by number using real-time sampling of particle number concentrations. The particle size distribution of the released aerosol is measured using direct-reading aerosol instruments. The released dust particles can be further sampled and characterized for, e.g. physical size distribution, morphology and chemical composition by off-line analysis (as required).This test uses the same dust generation principle as EN 15051-2 and EN 17199-2 [1], but the rotating drum volume and diameter is smaller and the sampling design different, which allows testing of small sample volumes and simultaneous sampling of all realtime data and dust for off-line analysis.



The small rotating drum method has been designed to simulate workplace scenarios and to represent general bulk material handling processes, including processes where bulk material is tipped, poured, mixed, scooped, dropped or similar, either mechanically or by hand.



The small rotating drum method presented here differs from the rotating drum, continuous drop and the vortex shaker methods presented in EN 17199-2 [1], EN 17199-3 [2] and EN 17199-5 [3] respectively. The rotating drum and small rotating drum methods perform, both, repeated pouring or agitation of a bulk material. The continuous drop method simulates continuous feed of a bulk material while the vortex shaker method simulates vigorous agitation of a bulk material.

This document was developed based on results in scientific literature [4,5,6,7] and pre-normative research [8]. The pre-normative research project investigated the dustiness of ten bulk materials (including nine bulk nanomaterials) with the intention to test as wide a range of bulk materials as possible in terms of magnitude of dustiness, chemical composition and primary particle size distribution as indicated by a large range in specific surface area.

Subsequently, the sampling line was optimized to improve dust transmission in the system and make the sampling closer to the efficiency in the prototype by [4] and EN 15051-2 [9].

# 1 Scope

This document describes the methodology for measuring and characterizing the dustiness of bulk materials that contain or release respirable NOAA or other respirable particles, under standard and reproducible conditions and specifies for that purpose the small rotating drum method.

This document specifies the selection of instruments and devices and the procedures for calculating and presenting the results. It also gives guidelines on the evaluation and reporting of the data.

The methodology described in this document enables

a) the measurement of the respirable dustiness mass fraction,

b) the measurement of the number-based dustiness index of respirable particles in the particle size range from about 10 nm to about 1 µm,

c) the measurement of the initial number-based emission rate and the time to reach 50 % of the total particle number released during testing,

d) the measurement of the number-based particle size distribution of the released aerosol in the particle size range from about 10 nm to about 10 µm,

e) the collection of released airborne particles in the respirable dustiness mass fraction for subsequent observations and analysis by analytical electron microscopy.



NOTE 1 The particle size range described above is based on the equipment used during the pre-normative research [8].



This document is applicable to the testing of a wide range of bulk materials including powders, granules or pellets containing or releasing respirable NOAA or other respirable particles in either unbound, bound uncoated and coated forms.



NOTE 2 Currently no number-based classification scheme in terms of particle number and emission rate has been established for powder dustiness. Eventually, when a large number of measurement data has been obtained, the intention is to revise the document and to introduce such a classification scheme, if applicable.

NOTE 3 The small rotating drum method has been applied to test the dustiness of a range of materials including nanoparticle oxides, nanoflakes, organoclays, clays, carbon black, graphite, carbon nanotubes, organic pigments, and pharmaceutical active ingredients. The method has thereby been proven to enable testing of a many different materials that can contain nanomaterials as the main component.

# 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.

CEN ISO/TS 80004-2, *Nanotechnologies - Vocabulary - Part 2: Nano-objects (ISO/TS 80004-2)*

EN 481, *Workplace atmospheres - Size fraction definitions for measurement of airborne particles*

EN 1540, *Workplace exposure - Terminology*

EN 13205-2, *Workplace exposure - Assessment of sampler performance for measurement of airborne particle concentrations - Part 2: Laboratory performance test based on determination of sampling efficiency*

EN 15051-1, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 1: Requirements and choice of test methods*

EN 16897, *Workplace exposure - Characterization of ultrafine aerosols/nanoaerosols - Determination of number concentration using condensation particle counters*

EN 17199-1, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 1: Requirements and choice of test methods*

ISO 15767, *Workplace atmospheres - Controlling and characterizing uncertainty in weighing collected aerosols*

ISO 27891, *Aerosol particle number concentration - Calibration of condensation particle counters*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540, EN 15051-1, CEN ISO/TS 80004-2 and EN 17199-1 apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp



## 4 Symbols and abbreviations



| | |
|---|---|
| CPC | Condensation Particle Counter |
| $d_{50}$ | A lower particle size at which the counting or sampling efficiency is 50 % |
| ELPI®[1)] | Electrical Low Pressure Impactor |
| EM | Electron Microscopy |
| FTIR | Fourier Transform Infra-Red Spectroscopy |
| GC | Gas Chromatography |
| HEPA | High Efficiency Particulate Arrestance |
| HPLC | High Performance Liquid Chromatography |
| ICP | Inductive Coupled Plasma |
| ID | Inner Diameter |
| LOQ | Limit Of Quantification |
| MS | Mass Spectrometry |
| NOAA | Nano-objects, and their aggregates and agglomerates > 100 nm |

1) ELPI® is the trade name or trademark of a product supplied by Dekati. This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.

| | |
|---|---|
| Raman | Raman Spectroscopy |
| RH | Relative Humidity |
| SEM | Scanning Electron Microscopy |
| SRD | Small Rotating Drum |
| TEM | Transmission Electron Microscopy |
| XRF | X-ray Fluorescence |

## 5 Principle

The small rotating drum (SRD) method described in this document measures the dustiness of bulk materials in terms of

— the respirable dustiness mass fraction,

— the number-based dustiness index,

— the number-based emission rates, and

— the time period to generate 50 % of the emitted particle numbers.



In addition, this document describes the procedures by which the aerosols can be further characterized in terms of their particle size distributions and the morphology and chemical composition of their airborne particles.



The sampling for the purpose of and the execution of qualitative or quantitative analysis of the morphology and chemical composition of the collected airborne particles are described. Performing these analyses is optional but can provide confirmation of the sizes of the particles generated and complementary information to the real-time instruments.

Table 1 provides

— an overview of the different measurands,

— information on whether determining these measurands is mandatory or not, and

— the aerosol instruments and sampling devices needed to determine a measurand.

**Table 1 — Measurands, aerosol instruments/sampling devices and associated recommendations for the small rotating drum method**

| Measurand | Method/Device specific to measurand | Mandatory/optional |
|---|---|---|
| Respirable dustiness mass fraction (mg/kg) | 25 mm- or 37 mm- air sampling cassette mounted on a cyclone for the respirable dust fraction | Mandatory |
| Number-based dustiness index of respirable particles in the particle size range from about 10 nm to about 1 µm (1/mg) | Condensation Particle Counter (CPC) | Mandatory |
| Number-based average emission rate of respirable particles in the particle size range from about 10 nm to about 1 µm (1/mg·s) | Condensation Particle Counter (CPC) | Mandatory |
| Number-based initial dustiness kinetics considering the number of particles released in the particle size range from about 10 nm to about 1 µm ($1/mg \cdot s^2$) | Condensation Particle Counter (CPC) | Mandatory |
| Time-based dustiness kinetics assessed as the time required to generate 50 % of the total number of particles released in the particle size range from about 10 nm to about 1 µm (s) | Condensation Particle Counter (CPC) | Mandatory |
| Number of modes of the time-averaged number-based particle size distributionas $dN/d\log D_i$ (-) | Time- and size-resolving instrument covering the particle size range from about 10 nm up to about 10 µm | Mandatory |
| Modal aerodynamic equivalent diameters corresponding to the highest mode ($M1_N$) and to the second highest mode ($M2_N$) of the time-averaged number-based particle size distribution as $dN/d\log D_i$ (µm) | | Mandatory |
| Number of modes of the time-averaged mass-based particle size distribution as $dM/d\log D_i$ (-) | Cascade impactor covering the particle size range from about 10 nm up to about 10 µm | Optional |
| Modal aerodynamic equivalent diameters corresponding to the highest mode ($M1_M$) and to the second highest mode ($M2_M$) of the time-averaged mass-based particle size distribution as $dM/d\log D_i$ (µm) | | Optional |