# SLOVENSKI STANDARD
# oSIST prEN ISO 27548:2023

**01-junij-2023**

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**[Not translated]**

Additive manufacturing of plastics - Environment, health, and safety - Test method for determination of particle and chemical emission rates from desktop material extrusion 3D printer (ISO/DIS 27548:2023)

Additive Fertigung von Kunststoffen - Umwelt, Gesundheit und Sicherheit - Prüfverfahren zur Bestimmung der Partikelemissionsrate und der chemischen Emissionsrate von materialextrusionsbasierten Desktop-3D-Druckern (ISO/DIS 27548:2023)

Fabrication additive de plastiques - Environnement, santé et sécurité - Méthode d'essai pour la détermination des taux d'émission de particules et de produits chimiques des imprimantes 3D de bureau par extrusion de matériau (ISO/DIS 27548:2023)

**Ta slovenski standard je istoveten z:** **prEN ISO 27548**

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**ICS:**

| | | |
|---|---|---|
| 13.040.40 | Emisije nepremičnih virov | Stationary source emissions |
| 13.100 | Varnost pri delu. Industrijska higiena | Occupational safety. Industrial hygiene |
| 25.030 | 3D-tiskanje | Additive manufacturing |
| 83.080.01 | Polimerni materiali na splošno | Plastics in general |

**oSIST prEN ISO 27548:2023** **en,fr,de**

DRAFT INTERNATIONAL STANDARD

# ISO/DIS 27548

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# Additive manufacturing of plastics — Environment, health, and safety — Test method for determination of particle and chemical emission rates from desktop material extrusion 3D printer

ICS: 13.040.30; 25.030; 13.100



This document is circulated as received from the committee secretariat.

**ISO/CEN PARALLEL PROCESSING**



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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 261, Additive manufacturing, Working Group WG 6, Environment, health and safety.

# Introduction

Academic communities have been releasing several papers warning that a significant number of particles and chemical substances emitted from 3D printing would be hazardous to humans when inhaled and absorbed into the human body.

However, currently, there is no well-known test method to measure particle and chemical substances emitted from desktop MEX-TRB/P 3D printer installed in the office environment, classroom, and residential space.

Therefore, the goal of this International Standard is to provide test procedures in line with specific operating conditions for measuring particle and chemical emission rates emitted from desktop MEX-TRB/P 3D printer which is widely used in the national marketplace.

Manufacturers of desktop MEX-TRB/P 3D printer will be able to take advantage of this document to develop and improve their products by minimizing particle and chemical emission rates, and the end-users also would purchase more safe and improved 3D printer from the market.

# Additive manufacturing of plastics — Environment, health, and safety — Test method for determination of particle and chemical emission rates from desktop material extrusion 3D printer

## 1 Scope

This document specifies test methods to determine particle emissions (including ultrafine particles) and specified Volatile Organic Compounds (including aldehydes) from desktop MEX-TRB/P processes often used in non-industrial environments such as school, homes and office spaces in an Emission Test Chamber under specified test conditions. However, these tests may not accurately predict real-world results.

This document describes a conditioning method using an ETC with controlled temperature, humidity, air exchange rate, air velocity, and procedures for monitoring, storage, analysis, calculation, and reporting of emission rates.

This document is intended to cover desktop MEX-TRB/P 3D printer which is typically sized for placement on a desktop, used in non-industrial places like school, home and office space. The primary purpose of this document is to quantify particle and chemical emission rates from desktop MEX-TRB/P 3D printer.



However, not all possible emissions are covered by this method. Many feedstocks could release hazardous emissions that are not measured by the chemical detectors prescribed in this document. It is the responsibility of the user to understand the material being extruded and the potential chemical emissions. An example is Poly Vinyl Chloride feedstocks that could potentially emit chlorinated compounds, which could not be measured by the method described in this document.

## 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.

ISO 16000-3, *Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor and test chamber air — Active sampling method*

ISO 16000-6:2011, *Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID*

ISO 16000-9, *Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method*

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

ISO/IEC 28360-1:2018, *Information technology — office equipment — Determination of chemical emission rates from electronic equipment — Part 1: Using-consumables*

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900, ISO/IEC 28360-1 and the following are applied.

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**
**aerosol**
system of solid or liquid particles suspended in gas

[SOURCE: ISO 15900:2009, 2.1]

**3.2**
**loading factor**
ratio of the device volume to the volume of the unloaded Emission Test Chamber

Note 1 to entry: For the purpose of this standard, the device subjected to the testing is typically a desktop MEX-TRB/P machine, also popularly called a 3D printer

[SOURCE: ISO/IEC 28360-1:2018(E), 3.15, modified — "EUT" replaced by "device"]



**3.3**
**emission test chamber**
**ETC**
test apparatus with controlled parameters (temperature, humidity, air exchange rate, etc.) for the determination of the chemical and the number of particles emitted from AM process



[SOURCE: ISO 16000-9:2006, 3.6, modified — Terminological entry is changed considering AM process]

**3.4**
**differential electrical mobility classifier**
**DEMC**
classifier that is able to select aerosol particles according to their electrical mobility and pass them to its exit

Note 1 to entry: A DEMC classifies aerosol particles by balancing the electrical force on each particle with its aerodynamic drag force in an electrical field. Classified particles are in a narrow range of electrical mobility determined by the operating conditions and physical dimensions of the DEMC, while they can have different sizes due to difference in the number of charges that they have.

[SOURCE: ISO 15900:2009, 2.7]

**3.5**
**differential mobility analysing system**
**DMAS**
system to measure the size distribution of submicrometre aerosol particles consisting of a DEMC, flow meters, a particle detector, interconnecting plumbing, a computer and suitable software

[SOURCE: ISO 15900:2009, 2.8]

**3.6**
**light scattering airborne particle counter**
**LSAPC**
instrument capable of counting and sizing single airborne particles and reporting size data in terms of equivalent optical diameter

Note 1 to entry: The specifications for the LSAPC are given in ISO 21501-4:2007.

[SOURCE: ISO 14644-1:2015, 3.5.1]

**3.7**
**accumulated particle number concentration**
**$C_p$**
time-dependent number concentration in a specified size range

**3.8**
**total particles**
number of total particles that is calculated as the test result from the measured accumulated particle number concentration based on the duration of particle emission

**3.9**
**particle emission rate**
**PER**
particles emitted from AM process per unit time (1/h) in a specified size range that is calculated from accumulated particle number concentration divided by the print time in h

[SOURCE: ISO/IEC 28360-1:2018, 3.19, modified]

**3.10**
**particle emission yield**
**$Y_{particle}$**
number of particles emitted per mass of extruded material during the build cycle

**3.11**
**chemical emission yield**
**$Y_{chemical}$**
mass of chemical emitted per mass of extruded material during the build cycle



**3.12**
**volatile organic compound**
**VOC**
organic compound that is emitted from the test specimen and all those detected in the chamber outlet air



Note 1 to entry: Due to practical reasons to be taken into account for test chambers, this definition differs from that defined in ISO 16000-6:2004. In ISO 16000-6, the definition is based on the boiling point range (50 °C to 100 °C) to (240 °C to 260 °C).

Note 2 to entry: The emission test method described in this part of ISO 16000 is optimum for the range of compounds specified by the definition of total volatile organic compounds (TVOC).

[SOURCE: ISO16000-9:2006, 3.15]

**3.13**
**chemical emission rate**
average mass of the analyte (total VOCs and individual aldehydes) emitted from the AM process per unit print time

**3.14**
**toluene response factor**
toluene equivalents used to quantify the unidentified substances detected with a flame ionization detector (GC-FID) or mass spectrometric detector (GC-MS)

**3.15**
**total volatile organic compounds**
sum of the concentrations of identified VOCs that elute between the retention times of n-hexane ($C_6$) and n-hexadecane ($C_{20}$) on a non-polar capillary GC column and the concentrations of the converted areas of unidentified peaks using the toluene response factor

[SOURCE: ISO 16000-9:2006, 3.14, modified — Terminological entry is expanded considering the analysis and calculation]

# 4 Abbreviated terms and symbols

## 4.1 Abbreviated terms

| | |
|---|---|
| ABS | Acrylonitrile Butadience Styrene |
| CPC | Condensation Particle Counter |
| DEMC | Differential Electrical Mobility Classifier |
| DMAS | Differential Mobility Analysing System |
| DNPH | Dinitrophenylhydrazine |
| ETC | Emission Test Chamber |
| FP | Fine Particles |
| GC/MS | Gas Chromatography/Mass Spectrometry |
| HPLC | High Performance Liquid Chromatography |
| LSAPC | Light Scattering Airborne Particle Counter |
| PER | Particle Emission Rate |
| PLA | Poly Lactic Acid |
| RH | Relative Humidity |
| RPD | Relative Percentage Difference |
| RSD | Relative Standard Deviation |
| TVOC | Total Volatile Organic Compounds |
| TP | Total Particles |
| UFP | Ultrafine Particles |
| VOC | Volatile Organic Compounds |
| $Y_{particle}$ | Particle Emission Yield |
| $Y_{chemical}$ | Chemical Emission Yield |



## 4.2 Symbols

| | |
|---|---|
| $\beta$ | particle loss-rate coefficient ($h^{-1}$) |