



**SLOVENSKI STANDARD**  
**oSIST prEN ISO/ASTM 52933:2023**  
**01-maj-2023**

---

**[Not translated]**

Additive manufacturing - Environment, health and safety - Test method for the hazardous substances emitted from material extrusion type 3D printers in the non-industrial places (ISO/ASTM/DIS 52933:2023)

Additive Fertigung - Umwelt, Gesundheit und Sicherheit - Prüfverfahren für die gefährlichen Stoffe, die von 3D-Druckern mit Materialeextrusion in nicht-industriellen Bereichen emittiert werden (ISO/ASTM/DIS 52933:2023)

Fabrication additive - Environnement, santé et sécurité - Méthode d'essai pour les substances dangereuses émises par les imprimantes 3D de type à extrusion de matière dans les lieux non industriels (ISO/ASTM/DIS 52933:2023)

**Ta slovenski standard je istoveten z: prEN ISO/ASTM 52933**

---

**ICS:**

13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres
13.100	Varnost pri delu. Industrijska higiena	Occupational safety. Industrial hygiene
25.030	3D-tiskanje	Additive manufacturing

**oSIST prEN ISO/ASTM 52933:2023**      **en,fr,de**



# DRAFT INTERNATIONAL STANDARD ISO/ASTM DIS 52933

ISO/TC 261

Secretariat: DIN

Voting begins on:  
2023-03-13

Voting terminates on:  
2023-06-05

---

---

## Additive manufacturing — Environment, health and safety — Test method for the hazardous substances emitted from material extrusion type 3D printers in the non-industrial places

ICS: 25.030; 13.040.30; 13.100

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[oSIST prEN ISO/ASTM 52933:2023](https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023)

<https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023>

This document is circulated as received from the committee secretariat.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

**ISO/CEN PARALLEL PROCESSING**



Reference number  
ISO/ASTM DIS 52933:2023(E)

© ISO/ASTM International 2023

# iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO/ASTM 52933:2023](https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023)

<https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023>



## **COPYRIGHT PROTECTED DOCUMENT**

© ISO/ASTM International 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester. In the United States, such requests should be sent to ASTM International.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11

Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

ASTM International  
100 Barr Harbor Drive, PO Box C700  
West Conshohocken, PA 19428-2959, USA  
Phone: +610 832 9634  
Fax: +610 832 9635  
Email: [khooper@astm.org](mailto:khooper@astm.org)  
Website: [www.astm.org](http://www.astm.org)

<b>Contents</b>		Page
<b>Foreword</b> .....		<b>iv</b>
<b>Introduction</b> .....		<b>v</b>
<b>1 Scope</b> .....		<b>1</b>
<b>2 Normative references</b> .....		<b>1</b>
<b>3 Terms and definitions</b> .....		<b>2</b>
<b>4 Hazardous substance targets and major factors</b> .....		<b>4</b>
<b>5 Relevant test standards</b> .....		<b>4</b>
5.1 General.....		4
5.2 Measuring target substances and overview.....		5
<b>6 Sampling conditions</b> .....		<b>5</b>
6.1 Sampling location.....		5
6.2 Sampling planning.....		6
<b>7 Measurement methods</b> .....		<b>7</b>
7.1 Short-term and long-term methods.....		7
7.1.1 Purpose.....		7
7.1.2 VOCs analysis.....		7
7.1.3 Aldehyde method.....		11
7.2 Continuous method.....		12
7.2.1 Purpose.....		12
7.2.2 Sampling.....		12
7.2.3 Determination of emission rate of particles.....		13
<b>8 Test report</b> .....		<b>14</b>
<b>Annex A (informative) Considerations for reducing the emission of hazardous substances</b> .....		<b>16</b>
<b>Annex B (informative) Checklist for reduction of hazardous substances</b> .....		<b>23</b>
<b>Bibliography</b> .....		<b>24</b>

## ISO/ASTM DIS 52933:2023(E)

### 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM Committee F42, *Additive Manufacturing Technologies*, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on Additive Manufacturing.

## Introduction

This document refers to the assessment of hazardous substances emitted during operation of material extrusion type 3D printers installed in schools or public places for educational and hands-on purposes, and basic countermeasures for reducing the substances.

This document provides the necessary information and test procedures to reflect the characteristics of the AM process based on the previous international standards related to indoor air quality and to assess hazardous substances in the non-industrial places.

Manufacturing personnel, supervisor, and manager who are working at the non-industrial places will be able to use this document to measure and diagnose air quality. This document also helps them to be able to try to reduce the hazardous substances emitted from the non-industrial places.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[oSIST prEN ISO/ASTM 52933:2023](https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023)

<https://standards.iteh.ai/catalog/standards/sist/ed22fed3-371d-450d-a620-aef7e3b34f74/osist-pren-iso-astm-52933-2023>





# Additive manufacturing — Environment, health and safety — Test method for the hazardous substances emitted from material extrusion type 3D printers in the non-industrial places

## 1 Scope

This document covers the test method for measuring hazardous substances emitted during the operation of material extrusion type 3D printer in the non-industrial places and considerations for reducing them.

This document:

- specifies main hazardous substances emitted from material extrusion type 3D printer during operation;
- describes the additional information and the associated test method for measuring hazardous substances, and;
- includes considerations for reducing the hazardous substances and basic countermeasures.

This document is to measure concentrations of hazardous substances generated in the non-industrial places (school, public place and so on) in which material extrusion type 3D printers are installed, and to maintain an acceptable work environment by managing field facilities, material extrusion type 3D printers, filaments, and additive manufactured products for the reduction of hazardous substances.

However, this document does not cover all gas-phase chemical emissions but are applicable to a range of VOCs from n-hexane to n-hexadecane, including aldehydes. Considerations for reducing chemical emissions and for improving the work environment are given in [Annex A](#) and [B](#).

## 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 16000-2, *Indoor air — Part 2: Sampling strategy for formaldehyde*

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

ISO 16000-4, *Indoor air — Part 4: Determination of formaldehyde — Diffusive sampling method*

ISO 16000-5, *Indoor air — Part 5: Sampling strategy for volatile organic compounds (VOCs)*

ISO 16000-6, *Indoor air — Part 6: Determination of organic compounds (VVOC, VOC, SVOC) in indoor and test chamber air by active sampling on sorbent tubes, thermal desorption and gas chromatography using MS or MS FID*

ISO 16000-8, *Indoor air — Part 8: Determination of local mean ages of air in buildings for characterizing ventilation conditions*

ISO 16017-1, *Indoor, ambient and workplace air — Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography — Part 1: Pumped sampling*

**ISO/ASTM DIS 52933:2023(E)**

ISO 16017-2, *Indoor, ambient and workplace air — Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography — Part 2: Diffusive sampling*

ISO 27628, *Workplace atmospheres — Ultrafine, nanoparticle and nano-structured aerosols - Inhalation exposure characterization and assessment*

ISO 28439, *Workplace atmospheres — Characterization of ultrafine aerosols/nanoaerosols — Determination of the size distribution and number concentration using differential electrical mobility analysing systems*

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

ISO/ASTM/CD 52932, *Additive manufacturing — Environment, health, and safety — Test method for determination of particle and chemical emission rates from desktop 3D printer material extrusion*

ISO/ASTM 16200-1, *Workplace air quality — Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography — Part 1:Pumped sampling method*

ISO/ASTM 16200-2, *Workplace air quality — Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography — Part 2:Diffusive sampling method*

**3 Terms and definitions**

For the purposes of this document, the terms and definitions from ISO/ASTM 52900 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**  
**additive manufacturing**  
**AM**

process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies

[SOURCE: ISO/ASTM 52900:2021, 3.1.2]

**3.2**  
**material extrusion**  
**MEX**

additive manufacturing process in which material is selectively dispensed through a nozzle or orifice

[SOURCE: ISO/ASTM 52900:2021, 3.2.3]

**3.3**  
**3D printer**

machine used for 3D printing

[SOURCE: ISO/ASTM 52900:2021, 3.1.1]

**3.4**  
**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: ISO 16000-9:2006, 3.15]

### 3.5

#### **aldehydes**

organic compounds containing formyl families

Note 1 to entry: Formaldehyde, acetaldehyde and vanillin are members of aldehyde families.

[SOURCE: ISO 21366:2019, 3.8]

### 3.6

#### **ultrafine particles**

##### **UFP**

particles with a particle diameter less or equal 0.1  $\mu\text{m}$

[SOURCE: ISO/IEC 28360-1:2018, 3.30]

### 3.7

#### **blank**

background concentration of the non-industrial place for individual substances, VOCs, aldehydes, and UFP

### 3.8

#### **background**

level of chemical substances and particles in the non-industrial place before the 3D printer is loaded into it for testing

### 3.9

#### **breakthrough volume**

volume of test atmosphere that can be passed through a sorbent tube before the concentration of eluting vapour reaches 5 % of the applied test concentration

Note 1 to entry: The breakthrough volume varies with the vapour and the sorbent type.

[SOURCE: ISO16017-1:2000, 3.1]

### 3.10

#### **background sorbent tube**

sorbent tube injected with reagents to collect gases released into the air during the AM process, but not used for gas collection at the non-industrial place

### 3.11

#### **short-term sampling**

short-period sampling method in which sampling for collecting chemical substances is performed within an hour

### 3.12

#### **long-term sampling**

long-period sampling method in which sampling for collecting chemical substances is performed for a few hours

### 3.13

#### **continuous sampling**

continuous sampling method in which measuring the total number concentration of aerosol particles is performed consecutively

## ISO/ASTM DIS 52933:2023(E)

### 4 Hazardous substance targets and major factors

VOCs, aldehydes, and UFP are currently identified as some of the potentially hazardous substances emitted during operation of material extrusion type 3D printers in schools and public places. The material extrusion type 3D printers which are currently used for AM process with filaments (ABS, Nylon, PC, etc.) can change the concentration of hazardous substances depending on the process and environment of the non-industrial places.

Since the following factors can increase the possibility of emission of hazardous substances, appropriate countermeasures are needed. See [Annex A](#) for information on considerations to reduce the emission concentrations of hazardous substances in the non-industrial place.

The factors are specified as follows:

- The possibility of emission of both UFP and chemical compounds increases during operation of a material extrusion type 3D printer for a long time without proper ventilation equipment;
- When the temperature of the non-industrial place is not constantly controlled during operation, the room temperature can increase continuously and thereby increase the possibility of higher concentration of VOCs and aldehydes due to 3D printer-related equipment and building materials in the non-industrial place;
- Emission concentration of UFP and chemical compounds (VOCs and Aldehydes) may vary depending on the operation conditions of material extrusion type 3D printers and kind of filaments used;
- The possibility of emission of chemical compounds increases when additive manufactured products are placed in open areas of the educational room.

### 5 Relevant test standards

#### 5.1 General

[Table 1](#) provides a list of some hazardous substances that could be emitted in case of using material extrusion type 3D printers and filaments, and the recommended sampling strategy and test methods for the analysis of hazardous substances that could be released during machine operation.

The standards below are the test methods for evaluating hazardous substances in the workplace and indoor environment. [Table 1](#) provides both a sampling and the relevant analysis method. However, there is no test method to measure VOCs, aldehydes, and UFP simultaneously and consecutively for an extended period, especially during the additive manufacturing process. Therefore, the non-industrial places where material extrusion type 3D printers are in operation require an integrated analysis method to evaluate three different substances of [Table 1](#) at the same time because each emission could vary depending on the duration of machine operation, type of filaments, temperature, and humidity of the place, etc.

This document, which includes the sampling method and strategy, is classified into three different methods depending on the hazardous substances.

**Table 1 — Relevant test standards for some hazardous substances**

Requirements	VOCs	Aldehydes	UFPs
Sampling method	ISO 16200-1	ISO 16000-2	ISO 28439 ISO 27628
	ISO 16000-5	ISO 16000-3	
	ISO 16000-6	ISO 16000-4	
	ISO 16017-2	ISO 16200-2	
	ISO 16017-1		